FINAL REPORT

Independent Management and Financial Review

Yucca Mountain Project, Nevada

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INTRODUCTION

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SECTION ONE INTRODUCTION

Peterson Consulting Limited Partnership in conjunction with John Reiss, Jr. & Associates, Inc. (the Review Team) has completed its review and prepared this final report of the Independent Management and Financial Review (Review) of the Yucca Mountain Project. The Review was conducted pursuant to the provisions of a contract with the National Association of Regulatory Utility Commissioners (NARUC). The NARUC contract contained a specific work statement in the form of questions to be addressed, and provided a not-to-exceed dollar budget and time frame for completion of the work. A copy of the work statement is included in the Appendix to this Final Report.

The Yucca Mountain Project is one part of the Department of Energy's Office of Civilian Radioactive Waste Management Program (the Program) which was established by the Nuclear Waste Policy Act of 1982, and as amended in 1987. The Program's goal is to site the nation's first geologic repository for the permanent disposal of high-level nuclear waste, in the form of spent fuel rod assemblies, generated by the nuclear power industry and a smaller quantity of Government radioactive waste. The Program, which also encompasses the transportation system and the multipurpose canister system was not the subject of this Review. The subject of this Review was only the Yucca Mountain Project in Nevada. While the Review was directed toward the Yucca Mountain Project rather than the Program as a whole, there are certain elements of the Project which cannot be addressed except through discussion of some Program issues. An example is the Total System Life Cycle Cost addressed in Section VII of this report. Where Program issues are discussed in this Report, the reader is reminded of the scope limitations of the NARUC contract to review only the Yucca Mountain Project.

The Yucca Mountain Project has been the subject of substantial criticism from a broad spectrum of parties including the Congress, various federal government organizations, the State of Nevada, industry groups, utilities, and the concerned public. Most of the criticism was publicized in fragments, and much of it was narrowly focused as to subject matter. Consequently, the need was expressed for an independent review, the results of which are presented in this Final Report.

This Independent Management and Financial Review was performed pursuant to a cooperative agreement wherein the Secretary of Energy and the Governor of Nevada each named a representative to a Special Review Panel to coordinate the work with the selected contractor. NARUC accepted the responsibility to manage the solicitation process and administer the contract. The Secretary of the Department of Energy named Mr. Alex Radin, President of

Radin & Associates of Washington, DC, as the Department's representative. The Governor of Nevada named Commissioner Judith M. Sheldrew of the Nevada Public Service Commission as the State's representative. Mr. Radin and Commissioner Sheldrew jointly defined the work statement which became part of the NARUC contract with the Review Team. The Review was funded by the Department of Energy through NARUC.

The scope of work in the contract with NARUC was to perform an Independent Management and Financial Review, as opposed to an audit, of the Yucca Mountain Project. The American Institute of Certified Public Accountants (the Institute) defines an audit as the process of gathering evidence through search and verification procedures to provide a reasonable level of assurance that the subject of the audit is free of material error and fraud. Audits typically involve confirmation and verification using outside sources who are more objective than those subject to the audit. The Institute defines a review as the process of performing inquiry and analytical procedures to provide a reasonable basis for expressing limited assurance that no material modifications are required of the review subject. The significance of this distinction goes to the degree of evidentiary material required to justify the examiner's findings and conclusions. In the context of the NARUC contract, the Review Team conducted a Review. While the Team conducted interviews with and reviewed documentation from sources outside the Department of Energy, no written verifications were required from those sources nor was the accuracy of information or data independently confirmed by the Review Team. Documentation and interviews provided the major evidentiary support for the Review Team's findings and conclusions. However, the extensive individual and collective experience of the Team members also significantly contributed to the findings and conclusions reached.

Review procedures involved inquiry (both documentation review and interview/discussions) and application of analytical procedures. They included, but were not limited to:

- Review of documentation (which included 860 documents totalling over 76,000 pages),
- Formal interviews with various government and contractor personnel,
- Formal interviews with Stakeholders (a total of 114 persons were formally interviewed by the Review Team),
- Discussions between and among the Review Team members concerning the members' individual and collective business and project experience,
- Discussions with the Special Review Panel,

- Informal discussions (following formal meetings) with various Program/Project personnel and Stakeholders,
- Information obtained from public hearings conducted on June 8, 1995, in Washington, DC, and on June 15, 1995, in Las Vegas, Nevada, and
- Written information received by NARUC not later than June 23, 1995, submitted by Stakeholders and others following the public hearings. (A listing of responses is included in the Appendix to this Final Report.)

The primary scope of the Review was to respond to the specific criteria contained in the NARUC scope of work. In responding to these criteria, the Review Team understood that some interested parties have expressed concern over the requirements of the Nuclear Waste Policy Act relative to the Yucca Mountain Project and the nature of activities currently being carried out by the Department of Energy at the Yucca Mountain Project site. The Review Team has attempted to analyze relevant portions of the Nuclear Waste Policy Act as Amended, but has not conducted a thorough analysis of this legislation that could lead to any specific legal conclusions about all aspects of it.

Although the Review Team is confident in its analysis based upon the information obtained and provided to the Team, there were limitations on the Review Team which could affect the results presented in this Report. These limitations included the restricted time period and limited budget provided to perform the Review. Notwithstanding the Review Team's efforts to avoid it, these limitations might have affected the completeness and comprehensiveness of the analysis of the information reviewed. In addition, these limitations might have affected the thoroughness of the identification of data sources which led to some of the conclusions in the Report.

The Review Team discussed these limitations with members of the Special Review Panel prior to the commencement of its work on this project, and has kept them informed of approach and progress matters throughout the life of the Review.

This Report is issued for use by the Special Review Panel in response to the specific requirements of the Independent Management and Financial Review criteria contained in the NARUC contract. The information and conclusions contained in this Report should not be relied upon by any party for any other purpose.

INSERT ACRONYM LIST HERE

ACRONYMS USED IN THIS REPORT

ACRONYM	DESCRIPTION
AUG	Affected Units of Government
CRWMS	Civilian Radioactive Waste Management System
DOE	Department of Energy
DPR	Director's Program Review
EG&G	
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESAAB	Energy System Acquisition Advisory Board
ESF	Exploratory Studies Facility
F&S	Fenix and Scisson, Inc.
FTE	Full time equivalent
FY	Fiscal Year
GAO	General Accounting Office
IRB	Internal Budget Request
IRM	Information Resources Management
ITE	Integrated Test Evaluation
Kiewit	Kiewit/Parson-Brinkerhoff
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LSS	Licensing Support System
M&O	Management and Operating Contractor
MOU	Memorandum of Understanding
MPC	Multi-purpose Canister/Multi-purpose Cask
MPR	Manager's Project Review (Meeting)
MRS	Monitored Retrievable Storage Facility
NARUC	National Association of Regulatory Utility Commissioners
NAS	National Academy of Sciences (Washington, DC)
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act

ACRONYMS USED IN THIS REPORT

ACRONYM	DESCRIPTION
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
NWF	Nuclear Waste Fund
NWPA	Nuclear Waste Policy Act
NWTRB	Nuclear Waste Technical Review Board
OCRWM	Office of Civilian Radioactive Waste Management
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
OWAST	Office of Waste Acceptance, Storage, and Transportation
PACS	Planning and Control System
PEP	Performance Evaluation Plan
PMO	Project Management Organization
Program Plan	Civilian Radioactive Waste Management Program Plan
REEC _o	Reynolds Electrical and Engineering Company, Inc.
RSN	Raytheon Services Nevada
SAIC	Science Applications International Corporation
SCP	Site Characterization Plan
TSLCC	Total System Life Cycle Cost
T&MSS	Technical and Management Support Services (SAIC)
TBM	Tunnel Boring Machine
TIP	Technical Implementation Plan
TRB	Technical Review Board (see NWTRB)
TRW	M&O Prime Contractor (Thompson, Ramo, Woolridge)
TSL	Topopah Spring Level (of the ESF)
USGS	United States Geological Survey (Department of Interior)
WBS	Work Breakdown Structure
YMP	Yucca Mountain Project
YMSCO	Yucca Mountain Site Characterization Office
YMSCP	Yucca Mountain Site Characterization Project

SECTION TWO
EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY**

This section presents a summary of the primary findings of the Review team.

The Program being undertaken by the Department of Energy's Office of Civilian Radioactive Waste Management (Program) and the Yucca Mountain Site Characterization Project (Project) is extremely complex in terms of science and has been made more complex by changing strategies, politics, and statutory and regulatory compliance requirements. While it is in the national interest to find a final solution to high-level nuclear waste disposal, the urgency and methodology to be utilized is the subject of a wide diversity of opinion. This has presented a substantial set of challenges to those charged with the responsibility of carrying out the objectives of the Program and the Project. This is manifestly true in 1995 with the variety of proposed legislative actions pending, all of which would change the strategy and direction of the Yucca Mountain Project.

Since the passage of the Nuclear Waste Policy Act in 1982 (Act), and specifically since the Act was amended in 1987, the plan for accomplishing the objectives of the Program/Project has undergone significant changes. The current concept, known as the Program Approach, represents the Department of Energy's initiative to provide a more responsive procedure for achieving the scientific bases necessary while providing a streamlined approach to determine site suitability for license application and performance assessment. Implementation of this Program Approach is less than one year old and observers, including the Department of Energy (and the Review Team), have had only limited opportunity to observe its progress. Based on this observation by the Review Team, some important concerns remain which are addressed in detail in this report and are highlighted in this Executive Summary. These concerns have been widely expressed by many of the persons interviewed by the Review Team and include the acceptance or rejection of the Program Approach by the Nuclear Regulatory Commission and the National Academy of Sciences, and the potential of deletion of some scientific investigations. The DOE points out, however, that the prioritization of scientific study under the Program Approach could save substantial unnecessary expenditures if an early disqualifying site condition is discovered. Furthermore, the Program Approach appears to be a positive improvement over previous attempts to achieve Program/Project objectives by providing a more focused priority to specific scientific endeavors. Time will determine if this initiative can

be implemented successfully as well as address all stated issues within the Act. (As explained in Section Three of this report, the Review Team's opinions regarding the Program Approach are in the context of its utility to management and financial issues and are not to be construed as an endorsement of policy issues.)

The scope of the review was explicitly presented in the work statement contained in the National Association of Regulatory Utility Commissioners contract and was consistently followed in the structure of Sections Four through Seven of this report. To highlight the findings presented in those sections, this Executive Summary has been organized along the lines of some common themes regarding management and financial issues which became evident during the Review.

These common themes may be expressed in the following six questions:

- What is the likelihood of the Project meeting its current schedule?
- What will be the cost of the Project?
- Will funding be adequate?
- Are there adequate contingency plans?
- Are funds being spent prudently?
- Is the Project being administered properly?

The observations and findings developed during the Review disclosed several symptoms of major problems which specifically related to the common themes described above. In the following paragraphs, the answers to these common themes are summarized based upon the findings resulting from the Review. Each of the issues presented is more fully developed within the body of the report. Following the observations and findings, options for consideration presented by the Review Team are detailed for the reader.

OBSERVATIONS AND FINDINGS OF THE REVIEW TEAM**What is the Likelihood of the Project Meeting Its Current Schedule?**

The opinion of the Review Team is that the Project has little chance of meeting its currently-established major schedule milestones. The basis of this opinion is founded on several categories of unaddressed risks which include an incomplete work scope definition, annual funding level uncertainties, an unresolved thermal loading issue, the extent of fracturing and faulting, the movement of water through the unsaturated zone; and processes which include the Final Environmental Impact Statement, the National Academy of Science acceptance of the eight Technical Basis Reports, the U.S. Environmental Protection Agency's Dose-based Standards, and Nuclear Regulatory Commission procedure, all of which are not yet well defined. (Section Six, pp. 12-30)

The current schedule contains very little float, which constrains the Project's flexibility and ability to recover from schedule impacts and, therefore, limits alternative application of Project resources. ("Float" is a term used in Critical Path Method (CPM) network scheduling and describes the degree of flexibility in selecting start and completion dates for a work activity. Float is the time frame an activity can remain unperformed without impacting overall schedule performance. For example, a work activity having 30 days of "float" can be started up to 30 days late without impacting the overall scheduled completion objectives.) (Section Six, pp. 12-30)

The scheduling process used on the Project is almost entirely "top-down," meaning developed from a conceptual level as opposed to a "bottom-up" method, which would develop the details necessary to calculate given milestone dates. This approach, in practice, results in an aggressively-prepared "milestone-driven" Project schedule. While the resulting schedule may be attainable, it is not likely to be achieved without continuously vigorous management attention to each critical work activity. This "top-down" approach was initiated in 1994 during the preparation of the Program Approach in an attempt to achieve high-level schedule milestones within certain cost parameters. A "rebaselining" effort is currently in progress. Rebaselining is the periodic scientific scope definition changes that result in adjustments to cost budgets and Project schedules. Rebaselining will validate the "top-down" Project schedule, but without "bottom-up" input from managers and assistant managers directly

involved in carrying out the work activities, the ultimate schedule performance of those work activities is speculative. (Section Six, pp. 10-21)

The Project schedule could be affected by the ultimate nonacceptance of the Program Approach philosophy by the Nuclear Regulatory Commission (for licensing activities) or the National Academy of Sciences (for peer review of Technical Basis Reports). While individuals within these organizations are most likely aware of the scientific philosophy embodied in the Program Approach, the philosophy has not been formally accepted. (Section Six, pp. 9-10)

The Review Team is concerned that the Program Approach, in an attempt to meet the 1998 technical site suitability evaluation milestone, will result in a de facto schedule-driven project. Furthermore, an aggressive schedule coupled with reduced funding levels may encourage risk-taking to eliminate or inappropriately postpone the necessary level of scientific evaluation. (Section Six, pp. 23-28)

Enhanced funding, beyond the current (fiscal year 1995) level, may not cost-effectively accelerate the Project schedule, but could reduce the risk of schedule delays by providing (managed) funding to focus on high-(schedule)-risk activities. In the opinion of the Review Team, a potential high-(schedule)-risk activity that has not been emphasized to date by the Department of Energy is the issue of transportation. Due to many potential obstacles and the lack of an intensive review, the transportation issue could be a major Achilles heel to the Program/Project and its related cost and schedule objectives. (Section Six, pp. 18-21, pp. 24-30)

What Will be the Cost of the Project?

The cost of the Project is ever-increasing and the adequacy of the Nuclear Waste Fund is not consistently evaluated as required by law. The Nuclear Waste Policy Act requires an annual evaluation of the adequacy of the Nuclear Waste Fund. One major component of the Nuclear Waste Fund is the Total System Life Cycle Cost. Except for the 1995 calculations (which are as yet unpublished to Congress), the last formal Total System Life Cycle Cost as determined by the Department was in 1990. Other informal and unpublished calculations have been made during the years subsequent to 1990, but the absence of formal calculations and examination of the adequacy

of the Fund are clearly in violation of the Nuclear Waste Policy Act. (Section Seven, pp. 35-38, p. 53)

The Review Team's calculation of the Total System Life Cycle Costs disclosed \$35.5 billion (in 1995 dollars) for a single repository. This is comparable to the Department's 1995 calculation of \$34.6 billion (in 1994 dollars). The 1990 calculation by the Department resulted in \$25.6 billion (in 1989 dollars) for a single repository, however, different assumptions were incorporated in the calculation. For a two-repository scenario, the Review Team's calculation produced a \$46.9 billion cost. The Department has not performed a two-repository calculation in its 1995 Total System Life Cycle Cost. The Department's 1990 calculation for a two repository scenario was \$33.6 billion (in 1988 dollars) under different assumptions. The Review Team's calculation for 1995 is generally based on the assumptions set forth by the Department. Both the Review Team and the Department's calculation for 1995 assume that no new nuclear generating plants will be built, thereby stabilizing estimates of quantities of waste, and that the first repository will accept radioactive wastes in the year 2010. For the two-repository case it was assumed that the second repository would be made available to accept waste when needed. (Section Seven, pp. 39-43)

As presented in other sections of this report, the scheduled repository waste acceptance date during the year 2010 is at risk and, in the opinion of the Review Team, is likely to be delayed. For this reason, the Review Team also calculated Total System Life Cycle Costs for two scenario variations: a three-year delay to repository waste acceptance (to 2013), and a five-year delay (to 2015). For the three-year delay scenario, the Total System Life Cycle Costs were calculated to be \$37.4 billion for the one-repository case, and \$48.8 billion for the two-repository case. For the five-year delay scenario, these costs become \$38.6 billion for the one-repository case, and \$50.1 billion for the two-repository case. The Review Team made no calculations for waste acceptance occurring earlier than the year 2010, since this event was considered unlikely. (Section Seven, pp. 43-44)

Because of the many factors, events and resulting variables, the Total System Life Cycle Costs Analysis by its nature represents an educated guesstimate. Nevertheless, when performed in a comprehensive mode, it incorporates the most current information available, provides involved and affected parties with an indication of the change in total cost over time and, for Fee Adequacy Analysis, it consequently assesses the potential resulting impacts on the Nuclear Waste Fund. As

such, the analysis should be performed and published annually and utilized with other analyses as an annual budgeting and long-term financing tool. (Section Seven, pp. 35-38, p. 53)

Will Funding Be Adequate?

Under any reasonable combination of cost and funding scenarios, the Nuclear Waste Fund is inadequate. Summary calculations supporting this finding are presented in Table I. The Nuclear Waste Fund shortfall is the difference between the fees coming into the fund, including interest, offset by the Total System Life Cycle Cost over the life of the Program/Project. In order to avoid a potential long-term financial crisis, the Department of Energy must confront, address, and resolve the cost/funding issue with great attention and vigor. Serious consideration should be given to various options proposed by many parties, including the General Accounting Office, the Planning Information Corporation (a consultant to Nye County, Nevada), and other organizations, agencies, and Stakeholders. The ability to reduce costs over time and/or receive deferred one-time fee payments from utilities may reduce the shortfall. However, at this time, those options do not seem viable. (Section Seven, pp. 47-53)

Table I
Review Team's Analysis of
Projected End-of-Program Nuclear Waste Fund Balance, Civilian Portion
with Ongoing Fee Constant at 1.0 mill/Kwh
(Billions of 1995 Dollars)

Single Repository	
Cost Variation	Less Optimistic Case
Base Case	-3
3-Year slip	-4
5-Year Slip	-5
Two Repository	
Cost Variation	Less Optimistic Case
Base Case	-12
3 -Year Slip	-13
5-Year Slip	-14

Due to budgetary constraints, competition among Department of Energy Programs (e.g., Environmental Restoration and Waste Management within the weapons complex), competition among specific waste management Program elements, a year-to-year funding shortfall also exists in the Program/Project. Depending on one's viewpoint, the funding shortfall created by differences in budget requests and approved baselines, as well as planned and actual funding levels, may or may not have had significant implications on the Program/Project. Despite its impact and the reasons behind the shortfall, the fact of the matter is that a difference exists and the Department of Energy must deal with ways to minimize this difference in the future. By reducing and/or eliminating inconsistencies among funding, as well as among legislative requirements and objectives, the Department of Energy's new Program Approach is an attempt to create a strong, successful Program/Project. As identified earlier, the Program Director through this new approach has managed to establish a funding trend that is positive and may reduce some of the short-term shortfalls. With continued foresight, initiative, and effective leadership on the part of the Program Director, vigorous

implementation of the Program Approach, and consistent funding; the Program/Project may be able to achieve its stated objectives. Without these elements, the Program/Project will continue to experience a lackluster performance. (Section Seven, pp. 2-26)

As stated previously in this Executive Summary Project scheduling, and enhanced funding, beyond the current (fiscal year 1995) level, may not provide a means to cost-effectively accelerate the Project schedule, but could assist to reduce the risk of schedule slippage. (Section Six, pp. 18-21, pp. 24-30, and Section Seven, pp. 31-32)

Given the history of funding shortfalls in this Program, the concept of a revolving fund appears to be a potential option for ensuring the appropriation of time-driven levels of funding. However, given the perception that the Department of Energy has not historically spent funds effectively and efficiently, a revolving fund could eliminate many if not all of the controls of Congress, without necessarily replacing them by controls exercised by another body having comparable responsibilities. A revolving fund clearly has both advantages and disadvantages that must be given serious consideration before a reasonable and well-informed decision can be made. (Section Seven, pp. 27-34)

Given the latest discussions in Congress regarding funding levels, as well as the risks associated with the Program Approach from a legislative standpoint, the future of the Program/Project remains uncertain.

Are There Adequate Contingency Plans?

Insufficient emphasis has been placed on contingency planning. Although the Program Approach alludes to a contingency planning function, the Review Team was unable to identify any real evidence of its existence. This is unfortunate in that contingency planning provides a function which has at its core the concept of identifying potentially significant problem scenarios which could prevent achievement of Project performance as to cost, schedule, or quality. "What-if" scenarios should be developed with appropriate preplanned responses should such scenarios actually materialize. Any major complex Project, such as Yucca

Mountain, that does not provide for contingency planning strategies will, most likely, suffer dire consequences if and when unanticipated events occur. (Section Six, pp. 30-36)

As stated in the Project scheduling portion of this Executive Summary, the Project's ability to achieve its scheduled milestones is currently, in the opinion of the Review Team, subject to great risk. This issue should become the focal point of contingency planning. (Section Six, pp. 30-36)

Potential Site unsuitability should be a major topic of high-level contingency planning. The provisions of the Nuclear Waste Policy Act as amended is very clear on this point: should a fatal flaw be found, work at Yucca Mountain must stop, and the Secretary must notify the Congress that new legislation will be required to provide for high-level radioactive waste disposal. In the opinion of the Review Team, specific contingency planning for this event has not been performed. The development of detailed procedures to cost-effectively demobilize site activities is an element of contingency planning which can be performed now. The Act, however, does allow for studies leading to an enhanced Engineered Barrier System (EBS) to augment the natural barriers. An enhanced EBS which is economically viable or technically effective represents an example of appropriate contingency planning. (Section Six, pp. 30-45)

Are Funds Being Spent Prudently?

Funds spent are consistent with the currently-defined Project objectives, but the prudence of those expenditures are yet to be determined. As mentioned previously in this Executive Summary, it is likely that the Nuclear Waste Fund will not be sufficient to pay for the Total System Life Cycle Cost of the funds. Given this potential shortage of funds, prudence in Program/Project expenditures is crucial. For the Department of Energy to be prudent in its expenditures, it must exercise sound financial management and fiscal control. This requires well thought-out goals, objectives and priorities that are effectively communicated and readily accepted. Once the Project strategy and priorities have been established, the Project must be organized and managed in a way to ensure that the strategy and priorities are accomplished. Once priorities have been established and the organizational structure is in place, the available

resources should be allocated to maximize the scientific and technical work to carry out the stated Project objectives. (Section Five, pp. 53-58)

Resources are allocated by the Department of Energy to objectives and their related activities through the annual planning and budgeting process. There appears to be a void between planning, the budget guidance provided, and the planning and budget estimates developed by the Yucca Mountain Assistant Managers and the Participants (Management and Operating Contractor and its contractors, National Labs and the USGS). Early in the planning and budgeting process, Assistant Managers were aware that the most likely funding scenario for fiscal year 1995 was \$381 million. Yet, in spite of this knowledge, the total "top-down" estimates approached \$500 million and participant's estimates approached \$600 million. These estimates were significantly higher than the estimate of \$381 million and the ultimate budget of \$375 million. (Section Five, pp. 53-58)

This disconnect in the planning and budgeting process appears to be caused, at least in part, by the "bottom-up" and "top-down" planning/budgeting process. While this approach has many strengths, these strengths can be negated by the inefficiencies and unproductive work effort required to reconcile the respective differences and negotiate a final budget which is in line with realistic funding expectations. Better planning and communication in terms of what the priorities are and what can realistically be achieved with available funding would improve this process while still ensuring that funds for scientific and technical activities are maximized to the fullest extent possible. (Section Five, pp. 53-58)

The result of the fiscal year 1995 planning and budgeting process is that funds were prioritized as follows:

Site Suitability	\$230,324,000
License Application	15,970,000
NEPA Process	28,718,000
Management and Compliance	<u>100,258,000</u>
Total for Yucca Mountain	<u>\$375,270,000</u>

As the above table indicates, the majority of funds for Yucca Mountain in fiscal year 1995 were allocated to activities related to the primary Project objective of site suitability determination; however, almost one-third of the expected expenditures were for management and compliance which is largely infrastructure. This relationship is consistent with historical spending at Yucca Mountain. The Yucca Mountain portion of Nuclear Waste Fund expenditures have increased steadily from a low of 58 percent in 1992 to a high of 75 percent in the six months ended March 31, 1995. Given the magnitude of management and compliance expenditures, there are most likely unnecessary or nonvalue-added activities that can be eliminated. (Section Five, pp. 53-58, pp. 70-78)

The Department of Energy has initiated a cost reduction effort; however, this initiative lacks the vigor and commitment to be truly effective. As mentioned previously in this Executive Summary, Program costs are planned which substantially exceed the revenue estimates in the Nuclear Waste Fund. If the Project is to be completed within reasonable cost budget estimates, and scarce funds spent prudently, the Department of Energy must find areas for substantial cost reductions. The Department of Energy has failed to adequately identify and quantify the major cost drivers of the Project. Such a study is essential for identifying appropriate cost reduction targets. (Section Five, pp. 58-65, pp. 70-78)

The Department of Energy has estimated site characterization cost savings of \$1.3 billion as a result of changing from the previous strategy (completing all of the Site Characterization Plan prior to the technical site suitability determination) to the Program Approach. However, the Department also acknowledged that the scope of the original Site Characterization Plan has not been reduced under the Program Approach but has instead deferred these costs. Work scope and the related costs have been deferred from site characterization to the licensing and performance confirmation periods of the Project. Cost savings will only be achieved if the site is determined to be unsuitable and licensing and performance confirmation tasks do not occur. (Section Five, pp. 58-65)

The Department of Energy has focused insufficient management effort on certain aspects of the Project. From a control and monitoring standpoint, certain activities are incorporated within larger budget items and, therefore, are obscure from individual item oversight. In

addition, the Department of Energy has failed to establish target goals or objectives for reducing infrastructure costs and bringing such costs into a more reasonable relationship with scientific/technical costs. Recognizing that this Project is a unique undertaking and that little comparative financial data exists to benchmark the performance; the Review Team suggests that the Department of Energy should be more diligent in establishing a well-defined optimal relationship of infrastructure costs to scientific/technical costs. A more thorough in-depth analysis of functions and their interrelationships is required. (Section Five, pp. 65-78)

In summary, the Department of Energy's attempts at prudence and sound financial management have been largely unsuccessful due to a number of factors. These factors relate to unrealistic planning and budgeting, excessive infrastructure costs, and a general lack of cost effectiveness which can be traced, in part, to the Department of Energy's failure to establish cost objectives and identify major cost drivers of the Project.

Is the Project Being Administered Properly?

Project administration and organizational structure has improved but remains seriously lacking in several areas. Overall, the Project appears to have identified and gathered adequate scientific and technical personnel resources, but Project personnel have not demonstrated proficient management abilities. This results in organizational structure and management impacts to the Project. The Project continues to suffer residual impacts from the introduction of the Management and Operating contractor, the most significant being ambiguity of reporting relationships among the Department of Energy, the Management and Operating contractor, the Project Management Organization and the Project participants. The Project's matrix organizational structure, though complex, could provide for the allocation of the vast array of diverse resources to achieve Project objectives, provided managers clearly and frequently communicate priorities and responsibilities to all participants. To date, the Project has not been completely successful in doing this. The Review Team believes the recent consolidation of reporting relationships under the Management and Operating contractor will be a positive move with respect to clarifying roles and reporting relationships, reducing the potential for duplicated activities, and effectuating improved Project integration. Until the reporting

relationships are clarified and the interface between the two organizations is better defined, Project management will suffer. (Section Four, pp. 1-8, pp. 22-37) (Section Six pp. 19-22)

Several key organizational elements require attention. The Review Team believes that the position of Chief Scientist could improve scientific coordination, but the position as currently envisioned by the Department of Energy lacks the independence that many believe is required to insure that all the necessary science is done. The Review Team is of a strong opinion that there is a need for long-term management continuity in the position of Program Director. In addition, a tunneling expert on the Department of Energy or Management and Operating Contractor staff would greatly enhance the Department of Energy's ability to effectively assess and manage the tunneling contractor. (Section Four, pp. 19-22)

Decisional processes could be improved. Based on an analysis of historical decisions, including those related to the purchase of the LM300 drilling rig and the tunnel boring machine, there has been inadequate evaluation of the financial and operational alternatives. Overall, the decision-making process does not effectively utilize outside advice and external expertise. In addition, as to the lower-level issues, Program and Project management has been reluctant to delegate decisional authority and accountability to lower levels, and as a result, there may be an increased risk of poor decisions because decision makers may be too far removed from important information. Finally, unrealistic pressures to always make the "right" decision have led to reluctance by managers to assume decisional responsibility and has led to organizational indecision and decisional inefficiencies. (Section Four, pp. 47-59)

While acknowledging the difficulty in involving the array of perspectives and opinions of Stakeholders, the Review Team is generally of the opinion that Stakeholder relations are inadequate. The Department of Energy has not defined a clear operational relationship with Stakeholders, nor has it accepted the fundamental premise advanced by the Public Trust and Confidence Report that public acceptance is a requisite for long-term success of the Project. As a result, there is no comprehensive Stakeholder plan, current Stakeholder interactions lack structure and direction, and Stakeholders are dissatisfied. (Section Four, pp. 58-71)

Project management and administration was also addressed in this report as it pertains to change control and contract management and controls. Change control involves the criteria utilized by the Department of Energy in changing the scope of the original Site Characterization Plan in developing the Program Approach and the process utilized by the Department of Energy to review and approve scope changes. The Department of Energy has recently adopted the Program Approach as its new strategy for the Project. The Program Approach establishes strategic objectives and priorities and a phased approach for accomplishing those objectives and priorities. The Department of Energy's short-term annual planning is consistent with the long-term objectives of the Program Approach. (Section Five, pp. 1-20)

The change control process within the Department of Energy does appear to provide a thorough review of scope changes for scientific and technical impacts as well as cost and schedule impacts. Scientific and technical impacts are analyzed thoroughly before a change is approved to ensure that the scientific and technical integrity of the Project is not compromised. (Section Five, pp. 1-20)

Significant questions remain unanswered, however, regarding the technical scope of the Program Approach and how it differs from the Site Characterization Plan. Among those unanswered questions are: (1) Is there consensus among key parties as to the scope changes from the Site Characterization Plan to the Program Approach? (2) What is the longer term impact of such changes? For the Program Approach to succeed and gain credibility and acceptance, the Department of Energy must take steps to address the many questions and concerns that exist regarding the Program Approach. To not do so, could result in increased risk that the site could be rejected by the Nuclear Regulatory Commission during license application, increased risk of opposition and intervention by opponents of the Project and concerned stakeholders, and increased risk of cost impacts and schedule delays. (Section Five, pp. 1-20)

In regard to contract management, the type of contract establishes the foundation for contract management and controls as it defines the extent to which performance and/or scope-related risk is assumed by the contractor or by the Department of Energy. The type of contract also

defines the manner in which the contractor will be compensated for its work and the responsibilities of both parties. The primary method of contracting at Yucca Mountain, cost-reimbursable contracts, provides little incentive for contractors to excel and minimizes the ability of the Department of Energy to properly manage and control its contractors. (Section Five, pp. 20-53)

The Review Team is of the opinion that some of the contracted work at Yucca Mountain, specifically the tunnel/alcove excavation and surface drilling, can be incentivized by utilization of unit-price contracting to reduce time and cost. Unit-price contracts for geoscientific investigations have been commonly utilized by the U.S. Army Corps of Engineers for many years. In addition to unit-price contracting, the Review Team is of the opinion that the management and operating contract for the Program can be converted to a performance-based contract. Performance-based contracts were recommended as an alternative to cost-reimbursable management and operating contracts by the Department of Energy Contract Reform Team in February 1994. (Section Five, pp. 20-53)

The Department of Energy utilizes an interrelated system of guidelines, performance reporting and analysis, meetings and performance evaluation plans to monitor and manage performance of contractors within the Program and the Project. The performance monitoring and management system at Yucca Mountain appears to be somewhat effective in controlling contractors, however, management control weaknesses exist in the subjectivity in the process of assigning numerical ratings during performance evaluation and the performance criteria do not effectively address cost-effectiveness and reasonableness in planning and budgeting. (Section Five, pp. 20-53)

OPTIONS FOR CONSIDERATION

During the course of its review, the Review Team identified, albeit at summary levels, options for consideration for Program/Project improvements regarding management and financial issues addressed in this report. These options must be viewed in the context of the detailed analyses presented in Sections Four through Seven of the report which are as follows:

- Organizational Effectiveness
- Financial and Contract Management
- Schedules and Credibility of Milestones
- Funding Levels and Funding Priorities

Organizational Effectiveness

Options for consideration identified regarding Organizational Effectiveness are presented in Section Four. Categories of analysis in that section include the following:

- Organizational Structure
- Contractor Relations
- Integration
- Decisional Processes
- Stakeholder Relations

Organizational Structure. The Review Team offers the following options for consideration relative to Organizational Structure:

- Yucca Mountain Site Characterization Project should develop a separate site-specific strategic plan that is fully compatible with the Office of Civilian Radioactive Waste Management Strategic Plan. Once written, the Yucca Mountain Site Characterization Project Strategic Plan should be widely disseminated to all Yucca Mountain Site Characterization Project employees, including all Management and Operating Contractor and Project participant personnel, in order to focus Project initiatives, reinforce Project identity and objectives, and foster teamwork among site participants.
- The Department of Energy must refrain from becoming over-involved in the day-to-day management of the Project by empowering and supporting the Management and Operating Contractor. Decisional authority should be pushed downward to the appropriate level of the Management and Operating Contractor structure, and consistently supported by Department of Energy managers so as not to undermine Management and Operating Contractor authority with Project participants.

- The strategic planning functions currently supported by the PMO should be the sole responsibility of permanent federal employees, while the integration and management reporting functions of the PMO should be given to the Management and Operating Contractor.
- The current Management and Operating Contractor organization should be carefully reviewed for possible streamlining of internal operations and reductions in midlevel management.
- The position (and staff) of the Chief Scientist should be filled, however there are certain issues that must be addressed: (1) the Chief Scientist should be a long-term position, insulated from changes in administration or Office of Civilian Radioactive Waste Management Director; (2) there should be consensus among Yucca Mountain Site Characterization Office managers, particularly the six Assistant Managers, that they will cooperatively support the position; and (3) the Chief Scientist's responsibilities should include technical interaction with external parties, including the NWTRB, the NRC, the EPA, and other regulators and advisory groups.
- The Secretary of Energy should investigate options for providing continuity of leadership for the Office of Civilian Radioactive Waste Management Program and, if legislative change is indicated, propose such a change to the Congress.
- Either the Yucca Mountain Site Characterization Office or the Management and Operating contractor should hire and assign a senior employee with experience comparable to that of the current tunnel contractor's Project Manager to oversee the tunnel contractor's work.

Contractor Relations. The Review Team offers the following options for consideration relative Contractor Relations:

- Now that the formal consolidation of Project participants under the Management and Operating Contractor has been accomplished, the Department of Energy must clarify the respective oversight and management roles of the Department of Energy and the Management and Operating Contractor. Office of Civilian Radioactive Waste Management and Yucca Mountain Site Characterization Office must continue to empower the Management and Operating Contractor by actively supporting the Management and Operating Contractor's decisional authority and management control.
- The degree to which staffing is reduced to eliminate duplicated support functions among contractors should be monitored following the consolidation of participants under the Management and Operating Contractor.
- Where there are opportunities to bring in new participants or new personnel, the Review Team encourages such change.

- Project procurement procedures should be reviewed to insure that no policy mandates exist that may result in the suboptimization of contractor resources for procurements with potential critical path impacts.

Integration. The Review Team offers the following option for consideration relative to Integration:

- The Department of Energy must empower TRW to act as Project manager and integrator in order to fully benefit from TRW's expertise. This means that TRW must not only be given authority to direct Project participants, but that Department of Energy must act accordingly by consistently supporting TRW's decisional and directional authority.
- Yucca Mountain Site Characterization Office should be aware that deeply-rooted cultural paradigms which may stem from the Nevada Test Site could hinder management's future attempts to effectively lead the Project in new directions. To the extent that such cultural paradigms exist, Yucca Mountain Site Characterization Project should consider breaking ties with the Nevada Test Site.

Decisional Procedures. The Review Team's options for consideration regarding decisional procedures are as follows:

- Office of Civilian Radioactive Waste Management and Yucca Mountain Site Characterization Office should consider expanded use of external experts in its decisional process when evaluating critical and high-profile capital expenditures.
- Where applicable, Office of Civilian Radioactive Waste Management and Yucca Mountain Site Characterization Office should consider a more thorough evaluation of financial and operational alternatives relative to leasing and/or contracting alternatives.
- In general, Office of Civilian Radioactive Waste Management and Yucca Mountain Site Characterization Office managers should empower the lower level managers with decisional authority so that decision are appropriately made by those closest to the issues at hand.
- The Project must accept some limited decisional risks by providing mechanisms and schedule allowances that accommodate the results of taking such risks.

Stakeholder Relations. The Review Team offers the following options for consideration relative to Stakeholder Relations:

- Office of Civilian Radioactive Waste Management and Yucca Mountain Site Characterization Project must accept the fact that excellent technical and scientific investigations are of no use if the public distrusts those conducting such investigations. Office of Civilian Radioactive Waste Management and Yucca Mountain Site Characterization Project have no choice but to accept the fact that public trust and confidence is a fundamental requisite to the successful completion of long-term Program and Project objectives.
- Office of Civilian Radioactive Waste Management and Yucca Mountain Site Characterization Project must clarify its vision of Stakeholder involvement. A clear vision of exactly what role Stakeholders will play in the long-term success of the Project must permeate through all levels of the organization, including Department of Energy managers, the Management and Operating Contractor, and Project participants. This vision must become the core of a new "corporate culture" of openness and service.
- A key component of the new "corporate" Stakeholder vision should be a clearly written Stakeholder Plan, which among other things, identifies specific decisions requiring early Stakeholder input and sets forth detailed procedures for objective and meaningful consideration of such input. This plan must be highly visibly and consistently implemented. On one hand, Stakeholders must realize that Department of Energy cannot abrogate its decisional responsibilities. On the other hand, Office of Civilian Radioactive Waste Management and Yucca Mountain Site Characterization Office must objectively consider constructive Stakeholder input as beneficial in accomplishing its ultimate long-term mission of resolving the nuclear waste dilemma.
- Office of Civilian Radioactive Waste Management and Yucca Mountain Site Characterization Office must accept and plan for the short-term costs of increased Stakeholder involvement, including budget and schedule impacts. These short-term costs will be outweighed by the long-term benefits of increased public trust and confidence, and ultimately, public acceptance.
- Office of Civilian Radioactive Waste Management and Yucca Mountain Site Characterization Office personnel should be trained in all aspects of Stakeholder communications to avoid inadvertent insults or expressions of disrespect toward Stakeholders.

Financial and Contract Management. Options for consideration identified regarding Financial and Contract Management are presented in Section Five. Categories of analysis in that section include the following:

- Evaluation of Change Control
- Contract Management and Controls
- Financial Management and Fiscal Controls
- Infrastructure

Change Control. The Review Team offers the following options for consideration relative to Change Control:

- In order to increase public trust and confidence and reduce the risk of opposition and intervention during the licensing process, Office of Civilian Radioactive Waste Management should reconcile the Program Approach technical scope of work baseline with the original SCP and explain deviations from the SCP and the criteria used in making the deviations.
- Office of Civilian Radioactive Waste Management should then seek acceptance of the revised technical baseline by those respected in the scientific community such as the NAS, NWTRB, and NRC. Feedback should also be sought from Stakeholders.

Contract Management and Controls. As a result of its review of contract management and controls at Office of Civilian Radioactive Waste Management and the Yucca Mountain Site Characterization Office, the Review Team has the following options for consideration:

- Given the ever increasing costs of the Project and the likelihood that the Nuclear Waste Fund (discussed in Section Seven) will be inadequate to pay for the total life cycle costs of a repository at Yucca Mountain, Office of Civilian Radioactive Waste Management should make the institution of fixed-price and performance-based contracting a top priority and pursue opportunities for changing existing contracts.
- Department of Energy should direct the Nevada Test Site that the tunnel excavation subcontract, the drilling portion of the REEC Co contract, and, possibly other similar critical work, be assigned to the Office of Civilian Radioactive Waste Management and Operating Contractor as subcontracts when the REEC Co contract at the Nevada Test Site expires December 31, 1995.
- Office of Civilian Radioactive Waste Management should convert the tunnel excavation scope of work and drilling scope of work to lump-sum unit-price

contracts which take into account the variable site conditions at the Project and periodic stand-by time.

- The Yucca Mountain Site Characterization Office should develop the scope of work for its fiscal year planning and budgeting in such a way that the resulting Yucca Mountain Site Characterization Office estimate is reasonably close to the expected target budget. The guidance to participants should be clear enough to ensure minimal misunderstanding regarding the scope of work to be performed and the related deliverables and milestones. If the Yucca Mountain Site Characterization Office believes that additional funding over and above the estimated funding may be received, additional scope can be planned over and above the base scope. This scope should clearly be separated from the base or core scope of work.
- The performance criteria and measurement standards under the Office of Civilian Radioactive Waste Management/Management and Operating Contractor Performance Evaluation Plan (PEP) should be modified to include measurement standards that address the cost effective accomplishment of Program and Project objectives. Examples of possible measurement standards are as follows:
 - Outstanding - Planned Work is Completed Ahead of Schedule *and* Under Budget.
 - Good - Planned Work is Completed Ahead of Schedule *or* Under Budget.
 - Satisfactory - Planned Work is Completed on Schedule *and* Within Budget.
 - Marginal - Planned Work is Completed on Schedule *or* Within Budget.
 - Unsatisfactory - Planned Work is Completed Behind Schedule *and* Over Budget.
- The PEP should include criteria which requires the Management and Operating Contractor to ensure that its budget proposal for a fiscal year is reasonable and consistent with the communicated funding profile estimates for the Project and is consistent with guidance given by Office of Civilian Radioactive Waste Management regarding priorities and scope of work.
- Office of Civilian Radioactive Waste Management should increase the objectivity of the numerical rating system within the PEP process. Evaluators should not have the discretion to subjectively determine a numerical rating within a broad range.

Financial Management and Fiscal Control at Yucca Mountain. The Review Team offers the following options for consideration relative to Financial Management and Fiscal Control at Yucca Mountain:

- The Yucca Mountain Site Characterization Office should develop the scope of work for its fiscal year planning and budgeting in such a way that the resulting estimate is reasonably close to the expected target budget. The guidance to participants should be clear enough to ensure minimal misunderstanding regarding the scope of work to be performed and the related deliverables and milestones. If the Yucca

Mountain Site Characterization Office believes that additional funding may be received, additional scope can be planned over and above the base scope. This scope should clearly be separated from the base or core scope of work.

- In order to effect significant cost reductions and distinguish between critical activities and nonvalue-added activities, Office of Civilian Radioactive Waste Management should perform a systematic analysis of root cost-drivers. The need for a cost-driver analysis is discussed in detail in the Review Team's analysis of infrastructure issues.

Integration. The Review Team offers the following options for consideration relative to Integration:

- The Department of Energy should establish some clear objectives for measuring the relationship between infrastructure costs and scientific/technical costs. Such objectives should be supported by steps to reduce the absolute costs of infrastructure.
- The Department of Energy should implement methods and procedures to identify and control perceived minor tasks to avoid the possible that they will become major obstacles for completion of the Project.
- As stated earlier in this report, such methods and procedures for controlling and minimizing costs should be implemented in conjunction with a systematic analysis of root cost drivers.

Schedules and Credibility of Milestones

Options for consideration identified regarding Schedules and Credibility of Milestones are presented in Section Six. Categories of analysis in that section include the following:

- Funding Impacts on Scheduling and Reasonableness of Schedules and Milestones
- Contingency Planning
- Fatal Flaw Analysis
- Scheduling Impacts on Scientific Investigations

Funding Impacts on Scheduling and Reasonableness of Schedules and Milestones. The Review Team's options for considerations regarding Funding Impacts on Scheduling and Reasonableness of Schedules and Milestone are as follows:

- Establish reasonable, but aggressive, schedule and then manage to that schedule. The schedule should be aggressive enough to be challenging, yet it must not be so optimistic that the milestones cannot be reasonably met.
- During the rebaselining effort, Project personnel must feel free to challenge the established milestones if they believe they cannot be met as shown by the "bottom-up" schedule. Senior management must address this issue so that people feel free to make this challenge. There is concern that so much effort has been placed on the "top-down" milestones that people will be reluctant to recommend change even though they feel change is necessary.
- During the rebaselining effort, senior management must ensure that the amount of risk assumed by the personnel involved in the effort is consistent and in accordance with the intent of the Program Approach.
- Senior management needs to bring the level of schedule understanding, knowledge, and use to a higher level than currently exists.
- The DOE and the Management and Operating Contractor should jointly prepare the Level 2 schedule with the DOE retaining ultimate authority and the Management and Operating Contractor responsible for managing the work to the schedule.
- The Management and Operating Contractor should be given more responsibility, such that the Department of Energy's role is to provide guidance and oversight only, rather than to manage the Project.
- Identify areas where enhanced funding could be beneficial to the Project and pursue funding for those areas.
- Additional emphasis should be placed on the cost reduction program.

Contingency Planning. The Review Team's option for considerations regarding Contingency Planning is as follows:

- Establish and implement a formal contingency planning strategy. Select approximately six intermediate level scenarios and identify contingency plans to be employed should the events in these scenarios occur.

Fatal Flaw. The Review Teams options for considerations regarding Fatal Flaw analysis are as follows:

- Consider the use of available enhanced funding to bring forward certain tests if that would benefit earlier disclosure of disqualifying conditions.
- Consider updating the portion of the ITE report that addressed the ranking of tests according to the highest probability to detect unsuitable conditions.

Scheduling Impacts on Scientific Investigations. The Review Teams options for considerations regarding Scheduling Impacts on Scientific Investigations are as follows:

- Clearly identify the process to determine when enough science has been accomplished. The position of Chief Scientist could provide an effective role in this area.
- After the scope of work is established through the rebaselining effort and schedules prepared that are consistent with that work, the scope of work should not be compromised for the sake of meeting a milestone.
- Surface mapping should be limited to those instances where underground exploration shows something unusual or questionable.

Funding Levels and Funding Priorities

Options for consideration identified regarding Funding Levels and Funding Priorities are presented in Section Seven. Categories of analysis in that section include the following:

- Level of Funding
- Programmatic Funding Priorities
- Revolving Fund
- Total System Life Cycle Cost Analysis

Level of Funding. The Review Teams options for considerations regarding the Level of Funding are as follows:

- As the Program Approach appears to be a conceptual improvement over previous strategic plans with hopes of moving the Program/Project forward, and showing real progress, Office of Civilian Radioactive Waste Management and Yucca

Mountain Site Characterization Office personnel ("internal players") should embrace the approach and work as a team to implement the strategies and plans contained therein. The Department of Energy should also make valiant efforts to get the public's (and other affected entities' understanding and) support of this approach with hopes of creating a confidence and commitment in the Program/Project from these key "external players" while being open to the public about the risks of using the Program Approach to make suitability and licensing decisions.

- The Department of Energy should continue to focus its attention on rebaselining the Project cost and schedule in order to establish realistic expectations and gain performance credibility with all Program/Project players.
- The Department of Energy should continue its attempts to secure consistent funding for the Program/Project with hopes of recapturing monies lost through the historical lack of funding and related schedule slippages.

Funding Priorities. The Review Teams options for considerations regarding the Funding Priorities are as follows:

- Department of Energy should continue to resolve technical and operational concerns of the repository that directly relate to or affect the design and development of multipurpose casks. If a "robust" design can be accomplished and satisfy waste acceptance, the Multi-Purpose Canister program should continue. If a "robust" design cannot be accomplished, the Multi-Purpose Canister should be designed primarily for ultimate disposal at a repository. In the latter case, the associated cost and schedule of Multi-Purpose Canister development should follow the time frame established for permanent disposal at a repository.
- The Department of Energy should consider the establishment of more effective integration strategies and activities among Program elements in order to increase awareness, communication, and overall management effectiveness.
- As alluded to in the Program Approach, the Department of Energy should continue to search for, and ultimately identify, ways to streamline operations, specifically as related to infrastructure costs. The Department of Energy must also maintain a focus on the mission, strategies, plans, etc., contained therein in order to increase its chance of effective implementation.

Revolving Fund. The Review Teams options for considerations regarding the Revolving Fund are as follows:

- Congress must decide/determine whether benefits outweigh the risks (or vice versa) relative to the revolving fund proposal. The approval/disapproval process must

also consider other Program recommendations in conjunction with the revolving fund proposal.

- While it is not certain that a revolving fund in and of itself would provide needed stability to this Program, it is in the best interest of Congress to consider the revolving fund and any and all recommendations or proposals affecting the stability of the Program.

Total System Life Cycle Costs and Fee Adequacy. The Review Team's options for consideration regarding Total System Life Cycle Costs and Fee Adequacy are as follows:

- With Program and Project uncertainties, and the multitude of variables and factors affecting the analysis, the Total System Life Cycle Cost is nothing more than a best guess estimate (i.e., "a moving target"). As a "moving target," it is extremely important for the Department of Energy to comprehensively analyze these costs on a regular basis in order to reflect the best available information and most current plans, events, and activities. The Total System Life Cycle Cost analysis should be performed, updated and published every year as required (or on some agreed-upon consistent basis) since it provides meaningful information and gives those involved and affected some indication of the change in total cost over time and, most importantly, the potential affects on the Nuclear Waste Fund. Furthermore, it should be openly reviewed and challenged by proponents and opponents alike. As a result, the Department of Energy will reduce the chance of being surprised by any significant fluctuations in its estimates of total system costs and be forced to reconcile its assumptions. Insuring the integrity of the Nuclear Waste Fund and assessing fee adequacy is difficult enough given the nature and unpredictability of the Total System Life Cycle Cost analysis. The Department of Energy should provide more timely and open comprehensive estimates to avoid compounding the problem.
- Should the results of the Department of Energy's 1995 Total System Life Cycle Cost analysis (and fee adequacy) indicate a lack of funds (as others have already found), serious consideration should be given to various recommendations provided by many including this Review Team, the General Accounting Office, Planning Information Corporation and other agencies, organizations and Stakeholders. General options for consideration of the Review Team include:
 - Continue to seek additional funding sources and propose alternative funding mechanisms that may ultimately provide additional monies to the Nuclear Waste Fund.
 - Consider ways to reduce the total system costs of the Program without jeopardizing its mission and objectives. While this is notably a formidable task for such a Program, cost reduction efforts should be constantly examined and implemented.

- Index the fee for inflation in order to minimize the potential shortfalls created by inflation swings.
- Potentially increase the fee possibly via step adjustments.

**SECTION THREE
BACKGROUND AND APPROACH
TO THE INDEPENDENT REVIEW**

SECTION THREE
BACKGROUND AND APPROACH TO THE INDEPENDENT REVIEW

This section provides a background summary of the Project and the need for an Independent Management and Financial Review, and the approach adopted by the Review Team in conducting its work.

BACKGROUND AND PROJECT DESCRIPTION**Nuclear Waste Policy Act of 1982 (Amended 1987)**

The Nuclear Waste Policy Act of 1982 (the Act) directed the Department of Energy to lead the nation's effort to create a system for the safe and final disposal of high level radioactive waste in one or more deep geologic repositories. From original enactment in 1982 until passage of the 1987 amendments, the Department of Energy was required to investigate three possible repository sites and, upon the formal selection of one, apply to the Nuclear Regulatory Commission for a license to construct a repository. These three investigations were conducted at the following locations: Deaf Smith County, Texas; Department of Energy's Hanford Reservation, Washington; and Yucca Mountain, Nevada. The Act specified that one repository was to be constructed and ready to receive waste by January 31, 1998.

Due to political and financial pressures and a growing discontent within Congress and the community of Stakeholders, Congress passed the 1987 amendments which directed the Office of Civilian Radioactive Waste Management to limit its investigations regarding site suitability to one site at Yucca Mountain, Nevada.

The philosophy behind the Nuclear Waste Policy Act of 1982 was to have those benefiting from nuclear power pay the cost of waste disposal and prevent the cost of waste disposal from being transferred to future generations. As a result, Congress required the collection of fees from utilities with nuclear power plants and established the Nuclear Waste Fund for financing costs associated with such disposal. (In practice, the Nuclear Waste Fund is paid for by rate payers to the electric utility who, in turn, pays into the fund.) The amendments also:

- Created the Nuclear Waste Technical Review Board, an independent body whose function is to formally evaluate the Office of Civilian Radioactive Waste Management's activities and formally report on a regular basis to the Secretary and the Congress.
- Authorized the Department of Energy to develop an above-ground facility for temporary storage of nuclear waste prior to permanently disposing of it in a repository.
- Prohibited the construction of the facility until the Nuclear Regulatory Commission had issued a license for construction of the geologic repository.
- Established the position of the Nuclear Waste Negotiator whose job it was to negotiate the siting of the Monitored Retrievable Storage facility at a voluntary host site.

Office of Civilian Radioactive Waste Management

The Office of Civilian Radioactive Waste Management's current mission statement, published following a strategic planning session within the Department of Energy in 1994, reads as follows:

Our mission is to manage and dispose of the nation's spent nuclear fuel and high-level nuclear waste. We will provide leadership in developing and implementing strategies that assure public and worker health and safety, protect the environment, merit public confidence, and are economically viable.

To accomplish its mission, the Office of Civilian Radioactive Waste Management is organized into several functional areas of interest. Four of the functional areas are of primary importance to the Independent Management and Financial Review. They are as follows:

- The Yucca Mountain Site Characterization Project (in total).
- Development of the Multipurpose Canister (in part).
- Development of a Monitored Retrievable Storage Facility (in part).
- Development of Transportation Systems between on-site waste storage currently at nuclear generating stations, possibly to a Monitored Retrievable Storage facility, and finally to a repository (in part).

The areas identified are intertwined as to scientific and funding considerations. Although this Independent Management and Financial Review is limited to the Yucca Mountain Site Characterization Project, portions of the other three functional areas of interest must be evaluated

with respect to systems integration, funding levels, funding priority considerations, organizational effectiveness, Project schedules and the credibility of Project milestones.

Funding for the Office of Civilian Radioactive Waste Management is obtained through annual Congressional appropriations from the Nuclear Waste Fund contributions made by electric utility ratepayers based on a mill levy per kilowatt hour on generated power from nuclear power stations.

Yucca Mountain Site Characterization Project

A separate written mission statement for the Yucca Mountain Site Characterization Project does not exist. However, the Review Team believes the mission to be in accordance with the mission statement of the Office of Civilian Radioactive Waste Management and formulated to accomplish the following:

- Determine site suitability of the Yucca Mountain Site (or disqualification).
- Design the repository.
- Prepare a license application for Nuclear Regulatory Commission approval.

The current schedule for achieving major milestones of the Office of Civilian Radioactive Waste Management and Yucca Mountain Site Characterization Project was published by the Department of Energy on December 19, 1994. This graphic, entitled "Figure 3. Major Milestones for Program Success," appears on the following page.

Project Plan

The plan for accomplishing the Yucca Mountain Site Characterization Project has evolved since 1987. Of importance to the Independent Management and Financial Review are three major planning initiatives:

- The Site Characterization Plan
- The Mission 2001 Study
- The Program Approach

Major Milestones for Program Success

PC1810

Figure 3. Major Milestones for Program Success

The Site Characterization Plan. This voluminous document, created in 1988 and published in 1989, consists of approximately 7,000 pages of text and over 6,000 discrete activities. The Site Characterization Plan is comprehensive and represents a major effort at collecting all, as then known, study elements and associated methodology that could be required to determine the suitability of Yucca Mountain as the nation's high-level nuclear waste repository. This plan has not been abandoned, but priorities for achieving its component parts have been changed by the current strategy as addressed subsequently in this section.

The Mission 2001 Study. This study, prepared and published in 1992, is basically an updated schedule for performing the work required within the Site Characterization Plan. In other words, the scientific requirements for site characterization were not changed, but the initial schedule for accomplishing the work was slipped approximately three years to 2001, thus the name of the study.

The Program Approach. During 1994, the Office of Civilian Radioactive Waste Management developed what is now known as the Program Approach. Published in December 1994, this approach maintains that scientific requisites necessary for development must be pursued, and prioritizes the acquisition of scientific data, analyses, and the monitoring of results. In other words, some scientific endeavors will continue after site suitability has been determined and while the repository is being permitted. This concept is consistent with the suggestions made by the Commission on Geosciences, Environment, and Resources of the National Research Council which published a position statement of its Board on Radioactive Waste Management in 1990. The statement titled, "Rethinking High-Level Radioactive Waste Disposal," states in part:

... The Board suggests an institutional approach that is more flexible and experimental--in other words, a strategy that acknowledges the following premises:

- Surprises are inevitable in the course of investigating any proposed site, and things are bound to go wrong on a minor scale in the development of a repository.
- If the repository design can be changed in response to new information, minor problems can be fixed without affecting safety, and major problems, if any appear, can be remedied before damage is done to the environment or to public health.

This flexible approach can be summarized in three principles:

- Start with the simplest description of what is known, so that the largest and most significant uncertainties can be identified early in the Program and given priority attention.
- Meet problems as they emerge, instead of trying to anticipate in advance all the complexities of a natural geological environment.
- Define the goal broadly in ultimate performance terms, rather than immediate requirements, so that increased knowledge can be incorporated in the design at a specific site.

In short, this approach uses a scientific approach and employs modeling tools to identify areas where more information is needed, rather than to justify decisions that have already been made on the basis of limited knowledge . . .

The concept of the Program Approach, as published in three volumes in 1994 by the Office of Civilian Radioactive Waste Management, incorporates what is stated above as a scientific approach philosophy and includes schedule milestones for achieving the scientific objectives based on an assumed level of funding.

As observed by the Review Team, the Program Approach means different things to different people. To some, it is interpreted as the basis of a management approach to focus and prioritize work activities which will allow more time- and cost-effective achievement of Program/Project objectives. To others, it is viewed in the context of significant policy issues which may be contradictory to the intent of the Nuclear Waste Policy Act, as amended. The Review Team's observations, comments, and opinions on the Program Approach presented in this report are strictly in accordance with an independent management and financial review and are not intended to be construed as an endorsement of policy issues.

While the Program Approach appears to have a sound scientific philosophy and to be an appropriate application to the Yucca Mountain Project, its ultimate acceptance and implementation remains to be seen. As to its acceptance, it is uncertain how it may ultimately be viewed by Congress, the Nuclear Regulatory Commission, the Environmental Protection Agency and the concerned public at large. As to implementation, since the Program Approach is less than one year old, the Review Team has had only a small window of opportunity to observe its progress.

According to the Director of the Office of Civilian Radioactive Waste Management, implementation of the Program Approach requires an aggressive, but what he considers to be achievable, schedule based on annual funding levels which could reasonably be expected. This, in the opinion of the Review Team, means that the Yucca Mountain Project is schedule-milestone and/or funding-driven. It follows that if funding levels are not maintained as planned, or if the deliverability of required scientific products is delayed, the milestone dates planned are not likely to be achieved. In addition, the "learn-as-you-go" scientific philosophy embodied in the Program Approach requires periodic "rebaselining" of the Project Plan; that is, periodic scientific scope definition changes must be made along with resulting adjustments to budgets and schedules. All of this rebaselining effort must conform to annual funding levels and allocations of funds to Project work activities. All of these elements contain financial and schedule risks that could impact the implementation and ultimate acceptance of the Program Approach.

Additionally, schedule-milestone and/or funding-driven projects occasionally run the risk of compromising quality. In the case of the Yucca Mountain Project, "quality" is synonymous with the achievement of scientific and technical objectives. During the term of the review, no such compromises were disclosed to the Review Team. It must be noted, however, that the Nuclear Regulatory Commission is the final authority on scientific and technical matters and has the responsibility for insuring the safety of the repository. The Review Team must assume that the Nuclear Regulatory Commission will not grant a license if it is not satisfied that the site characterization activities demonstrate a safe site. Given that the Nuclear Regulatory Commission will grant a license only after it is satisfied that the site is safe, there is a risk that the Yucca Mountain Project may spend funds and time needlessly and then have the Nuclear Regulatory Commission reject the site. Short of site rejection, the Nuclear Regulatory Commission may require additional scientific and/or technical work be accomplished which would result in additional fund expenditures and schedule-milestone delays.

The Nuclear Regulatory Commission has remained silent (at least in terms of formal, written commentary) on its acceptance or rejection of the Program Approach. Because of the deferral of some studies to later phases, the Program Approach may be at a higher financial and schedule risk than total pursuit of the highly comprehensive Site Characterization Plan.

In summary, while the philosophy underpinning the Program Approach appears to be basically sound, in the opinion of the Review Team, it does carry with it a significant amount of financial risk which should be continuously evaluated by the Department of Energy.

APPROACH TO THE INDEPENDENT MANAGEMENT AND FINANCIAL REVIEW

The Yucca Mountain Project has been the subject of substantial criticism from a wide variety of parties and individual interests. Due to escalating Project costs and overruns, and perceptions of organizational problems, a need was expressed for an independent review of the Project, in the management and financial areas.

Scope of Review

The scope of the review specified by the National Association of Regulatory Utility Commissioners in its Request for Proposal document was developed by the Special Review Panel. Four categories of analysis were required:

- Financial and Contract Management Techniques and Controls.
- Project Schedules and the Credibility of Milestones.
- Project Organizational Effectiveness and Internal Planning Processes.
- Adequacy of Funding Levels and Funding Priorities.

These four analysis categories, specified in the Review Team's contract with the National Association of Regulatory Utility Commissioners, were subdivided by the Review Team into 54 analytical tasks. The work was required to be completed within eight months. With a contract commencement date of November 16, 1994, the review was to be accomplished by July 15, 1995. The collection of 54 analytical tasks provided the framework for data gathering and analysis work. This limited framework, in essence, defined the scope of the Independent Management and Financial Review.

Approach to the Review

The Review Team's planned approach, contained in its proposal to the National Association of Regulatory Utility Commissioners, was sequentially stated as follows:

- Project orientation.
- Data gathering, including document collection and personnel interviews.
- Analysis, both individually and collectively by Review Team members.
- Report preparation followed by the receipt and integration of public comment.

To some extent, portions of the second, third, and fourth steps were to be overlapped.

Work Performed

The Review Team consistently followed its planned approach. During the course of its work, the Review Team performed the following activities:

Orientation. The Review Team's orientation commenced on November 16, 1994, and consisted of the following:

- On November 16, 1994, the Review Team's Project Manager met with Mr. Jan Marfyak of the Department of Energy (DOE) in Washington, DC, to plan and coordinate orientation activities and schedules.
- On November 22, 1994, four senior members of the Review Team met Commissioner Sheldrew, Mr. Marfyak, and other DOE personnel in Las Vegas to arrange details of orientation activities and the Stakeholder briefing planned for December 1 in Las Vegas.
- During the period November 29 through December 2, 1994, the entire Review Team received an orientation in Nevada. The following orientation activities were accomplished:
 - An all-day site visit to Yucca Mountain was conducted on November 29, preceded by an indoctrination at one of the Department of Energy's Las Vegas Science Centers.
 - Briefings by Yucca Mountain Site Characterization Project Office management personnel were received by the Review Team on November 30 and December 2.
 - An all-day meeting with Stakeholders was conducted on December 1. The Review Team was introduced by Commissioner Sheldrew. The Review Team then made an introductory presentation which was followed by a question/answer session. Stakeholders were invited to provide, at any time during the Review, input to the Review Team.

- On December 5 and 6, 1994, the entire Review Team, accompanied by Mr. Radin, received orientation briefings in Washington, DC by:
 - Nuclear Waste Technical Review Board staff members.
 - Office of Civilian Radioactive Waste Management Program Director, Dr. Dan Dreyfus and his deputy, Mr. Lake Barrett.
 - General Accounting Office personnel.

Interviews. Interviews were conducted with 114 persons to obtain valuable background information, guidance in the acquisition of documented evidence, and to obtain answers to specific questions arising from the review of relevant Program documents. The persons interviewed are listed in the Appendix to this report. A summary of the numbers of persons interviewed by organizational category follows:

- Office of Civilian Radioactive Waste Management: 15 persons.
- Yucca Mountain Site Characterization Project Office: 29 persons.
- Management and Operations Contractor and Project Management Organization Contractor Personnel (several organizations): 27 persons.
- General Accounting Office: 9 persons.
- Other Federal Government Offices (Department of Energy Inspector General, Nuclear Waste Technical Review Board, Nuclear Regulatory Commission): 7 persons.
- Affected Units of Local Government and Other Stakeholders: 27 persons.

The above-listed interviews do not include countless other persons met at various meetings attended by Review Team members or numerous telephone contacts with other persons where informal conversations occurred.

Meetings Attended. During the course of its work, Review Team members attended a variety of meetings to obtain further background information, as well as to observe the organizational mechanics of internal and external communications, and the planning and Project control process. The meetings attended were as follows:

- Office of Civilian Radioactive Waste Management Director's Program Review:
 - December 8, 1994, in Las Vegas, Nevada.
 - February 9, 1995, in Las Vegas, Nevada.
- Affected Units of Local Government:
 - December 8, 1994, in Las Vegas, Nevada.
 - January 13, 1995, with DOE Under Secretary Charles Curtis in Washington, DC
 - March 10, 1995, in Las Vegas, Nevada.
- Nevada Commission on Nuclear Projects on December 16, 1994, in Las Vegas, Nevada.
- The National Association of Regulatory Utility Commissioners Briefing on Nuclear Waste Disposal Issues on January 23, 1995, in Washington, DC.
- Nuclear Waste Technical Review Board Winter Meeting on January 10 and 11, 1995, in Beatty, Nevada.
- The Office of Civilian Radioactive Waste Management meeting on thermal loading issues on January 12, 1995, in Las Vegas, Nevada. This meeting was also attended by the National Laboratories, M&O contractors, and the Nuclear Waste Technical Review Board.
- The Office of Civilian Radioactive Waste Management and the Yucca Mountain Site Characterization Project Office Technical Program Review meetings during the week of February 13 through 17, 1995, in Las Vegas, Nevada.
- The Office of Civilian Radioactive Waste Management Project Schedule Review on February 21, 1995, in Washington, DC.
- Management and Operating Contractor (TRW) meeting on March 2, 1995, in Vienna, Virginia, which was video-conferenced to Las Vegas, Nevada.

Internal Team and Panel Meetings. To ensure that analytical activities performed by individual Review Team members were not performed in a vacuum, and to assure that the Special Review Panel members were informed of progress during the Review Team's work, Team and Panel meetings were routinely conducted to promote necessary communications.

Documents Reviewed. During the course of its work, the Review Team obtained, organized, and reviewed approximately 860 documents totalling over 76,000 pages.

Analysis. The information described above was utilized in the analysis process for the National Association of Regulatory Utility Commissioners-specified scope of work. The results of the Review Team's analyses are presented in this report.

Revisions to Deliverable Product Requirements of the Contract

The Review Team's scope of work, as originally specified by the National Association of Regulatory Commissioners, required four preliminary written reports, one for each analysis category, followed by one final report, which would encompass all four analysis categories. In addition, the National Association of Regulatory Utility Commissioners specified which of the 54 distinct analysis tasks would be incorporated within each of the four categories.

During the course of its investigation, the Review Team determined that one preliminary report followed by one final report would better serve the objectives of the review. Additionally, to avoid extensive cross-referencing and needless duplication, a reorganization of the four categories and 54 analysis tasks was found to be desirable. This concept was proposed to the Special Review Panel and was subsequently approved. It is important to note that none of the National Association of Regulatory Utility Commissioners-specified analysis tasks have been eliminated—they have simply been reorganized. The table located at the end of this section provides the Review Team's breakdown of the original scope of work into 54 distinct tasks. Each of the 54 tasks is cross-referenced to the Review Team's report.

Review Team

The Review Team consisted of key analysts selected by Peterson Consulting Limited Partnership and John Reiss, Jr. & Associates, Inc. The background of the persons selected follows:

James E. Kelley, Jr., P.E. Mr. James E. Kelley, Jr., P.E. is a Vice President with Peterson Consulting Limited Partnership operating from offices in Denver, Colorado and Washington, DC. Mr. Kelley has over 30 years of construction and consulting experience specifically in the areas of heavy marine and underground construction, contract disputes management, hazardous waste investigations, evaluation of applications of automated technologies to information management, management and organizational performance assessments, estimating, scheduling, value engineering,

construction and mining engineering, and management. Mr. Kelley served as Project Manager for this review.

Mr. Kelley has experience in large construction projects which have included oil shale mining operations in the western United States; subway tunneling operations in several metropolitan locations throughout the United States; and navigation locks, dams, bridges, major highways, and other large infrastructure projects throughout the United States and abroad.

Mr. Kelley has written numerous articles related to construction issues and is a member of the Moles and the Underground Technology Research Council serving on the Technical Committee on Tunnel Construction. He is a member of the American Underground Space Association (AUA) and served as a speaker at the 1989 Rapid Excavation and Tunnelling Conference (RETC). He has testified on numerous occasions.

Mr. Kelley is a graduate of Purdue University with a Bachelor of Science degree in Civil Engineering (1964). He is a registered professional engineer in Colorado, the District of Columbia, Pennsylvania, and Virginia and is a member of several professional societies.

Joseph C. Kellogg. Mr. Joseph C. Kellogg is a Vice President with Peterson Consulting Limited Partnership and is located in Denver, Colorado. Mr. Kellogg has over 40 years of consulting/engineering experience and was the founder of Kellogg Corporation which later combined with Peterson. Mr. Kellogg has been involved in construction of commercial and industrial buildings; heavy construction projects, such as coal, gas, and nuclear power plants; mines, tunnels, and underground facilities; highways, bridges, and transit systems; airports, pipelines, hazardous waste sites, water and wastewater facilities; seaports, and heavy industrial facilities. Mr. Kellogg served as Management Issues Technical Director for this review.

Mr. Kellogg has developed many of the firm's key systems, models, and workshop/seminar programs, including the contract disputes resolution and partnering seminars. Mr. Kellogg has authored numerous papers for presentation and publication, and provided workshops and lectures on a wide range of construction and underground facilities subjects. He is a member of several important national societies, committees, and boards including: The Moles, the Beavers, American

Society of Civil Engineers (ASCE) serving as Chairman of the Underground Construction Research Council, ASCE Task Committee on Tunneling and Underground Construction, Construction Science Research Foundation Board - Editorial Board, American Underground-Space Association, and many others. He was the 1982 recipient of the Golden Beaver Award for Engineering which recognized his lifetime contributions to the construction industry. He has testified on numerous occasions.

Mr. Kellogg has a Bachelor of Science degree in Civil Engineering/Business Management from the University of Minnesota (1951).

Charles L. Wilkins, CPA. Mr. Charles L. Wilkins is a Vice President with Peterson Consulting Limited Partnership operating from offices in Los Angeles, California and Washington, DC. Mr. Wilkins has nearly 30 years of experience in financial and management performance auditing and analysis. He served as Financial Issues Technical Director for this review.

Mr. Wilkins' experience includes responsibilities in finance, accounting, management services, organizational consolidations, treasury, auditing, pricing, acquisitions, sales and mergers, financial planning (strategic and tactical), security, industrial relations, information systems, and government relations. Mr. Wilkins has consulted with clients about training, organizational and cost pool structuring, working capital and cash flow management, accounting and management systems evaluations, policy and procedures development, various regulatory issues — e.g., Federal Acquisition Regulations, Cost Accounting Standards, "Truth in Negotiations Act" requirements, etc., — claims, pricing, and litigation support. Ten years of his professional life were spent as Vice President and Chief Financial Officer of a large aerospace/defense contractor.

Mr. Wilkins has accounting and management degrees from California State University-Fullerton (1985), the University of California-Davis (1976) and LaSalle University (1969). He is a Certified Public Accountant in California, and a member of several professional organizations. He has testified on numerous occasions.

John Reiss, Jr. Mr. John Reiss, Jr., is a Principal and Vice President with John Reiss, Jr. & Associates, Inc. and is located in Denver, Colorado. Mr. Reiss has over 23 years of consulting experience within the geotechnical, hydrogeological, and rock mechanics area. Mr. Reiss provided

technical assistance to the financial, management, and scheduling team members regarding the various elements of science and technology to be employed at the Yucca Mountain Project.

Mr. Reiss, as Vice President of John Reiss, Jr. & Associates, Inc., is responsible for overseeing all technical aspects of the firm's projects, including developing the scope of work, methodologies to be employed, quality of the work product, schedule and cost. Mr. Reiss' previous experience includes: technical support for preliminary design of the Singapore tunnel system; installation of instrumentation and interpretation for a cut-and-cover subway excavation in New York City; and co-author of "Design Guidelines for Mined Cavern Storage of Natural Gas" prepared for the Pipeline Research Committee, American Gas Association. Mr. Reiss was also a team member in evaluating salt domes in the gulf coast area for high level radioactive waste storage and has conducted numerous geotechnical and environmental studies involving uranium mining and milling operations in the Western United States.

Mr. Reiss is a graduate of the University of Missouri-Rolla and received his Bachelor of Science degree in Geology (1971). He also was the 1990 recipient of a Professional Degree in Geological Engineering from the University of Missouri-Rolla. In April 1995, he was inducted as one of twelve founding members of the Academy of Mines and Metallurgy at the University of Missouri Rolla in recognition of his science and engineering contributions to industry.

Calvin R. Tininenko. Mr. Calvin R. Tininenko is a Senior Associate with John Reiss, Jr. & Associates, Inc. and is located in Denver, Colorado. He has over 22 years of professional experience in all phases of environmental management, including seven years as the Corporate Director of Environmental Affairs for a Fortune 100 company. He has diverse experience in the design, permitting, and operation of numerous wastewater treatment, air pollution control, and solid waste management units within numerous industrial categories, including metal plating, battery processing, mining, nitrogen fertilizer production, meat processing/slaughtering, petroleum refining, pesticide manufacturing and grain handling/feed mill processes. He provided technical assistance to the financial, management, and scheduling team members regarding the various elements of science and technology to be employed at the Yucca Mountain Project.

Mr. Tininenko has eight years of experience providing contract waste management services to both hazardous and nonhazardous waste generators and has been involved in the design and implementation of several multiyear site cleanup and closure projects involving soils and groundwater contaminated with metal and/or various organic chemicals. He is a recognized expert in the cause/effect analyses for numerous Superfund litigations. He has been involved in the troubleshooting, design, and construction of over 15 wastewater treatment facilities for a large railroad and continues to provide waste minimization consulting services as well as oversight of the firm's remediation activities.

Mr. Tininenko holds a Master of Science in Microbiology from the University of North Carolina (1970) and a Bachelor of Science degree in Biology from Walla Walla College, Walla Walla, Washington (1969).

Mark W. Pedigo. Mr. Mark W. Pedigo is an Executive Consultant with Peterson Consulting Limited Partnership and is located in Denver, Colorado. Mr. Pedigo has 14 years of experience and has applied his education in conducting financial audits in the area of contract dispute damage analysis, and analysis of operating and financial performance for troubled projects. Mr. Pedigo has been involved in the analysis of claims ranging from several thousands of dollars to many hundreds of millions of dollars. Many of his projects have included the assemblage of very large databases related to cost components of the claim and the analysis of project cost variances. Mr. Pedigo was primarily involved in the financial and management analyses for this review.

Previously, Mr. Pedigo has been a Senior Auditor for a large oil and mining concern providing construction contract audit services, overall accounting systems development, inventory management, and revenue recognition systems for the company's operating divisions. He has also been an Internal Auditor for an electric utility providing financial and managerial audits of the company's power plants, production departments, accounting departments, and materials and supplies warehouses. He is a member of the American Institute of Certified Public Accountants, Colorado Society of CPAs, and the Construction Financial Management Association.

Mr. Pedigo received a Bachelor of Business Administration degree in Accounting from Texas Tech University (1980) and a Master of Science in Management with a minor in Finance from the University of Colorado at Denver. He is a Certified Public Accountant in Colorado and Texas.

Herbert D. Casner, Jr., PE. Mr. Herbert D. Casner, Jr., P.E., is a Principal with Peterson Consulting Limited Partnership and is located in Denver, Colorado. Mr. Casner has over 30 years of experience providing management and technical consulting for a wide variety of projects and clients, including project management oversight, claims resolution and litigation support, expert witness, schedule analysis, preparation and review of construction estimates, preparation of policies and procedures for construction projects, assistance in organization and program management activities, assistance to insurers for major lost profits cases, seminars and training on matters of claims and construction management. Mr. Casner was involved with the management and scheduling aspects for this review.

Projects which Mr. Casner has been involved with include rapid transit, airports, large dams, paper and pulp, major bridges, mining, and gas and oil production facilities, and buildings. Specifically, Mr. Casner has served as project manager for project management oversight services for the design and construction of \$2.3 billion light and heavy rail systems in the Los Angeles area; project manager for major property losses resulting from hurricane Andrew in Florida, and losses from the 1993 Midwest flooding. He served as project manager for major design and production of oil/gas facilities in the North Sea including scheduling, cost engineering, procurement of materials, and equipment, awarding of fabrication and installation contracts, and the administration of accounts.

Mr. Casner received a Bachelor of Science degree in Civil Engineering from Penn State University (1961). He is a registered professional engineer in several states.

James M. Barolak. Mr. James M. Barolak is an Executive Consultant with Peterson Consulting Limited Partnership and is located in Denver, Colorado. Mr. Barolak has 11 years of experience in financial and engineering analysis and management. He was involved in the organizational structure and effectiveness aspects for this project.

Mr. Barolak specializes in financial evaluations and is particularly effective in cases involving engineering or technical issues. Mr. Barolak has applied his skills to a wide range of matters involving construction claims, contract disputes, business interruptions, lost profits, business valuations and intellectual property. He has provided services to the construction, petrochemical, mining, banking, insurance, and real estate industries.

Mr. Barolak holds a Master of Business Administration degree in Finance from the University of Colorado (1991), a Bachelor of Science degree in Petroleum Engineering from Texas A&M University, and a Bachelor of Science degree in Geology from Texas A&M University.

Byron O. Spruell. Mr. Byron O. Spruell is an Executive Consultant with Peterson Consulting Limited Partnership and is located in Houston, Texas. Mr. Spruell's broad experience is in the areas of government contracts, construction, environmental services, and commercial litigation including lost profits, business interruption, and property damages claims. He was involved in providing financial, scheduling, and government contracts procurement/ administration issues for this review.

While involved in contract and/or claims-related disputes, he has analyzed cost and schedule impacts associated with formal and constructive contract changes, as well as full and partial terminations; reviewed and/or prepared various aspects of equitable price adjustments including construction costs, profits, extended or unabsorbed overhead, etc. In construction claims, Mr. Spruell has been involved in the preparation of delay, disruption, and impact assessments, analysis of changed work conditions, and calculation of related cost and financial effects. Within the environmental area, he has performed analyses of site remediation costs; assisted in financial analysis of coverage blocks based on site-specific facts, insurance policies, and legal precedents; and assisted in the development of coverage charts showing dates, deductions, costs, and evaluated site-specific claims involving occurrences and triggers.

Mr. Spruell graduated with a Bachelor of Science degree in Mechanical Engineering (1987) and a Master of Business Administration in Finance (1989) from the University of Notre Dame.

Diane Carlson-Reiss. Ms. Diane Carlson-Reiss is President of John Reiss, Jr. & Associates, Inc. and is located in Denver, Colorado. Ms. Carlson-Reiss has over 15 years of experience in contract management and procurement services. Currently, as President of John Reiss, Jr. & Associates, Inc., her duties include the financial and administrative functions of the corporation, along with technical analysis of project scheduling, proposal preparation and the contract negotiation of the company's projects (both vendors and clients.)

Ms. Carlson-Reiss' background includes serving as Control Data Corporation's Eastern Region's Senior Contracts Administrator for General Services Administration contracts; Department of Energy and Department of Defense contracts, with duties involving the implementation and tracking of government contracts; to inclusion in the corporate negotiation team for the company's General Services Agreement for purchases throughout the United States and Europe. Additional duties with Control Data Corporation included heading the corporate audit and negotiation team for disk/tape product support.

She provided technical advisory services to the Review Team on government contract procurement/administration/management issues. As Regional Contracts Manager with Storage Technology Corporation, Ms. Carlson-Reiss was responsible for the contracts negotiation and administration of the northeast quadrant of the United States. She has also provided litigation support for EPA Region VIII and IX contracts.

Ms. Carlson-Reiss holds a Bachelor Degree in Business Administration from Metro State University, Minneapolis, Minnesota (1979), and completed coursework in Accounting from Rutgers University, New Brunswick, New Jersey (1970/1975). She also has a Certificate, 60 hours, in Marketing/Management from Storage Tech Corporation in Louisville, Colorado (1983/1986); and a Certificate, 120 hours, in Government Procurement/Regulations/Law/Management from Control Data Corporation, Minneapolis, Minnesota (1973/1982).

W. Dixon Shay. Mr. William Dixon Shay, Jr., is a Consultant to Peterson Consulting Limited Partnership and is located in Denver, Colorado. Mr. Shay has over 25 years of experience in the areas of government relations and compliance both as a consultant and as internal Corporate Counsel. Responsibilities have included rendering advice in the areas of labor relations, collective

bargaining, equal opportunity compliance, trade regulation, implementation of corporate antitrust policies, management of antitrust litigation, general real estate legal work, acquisition of federal, state, and local environmental permits for major synfuels and surface coal mining operations, and development/administration of all legal work associated with two major infrastructure projects. Mr. Shay provided the Review Team with advisory services on governmental organizational structure and relations, and legislative background on large governmental initiatives.

He has extensive experience in the areas of government relations for major synfuel projects. This experience includes acquisition of major federal, state, and local permits; preparation and implementation of socioeconomic policy and acquisition of services; master planning, zoning, subdivision infrastructure and residential mortgage financing associated with the development of the new community of Battlement Mesa, Colorado—a \$300 million capital venture initiated to support the Colony Oil Shale Project in western Colorado.

Mr. Shay received his Bachelor of Arts degree in History from Brown University (1965) and a J.D. from Dickinson School of Law (1968). He is currently licensed to practice law in the State of Colorado (1972) and the Commonwealth of Pennsylvania (1968).

RESTATED NARUC SCOPE OF WORK

<u>Scope of Work Reference</u>	<u>Scope of Work Description</u>	<u>Report Reference</u>
A.	Financial and Contract Management Techniques and Controls	
A.1.	Analyze the DOE financial and contractual management systems to assess techniques and controls to manage contractors.	Section 5 - Financial and Contract Management, Contract Management Control
A.2.	<p>(1) Determine how DOE organizes and manages the Project to maximize the use of available funds on scientific and technical activities that are essential to determining site suitability/licensability.</p> <p>(2) Assess steps taken by DOE to reduce the cost of site characterization, and additional steps which might be taken in this regard, without jeopardizing scientific studies.</p>	<p>Section 5 - Financial and Contract Management, Financial Management and Fiscal Control</p> <p>Section 5 - Financial and Contract Management, Financial Management and Fiscal Control</p>
A.3.	<p>(1) Is there a relationship between the work identified in the Mission 2001 study that would/could be deferred and the work to be deferred under DOE's new site characterization approach?</p> <p>(2) Specifically, what are the criteria, processes and/or mechanisms used by DOE to make reductions in previously planned scientific work? What should be the criteria?</p> <p>(3) What roles do the various change control boards play in assuring that any decision to reduce or eliminate scientific studies is based on scientific rather than cost or schedule considerations?</p> <p>(4) What role will the new Chief Scientist position play in ensuring that all the science that is necessary is done?</p>	<p>Section 6 - Schedules and Credibility of Milestones, Scheduling Impacts on Scientific Investigations</p> <p>Section 5 - Financial and Contract Management, Change Control</p> <p>Section 5 - Financial and Contract Management, Change Control</p> <p>Section 4 - Organizational Effectiveness, Organizational Structure</p>

RESTATED NARUC SCOPE OF WORK

<u>Scope of Work Reference</u>	<u>Scope of Work Description</u>	<u>Report Reference</u>
	(5) Why were DOE's budget requests to implement the "logical sequencing of activities to accomplish license application" as stated in the Executive Summary of the Mission 2001 exercise approximately \$900 million less for fiscal years 1991-1994 than the approved cost, schedule, and technical baselines for the project?	Section 7 - Funding Levels and Funding Priorities, Level of Funding
	(6) What assumptions led DOE to believe that adequate funds would be provided once the sequencing of activities to accomplish the tasks needed for license application were outlined in the Mission 2001 plan?	Section 7 - Funding Levels and Funding Priorities, Level of Funding
A.4.	Evaluate the management process used by DOE to make its decision to purchase a large diameter tunnel boring machine (TBM), rather than having a contractor perform this work. For example, what analyses were prepared, and by whom, as inputs to the procurement decisions? Were recognized tunnel boring experts consulted? What factors (cost, schedule, etc.) were weighed, by whom, in making the decision? In light of a constrained budget, what factors were considered by DOE in its decision to purchase a large-diameter TBM rather than a smaller diameter machine?	Section 4 - Organizational Effectiveness, Decisional Processes
A.5.	Analyze the studies that would be deleted if future funding is constrained to the existing level and the significance of the unavailability of that data to site suitability and license determination.	Section 6 - Schedules and Credibility of Milestones, Funding Impacts on Scheduling and Scheduling Impacts on Scientific Investigations
A.6.	(1) Assuming constrained funding, estimate how long will it take to complete the work that must be done to determine the suitability/licensability of the site?	Section 6 - Schedules and Credibility of Milestones, Funding Impacts on Scheduling and Scheduling Impacts on Scientific Investigations

RESTATED NARUC SCOPE OF WORK

<u>Scope of Work Reference</u>	<u>Scope of Work Description</u>	<u>Report Reference</u>
	(2) Alternatively, assuming a budget enhanced beyond that proposed by the Administration for fiscal year 1995, estimate how long will it take to complete the work that must be done to determine the suitability/licensability of the site.	Section 6 - Schedules and Credibility of Milestones, Funding Impacts on Scheduling and Scheduling Impacts on Scientific Investigations
B.	Project Schedules and Credibility of Milestones	
B.1.	Assess DOE's strategy for contingency planning. Include analysis of potential program sunk costs relative to alternative selected by DOE.	Section 6 - Schedules and Credibility of Milestones, Contingency Planning
B.2.	Analyze the reasonableness of program schedules and milestones given alternative funding scenarios developed by DOE in 1994.	Section 6 - Schedules and Credibility of Milestones, Funding Impacts on Scheduling and Reasonableness of Schedules and Milestones
B.3.	Determine whether DOE's self-imposed schedules constrain scientific investigations to an extent that would impair DOE's ability to reach sound site suitability and licensability determinations.	Section 6 - Schedules and Credibility of Milestones, Scheduling Impacts on Scientific Investigations
B.4.	(1) Evaluate the management process DOE followed that led to the decision to develop the dry drilling technology, procure the special rig, and assume the funding would be adequate to purchase several more rigs and operate all of them efficiently.	Section 4 - Organizational Effectiveness, Decisional Processes

RESTATED NARUC SCOPE OF WORK

<u>Scope of Work Reference</u>	<u>Scope of Work Description</u>	<u>Report Reference</u>
	(2) Further, in view of different funding scenarios, the recipient should evaluate the Project Office's effort to reduce the projected drilling program while still acquiring essential data, and the impact of that decision on suitability/licensing requirements.	Section 6 - Schedules and Credibility of Milestones, Funding Impacts on Scheduling and Reasonableness of Schedules and Milestones
C.	Project Organizational Effectiveness and Internal Planning Process	
C.1.	(1) In light of existing regulatory requirements, assess the management and organizational structure, including resources needed to understand and apply the requirements of the program.	Section 4 - Organizational Effectiveness, Organizational Structure
	(2) Determine to what extent project funds are being used to satisfy internal DOE requirements, and whether some of these regulatory requirements could be waived or adjusted to conserve project funds.	Section 5 - Financial and Contract Management, Infrastructure Costs
C.2.	Analyze DOE's relationship to contractors, cooperative agreement recipients and its institutional program to assess effectiveness, controls, and deliverables and schedules.	Section 4 - Organizational Effectiveness, Contractor Relations
C.3.	(1) Analyze the DOE organization to assess the effectiveness of the integration, including internal planning processes and systems, of the Yucca Mountain Project Office, Nevada Operations Office, DOE Headquarters, and OCRWM. Specifically, address the following questions:	Section 4 - Organizational Effectiveness, Integration
	(2) What is the best way to organize the management of a scientific investigation project such as this?	Section 4 - Organizational Effectiveness, Organizational Structure

RESTATED NARUC SCOPE OF WORK

<u>Scope of Work Reference</u>	<u>Scope of Work Description</u>	<u>Report Reference</u>
	(3) Is it cost effective and efficient to have OCRWM based in Washington when the disposal program is essentially based in Las Vegas?	Section 4 - Organizational Effectiveness, Integration
	(4) Should DOE personnel be the on-site project managers or should they concentrate their resources on setting the objectives of the project and overseeing a management contractor to ensure the objectives are met? If DOE manages the project, does it have or can it acquire sufficient technical skills to effectively perform this function?	Section 4 - Organizational Effectiveness, Contractor Relations
C.4.	(1) Evaluate the role of the management and operating contractor, especially in relationship to DOE staff and other contractors.	Section 4 - Organizational Effectiveness, Contractor Relations
	(2) Is the correct mix of contractors, and the distribution of work among them, the best scientific and most cost-effective way to characterize the site?	Section 4 - Organizational Effectiveness, Contractor Relations
	(3) Should the Project's ties to the Nevada Test Site be severed entirely, both administratively and physically?	Section 4 - Organizational Effectiveness, Integration
	(4) The recipient should evaluate the changes that DOE is making at the project, what effect these changes may have on improving relationships among contractors and between DOE and the management and operating contractor, whether DOE considered more fundamental changes, and whether additional changes would enhance the project.	Section 4 - Organizational Effectiveness, Contractor Relations
C.5.	(1) Evaluate whether adequate efforts are being made to integrate the views of Stakeholders during the decision making process.	Section 4 - Organizational Effectiveness, Stakeholder Relations

RESTATED NARUC SCOPE OF WORK

<u>Scope of Work Reference</u>	<u>Scope of Work Description</u>	<u>Report Reference</u>
(2)	What are the criteria by which DOE evaluates the adequacy of its efforts to integrate Stakeholder views in the decision making process?	Section 4 - Organizational Effectiveness, Stakeholder Relations
(3)	What has DOE done to implement the recommendations of the Secretary's task force on public trust and confidence?	Section 4 - Organizational Effectiveness, Stakeholder Relations
C.6.	Evaluate whether decision making is being spread among too many managers, and whether program activities are too dispersed geographically.	Section 4 - Organizational Effectiveness, Integration, Decisional Processes
D.	Adequacy of Funding Levels and Funding Priorities	
D.1.	(1) Provide a total system life cycle cost analysis of the overall mission and program in order to identify the costs of the functional elements of the program, including a total system life cycle costs analysis of the funding levels needed in the Nuclear Waste Fund to pay for a repository through the time it has reached closure under the current program plan and proposed program plans currently being considered by DOE.	Section 7 - Funding Levels and Funding Priorities, Total System Life Cycle Cost Analysis
	(2) Determine whether or not the methodology is adequate to provide data precise enough to insure the integrity of the Nuclear Waste Fund and the adequacy of the fees charged through utilities to their customers. The examination described above should include the actual expenses incurred through fiscal year 1994 (or through fiscal year 1993, if 1994 data are not available) and the additional costs necessary to complete characterization of the Yucca Mountain Site, as described in Section 113(c) of the NWPA under the under the current program plan and proposed program plan currently being considered by DOE.	Section 7 - Funding Levels and Funding Priorities, Total System Life Cycle Cost Analysis

RESTATED NARUC SCOPE OF WORK

<u>Scope of Work Reference</u>	<u>Scope of Work Description</u>	<u>Report Reference</u>
D.2.	<p>(1) Assess the allocation to date of funds between scientific and technical activities, and those used to support the project's infrastructure, and evaluate alternative funding allocations which would better achieve the project's objectives.</p> <p>(2) The recipient should determine if the project's objectives are consistent with the funding profile in a constrained budget environment and the legislative requirement to characterize a site versus construct a repository.</p>	<p>Section 5 - Financial and Contract Management, Infrastructure Costs</p> <p>Section 7 - Funding Levels and Funding Priorities, Level of Funding</p>
D.3.	<p>(1) Evaluate the benefits and risks of DOE's proposal for the establishment of a revolving fund which would be used to fund part or all of the financial requirements of the project.</p> <p>(2) The evaluation should include an assessment of where the increased funds would likely be spent, and the ability of the project to absorb, with a high degree of efficiency, the increase in funding.</p> <p>(3) Also indicate whether establishment of a revolving fund would likely lead to a greater stability of the project, from one Administration to another.</p>	<p>Section 7 - Funding Levels and Funding Priorities, Revolving Fund</p> <p>Section 7 - Funding Levels and Funding Priorities, Revolving Fund</p> <p>Section 7 - Funding Levels and Funding Priorities, Revolving Fund</p>
D.4.	<p>(1) Assess the cost effectiveness of using a multipurpose cask, in the absence of a monitored retrievable storage facility.</p> <p>(2) Is it prudent to expend large sums of money to develop a multipurpose cask without the benefit of thermal testing and other crucial information on aspects of the proposed repository, in the absence of a legal determination as to the obligation of the Federal government to provide storage for civilian nuclear wastes by 1998?</p>	<p>Section 7 - Funding Levels and Funding Priorities, Programmatic Funding Priorities</p> <p>Section 7 - Funding Levels and Funding Priorities, Programmatic Funding Priorities</p>

RESTATED NARUC SCOPE OF WORK

<u>Scope of Work Reference</u>	<u>Scope of Work Description</u>	<u>Report Reference</u>
D.5.	Evaluate the implications for funding and schedules of uncertainty about the Ghost Dance and Sundance Faults. Has DOE considered whether it would be prudent to study the remainder of the surface areas of Yucca Mountain where the repository would be sited in the same way that the U.S. Geologic Survey is examining these faults? What would be the implication of such studies on funding and scheduling?	Section 6 - Schedules and Credibility of Milestones, Scheduling Impacts on Scientific Investigations
D.6.	(1) Assess the allocation of funds between the Yucca Mountain Project, the monitored retrievable storage facility, and the transportation system.	Section 7 - Funding Levels and Funding Priorities, Programmatic Funding Priorities
	(2) Has this allocation retarded the site characterization process?	Section 7 - Funding Levels and Funding Priorities, Programmatic Funding Priorities
	(3) Is this allocation balanced properly relative to DOE's waste management mission?	Section 7 - Funding Levels and Funding Priorities, Programmatic Funding Priorities
D.7.	Review the criteria that would disqualify the site and measure how efficiently and effectively funds for activities that could facilitate identification of features that would disqualify the site are being expended.	Section 6 - Schedules and Credibility of Milestones, Fatal Flaw Analysis
E.	General	

RESTATED NARUC SCOPE OF WORK

Scope of Work Reference	<u>Scope of Work Description</u>	<u>Report Reference</u>
E.1.	If not already covered above, review recommendations, responses and implementation status of recommendations made during the past five years with regard to the Yucca Mountain Project in studies or letter reports by the Nuclear Waste Technical Review Board, the General Accounting Office, the DOE Inspector General, other federal agencies, and major reports referenced in the <u>Report on Selected Published Works and Written Comments Regarding the Office of Civilian Radioactive Waste Management Program, 1989-1993</u> by Dr. James A. Thurber, Center for Congressional and Presidential Studies, the American University, March 1, 1994.	Review of Prior Recommendations

SECTION FOUR
ORGANIZATIONAL EFFECTIVENESS

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SECTION FOUR ORGANIZATIONAL EFFECTIVENESS

This section presents the Review Team's analyses of Project organizational effectiveness. Five issues relating to organizational effectiveness are addressed:

- Organizational Structure
- Contractor Relations
- Integration
- Decisional Processes
- Stakeholder Relations

A discussion of each of these five issues follows. Each issue is further subdivided into specific topics of interest. It is in the context of these various subdivided topics of interest that the Review Team answers the National Association of Regulatory Utility Commissioners (NARUC)-specified scope of work items, as required.

ORGANIZATIONAL STRUCTURE

Four NARUC-specified scope of work requirements pertain to the issue of organizational structure. The discussion that follows addresses each of the four work requirements. In some cases, related topics are also explored where such discussions more fully develop and support the workstep analyses pursued by the Review Team. The four primary topics and the corresponding worksteps addressed within the context of these topics are as follows:

- Resource Requirements

In light of existing regulatory requirements, what resources are needed to understand and apply the requirements of the Program? [NARUC C.1.1]

- Organizational and Managerial Architecture

What is the best way to organize the management of a scientific investigation project such as this? [NARUC C.3.2]

- YMSCP's Organizational Structure

In light of existing regulatory requirements, assess the DOE's management and organizational structure. [NARUC C.1.1]

- Key Personnel

What role will the new Chief Scientist position play in ensuring that all the science that is necessary is done? [NARUC A.3.4]

Resource requirements is the first topic addressed because it is one of the fundamental considerations in organizational design. This is followed by a discussion of organizational and managerial architecture which is intended to provide the foundation for the subsequent analyses of the Yucca Mountain Site Characterization Project's organizational structure. The final topic is a brief discussion of key personnel positions within the organization. The evaluation of organizational structure is concluded with a summary and a presentation of options for consideration.

Resource Requirements

In order for any organization to be effective, the organization's mission and goals must be clearly defined and the resources required to carry out the mission and achieve the stated goals must be identified. An organizational structure can then be designed that efficiently allocates resources in accordance with the stated mission and goals.

Because the resource requirements of the Project are a fundamental consideration in designing an effective organization and management architecture, the Review Team addresses the following NARUC scope of work item as an introduction to its overall analysis of Project organizational structure.

- *In light of existing regulatory requirements, what resources are needed to understand and apply the requirements of the Program? [NARUC C.1.1]*

To determine what resources are needed to understand and apply the requirements of the Program, the Review Team's approach was to:

1. Gain an overall understanding of the existing regulatory requirements,

2. identify the stated mission and goals of the Office of Civilian Radioactive Waste Management (OCRWM or the Program) and the Yucca Mountain Site Characterization Office (YMSCO or the Project), and
3. assess the overall resource requirements in light of the existing regulatory requirements and stated mission and goals.

It should be noted that the intent of the Review Team was to assess, in general terms, Project resource requirements. It was not the intent of the Review Team to (1) specifically analyze or offer independent interpretation of any applicable laws or regulations, or (2) specifically assess whether DOE's stated mission and goals support an appropriate interpretation of such laws or regulations. Accordingly, the Review Team limited its analysis to:

- A general overview of the regulatory environment within which the Program operates.
- A review of DOE's mission, goals, objectives, and strategies, as stated, without regard to their specific compliance with the requirements of any laws or regulations.

Legislative and Regulatory Requirements. The most applicable statutory requirements for the Program/Project are the Nuclear Waste Policy Act (Act) of 1982 (Public Law 97-425, dated January 7, 1983) and the following amendments: Title V (Public Law 100-203, dated December 22, 1987, Public Law 100-507, dated October 7, 1988, and the Energy Policy Act (Public Law 102-486, dated October 24, 1992). The Act and the subsequent amendments are collectively and commonly referred to as the Nuclear Waste Policy Act, as amended (NWPA).

The NWPA provides a general framework for the siting, design, and operation of a repository for the disposal of high-level radioactive waste and spent fuel. Under the Nuclear Waste Policy Act of 1982, the Secretary of Energy was "to consider the various geological media in which sites for repositories may be located and, to the extent practical, to recommend sites in different geologic media." Subsequent amendments to the Act (as defined above) required that only the Yucca Mountain Site in Nevada be evaluated as a geologic repository. Other portions of the Act and amendments relate to issues associated with the repository, such as Monitored Retrievable Storage, disposal packages, transportation, and other critical repository elements.

Pursuant to the Act, various federal regulations have been promulgated regarding repository siting and operation to protect public health and the environment. These regulations are contained in the Code of Federal Regulations (CFR), and include: 10 CFR Part 2, The Nuclear Regulatory Commission regulation titled *Rules of Practice for Domestic Licensing Proceedings and Issuance of Orders*; 10 CFR Part 60, the Nuclear Regulatory Commission regulation titled *Disposal of High-Level Radioactive Wastes in Geologic Repositories*; 10 CFR Part 71, the Nuclear Regulatory Commission regulation titled *Packing and Transportation of Radioactive Material*; 10 CFR Part 72, The Nuclear Regulatory Commission regulation titled *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste*; 10 CFR Part 960, the Department of Energy guideline titled *General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories*; and 10 CFR Part 961, the Department of Energy regulation titled *Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste*.

In addition, the Energy Policy Act of 1992 required the U.S. Environmental Protection Agency, based upon and consistent with the findings and recommendations of the National Academy of Science, to promulgate public health and safety standards for protection of the public from releases of radioactive materials stored or disposed of in the repository at the Yucca Mountain Site.

The ultimate oversight of the Program/Project rests with the U.S. Nuclear Regulatory Commission which will provide the final determination that all pertinent regulations have been met and a license will be issued for operation of the repository.

Program and Project Mission and Goals. OCRWM's mission statement, as stated in the introduction to the *Civilian Radioactive Waste Management Program Plan, Volume I*, is as follows:

Our mission is to manage and dispose of the Nation's spent nuclear fuel and high-level radioactive waste. We will provide leadership in developing and implementing strategies that assure public and worker health and safety, protect the environment, merit public confidence and are economically viable.

OCRWM's mission statement is supported by the following broad-based goals, as stated in the Appendix A of the *Civilian Radioactive Waste Management Program Plan, Volume I*:

- Goal 1 Lead the collaborative development and implementation of national policy for the disposal of high-level radioactive waste.

- Goal 2 Participate actively in key deliberations which affect disposal of Department of Energy nuclear materials.
- Goal 3 Strengthen fiscal and Program management practices.
- Goal 4 Enhance effectiveness of human resources.
- Goal 5 Resolve the 1998 waste acceptance expectation issue.
- Goal 6 Provide for interim storage, timely waste acceptance, and transportation of spent nuclear fuel compatible with disposal.
- Goal 7 Evaluate site suitability for Yucca Mountain.
- Goal 8 Provide for timely waste emplacement in a disposal facility.

These eight broad-based strategic goals were first articulated in September 1994 in a document entitled *Strategic Plan for High-Level Nuclear Waste Disposal*. This document does two things: (1) it suggests that the eight broad-based OCRWM goals logically support the overall DOE strategic plan, and (2) it expands the eight broad-based OCRWM goals by identifying metrics, objectives and issues relevant to each goal. With respect to how the eight OCRWM goals tie to the overall DOE strategic plan, the document states: "The Office of Civilian Radioactive Waste Management (OCRWM) Strategic Plan reflects and supports the Department's goals and strategies and provides for effective OCRWM participation in the team effort to achieve the Secretary of Energy's leadership vision." Key elements of the overall DOE strategic plan are identified and examples are presented which demonstrate how the eight OCRWM goals support these DOE strategies. With respect to expanding the eight broad-based OCRWM goals, the document identifies "strategic metrics," "strategic objectives," and "strategic issues" which appear to drive each broad-based goal down to a more discrete and measurable level of detail.

In the context of the Review Team's evaluation of the OCRWM mission and goals, it was noted that there is no separate, site-specific, YMSCO strategic plan. Just as the OCRWM strategic plan provides goals and objectives that logically support the broader DOE mission, it may be appropriate for YMSCO to develop site-specific goals and objectives that logically support the stated OCRWM goals and objectives. In interviews with OCRWM and YMSCO managers, the Review Team noted a "Program v. Project" mentality, suggesting a possible "disconnect" in team spirit between Washington and Las Vegas. While the OCRWM Strategic Plan includes YMSCO activities,

a separate YMSCO strategic plan might help focus Project initiatives, reinforce Project identity, and foster teamwork among Project participants.

Project Resources. In light of existing regulation and the Program/Project goals and objectives outlined above, the scientific, technical, engineering, administrative, and managerial resources to understand and apply the requirements of the Program/Project are enormous. In the area of scientific and technical studies, the Project requires the services of geologists, hydrologists, geophysicists, chemists, geochemists, biologists, botanists, meteorologists, and many other specialized scientific and technical professionals. In the engineering and construction fields, the Project employs civil, mechanical, electrical, chemical, and construction engineers, as well as construction personnel for surface drilling, tunneling and a variety of construction support functions. Finally, the Project administration and management area employs individuals from the above fields, as well as computer scientists and information specialists, accountants, financial and managerial personnel, public relations personnel, and many others. In summary, the Program/Project, as set forth by existing regulations and as specified by the Program/Project goals and objectives, is a vast and unprecedented undertaking requiring a multitude of capable and innovative scientists, engineers, and administrators.

In light of these vast resource requirements, the Review Team's overall impression is that the DOE appears to have identified, gathered, and engaged adequate scientific and technical talent for the job. Certainly the pool of over 2,300 full-time equivalent (FTE) employees represents a formidable collection of intellectuals and capable professionals. Overall, the Review Team found Project personnel to be fully committed to professional work of the highest standards. In addition, Project managers possess an impressive collection of scientific and technical knowledge and experience. The Review Team noted a clear propensity by Project management toward the scientific and technical aspects of the Project. However, these same individuals appear to be less experienced in project management. While noting the value of this scientific and technical excellence, the Review Team has significant concerns regarding the limited breadth and depth of the collective managerial experience and knowledge. This concern is based on the many management issues observed by the Review Team during its review, including, among others: ambiguity in historical organizational structure, contractor responsibilities, and participant relationships; inadequate scientific and administrative integration; inefficient and incomplete decisional processes; strained Stakeholder

relations; and the overall lack of public trust and confidence. These issues are fully addressed in various sections of this report.

Organizational and Managerial Architecture

This discussion of organizational and managerial architecture is intended to provide background information and to preface the more detailed evaluation of the Yucca Mountain organizational structure that follows. Alternative forms of organizational structure are presented as well as a brief discussion of information flow and decisional authority considerations. This section provides the foundation for addressing the following NARUC-specified scope of work item:

- *What is the best way to organize the management of a scientific investigation project such as this? [NARUC C.3.2]*

Forms of Organizational Structure. Three forms of organizational structure are discussed below: the departmental structure, the product structure, and the matrix structure.

- **Departmental Structure:** This is the simplest organizational structure wherein all resources support a single product, service, or geographic profit center. Resources are typically grouped according to functional traits into various departments, such as engineering, research, production, construction, legal, and finance/accounting.
- **Product Structure:** In this organizational structure, product lines or geographic locations are the dominant organizational feature. Each product or geographic location is established to operate autonomously with its own resources for departmental functions such as engineering, research, production, and finance/accounting. Accordingly, each product line or location operates as a distinct business and cost center, with organizational resources duplicated to insure exclusive availability of resources to each project or geographic unit.
- **Matrix Structure:** This is a hybrid of the departmental and product structures. Separate product lines or geographic locations share common resources such as engineering, research, accounting/finance, etc., in a matrix arrangement. The result is that a single department (i.e., resource) may support multiple product lines.

In practice, many large organizations utilize some form of matrix structure. The matrix structure offers the economic advantage of shared resources. However, the matrix structure also has disadvantages. For example, internal relationships can become blurred as resource providers report to a matrix of resource users. Lines of authority and accountability can become ambiguous and

onerous unless organizational priorities are clearly and frequently communicated to all resource providers and users. In addition, the matrix form of organizational structure can complicate external communications as external parties may find it difficult to "plug in" to the matrix for information or communication purposes.

Information Flow and Decisional Authority Considerations. Another important organizational consideration is the efficiency with which information and authority flows through the organizational structure. Ideally, information is gathered at the lower organizational levels and flows upward to the higher-level decision-makers. On the other hand, authority stems from the higher-level decision-makers and flows downward to the lower organizational levels to direct the efficient gathering of information and implementation of work activities. The more levels that exist between the decision-makers and the information gatherers, the more opportunity for miscommunication, duplication of effort, and functional inefficiency. In a profit-oriented, competitive environment, market forces dictate that mid-level management be kept to a minimum, thereby resulting in flatter organizational structures.

What is the best way to organize the management of a scientific investigation project such as this? With respect to organizational structure considerations, given the complexity and vast resource requirements of the Project, the Review Team believes that the matrix structure provides the best structural framework from which to manage a scientific investigation such as this. The Project's organizational structure, as discussed below, is in fact a matrix structure with multiple "departments" and multiple "product lines." Although the project has encountered many management problems common to matrix organizations (including ambiguous lines of authority and accountability, difficult external communication, inadequate information flow, and inefficient decisional processes), the Review Team believes that many of these difficulties can be significantly mitigated as discussed in subsequent sections of this report.

YMSCP Organizational Structure

The managerial and organizational structure of the Yucca Mountain Project is evaluated in response to the following NARUC-specified scope of work item:

- *In light of existing regulatory requirements, assess the DOE's management and organizational structure. [NARUC C.1.1]*

Figure IV - 1
Yucca Mountain Project
Organizational Structure - As of 1993

Figure IV - 2
Yucca Mountain Project
Organizational Structure - As of 1994

The Project's management and organizational structure has evolved into what appears to be a more workable form. In 1991, the DOE awarded a Management and Operating (M&O) contract in order to enhance system integration, improve Project control, and reduce the number of DOE/Project participant interfaces. However, as of 1993, Project participants apparently maintained independent reporting relationships directly to YMSCO as depicted in Figure IV-1. The DOE recognized the need to reduce the number of DOE/participant contacts and initiated structural changes to channel Project participant reporting relationships through the M&O. In addition, a Program Management Organization (PMO) was introduced to assist with integration and project management. Figure IV-2 illustrates the Project structure with the PMO and the anticipated consolidation of Project participants as of 1994.

The Review Team's analysis of organizational structure focuses on the stated and actual functions and the interrelationship of the YMSCO, the M&O, the PMO, and the Project Participants. Collectively, these four entities are hereafter referred to as the Yucca Mountain Site Characterization Project (YMSCP). Figure IV-3 depicts the current conceptual relationship of these four organizational components of the YMSCP.

YMSCP Organizational Components. The following is a brief description of the four component members of the YMSCP organization:

The YMSCO. The YMSCO consists of approximately 100 FTE federal employees. According to interviews with YMSCO managers, the stated function of the YMSCO is to provide oversight, high-level planning, and direction for the Project. In theory, its function is to direct rather than actively manage.

The PMO. The PMO is comprised of approximately 60 FTEs which are "on-loan" from the M&O. The use of M&O employees is a temporary measure until a proposed Support Services Contract can be filled. The Request for Qualification for the Support Services Contract is currently being developed by OCRWM and is planned for release in late 1995. The stated function of the PMO is to provide direct support to YMSCO managers in matters pertaining to high-level strategic planning, integration, control, and reporting.

The M&O Contractor. The M&O contractor is comprised of TRW Environmental Safety Systems, Inc., and various subcontractors which in total contribute approximately 825 FTEs to the Project. The function of the M&O is to manage the day-to-day operations of the Project, and to provide resources to implement project activities. To the degree that the M&O is comparable to the prime or general contractor, all other participants report to the

M&O. It is the M&O's responsibility to implement and manage operations, and as such, the M&O directs participant activities.

The Project Participants. The major Project participants include Los Alamos National Laboratories (LANL), Lawrence Livermore National Laboratory (LLNL), Sandia National Laboratories (SNL), Reynolds Electrical and Engineering Company (REECo), and the U.S. Geologic Survey (USGS). In total, these major participants and several minor participants contribute approximately 1,380 FTEs to the Project. The Project participants share responsibility for conducting scientific, technical and public outreach activities under the direction of the M&O.

Prior to organizational changes beginning in October 1994, the participants reported to YMSCO, effectively bypassing the M&O. YMSCO recognized this significant flaw in organizational structure and has negotiated Memorandums of Understanding (MOU) and other arrangements to realign reporting relationships so that these participants now report to the M&O. The USGS, because it is part of the U.S. Department of the Interior, cannot be legally bound by any such agreement, but it has committed to cooperative Project support.

Figure IV - 3

Yucca Mountain Project

**The Organizational Components of the
Yucca Mountain Site Characterization Project
As of May 1995**

The YMSCP Matrix Organizational Structure. The four organizational components of the YMSCP interrelate in a complex three-dimensional matrix structure designed to allocate the diverse array of Project resources in accordance with Project objectives and priorities. The YMSCP matrix organizational structure is illustrated by Figure IV-4.

As previously described, the matrix organization is a hybrid of the departmental and product structures in which departmental resources are shared among multiple product lines. Applying this terminology to the YMSCP, the "departments" are analogous to the functional areas of the six YMSCO Assistant Managers: Scientific Programs; Engineering and Field Operations; Environmental, Safety and Health; Suitability and Licensing; Administration; and Public Affairs. The "product lines" are analogous to the four Project priorities identified by OCRWM: site suitability; National Environmental Policy Act (NEPA) requirements; licensing; and management and compliance. Resources are shared as the "departments" support multiple "products." For example, the activities relating to the Exploratory Studies Facility (ESF) are grouped under Work Breakdown Structure (WBS) 1.2.6., which falls under the Assistant Manager for Engineering and Field Operations. This "department" provides resources in support of two "products," namely site suitability and licensing.

The "departments" and "products" represent two dimensions of the matrix structure, but the YMSCP matrix is further complicated by multiple project participants. These participants represent the third dimension of the YMSCP three-dimensional matrix structure. Continuing with the ESF example, for WBS 1.2.6., there are four primary participants which provide resources: the M&O, LANL, SNL, and REEC0.

Note: This figure illustrates the overall organizational structure of the Yucca Mountain Project. It is not intended to document specific reporting relationships.

The YMSCP Matrix Organizational Structure - As of May 1995

While the YMSCP organizational matrix appears to be very complicated, this fact alone is not necessarily a problem. Complicated programs requiring the allocation of vast and diverse resources, by necessity, require more complex organizational structures. Such structures can work well, provided the organization's management recognizes the challenges and works to overcome two potential disadvantages. First, reporting relationships and priorities can easily be "lost in the maze." To accommodate for this, project managers must clearly and frequently communicate project priorities to all participants. Secondly, the organizational structure may be difficult for outsiders to understand. Accordingly, managers must work hard to overcome potential problems by communicating with the external parties. For YMSCP, external parties include the Nuclear Regulatory Commission (NRC), the Environmental Protection Agency (EPA), the Nuclear Waste Technical Review Board (NWTRB), the General Accounting Office (GAO), the Stakeholders, and other oversight parties.

Organizational Structure - Areas of Concern. In theory, YMSCO provides Project oversight and direction; the PMO assists with strategic planning, integration and management reporting; the M&O serves as a prime contractor, managing and implementing the day-to-day operations of the Project; and the Project participants supply the vast technical and scientific resources necessary to accomplish the required functional activities. In practice, the roles and interorganizational relationships of these four entities have been blurred and ambiguous. YMSCO has been heavily involved in the day-to-day management of the project. This involvement has undermined the effectiveness of the M&O in fulfilling its primary function of managing the day-to-day Project activities and Project participants. YMSCO's reasons for retaining possession of the management function are largely due to the historical circumstances surrounding the M&O's introduction into the Project in 1991. This issue is further discussed under the contractor relations portion of this section.

DOE's struggle to define its role as either a high-level oversight body or an active project participant and manager has been perhaps the single most significant organizational element impacting operational effectiveness of the YMSCP. The DOE continues to struggle with this issue, though the recent consolidation of participants under the M&O umbrella has laid the framework to transition YMSCO from active involvement in the day-to-day project activities to more high-level planning and directional oversight role. Clarification of YMSCO's role is important because the

level of YMSCO's day-to-day management and involvement dictates the mode by which the M&O contractor, the Project participants, and the PMO will manage and administer the Project activities.

Another area of concern identified by the Review Team is the PMO. In order to avoid any potential conflicts of interest, there is supposed to be a distinct separation of duties between the M&O/PMO employees and other M&O employees. Some Project participants have expressed a concern that TRW's dual roles of integrating project activities through the PMO, as well as performing some Project activities as M&O, could place TRW in a position to take unfair advantage of other participants in allocating project work.

Given the current organizational roles of the PMO and the M&O, the conflict-of-interest issue is a valid concern; but more importantly, it underscores a number of functional questions regarding the respective roles of the PMO and the M&O. For example, if the stated function of the *Management and Operating Contractor (M&O)* includes Project *management*, why is there a need for a separate Program *Management* Organization (PMO)? Furthermore, why is there a concern by other participants of a conflict of interest if it is accepted that the M&O's job is to manage? Should not the M&O, as prime contractor, have the power to exercise managerial authority in allocating Project work among qualified participants?

If one accepts the stated role of the M&O to include Project management, then it follows that the M&O should possess the authority to allocate work among qualified participants. The Review Team detected a historical tendency by YMSCO to shield the national laboratories, the NTS contractors, and other Project participants that predate the M&O from the M&O's management control. For example, the DOE required that direction from the M&O contractor to DOE's national laboratories, other federal agencies, and contractors at the Nevada Test Site, pass through a DOE representative. While recent actions by YMSCO, including the consolidation of Project participants under the M&O, have begun to address this problem, the Review Team remains concerned that the PMO could be used by YMSCO to assert continued managerial control over the M&O and the Project participants.

The stated role of the PMO is to provide direct support to YMSCO managers in matters pertaining to high-level strategic planning, integration, and managerial reporting. However, the

Review Team believes that the strategic planning function should reside solely with federal YMSCO employees, while the integration and managerial reporting functions should reside with the M&O. Accordingly, the Review Team questions the long-term need for the PMO or the proposed Services Support Contractor.

The final area of concern is that the M&O has introduced an additional level of middle management to the YMSCP structure. Although the Review Team performed only limited analysis of the M&O organizational structure in terms of a review of functional design and internal M&O reporting relationships, it did receive comments from DOE and M&O personnel expressing this concern. This criticism may, in part, originate from Project participants, perhaps because they resent taking direction from the M&O. Nevertheless, it may be a valid criticism in two respects. First, although M&O managers have indicated that the M&O organizational structure was reorganized to align M&O personnel with the DOE's six Assistant Managers and their subordinate Team Leaders, the M&O organizational chart does not appear to correlate to the DOE organizational structure. In most cases, a single DOE Team Leader would have to consult numerous M&O personnel for information directly pertaining to his or her team. Accordingly, the M&O might benefit from additional streamlining and reduction in midmanagement levels and some additional restructuring to better align M&O functional divisions with DOE teams. The Review Team suggests that this be further evaluated. Second, if key decisions continue to be made by YMSCO managers at the top of the YMSCP organizational structure, then, in fact, the M&O has introduced an additional level in the management structure which moves the decision-makers further away from the day-to-day operations. If the YMSCO decision-makers want first-hand information, they must go to the participants. This perpetuates ambiguity in reporting relationships and creates organizational disruptions and inefficiencies. The solution to this problem, however, does not lie with simply changing the M&O structure, but rather in empowering a qualified M&O to manage operations with greater decisional authority at lower levels. Accordingly, the DOE must limit its function to that of an oversight body, affirming its role by limiting its day-to-day management involvement and by empowering the M&O to perform its assigned activities.

Key Personnel

In addition to gathering the required resources, identifying organizational priorities, setting the organizational structure and effectively allocating resources in support of the identified priorities, the

entire system must be fueled by key personnel with the skills required to guide the organization to its stated objectives. The Review Team has considered three issues regarding Project leadership and key personnel:

- The role of the Chief Scientist; this issue is examined in response to NARUC's question:

What role will the new Chief Scientist position play in ensuring that all the science that is necessary is done? [NARUC A.3.4]

- The need for long-term management continuity.
- The need for a tunnel expert.

The Chief Scientist. The idea of a Chief Scientist originated with a memorandum from the Secretary indicating the need for improved integration of scientific studies. The idea has generally been endorsed by external parties, but is less favorably viewed by many Project managers and participants. The position has been authorized, but to date has not been filled.

The Chief Scientist, as defined by OCRWM, would serve as the senior technical advisor for the Yucca Mountain Site Characterization Project, reporting to the OCRWM Program Director. The Chief Scientist would have a broad oversight role for the scientific aspects of the Program. According to the authorized position description, the duties of the Chief Scientist are as follows:

- Oversees scientific investigations at Yucca Mountain and assures coordination and integration of these aspects through the Project Manager.
- Provides recommendations to the Director, OCRWM, and Project Manager, as necessary, to modify or focus parts of the technical program.
- Coordinates with cognizant line managers to ensure the collection of scientific data is appropriately focused and integrated with the evaluation of site suitability and resolution of other regulatory compliance issues.
- Coordinates with the cognizant line managers in evaluating testing and data analyses to ensure the highest quality science.
- Coordinates peer reviews
- Conducts technical outreach.

In response to the NARUC scope of work question, "What role will the new Chief Scientist position play in ensuring that all the science that is necessary is done?" the Review Team is of the opinion that the position, as currently defined by OCRWM, would lack the necessary independence to satisfy many external critics that all the science that is necessary is done. Critics have articulated

the need for a Chief Scientist with over-riding authority to safeguard the Site Characterization process from schedule or funding pressures that might otherwise compromise the quality and quantity of scientific investigations. Based on OCRWM's current definition of the Chief Scientist position as directly reporting to the OCRWM Director, the Review Team does not believe the position would possess the level of independence that many critics demand.

It should be noted that the Review Team also detected some disagreement at the Project level as to whether the Chief Scientist position should be filled. Overall, YMSCP managers and participants are uncertain as to the limits of the position and are concerned that the Project may suffer a significant setback if basic scientific priorities and approaches are subject to rethinking at this late stage. If the position is filled, the individual selected for the new position should anticipate resistance. The Chief Scientist will need to work closely with the Project managers to overcome current apprehensions.

Although the Review Team acknowledges the limited independence of the position as defined, it still advocates filling the position. The Review Team believes that a qualified Chief Scientist could significantly enhance the coordination of scientific studies as well as facilitate improved communication to external parties. In order to be effective, the individual selected to fill the Chief Scientist job must be an extraordinary technical scientist having an interdisciplinary intellect, with an equally exceptional business acumen. Although the description above implies a single person will fill the role, the Review Team envisions that a small staff of very talented, multidisciplined people would be required to assist the Chief Scientist in obtaining the desired objectives of the position.

If the Chief Scientist position were structured with the independence that many believe is required to ensure that all the science that is necessary is done (as opposed to the Chief Scientist position as currently envisioned by the DOE), the Review Team acknowledges the possibility that short-term delays and costs could result from the independent Chief Scientist rethinking many of the Project's scientific approaches. However, the long-term benefits could easily outweigh the short-term disadvantages, provided that the Chief Scientist position is appropriately structured. For example, it must be a long-term position, insulated from changes in administration or OCRWM directors. Nothing could be as potentially disruptive to the Project as turnover in the Chief Scientist's office. In addition, the position should be the primary Project contact for all technical

interaction with external parties, including the NWTRB, the NRC, the EPA, and other regulators and advisory groups. Expanding the role of the Chief Scientist to include external technical relations could significantly ease current demands on YMSCO managers and reduce external communication barriers caused in part by YMSCP's complex matrix organizational structure.

The Need for Long-term Management Continuity. Although this issue is not specifically set forth in the NARUC-defined scope of work, it was identified as a common concern during the course of the Review Team's analyses of many of the NARUC scope of work items. As such, the Review Team has chosen to specifically address the issue in order to present a more complete discussion of organizational effectiveness issues.

The Review Team believes that lack of managerial continuity has negatively impacted the performance of the Program/Project's ability to succeed and to remain on schedule and within budget. It is the collective opinion of the Review Team, based on over 200 person-years of project experience, that continuity of leadership is a required tenet of any successful complex long-term undertaking. The Review Team's experience on major programs and projects has identified common denominators that are generally present. Projects with continuity of leadership are generally successes; projects without continuity are generally problematic.

Since its inception in 1982, the OCRWM has had eight Directors in total, of which five were Acting Directors. The OCRWM Directors and their respective terms of office are as follows:

Robert Morgan (Acting)	10/02/83	through	01/05/84
Michale Lawrence (Acting)	01/06/84	through	05/24/84
Ben Rusche	05/25/84	through	11/03/87
Edward Kay (Acting)	11/03/87	through	11/07/88
Samuel Rousso (Acting)	11/08/88	through	04/05/90
John Bartlett	04/06/90	through	01/20/93
Lake Barrett (Acting)	01/21/93	through	10/07/93
Daniel Dreyfus	10/08/93	through	present

The OCRWM Director's position requires U.S. Senate confirmation. When a new administration takes office, the first order of business with respect to appointee confirmation relates to the President's cabinet and other high-ranking administration positions. There are also certain priority prerogatives of the Senate that take precedence over other confirmation considerations. In other

words, it may take months to confirm an OCRWM Director. In the interim, an Acting Director is in charge. As a result, many of the key decisions and initiatives are postponed while waiting for the confirmed Director to take charge.

The OCRWM Program and its Yucca Mountain Project are constantly subjected to complex changes. The institutional knowledge and "learning curve" require months or several years to acquire. Each new Director must become engulfed in Program/Project orientation, learn first-hand of its intricacies, conceive and implement any desired changes, and stay on top of the position's responsibilities.

The history of OCRWM with its eight Directors over a 12-year period indicates typically a tenure of less than two years. After subtracting the learning curve time and the time of the Team to adjust to the new Director's mode and style of operation, there is hardly enough time to carry out any significant changes to direct the operation, maintain momentum, and assure continuity. In the opinion of the Review Team, if this history is allowed to continue, the Program/Project has a very limited chance to succeed.

Many interviewed by the Review Team, including DOE and M&O personnel as well as various Stakeholders, share the Review Team's opinion that the Project has been negatively impacted due to the lack of management continuity. According to a previous YMSCO Acting Project Manager, it takes approximately three years to "get back to business" following a major redirection of the Program or Project. According to those interviewed by the Review Team, changes in Program/Project leadership have caused changes in Program/Project direction which have undermined accountability and commitment at every level. Midlevel managers and participants point to redirected Program/Project objectives or priorities as the reason why certain activities may have been reprioritized or abandoned or why the schedules may have slipped. One M&O senior manager commented, if the current goals and objectives are likely to be redirected by a new Program Director or Project Manager, why should managers and participants seriously commit to current activities and/or schedules?

The Review Team views the lack of continuity of directorship and management as a very important issue with global Program/Project implications. It is the opinion of the Review Team that

an in-depth consideration of this issue by DOE and, as appropriate, the Congress, would best serve the objectives of the Program/Project, nuclear power industry interests, and the public at large.

Solution of this problem will require legislative change. It is not within the Review Team's scope of services to analyze the pros and cons related to this issue. Potential options for future consideration, by the Congress, include appointment of an OCRWM Director for a term of office as specified in years (i.e., 6, 8, or 10 years), or moving the OCRWM Program to a federal corporation or commission.

The Need for a Tunnel Expert. This issue is also not set forth in the NARUC-defined scope of work, however, through discussions with Project personnel and observations at the Project site, the Review Team recognized what it believes is a serious deficiency in the current organizational structures of the YMSCO and the M&O contractor.

The tunnel and alcove excavation work for the development of the exploratory studies facility is currently being performed by a premier tunnel contractor who has assigned a well-qualified project manager to supervise the work. While the YMSCO and the M&O contractor are currently overseeing the tunnel contractor's work, neither organization has senior personnel possessing appropriate underground construction experience to enable or facilitate appropriate decision-making input with regard to exploratory studies facility progress. The Review Team believes that either the Yucca Mountain Project or the M&O contractor should hire and assign a senior employee with experience comparable to that of the tunnel contractor's project manager to oversee the tunnel contractor's work. This work is critical to the overall objectives of the project and is a highly visible deliverable product in the minds of the public, media, and critics of the Yucca Mountain Project.

Summary of Organizational Structure

For any organization to be effective, the organization's mission and goals must be clearly defined and communicated, the resources required to carry out the mission and achieve the stated goals must be identified, and the organizational structure must be designed to efficiently allocate such resources in accordance with the stated mission and goals. To date, the Yucca Mountain Site Characterization Project does not have a separate site-specific strategic plan. Such a plan, however, is needed to focus on site-specific Project initiatives, reinforce Project identity, and foster teamwork among site

participants. Further, the Project appears to have identified and gathered adequate scientific and technical talent for the job, but this same pool of talent lacks the depth and breadth of management skills required of the complex, three-dimensional organizational structure currently in place.

That said, the Review Team generally believes that the organizational structure, though complex, can provide for the allocation of a vast array of diverse resources to Program and Project objectives. To do so, however, managers must be able to clearly and frequently communicate project priorities to all participants and work to overcome potential communication problems with external parties such as the NRC, EPA, NWTRB, GAO, Stakeholders, and others. Additionally, YMSCO managers should relinquish their role of being heavily involved in the day-to-day management of the Project. The recent consolidation of participants under the M&O umbrella has laid the groundwork to transition the YMSCO from active involvement in day-to-day project activities to more high level planning and oversight.

When dealing with a complex organizational structure, diverse resources and arduous goals and objectives, the need for continuity in Program and Project leadership cannot be overemphasized. Based on the Review Team's collective experience with other major long-term projects, those with continuity of project leadership are generally successful while those lacking continuity are generally problematic. The role of the Chief Scientist could potentially provide some degree of continuity as the position would be long-term and insulated from changes in administration or the OCRWM Director. Furthermore, as a facilitator of improved communication and a coordinator of scientific studies, the Chief Scientist could potentially provide an element of cohesiveness to the organizational structure. The addition of a tunnel expert to either the YMSCO or M&O organizations could provide for better interactions with the tunnel contractor. In addition, this position could provide better communications to the public, media and critics of the Project on tunnel excavation issues.

Options for Consideration

The Review Team offers the following options for consideration relative to the observations above:

- YMSCP should develop a separate site-specific strategic plan that is fully compatible with the OCRWM Strategic Plan. Once written, the YMSCP Strategic Plan should be widely disseminated to all YMSCP employees, including all M&O and Project participant personnel,

in order to focus Project initiatives, reinforce Project identity and objectives, and foster teamwork among site participants.

- The DOE must refrain from becoming over-involved in the day-to-day management of the Project by empowering and supporting the M&O. Decisional authority should be pushed downward to the appropriate level of the M&O structure, and consistently supported by DOE managers so as not to undermine M&O authority with Project participants.
- The strategic planning functions currently supported by the PMO should be the sole responsibility of permanent federal employees, while the integration and management reporting functions of the PMO should be given to the M&O.
- The current M&O organization should be carefully reviewed for possible streamlining of internal operations and reductions in midlevel management.
- The position (and staff) of the Chief Scientist should be filled, however there are certain issues that must be addressed: (1) the Chief Scientist should be a long-term position, insulated from changes in administration or OCRWM Director; (2) there should be consensus among YMSCO managers, particularly the six Assistant Managers, that they will cooperatively support the position; and (3) the Chief Scientist's responsibilities should include technical interaction with external parties, including the NWTRB, the NRC, the EPA, and other regulators and advisory groups.
- The Secretary of Energy should investigate options for providing continuity of leadership for the OCRWM Program and, if legislative change is indicated, propose such a change to Congress.
- Either the YMSCO or the M&O contractor should hire and assign a senior employee with experience comparable to that of the current tunnel contractor's project manager to oversee the tunnel contractor's work.

CONTRACTOR RELATIONS

Five NARUC-specified scope of work items concern contractor relations. The five items are restated below under five somewhat broader topic headings:

- DOE's Role in Project Management

Should DOE personnel be the on-site project managers or should they concentrate their resources on setting the objectives of the Project and overseeing a management contractor to ensure the objectives are met? If DOE manages the Project, does it have or can it acquire sufficient technical skills to effectively perform this function? [NARUC C.3.4]

- The M&O Contractor's Role in Project Management

Evaluate the role of the management and operating contractor, especially in relationship to DOE staff and other contractors. [NARUC C.4.1]

- Contractor Resources and the Distribution of Work

Is the correct mix of contractors, and the distribution of work among them, the best scientific and most cost-effective way to characterize the site? [NARUC C.4.2]

- Contractual and Extracontractual Considerations

Does DOE's relationship to contractors, cooperative agreement recipients, and its institutional program, facilitate effectiveness and adequate control with respect to deliverables and schedules? [NARUC C.2]

- Recent Changes in Contractor Relations

In light of changes that DOE is making at the Project, what are the potential effects of these changes on improving relationships among contractors and between DOE and the management and operating contractor. Should DOE consider more fundamental changes, and, if so, what changes should be made to enhance the Project? [NARUC C.4.4]

A discussion of these five topics follows, along with the Review Team's summary and options for consideration relative to contractor relations.

DOE's Role in Project Management

The DOE has struggled in recent years to define its role at Yucca Mountain. Accordingly, NARUC has posed the following questions:

- *Should DOE personnel be the on-site project managers or should they concentrate their resources on setting the objectives of the Project and overseeing a management contractor to ensure the objectives are met? If DOE manages the Project, does it have or can it acquire sufficient technical skills to effectively perform this function? [NARUC C.3.4]*

To address these concerns the Review Team interviewed various federally-employed OCRWM and YMSCO managers, M&O-employed managers, and external parties such as the GAO and the NWTRB. In addition, the Review Team read numerous reports and ancillary materials received from OCRWM, YMSCO, Project participants, the GAO, the NWTRB, and others.

Historical/Cultural Considerations. The DOE has historically used contractors to carry out its mission. Department-wide, approximately 18,000 FTE federal employees oversee a total contractor work force of approximately 150,000. In addition, the DOE has a long legacy of using M&O contractors to manage and operate various nuclear-related sites and/or facilities. Given these considerations, it is understandable that the DOE elected to use the M&O concept in its nuclear disposal program.

Current Conditions. As pointed out by the GAO in its December 1994 report entitled "DOE's Management and Organization of the Nevada Repository Project," the disposal program differs from past experiences in that the M&O contractor is expected to manage a program rather than a site or a facility. The Program is a first of its kind, with unprecedented technical challenges, a politically charged environment, and an emerging and potentially changing regulatory arena. In addition, the significant environmental and public health and safety aspects of the Project have driven the DOE into greater management involvement than would normally be expected.

On one hand, historical and cultural considerations may have lead the DOE to seek an M&O contractor to provide for the day-to-day management and operation of the Project, but on the other hand, the Project's unique technical challenges and the public's demands for governmental accountability have caused DOE to retain much management control. These conflicting dynamics have resulted in over-involvement by OCRWM and YMSCO and a corresponding under-utilization of the M&O contractor. In addition, DOE's continued active involvement with the many Project participants has created considerable ambiguity in organizational structure and operational functions.

Recent actions to consolidate participants under the M&O umbrella have clarified reporting relations and should facilitate the transfer of greater management authority from the DOE to the M&O. In the past, the DOE has been conciliatory to participants in order to facilitate cooperation and the ultimate consolidation of participants under the M&O. Now that such consolidation has occurred, the DOE must demonstrate strong and unwavering support for the M&O's new role. This means strict compliance with formal lines of communication and authority. Anything less will continue to undermine the authority and effectiveness of the M&O. The DOE's recent consolidation of participants under the M&O, as well as the need for the DOE to demonstrate support for the

M&O's authority under the new structure, are more fully discussed in subsequent sections of this report.

With respect to the questions posed by NARUC, the Review Team acknowledges that the Department has the capacity to hire technically talented individuals, as is evident by the many highly intellectual federal employees currently involved in the disposal program. Furthermore, the extension of the Department's work force through the use of contractors is appropriate given the structure of the Department, the technical nature of its many programs, and the political and funding variables that can at any time redirect activities and shut down Project tasks. The Review Team concludes that it is appropriate for the DOE to concentrate its limited resources on setting the objectives of the Project and overseeing a management contractor to ensure the objectives are met. However, clarification is needed with respect to the role of the M&O as discussed here, and also with respect to the role of the PMO, as discussed under the previous section regarding organizational structure.

The M&O Contractor's Role in Project Management

With respect to the role of the M&O contractor, the Review Team has already indicated that the DOE's reluctance to empower the M&O contractor has limited the contractor's effectiveness. It is within this context that the Review Team addresses the following NARUC question:

- *Evaluate the role of the management and operating contractor, especially in relationship to DOE staff and other contractors. [NARUC C.4.1]*

The M&O Concept. In theory, the M&O contract is an agreement under which DOE contracts for the operation, maintenance, or support of a site or facility devoted to one or more of its programs. DOE retains responsibility for defining the scope of the Program and providing technical direction to the contractor; the contractor is responsible for the day-to-day management of the work, including providing necessary resources and technical, schedule, and budget direction to other Project participants. DOE and its predecessor agencies have used this type of contract, in which DOE pays virtually all the costs and exercises only broad general oversight, to operate nuclear-related sites and facilities since World War II.

With respect to the nuclear disposal program, one of DOE's original objectives for hiring an M&O contractor was to reduce the number of participants working on the disposal program and to streamline reporting relationships. The intent was to reduce the total number of contractors working on the Project (as the work of some existing contractors would be transferred to the M&O) and reduce the number of DOE/participant contacts by establishing a strong central management and thus, a single point of contact for the DOE managers. The anticipated result was that DOE managers would be freed from the day-to-day operation of the Project to enable them to conduct high-level planning and Project oversight.

Historical Considerations. The M&O contractor has faced significant challenges from the onset due to limitations and ill-conceived lines of authority imposed by the DOE. While the DOE felt compelled to establish a strong centralized management structure (in part due to the historical and cultural considerations discussed above), it had already established long-term relationships with numerous Project contractors. In an effort to accommodate these existing contractors, the DOE required the M&O contractor to conduct field-related site characterization and environmental work utilizing these existing project contractors. The M&O was also made responsible for providing technical, schedule, and budget direction to project contractors. However, the DOE required that direction from the M&O contractor to DOE's national laboratories, other federal agencies, and contractors at the Nevada Test Site, pass through a DOE representative. These laboratories, agencies, and contractors included six of the project's seven major participants as well as several of the minor participants.

TRW Environmental Safety Systems (TRW) was brought on as the M&O contractor in 1991 after it filed a legal challenge to DOE's decision in 1988 to award the contract to Bechtel Systems Management, Inc. According to the GAO, the YMSCO Project Manager in 1991 did not agree that an M&O contractor was necessary and established procedures that limited the M&O's authority. TRW aggravated this situation by demonstrating what other participants have characterized as naive arrogance. DOE's actions to limit the M&O's authority empowered Project participants to act independently of the M&O. According to the GAO and others, these conditions perpetuated a complex distribution of work and duplication of contractors' responsibilities.

Current Conditions. While recent initiatives have resulted in a formal consolidation of Project participants under the M&O structure, the DOE still retains significant management control. TRW has overcome much of the earlier resistance by YMSCO and Project participants, but the recent consolidation of participants alone will not ensure effective M&O Project management. OCRWM and YMSCO must continue to empower the M&O by actively supporting the M&O's decisional authority and managerial control. This is further discussed below under the section entitled "Recent Changes in Contractor Relations."

Contractor Resources and the Distribution of Work

Given the diversity of resources and talent within the DOE, the M&O, and the many Project participants, NARUC asks the basic question:

- *Is the correct mix of contractors, and the distribution of work among them, the best scientific and most cost-effective way to characterize the site? [NARUC C.4.2]*

The scope of the Review Team's evaluation is strictly limited to the financial and management aspects of the Yucca Mountain Project. As such, the Review Team has made no assessment of any participant's technical qualification to perform its assigned work and the Review Team offers no opinion as to whether the distribution of work among contractors facilitates the "best scientific" way to characterize the site. With respect to "cost-effectiveness," the Review Team investigation was limited to include a brief discussion of selected areas of concern, including the historic lack of participant integration and the sensitive issue of special set-asides in the procurement process.

Major Project Participants. The following table is provided for informational and reference purposes only. It summarizes the Project participants and the distribution of work among them. For reasons previously discussed, the Review Team did not evaluate the technical qualifications of any contractors, nor did it assess specific scientific work assignments or the "mix" of contractors to ensure the DOE had engaged the appropriate scientific resources to achieve the "best scientific" way to characterize the site.

PARTICIPANT RESPONSIBILITIES	
Participant	Primary Responsibilities
TRW Environmental Safety Systems	Prime contractor, systems engineering, design, development, technical directions, management, and operations
Lawrence Livermore National Laboratory	Waste package
Los Alamos National Laboratory	Site investigation, ESF test management
Sandia National Laboratories	Performance assessment, geotechnical studies
Reynolds Electric and Engineering Company	Construction, maintenance, and administration
Science Applications International Corporation	Environmental studies, public outreach
B&W Fuel Company	Engineered barrier design and development, training
Duke Engineering and Services	Repository licensing, MRS design, MRS siting support, outreach, quality assurance
Fluor Daniel	Surface facilities design and development
INTERA	Performance assessment
Morrison-Knudson Corp.	Underground facility design
Woodward-Clyde Federal Services	Site characterization
U.S. Geologic Survey	Site investigations

Areas of Concern. The Review Team observed inefficiencies in interparticipant relations including overlapping technical studies and the lack of shared data. The GAO and others have also identified past inefficiencies and duplication of work resulting from poor participant integration. Specifically, the GAO has reported that DOE's actions to limit TRW's role in the project while allowing for contractor independence has perpetuated a complex distribution of work and duplication of contractors' responsibilities. These and other integration-related issues are more fully covered in the discussion of organizational effectiveness entitled "Integration."

Another area of concern regarding contractor resources pertains to procedures that may suboptimize the Project's procurement process. For example, two members of the Review Team were informed on separate occasions that small business set-aside considerations may have been given priority over bidder qualifications for the procurement of critical TBM conveyor systems and electrical switching equipment. The Review Team offers no comment on the policy of set-asides for the purpose of promoting specific government contracting policies. However, the Review Team believes that the DOE should make as one of its priorities, the selection of contractors and suppliers who will not jeopardize critical path or near-critical path schedule activities and who are the most capable and competitive from among an array of qualified bidders.

Contractual and Extracontractual Considerations

This section serves as an introduction to subsequent sections of this report in which the Review Team presents its analyses of contractual and procedural controls for the effective management of Project participants. The discussion presented here is not intended to be a rigorous analysis of the legal or contractual relations between the DOE and Project participants, but rather an overview of the informal considerations that impact DOE, M&O and participant relations. This introductory discussion stems, in part, from the following NARUC question:

- *Does DOE's relationship to contractors, cooperative agreement recipients, and its institutional program, facilitate effectiveness and adequate control with respect to deliverables and schedules? [NARUC C.2]*

DOE Contracting Practices. DOE has historically used cost-reimbursable contracts. In February 1994, a DOE team evaluated the Department's contracting practices and recommended, among other things, that DOE replace cost-reimbursable M&O contracts such as the TRW contract with competitively awarded fixed-priced contracts or performance-based management contracts. It is GAO's opinion, as expressed in its December 1994 report on DOE's Management and Organization of the Nevada Repository Project, that OCRWM fell short of the DOE's contract reform recommendations when it approved TRW's M&O contract extension in June 1994 without evaluating whether TRW's contract could be replaced with a performance-based management contract. As OCRWM and YMSCO transition from an active manager to more of an oversight body, the M&O will have increased management authority. This presents a greater concern with the cost-reimbursable contract concept. However, it should be noted that DOE's administration of the M&O

contract provides for various controls, including performance-based award fees and penalties, which encompass many of GAO's recommended reforms. The Review Team addresses these financial and contract management issues in more detail in Section Five of this report.

Other areas of concern include DOE's past requirement that direction given by the M&O to Project participants pass through a DOE representative. This is inconsistent with the DOE's stated objective of reducing the number of DOE/participant points of contact. In addition, DOE's requirement that the DOE use existing Project contractors is inconsistent with the stated objective of reducing the number of Project participants.

Extracontractual Considerations. According to DOE managers, M&O personnel, and others, contractor relations were negatively impacted by: YMSCO's own reluctance to accept the M&O; TRW's mistaken arrogance that it could "solve the Project's many problems"; Project participants' resentment that TRW gained the M&O contract from Bechtel through a legal challenge; and participants' general unwillingness to report to TRW. These historical factors still present a significant barrier to productive and effective relations. Even with the agreements now in place to consolidate lines of authority under the M&O, the long history of individual participants reporting directly to the YMSCO, and the unfortunate circumstances surrounding the M&O's introduction to the Project, will have a significant negative impact on contractor relations for some time to come.

Recent Changes in Contractor Relations

It has taken three years to overcome participants' misgivings toward the M&O to the extent that the participants have agreed to report to the M&O. It will take much longer to build effective, positive, and cooperative team relationships. Accordingly, NARUC has asked the following questions:

- *In light of changes that DOE is making at the Project, what are the potential effects of these changes on improving relationships among contractors and between DOE and the management and operating contractor? Should DOE consider more fundamental changes, and, if so, what changes should be made to enhance the Project? [NARUC C.4.4]*

YMSCP Managers Must Limit Their Involvement. DOE's consolidation of the remaining Project participants in April 1995 lays the foundation for greatly improving the organizational architecture of YMSCP and moving toward improved contractor relations. However, DOE actions must now

be consistent with the intent of the reorganization. OCRWM and YMSCO managers must limit their involvement in the day-to-day management activities of the Project. Breaking with past practices may pose a personal challenge to the YMSCO managers, given their scientific and technical backgrounds. According to the most recent Acting Project Manager, he expended considerable time in "pastoral counseling" attempting to get his staff to release their technical grip on the Project and move to an oversight role. Furthermore, YMSCO managers must fully support the M&O by consistently enforcing reporting channels through the M&O. If DOE short-circuits the new organizational lines of authority by engaging in discussions directly with such participants, or if the DOE fails to support decisions by the M&O relevant to the allocation of participant work assignments, the formal organizational structure that took three years to craft will be rendered ineffective.

Duplicated Activities Should Be Eliminated. One item that should be monitored following the April 1995 contractor consolidations is the degree to which staffing is reduced to eliminate duplicated support functions among contractors. Because each project participant incurs costs for management, coordination and planning, and support services in performing its assigned activities, the total Project cost for these activities is the aggregate cost for all Project participants. Therefore, consolidating activities under fewer participants should reduce the total costs for management, coordination and planning, and support services, and free up project funds for other uses, such as site investigations and activities related to the repository, exploratory studies, and waste package design.

A recent example of how DOE's continued involvement in specific management activities has hindered the effectiveness and undermined the authority of the M&O involves a situation where a high-level YMSCO manager verbally directed the M&O not to reduce staffing in management and administrative functions, despite an overall OCRWM directive to achieve a 1995 budget reduction of ten percent in this area. This issue surfaced in the recent midyear review when the M&O requested additional funding for "unfunded staffing." Apparently, the DOE manager issued the verbal directive in anticipation of growth in Project activities and expanded M&O duties in light of anticipated consolidation of management activities under the M&O. As a result, the desired reduction in duplicated managerial and administrative staff was not realized, nor was the M&O free to redirect and streamline staffing to gain greater efficiency in these functional areas.

Changes in Personnel and Project Participants. With respect to the NARUC question of whether DOE should consider more fundamental changes to enhance the Project, the Review Team believes that new personnel could facilitate positive change. The fundamental question is: "If there is a change in the organizational structure or management, but the same people continue to perform the same activities, is there really a change?" This question stems from the DOE's practice of giving preference to existing personnel when a new contractor assumes the responsibilities of a prior contractor. For example, REEC Co will no longer be a Project contractor after 1995, and TRW, as the M&O, will assume the procurement duties previously assigned to REEC Co. Although there is no contractual requirement by the DOE or M&O to retain the REEC Co procurement personnel, termination benefits such as voluntary reduction pay, early-out pay, and/or severance pay, may cost as much as \$15,000 to \$20,000 for each individual that is not retained. Accordingly, the DOE has requested that the M&O give special consideration to existing REEC Co employees. Obviously, it may be advantageous to retain highly qualified people, both for their corporate knowledge and for the savings associated with termination pay. However, the cost of termination pay should not be overemphasized as a reason for retaining personnel, as such a practice could hinder opportunity for constructive change. While the Review Team acknowledges that the learning curve is significant on such an involved project, the Team still maintains that change of personnel can bring fresh ideas and improved ways of doing things, as well as renewed excitement and heightened morale. To the degree that there are opportunities to bring in new participants or new personnel, the Review Team encourages such change where appropriate. However, the process of continual team integration and team building must be practiced.

Summary of Contractor Relations

The DOE has historically utilized an M&O contractor to provide the day-to-day management and operation of its programs. Due to the unique technical challenges, the public's demand for governmental accountability, and other factors, the DOE has been more reluctant to relinquish managerial control in the Yucca Mountain Site Characterization Project. As such, DOE's over-involvement in managing Project activities (as well as the M&O's underutilization) has created considerable ambiguity in organizational structure and operational functions. Further, in years past there has been much resistance by Project participants and YMSCO managers toward the M&O contractor. These conditions have led to inappropriate distributions of work, duplication of efforts, and in general, contractor independence.

It is the opinion of the Review Team, that it is appropriate to use contractors to manage and implement the activities of the disposal program provided the respective DOE oversight and M&O management roles are clearly defined, communicated and embraced. Over the last three years, attitudes toward the M&O have changed to the extent that participants have agreed to report to the current M&O contractor. It will likely take longer still to build effective, positive, and cooperative team relationships. Periodic changes and/or additions to contractor personnel can also help to renew Project excitement, introduce fresh ideas, integrate improvements, and heighten morale. The process of team building and team integration is a continuous effort that must be practiced.

Options for Consideration

The Review Team offers the following options for consideration relative to the observations above:

- Now that the formal consolidation of Project participants under the M&O contractor has been accomplished, the DOE must clarify the respective oversight and management roles of the DOE and the M&O. OCRWM and YMSCO must continue to empower the M&O by actively supporting the M&O's decisional authority and management control.
- The degree to which staffing is reduced to eliminate duplicated support functions among contractors should be monitored following the consolidation of participants under the M&O.
- Where there are opportunities to bring in new participants or new personnel, the Review Team encourages such change.
- Project procurement procedures should be reviewed to insure that no policy mandates exist that may result in the suboptimization of contractor resources for procurements with potential critical path impacts.

INTEGRATION

The Review Team addressed four NARUC-specified scope of work requirements as part of its analyses of integration issues. The four items, as restated below, are discussed within the broader context of the following three subheadings:

- Integration Effectiveness

Analyze the DOE organization to assess the effectiveness of the integration, including internal planning processes and systems, of the Yucca Mountain Project Office, Nevada Operations Office, DOE Headquarters, and OCRWM. [NARUC C.3.1]

- Geographical Considerations

Is it cost effective and efficient to have OCRWM based in Washington, DC when the disposal program is essentially based in Las Vegas? [NARUC C.3.3]

Are Program activities too dispersed geographically? [NARUC C.6]

- YMSCP Ties to the Nevada Test Site

Should the Project's ties to the Nevada Test Site be severed entirely, both administratively and physically? [NARUC C.4.3]

Each of these three subheadings are discussed below followed by the Review Team's summary and options for consideration relative to integration issues.

Integration Effectiveness

The complex three-dimensional matrix structure of the YMSCP requires that Project priorities and participant activities be clearly defined and communicated; otherwise, the complex organizational matrix is at risk of becoming a "Rubik's Cube" of unsupervised and poorly integrated activity. Accordingly, this section provides an overview of Project integration and serves as an introduction to more rigorous analyses of Project controls and scheduling issues in subsequent sections of this report. The work scope addressed under this heading is contained in the following NARUC statement:

- *Analyze the DOE organization to assess the effectiveness of the integration, including internal planning processes and systems, of the Yucca Mountain Project Office, Nevada Operations Office, DOE Headquarters, and OCRWM. [NARUC C.3.1]*

Areas of Concern. Perhaps the most significant area of concern noted by the Review Team stems from DOE's reluctance to fully empower and utilize the M&O contractor, TRW, as a Program and Project integrator. TRW's promotional literature emphasizes its long legacy of successful project management in a highly complicated and technically integrated endeavors:

. . . In the 1950's, the company became the systems engineer and technical advisor for the U.S. intercontinental ballistic missile program, among the largest technical programs in the nation's history. On this program, TRW integrated the work of more than 200 contractors and pioneered the systems-engineering process, which ensures that all parts of a complex

system work together to achieve the desired result. TRW is applying this process - and its successful track record with large, complex programs - in its role as prime contractor for the Civilian Radioactive Waste Management Program.

Despite TRW's claim to be a leader in the systems approach to project management, the DOE appears to have underutilized TRW's purported expertise in this area. According to some TRW managers, the DOE has not provided TRW the overall management authority required to fulfill its role as Project integrator. Perhaps the most encompassing example of this is DOE's original requirement that direction from the M&O contractor to DOE's national laboratory, other federal agencies and contractors at the NTS, pass through a DOE representative. Such a requirement essentially supplants TRW, placing the DOE in the role of integrator.

The Review Team notes Criticism by the DOE Office of Inspector General (IG), the GAO, the NWTRB and others regarding the lack of Project integration. For example, the IG concluded in its June 23, 1994, report that ". . . the anticipated reductions in the number of project participants had not materialized, nor had management and integration of the project been effectively implemented." Likewise, the GAO concluded in its December 1994 report that construction management on the Yucca Mountain Project is spread among several contractors with little control to ensure that planning, design, and performance are coordinated with the Project's testing needs. According to the GAO, DOE's Project office and five participants are involved in drilling a test hole from the surface of the Yucca Mountain Site. Three Project contractors and other subcontractors are also involved in planning construction and testing in the underground exploratory studies facility. In another example, the GAO references a March 1994 review of quality assurance by DOE on how effective the Project was integrating data for design purposes. The review found, among other things, that some of the work being done was so narrowly focused that information necessary to complete or modify construction designs, which could have been collected while the work was in progress, was overlooked. The review also stated that some of the Project's principal investigators were withholding data until they could publish professional papers with no regard for other Project participants having need for the data. Finally, the NWTRB has expressed concerns that designs and test plans for thermal loading and waste package design are not far enough along in their development to provide needed information for the design of one part of the underground test area.

The Review Team also observed evidence of poor communication and a lack of integration during a technical exchange pertaining to the thermal loading issue in a meeting in Las Vegas in January 1995. Specifically, one of the DOE national labs had expended an effort related to the calibration of a mathematical model, and upon presenting its work at the meeting, was informed by a second DOE national lab that it had performed the same work several months prior. Apparently, neither lab knew what the other was doing.

Another technical issue that has caused some to express concern regarding overall Program/Project integration pertains to the engineered barrier system (EBS). The following excerpt is from the March 1, 1994, report by Dr. James A. Thurber (the Thurber Report):

DOE must also decide whether to make an engineered barrier system (EBS) an integral part of the repository or an added safeguard. Under current law and regulation, DOE may consider an EBS as an integral part of the repository. However, some critics are concerned that DOE not walk away from an imperfect site when an EBS could provide the margin of safety.

The Review Team interprets the primary concern here as follows: "Is the EBS being relied upon as the primary mechanism for isolating radionuclides, and as such, could it be used to justify an imperfect geologic site?" The Review Team found that DOE appears to be addressing this concern by acknowledging the prudence of enhancing natural geologic barriers with an EBS, but not relying solely on the EBS for long term containment. At the spring meeting of the Nuclear Waste Technical Review Board on April 19-20, 1995, the OCRWM Director stated in his opening remarks regarding the topic of Waste Isolation Strategy, "I have assured the Nuclear Regulatory Commission that our current strategy, as well as that contained in the Site Characterization Plan, relies upon multiple engineered barriers to limit the release of radionuclides to a natural barrier." The Director further stated, "Engineering solutions are not likely to replace reliance upon the natural environment over the very long term." Currently, a new Total-System Performance Assessment regarding the Waste Package Design/Engineered Barrier System is being prepared and will address the following technical issues: drift-scale thermal hydrology; alternative backfill designs; corrosion initiation and rate; radionuclide mobilization; waste package/EBS release; and colloid-enhanced radionuclide mobility and transport. This new Total-System Performance Assessment is scheduled for external review in January 1996.

Positive Actions by DOE. With respect to Project management and integration, the OCRWM Program Approach represents a significant and appropriate effort to improve management efficiency based on clearly stated Program and Project objectives. Integral to the Program Approach are a series of critical path diagrams and schedules designed to integrate activities to support and meet milestone objectives. The Review Team considers the Project schedule as one of the very important tools available to management. A carefully structured and properly utilized schedule will provide the required linkage to bring unity to the various elements of a project. A review and discussion of the Project schedule is included in Section Six of this report.

In addition, the Review Team evaluated the YMSCP's use of various management tools to integrate Project activities. These tools include, among others: the annual budgeting and planning process, including the Technical Implementation Plans (TIP); the Planning and Control System (PACS), the change control process, and the bimonthly Director's Program Reviews (DPR). It is the collective opinion of the Review Team that, overall, these systems and procedures provide meaningful information to DOE management. Such systems and procedures, if properly applied, can continue to serve as effective tools for enhancing communication and promoting Project integration.

Geographical Considerations

Related to programmatic integration is the question of whether the OCRWM should be based in Washington, DC, or Las Vegas. Specifically, NARUC asks:

- *Is it cost effective and efficient to have OCRWM based in Washington, DC, when the disposal program is essentially based in Las Vegas?* [NARUC C.3.3]
- *Are program activities too dispersed geographically?* [NARUC C.6]

With respect to the first question, it is true that OCRWM forecasts that Yucca Mountain activities will total \$2.9 billion, or 73 percent of the \$4.0 billion total Program costs, through FY 2000. Certainly, the majority of activities under the current plan will be focused on the Yucca Mountain Site. Accordingly, it is appropriate that the majority of resources should be based in Nevada.

The Review Team acknowledges that there are added costs due to travel and communication between Washington, DC, and Las Vegas. In addition, there are inefficiencies due to the geographic distance

and time zone differences between OCRWM and YMSCP. Nevertheless, mounting national pressure to resolve the high-level nuclear waste issue will continue to warrant a strong programmatic presence in Washington, DC. If OCRWM were to be moved to Nevada, high-level OCRWM managers would spend more time and expense traveling back to Washington, DC, for interaction with governmental agencies. It is unlikely that significant cost savings in travel and communication would be realized. Certainly, such cost savings, if any, would not outweigh the significant cost and disruption of moving OCRWM to Nevada.

The second NARUC question of whether Program activities are too geographically dispersed is significant from the perspective of project integration. With multiple participants, including the national laboratories and the U.S. Geologic Survey, scientific studies are being conducted in several geographic locations. The Review Team is unaware of any proposal that suggests the Project participants should be physically brought together in one work location. Such a proposal would not be practical or cost effective, nor would it insure effective integration. The relevant question is not whether program activities are too geographically dispersed, but rather "How should the activities of these dispersed participants be planned and monitored to insure effective integration?" As discussed above, the answer to this question lies in clear communication of Project goals, schedules, and priorities. This includes the effective use of management, planning, budgeting, and scheduling tools such as the TIPs, PACS, the Director's Program Reviews, and other televised communication meetings and conferences.

YMSCP Ties to the Nevada Test Site

Another issue of concern is the Project's ties with the Nevada Test Site (NTS). Accordingly, the NARUC scope of work asks:

- *Should the Project's ties to the Nevada Test Site be severed entirely, both administratively and physically? [NARUC C.4.3]*

YMSCP is connected with the NTS in three ways: physically, operationally and culturally. Physical ties include Yucca Mountain's partial geographical location on NTS land; operational ties include the sharing of certain resources; cultural ties include the manner in which the organizations view and conduct their work.

With respect to the first category, physical ties, a portion of Yucca Mountain lies within the perimeter of the NTS. To gain access to Yucca Mountain, one must be cleared through the NTS security.

Regarding the second category, operational ties, approximately \$73 million, or 2.5% of the Project's total cost, is projected for the NTS allocation over the next five years. This allocation is for shared overhead and resources, including perimeter security services, medical emergency and fire response services, food services, communication services, and others. In addition to the NTS allocation, additional security services specific to the Yucca Mountain Site and facilities are provided by Wackenhut Services, Inc., at a reduced "non-weapons" rate. Another NTS contractor is Kiewit/Parsons-Brinkerhoff (Kiewit), a tunneling contractor. Kiewit remains an NTS contractor although its primary work is on the ESF tunneling operation. As of May 1995, Kiewit had not yet joined with other participants in a subcontracting agreement with the M&O.

The final category, cultural ties, is less tangible and therefore harder to define. The historic mission of the NTS and the current mission of OCRWM and YMSCO are entirely different. Accordingly, the respective organizational operations and cultures should be different. Many of the early and current personnel working on the YMSCP previously worked at the NTS. In fact, seven participants that began the Yucca Mountain Site Characterization Project were drawn from the nuclear weapons testing program at DOE's NTS. They include two architect-engineer firms, a construction contractor, three DOE laboratories, and the U.S. Geological Survey. In addition, in 1987, DOE hired Science Applications International Corporation (SAIC) to provide technical and management support. Until recently, the YMSCO Project Manager and one of the Project Assistant Managers split their duties and worked for both the NTS and the YMSCO. This collective body of NTS personnel which is now employed by YMSCP carries with it a cultural element that may be inappropriate for YMSCP.

The Review Team has received substantial and diverse opinion with respect to suggestions that the YMSCO sever ties with the NTS. On one hand, a portion of the general public associates the NTS with a history of secretive governmental operations and undisclosed public radiation risks. To the degree that this population also associates YMSCP with the NTS, the physical, operational and cultural ties discussed above have a corresponding negative impact on public trust and confidence.

On the other hand, the Team received comment that another portion of the general public views the NTS as having a positive and beneficial impact on the region, providing significant economic benefits to Nevada and possessing a more positive level of public trust and confidence than does the YMSCO.

Based solely on economic considerations, specifically with respect to physical and operational ties, the Review Team concludes that there is little basis for the YMSCO severing relations with the NTS. To do so would require the YMSCO to replace (and thereby duplicate) resources such as roads and fencing, security services, medical emergency and fire response services, food services, communication services, and others. In total, the Review Team found no compelling evidence that such resources could be replaced at direct cost substantially lower than the current NTS nonweapons rate. In addition, overhead cost would still be incurred, although there might be some savings compared to the current arrangement whereby total test site overhead is allocated between YMSCO and NTS based on the direct costs incurred by each organization.

Notwithstanding the argument above, the Review Team maintains its opinion that cultural considerations alone may be sufficient cause to justify the YMSCO severing ties with the NTS, although it is difficult, if not impossible, to provide hard evidence to support this position. It is the Review Team's collective opinion that deeply rooted cultural elements can have a profound impact on organizational paradigms, and these paradigms can single-handedly result in an inability to change. To the extent that certain changes may be required for more effective Project management and administration as noted within the context of this report, and to the degree that the cultural elements inherited from the NTS may impact the YMSCO, the Review Team argues that the YMSCO will have difficulty in achieving the desired change.

Summary of Integration Issues

Many have been critical of the lack of Project integration, including the GAO, the NWTRB, the IG and this Review Team. One of the most significant areas of concern noted by the Review Team stems from DOE's reluctance to fully empower and utilize the M&O contractor as the Program and Project integrator. The Review Team also observed evidence of poor communication and a lack of integration among major Project participants. Given its track record and apparent qualifications as an experienced project integrator, the M&O contractor should be given the opportunity to live up to its stated potential. Further, the Program Plan, along with various management tools and procedures, represent significant efforts and effective tools for enhancing communication and promoting Project integration.

Over the next five years, as the majority of activities will be focused on the Yucca Mountain Site, it is appropriate that the majority of resources reside in Nevada. Mounting national pressure to resolve the high-level nuclear waste issue will continue to warrant a strong programmatic presence in Washington, DC, however.

With respect to the Project's ties to the Nevada Test Site, the Review Team has contemplated substantial and diverse opinions and suggestions. A portion of the general public associates the NTS with a history of secretive governmental operations and undisclosed public radiation risks. Another portion views the NTS as having a beneficial economic impact on the region. The former public perception has a negative impact on public trust and confidence while the latter perception has a positive impact. It would serve the DOE well to consider the economic, managerial, operational, and public relation advantages and disadvantages associated with both options before a decision is made.

Options for Consideration

The Review Team offers the following options for consideration relative to the observations above:

- DOE must empower TRW to act as Project manager and integrator in order to fully benefit from TRW's expertise. This means that TRW must not only be given authority to direct Project participants, but that DOE must act accordingly by consistently supporting TRW's decisional and directional authority.

- YMSCP should be aware that deeply rooted cultural paradigms that may stem from the NTS could hinder management's future attempts to effectively lead the Project in new directions. To the extent that such cultural paradigms exist, YMSCP should consider breaking ties to the NTS.
- Where possible and appropriate, YMSCP should sever ties with the NTS.

DECISIONAL PROCESSES

There are three NARUC-specified scope of work items regarding the decisional processes at Yucca Mountain. The first and second items address historical decisions leading to the procurement of the TBM, and the LM300 drill rig, respectively. The third item raises the more general concern that decision-making may be spread among too many managers.

The three NARUC issues, as restated below, are addressed under the following topic headings:

- The TBM Decision

What management processes were used by DOE to make its decision to purchase a large diameter tunnel boring machine (TBM), rather than having a contractor perform this work? For example, what analyses were prepared, and by whom, as inputs to the procurement decisions? Were recognized tunnel boring experts consulted? What factors (cost, schedule, etc.) were weighed, and by whom, in making the decision? In light of a constrained budget, what factors were considered by DOE in its decision to purchase a large-diameter TBM rather than a smaller diameter machine? [NARUC A.4]

- The LM300 Decision

What management processes led DOE to the decision to develop the dry drilling technology, procure the special rig, and assume the funding would be adequate to purchase several more rigs and operate all of them efficiently? [NARUC B.4.1]

- Decisional Processes - Areas of Concern

Is decision-making being spread among too many managers? [NARUC C.6]

Each of these three topics is discussed below followed by the Review Team's summary and options for consideration relative to decisional processes.

The TBM Decision

The following discussion explores the historic decisions surrounding the sizing and selection of the 25-foot TBM. Specifically, the NARUC-specified scope of work asks:

- *What management processes were used by DOE to make its decision to purchase a large diameter tunnel boring machine (TBM), rather than having a contractor perform this work? For example, what analyses were prepared, and by whom, as inputs to the procurement decisions? Were recognized tunnel boring experts consulted? What factors (cost, schedule, etc.) were weighed, and by whom, in making the decision? In light of a constrained budget, what factors were considered by DOE in its decision to purchase a large-diameter TBM rather than a smaller diameter machine? [NARUC A.4]*

DOE's decision to purchase the 25-foot TBM has been widely criticized. The following discussion presents a summary of the many considerations that were weighed by the DOE in making the TBM decision, including: the purpose of the Exploratory Studies Facility (ESF), the assumptions and criteria considered, the potential utilization of the ESF as a repository, the regulatory constraints, tunnel sizing considerations, and the decision to buy and operate the TBM versus the alternative of contracting out the tunnel driving operations.

Background. DOE's decision to use a TBM was based on advice from the NWTRB. The TBM is important for construction of the ESF and, if Yucca Mountain is found to be suitable for high level waste emplacement, the repository itself. A number of in-situ tests are planned for the ESF which will provide data for site suitability, license application, and ultimate design of the repository.

In concept, the requirement for developing an ESF was well-founded. The ESF provides a means for horizontal exploration to supplement the acquisition of scientific information and data available from surface-based testing. Furthermore, access to appropriate testing in support of a thermal loading strategy will be more efficient. The ESF concept will be applied to both the Topopah Springs Formation (the proposed repository block), and the underlying Calico Hills Formation (the proposed natural barrier to vertical radionuclide migration). As conceived, it will provide important scientific information and data regarding fault-systems, fractures, joints, and other geologic features. Of particular importance, the ESF will provide much needed information and data regarding hydrogeological/geochemical conditions within the formations identified.

Simply stated, the configuration of the ESF consists of two tunnels with associated alcoves. The upper tunnel alignment is U-shaped, approximately five miles in length, with portals at the north and south ends. The lower tunnel, also called a ramp, is planned to be less than five miles in length and constructed in the Calico Hills Formation. The limited number of portals is intended to minimize disturbances to the existing geology as required by the U.S. Nuclear Regulatory Commission (NRC) regulations contained in 10 CFR Part 60. The purpose of the alcoves projected laterally from the tunnel walls is to provide for the scientific studies prescribed in the Site Characterization Plan. While most in-depth scientific acquisition of information and data is expected to come from the alcoves, the tunnel is geotechnically mapped as tunnel driving progresses. Observations are made and recorded of the tunnel walls; hand samples are taken as appropriate; and the tunnel face is video recorded.

From the outset, the design of the ESF has been subjected to critical review and comment by the Nuclear Waste Technical Review Board, the Department of Energy, the M&O, Project participants, and Stakeholders at large. This critical review has included: the application of a Tunnel Boring Machine; the design and size of the Tunnel Boring Machine; the necessity for imposing "Q" criteria on steel sets, rock bolts and other ancillary equipment; and the design, timeliness, and procurement of the conveyor system, electrical switches, and a host of other materials and equipment.

The Review Team is of the opinion that the controversy surrounding these issues can be attributed to three things:

1. Differing criteria and assumptions by various parties in evaluating the design considerations of the ESF.
2. The potential utilization of the ESF as a repository
3. Constraints imposed by the regulatory community—in particular, the NRC-defined 10 CFR Part 60.

With respect to the first two items above, the designers did not appear to make a clear distinction between the requirements of the ESF and those (which were substantially different) for

a repository. This is readily apparent from several excerpts from a report entitled "North Portal Starter Tunnel Sizing Analysis, Raytheon Services Nevada, 1992":

The Starter Tunnel should be constructed large enough so that it will not require enlargement resulting from any ramp size increases when repository requirements are finalized.

Conservative design philosophy indicates that the portal should be initially constructed to accommodate **future operations** this eliminates the necessity of (1) later enlargement with the possibility of destabilizing the portal area rock mass and (2) possible disruption of **future underground operations**. [Emphasis added]

Estimate the largest North Ramp cross section diameter that can be reasonably predicted using the available **repository** and ESF data. [Emphasis added]

Entry of ramp function: the ramp will have several functions during its life. These functions are:

- a. Support of ESF construction before and after flow through ventilation is established.
- b. Support of ESF operations after muck haulage is essentially completed.
- c. Support of **Repository Operations**. [Emphasis added]

The Alternative Studies (Ref. 6) indicated that the preferred development is TBM boring wherever possible and advisable. Within this guideline, the various **repository plans** were reviewed with the objective of identifying the repository development scheme which uses TBM excavation methods and requires the largest amount of ventilation airflow in the North Ramp. [Emphasis added]

This same point is additionally supported by the following excerpts from a report Entitled "ESF Ramp and Main Drift Sizing Analysis, Raytheon Services Nevada, 1992":

Provide for the incorporation of the ESF into a potential **repository**. [Emphasis added]

Ramp configuration (access location, access size, access separation, and access depth) shall contribute to, or not detract from, the **isolation capability** of the site. [Emphasis added]

The ESF designers shall interface with surface-based testing and **repository** designers on ESF site location and layout, and on permanent ESF structures, systems, and components. [Emphasis added]

Other considerations factored into the design of the ESF were the maximum size of the waste packages and the waste package transporter for repository operation.

With regard to item 3 above, the NRC's 10 CFR Part 60, in particular 10 CFR Part 60.15 and 10 CFR Part 60.21, has had a substantial impact on the ESF decision-making process. Basically, the regulations require that any portion of the ESF that becomes part of the repository must meet the design requirements of the repository.

TBM Sizing. Engineering design studies for the ESF were conducted in 1992 by Raytheon Services Nevada (RSN). These studies were based on the driving of tunnels into the Topopah Springs Formations and the underlying Calico Hills Formation. Based on a set of assumptions (ventilation requirements, configuration of the conveyor system, one or two road beds, worker health and safety requirements, etc.), overall configuration of the ESF tunnel sizes and associated TBM diameters were recommended to be 27.5 feet for the Topopah Springs Formation and 19 feet for the Calico Hills Formation.

These analyses and reports were provided by RSN engineering personnel which laid the basis for choosing a large diameter TBM. The Review Team did not uncover any information or documents that showed that "outside" and recognized tunnel boring experts were consulted.

TRW, the M&O, concurred with the engineering findings of RSN and primarily through correspondence and recommended that DOE adopt the recommended size requirements of the TBM. DOE accepted this recommendation.

Subsequently, a presentation was made by Morrison-Knudsen to the NWTRB on November 4 - 5, 1992, entitled "Structural Geology and Geoengineering Panel Meeting" which primarily focused on the ventilation requirements associated with the design of the ESF. The conclusions of this presentation again reinforced the size requirements of the TBM recommended by RSN and TRW. In November 1992, REEC0 issued a procurement for construction of a TBM, the diameter of which was to be 25 to 30 feet. In December 1992, the NWTRB questioned the DOE on the need for such a large diameter TBM. NWTRB was of the opinion that the diameter of the TBM could be from 16 to 18 feet.

Other than technical documentation and some preliminary cost comparisons of the larger (25 to 30-foot diameter) TBMs, the Review Team did not uncover any preliminary or detailed cost/benefit analyses of various size TBMs. The Review Team is of the opinion that this analysis would have been most appropriate at that time.

An additional study was conducted by TRW entitled "Comparison of Small vs. Large TBMs" (not dated) that showed, based on a number of assumptions, that the advance rate was essentially the same for a large diameter TBM as it was for a small diameter TBM. The intent of this study was supposedly to demonstrate that by going to a larger diameter TBM, the project cost and schedule would not be adversely impacted.

The Review Team found this report to be inadequate and somewhat misleading. Although this report evaluated 71 TBM projects, and used several parameters (TBM diameter, rock strength, average advance rate, and others) for comparison purposes, other key parameters were not evaluated; for instance, the presence and type of groundwater is considered critical to a TBMs advance rate but was not considered in this analysis. For example, a larger diameter TBM with minimal groundwater conditions could be shown to have the same advance rate as a smaller diameter TBM that encountered difficult groundwater conditions. Additionally, it is unclear if the report appropriately considered the potential operational impacts of increased muck volumes created by a larger diameter TBM. Finally, when comparing the advance rates of these various sized TBMs, the graphical presentation in the report showed a significant statistical distribution which could be interpreted either to show a close correlation between the size of the TBM vs. advance rates or a very dispersed correlation.

One of the key issues surrounding the controversy involving the size of the TBM related to various interpretations of the NRC 10 CFR Part 60 requirements, and in particular, the 10 CFR Part 10.15 and 10 CFR Part 60.21 requirements. The main issue related to the design of the ESF and, ultimately, the repository; is "Should the design of the ESF comply with the requirements of the design of the repository?" DOE was of the opinion that the answer was "Yes"; therefore, the DOE opted for the larger diameter TBM.

In order not to impact Project schedule and costs, the NWTRB decided in March 1993 not to pursue the issue of TBM sizing. In April 1993, the Secretary of Energy concluded that the 25-foot diameter TBM was appropriate for the project.

Purchase v. Lease and Operate v. Contract Considerations. During the course of this study, no documentation was found regarding the decision of the DOE to purchase rather than lease the TBM. Additionally, there appears to have been no critical evaluation of contracting options, such as turn-key arrangements or fixed-price/unit-price options. Several of the DOE and M&O interviewees stated that the main reason that DOE purchased the TBM and elected to operate it using a cost-plus contractor (instead of possibly leasing a TBM and subcontracting the tunneling on some alternative basis) was that they felt it would not be cost effective to have a tunneling contractor paid on stand-by while scientific studies were being conducted. In the opinion of the Review Team, standby costs would accrue during nontunneling periods irrespective of the contracting arrangement. Accordingly, the Review Team believes that additional contracting alternatives could have been considered that would have contracted the tunnel advance on a fixed or unit price basis while providing for reimbursement of standby costs. The Review Team addresses these financial contract management issues in more detail in Section Five of this report.

The LM300 Decision

The following discussion explores the historic decisions surrounding the LM300 drill rig. Specifically, the following NARUC-specified scope of work item is discussed:

- *What management processes led DOE to the decision to develop the dry drilling technology, procure the special rig, and assume the funding would be adequate to purchase several more rigs and operate all of them efficiently? [NARUC B.4.1]*

The Review Team's analysis of the management processes which led to the decision to develop and purchase the LM300 drill rig is limited due to insufficient documentation. The following is a summary of information obtained from the limited documents received by the Review Team.

Background. The technical requirements for surface-based activities involving drilling and coring to assist the site characterization process were established in a workshop involving DOE and several other participants on August 8, 1988. The workshop included technical discussions by

various Project participants detailing the requirements of each discipline (hydrology, geology, geochemistry, and other disciplines) for drilling and coring as part of the surface-based activities. Various drilling technologies using case studies were presented and discussed. This workshop apparently became the basis for selection by the participants, and subsequent approval by the DOE of a drilling and coring technique to be used at the site. This is documented by a November 29, 1988, letter from the Science Applications International Corporation to the YMSCP Project Manager. In other words, the requirements of the Project scientists dictated the need for a unique type of drilling technology and associated drill rig.

Development and Procurement. In early 1989, with the DOE approval, several of the participants (SAIC, F&S and REEC Co) solicited information on the availability of large, dual-wall, reverse circulation drill rigs. The dual-wall dry coring technique was selected with specifications for the drill rig apparently developed by the Project participants. However, drill rigs that could meet the required specifications did not exist. Accordingly, several vendors across the country were evaluated, but only one vendor (Lange Exploratory Drilling) was willing to manufacture the three drill rigs required for surface exploratory site investigations within the anticipated schedule and specification requirements. Reasons given by other vendors for not bidding were: (1) too large a machine, and (2) could not meet required schedule. This is documented by a REEC Co file memorandum dated February 6, 1989.

In a letter from REEC Co to the YMSCP Project Manager dated February 7, 1989, REEC Co responded to a request by the YMSCP for an analysis of alternatives and associated risks concerning the procurement of three drill rigs required for the Yucca Mountain Project. The type of procurement was a sole-source procurement either in the form of an outright purchase (\$7.3 million for three rigs) or a rental (\$9.7 million for three rigs for three years) with purchase option. Additional costs (\$2.6 million) was estimated for down-hole tools and coring equipment. The Review Team was informed that at the time of procurement, YMSCP was informed by NTS/NVO that purchase of the LM300 was preferred to any form of rental agreement.

It was anticipated that the first drill rig would be delivered on September 1, 1989, the second on November 1, 1989, and the third on January 1, 1990. However, for reasons not specified in available documentation, procurement for the rigs did not begin until July 12, 1989. An amendment

to the original procurement was issued on July 18, 1989, followed by a second amendment (not documented) and a third amendment on October 4, 1989. A purchase order between REECo and Lange Exploratory Drilling was ultimately finalized on March 12, 1991, for one rig at a total cost of \$3,194,536.

In summary, the decision to develop the dry drilling technology was a result of requirements of the Project scientific community. A drilling technology and associated type of drill rig that would satisfy all scientific concerns was not available at the time from qualified sources. This required the development of a prototype drilling program, but only one vendor was willing to accept the assignment, Lange Exploratory Drilling. The absence of any design specifications or drawings resulted in the vendor doing the design work internally with DOE/M&O providing oversight. As far as procurement, the Nevada Operations Office preferred their purchase agreement to rental. Further, the Review Team was informed during the interview process that very little documentation that could trace management decisions regarding the LM300 existed and much of the decision making process was in the form of informal communications.

Decisional Processes - Areas of Concern

On one hand, the TBM and LM300 decisions illustrate that OCRWM and YMSCO appropriately considered many important factors before converging on its final decisions. On the other hand, there are certain areas where these decisional processes might have benefited from a more rigorous analysis of alternatives. The following discussion explores areas of concern noted by the Review Team. The discussion includes the Review Team's observations regarding the following item from the NARUC-specified scope of work:

- *Is decision-making being spread among too many managers?* [NARUC C.6]

The key to effective decision making lies in *empowering* managers to make decisions *at the appropriate level* within the organization. "Empowering" means providing access to the required information, providing the necessary decisional authority, and enforcing/supporting decisional accountability. "At the appropriate levels" means that the most important decisions should be made at the higher organizational levels consistent with granted authority, while less significant decisions should be made at lower levels. Ideally, top management establishes policy, middle management

establishes parameters to implement policy, and lower management carries out policy. Generally, this means that most decisions should be pushed down to appropriate lower level management.

OCRWM and YMSCO's organizational structure would appear to support a hierarchical decisional framework, but operationally, top level DOE managers are reluctant to relinquish decisional authority. The Review Team received comments from managers at all levels regarding the "top-down" micromanagement of the Project. YMSCO managers expressed frustration that OCRWM is involved with the operational details at the Project level. Likewise, M&O managers criticize YMSCO managers for being too heavily involved in the M&O activities. In this respect, the Review Team's findings support the assertion that too many managers are involved in the decision-making process.

Another concern expressed to the Review Team by YMSCO and M&O managers is that it takes too long to make many important decisions. Because top OCRWM and YMSCO managers historically have not empowered middle and lower level managers with decisional authority, the lower level managers are reluctant to make decisions. Instead, they routinely seek the involvement of upper level managers. For many significant decisions, there is a chain of consensus building that extends throughout the organization to the very top levels of OCRWM. The result is organizational indecision and decisional inefficiency.

The tendency to be cautious in decision-making, if taken to an extreme, becomes a significant issue with widespread ramifications. In part, the Project's conservative decisional tendency is an appropriate response to the serious public health and safety issues that underlie the storage of high-level nuclear wastes. In addition, vocal Stakeholder groups opposing the Project have increased pressure to always make the "right" decisions. The driving mechanism of the Project is the Site Characterization Plan, a document that has been criticized by many as being unrealistically comprehensive. In short, caution is a cultural reality for the Project. Nevertheless, excessive fear of making a bad decision can paralyze the functional effectiveness of an organization. If the Project's decisional framework is to effectively empower decision-making at the appropriate level, it must tolerate a limited amount of performance risk. This begins by acknowledging that a "bad" decision may from time to time be made. Accordingly, the system must provide for the periodic

evaluation of past decisions, and weigh the actual cost of a questionable decision against the value of a more responsive decision-making process.

With respect to the specific decisions regarding the TBM and LM300, it appears that the DOE attempted to conduct a thorough analysis of critical scientific and safety factors. Although the choice of the size of the TBM was evaluated using a number of assumptions regarding configuration of the ESF/Repository, there appeared to be a lack of critical external peer review. Although the NWTRB provided a critique on this issue, the OCRWM and YMSCO failed to accept such critique in making their decision. Some of the regulatory issues clouded the decision regarding the size of the TBM and there seemed to be a lack of communication to elicit comment from the NRC regarding this issue. It appears that decisions were being made internally without benefit of outside advice. This seems to be inconsistent with the "consensus building" and "cautious decision making" character noted by the Review Team in other areas. One would think that a cautious Project staff would welcome input by qualified parties. In the opinion of the Review Team, outside advice was certainly needed and warranted. Nevertheless, for reasons unknown to the Review Team, external input appears to have been inadequately sought and considered. These internally made decisions also impacted the timing and type of procurement involving the conveyor system, electronic switching units, and steel sets.

The same problems apparently plagued the ultimate design and procurement of the LM300 drill rig. The final specifications for the LM300 and associated drill pipe were internally made with little assistance from outside experts, i.e., drilling companies, petroleum companies, mining companies, who are in the business of evaluating drilling technology and, in particular, innovative drilling technology such as the LM300. This is especially true of the innovative dual wall drill pipe that was designed for the LM300.

The critical issues of technical credibility, schedule and allocated costs regarding the Program/Project cannot be overemphasized and the ability to bring on board the "best of the best" technical expertise for review and advice should be exercised at all times.

In addition, financial and contractual considerations appear to have been given inadequate consideration. While the Review Team appreciates the need to give priority to safety and science

considerations, both the TBM and the LM300 decisions could have benefited from a more thorough evaluation of economic considerations, particularly an expanded analysis of leasing and/or contracting alternatives.

Summary of Decisional Processes

Based on various documents, interviews, and observations, the Review Team concludes that considerably more analysis went into the important TBM and LM300 decisions than many critics acknowledge. However, both decisions lacked a thorough evaluation of the financial and operational alternatives associated with leasing versus contracting. There are also other areas of concern related to OCRWM's and YMSCO's decisional processes, in general, that the Review Team recognizes. The decision making process does not effectively utilize outside advice and external expertise. Instead, decisions are made internally and somewhat in a vacuum. Further, OCRWM and YMSCO managers are reluctant to delegate decisional authority and accountability to lower levels. This is a concern because the further the decision makers are from the facts, the greater the risk of poor decisions. Unrealistic pressures to always make the "right" decision have also led to reluctance by managers to assume decisional responsibility and has led to organizational indecision and decisional inefficiencies.

As activities at Yucca Mountain increase and public interest continues to grow, future OCRWM and YMSCO decisions will come under ever-increasing external scrutiny. Accordingly, OCRWM and YMSCO should review its internal decisional framework to insure its decision-making procedures are effectively structured and implemented to support appropriate decisions at all organizational levels.

Options for Consideration

The Review Team's options for consideration regarding decision-making procedures are as follows:

- OCRWM and YMSCO should consider expanded use of external experts in its decisional process when evaluating critical and high-profile capital expenditures.
- Where applicable, OCRWM and YMSCO should consider a more thorough evaluation of financial and operational alternatives relative to leasing and/or contracting alternatives.

- In general, OCRWM and YMSCO managers should empower the lower level managers with decisional authority so that decisions are appropriately made by those closest to the issues at hand.
- The Project must accept some limited decisional risks by providing mechanisms and schedule allowances that accommodate the results of taking such risks.

STAKEHOLDER RELATIONS

There are three specific NARUC-specified scope of work questions that concern Stakeholder relations. These three questions, as identified below, are discussed within the broader context of the following topics:

- The Stakeholders' Perspective

Are adequate efforts being made to integrate the views of Stakeholders during the decision-making process? [NARUC C.5.1]

- DOE Activities

What are the criteria by which DOE evaluates the adequacy of its efforts to integrate Stakeholders' views in the decision-making process? [NARUC C.5.2]

- Public Trust and Confidence

What has DOE done to implement the recommendations of the Secretary's task force on public trust and confidence? [NARUC C.5.3]

In conducting its analysis of Stakeholder relations, the Review Team read various Program/Project documents and observed DOE/Stakeholder interactions at selected Stakeholder meetings. In addition, the Review Team interviewed representatives from numerous Stakeholder groups, including the State of Nevada, affected counties, municipalities, Native American Indian tribes, citizens groups, and interested members of the public.

The Stakeholders' Perspective

The following discussion explores the current state of YMSCP/Stakeholder relations from the perspective of the Stakeholders. While several issues and subissues are discussed, the Review Team's ultimate objective is to address the following question from the NARUC-specified scope of work:

- *Are adequate efforts being made to integrate the views of Stakeholders during the decision-making process? [NARUC C.5.1]*

In assessing what constitutes "adequate efforts," the question is whether one defines adequate efforts from the viewpoint of the DOE, the Stakeholders, or from some independent perspective. The Review Team addresses this issue from an independent perspective. However, because it is the Stakeholders that collectively formulate public opinion, and because the Review Team believes public trust and confidence is a fundamental requisite for the ultimate success of the Project, it is the Stakeholder perspective that is the primary focus of the Review Team's analysis.

The discussion that follows is divided into three subsections that track the Review Team's approach to addressing the Stakeholder perspective. The first subsection defines the Stakeholders in the context of the Review Team's analysis. The second subsection discusses the differences in Stakeholder concerns and relationships with the DOE. The final subsection lists two primary concerns which are common, at least in part, to all Stakeholders interviewed by the Review Team. Included in this subsection is a discussion regarding the Stakeholders' perspective of DOE's efforts to integrate Stakeholder input into the decision-making process.

Definition of Stakeholders. It is recognized that many parties have a potential stake in the disposal of high-level nuclear waste. Stakeholders include the U.S. Congress, DOE, NRC, EPA, NWTRB, NARUC, the nuclear power industry, numerous industry associations and trade unions, multiple environmental organizations, and all of the various governmental units and the general public at or surrounding locations where such waste is either stored or transported. However, for the purposes of this analysis, the term Stakeholder generally refers to governments, organizations, and individuals within the regional proximity of the Yucca Mountain Site that may be impacted by placement of high-level nuclear waste at Yucca Mountain. This includes the State of Nevada, county governments of Nevada and California having Affected Units of Government status (AUG), surrounding municipalities, Native American Indian tribes, certain special interest groups, and the general public within the regional proximity of the Yucca Mountain Site.

The Review Team recognizes that some may believe that this Stakeholder definition is insufficient because it narrows the population to those who are likely to be opposed to the Project. While this simplifies the analysis, it ignores the problem that OCRWM has in balancing conflicting

external demand. In response to this concern, the Review Team offers two considerations. First, the Review Team is aware of Project proponents within the limited population as defined. Second, accepting the premise that the population as defined may have a greater tendency to oppose the Project, the Review Team believes that an analysis from the perspective of adverse Stakeholders is likely to provide a more critical analysis of DOE/Stakeholder relations and thereby lead to greater insight than a similar analysis from the perspective of Project proponents. This is not to imply that the perspectives of either group are more important than the other, nor does it deny DOE's need to balance conflicting Stakeholder demands.

Additionally, the Review Team acknowledges that there are professional opponents and proponents employed by various Stakeholder groups. These individuals will never be entirely satisfied unless the views that they have been hired to advance are adopted. This does not mean that their views are invalid, unsupported, or should be discounted because they are paid. It simply means that because the DOE will never satisfy these paid professionals, it would be inappropriate to base an objective critique of DOE/Stakeholder relations on DOE's interaction with these individuals. Accordingly, the Review Team's analysis of Stakeholder relations does not apply to paid professionals, be they Project opponents or proponents.

Stakeholders have different concerns and different relationships with DOE. Stakeholder groups, while unified on many overall programmatic issues, each have unique agendas and different relationships with the DOE. In the course of the Review Team's limited observations and interviews, a wide diversity in Stakeholder concerns and relationships with OCRWM and YMSCP was noted. The subsequent paragraphs briefly describe some representative Stakeholder groups.

The State of Nevada Nuclear Waste Project Office has a long and well-documented history of opposition to the Project. Based on observations from numerous interviews and public meetings, the Review Team noted significant mutual distrust between the State of Nevada and YMSCP. The Review Team offers no opinion as to the whether the State's opposition to the Project is appropriate or justified. However, the Review Team acknowledges that the current DOE/State of Nevada relationship presents a major hurdle in establishing mutual trust and confidence.

Nye County and the nine contiguous counties that make up the entities designated by statute as Affected Units of Local Government (AUG) have expressed differing levels of concern about the activities of YMSCP. The counties generally focus on specific issues relevant to their populations, such as socioeconomic studies, groundwater flow, potential transportation routes, and emergency response preparedness. In contrast to DOE/State of Nevada relations, DOE/county relations appear to be more constructive, as evidenced by dialog and agreements between the DOE and certain counties. Again, this is a generality with noted exceptions, but nevertheless, the OCRWM and YMSCP relationships with the AUG seems to be workable.

The various municipalities of southern Nevada, including Las Vegas, the City of North Las Vegas, and the rural towns dispersed throughout the affected counties, seem to share the concerns of the counties, but are further frustrated by limited budgets. These municipal programs are mostly supported by funds from the State, as they do not receive direct statutory funding from the federal government.

The Native American population of the region has demonstrated perhaps the greatest frustration, as the Indian tribes typically have fewer resources and struggle to stay informed of planned YMSCP activities. In addition, the DOE has displayed a lack of cultural knowledge and a lack of institutional experience in tribal relations. This, coupled with the long legacy of distrust by the tribes, creates a significant barrier to productive and cooperative relations.

Citizen groups and special interest groups have a broad diversity of concerns. While there are those who generally oppose the Project, there are others, such as the Study Committee, that have expressed support (while remaining officially "neutral"). Although opponent and proponent citizens groups differ in their opinions, both encourage increased citizen education and involvement in issues such as public and/or environmental health and safety, economic impacts, and transportation.

Common Stakeholder Concerns. While Stakeholders differ in their specific areas of concerns and in their respective relationships with the DOE, the Review Team noted two related criticisms shared by all of the Stakeholders interviewed:

- The DOE has historically failed to communicate important project information to Stakeholders in a consistent and timely manner.

- More importantly, the DOE has not considered Stakeholder input in its decisional processes.

While some Stakeholders acknowledge recent improvement by the YMSCP in providing information, they point out that much information is still provided in an ad hoc fashion, and overall, Stakeholders lack confidence that they are fully informed on important issues. YMSCP personnel acknowledge that they struggle with what, when, and how important information should be conveyed to Stakeholders.

The issue of adequate information is particularly important when viewed in the context of predecisional input. Stakeholders interviewed by the Review Team were critical of OCRWM's and YMSCP's failure to objectively include Stakeholder input in its decision-making process. Stakeholders expressed particular anger in cases where DOE represented that Stakeholders were consulted, thus implying that they somehow endorse a particular issue or process, perhaps because Stakeholders were given a preview of DOE actions in one or a series of informational meetings.

Stakeholders interviewed by the Review Team denied that they have been given opportunity for true predecisional input on significant DOE decisions. Instead, Stakeholders contend that OCRWM and YMSCP typically hold informational meetings which provide a forum for Stakeholders to express their concerns. However, no follow-through occurs whereby such concerns are thoughtfully channeled into the decision-making process. Consequently, Stakeholders contend that OCRWM and YMSCP "go through the motions" but there is no true predecisional Stakeholder input. Stakeholders view this practice as further undermining public trust and confidence.

DOE Activities

The following discussion explores the current state of Stakeholder relations with emphasis on OCRWM and YMSCP activities. The primary question to be addressed is: What actions do OCRWM and YMSCP take to involve and empower Stakeholders and how effective are these actions? Also addressed is the question posed by the NARUC-specified scope of work:

- *What are the criteria by which DOE evaluates the adequacy of its efforts to integrate Stakeholders' views in the decision-making process? [NARUC C.5.2]*

In response to NARUC's question, YMSCO's Office of Public Affairs plainly states that there are no formal criteria used to assess the adequacy of DOE's efforts to integrate Stakeholders' views in the decision-making process. Instead, the office points to numerous public participation and outreach programs as evidence that it is actively engaged in fulfilling the Secretary's policy of openness and service.

The discussion that follows addresses the effectiveness of OCRWM and YMSCP public participation activities. An overview of the current DOE public participation policy is provided, followed by a brief recap of YMSCP public participation activities. This is followed by a discussion of things OCRWM and YMSCP has done or is doing right, as well as a discussion of areas where OCRWM and YMSCP fall short in public participation effectiveness.

DOE Public Participation Policies. According to YMSCP's Office of Public Affairs, the current DOE guidance on public participation is a July 29, 1994, memorandum from the DOE Secretary which is somewhat general in its advancement of five critical policy elements:

1. The Department recognizes that honesty and forthrightness in dealing with Stakeholders, and consistent, credible, quality performance are the bases upon which to build understanding and trust.
2. Departmental program development, planning and decision-making processes will be clearly defined, with regular, easily identified access points for public input.
3. Headquarters, field offices, laboratories, and facilities will operate as an integrated team in planning local and national public participation programs by combining resources, sharing information, and coordinating activities.
4. The Department will establish and support training and educational programs to meet evolving public participation needs, both internally and externally.
5. The Department will foster candid information exchanges and ongoing two-way communication using a variety of mediums.

The Secretary's guidance states that within the policy framework, each site will develop its own public participation program and plans in consultation with Stakeholders and with the concurrence of appropriate Headquarter's program offices. According to YMSCO's Office of Public Affairs, YMSCP currently has no published site policy because it is awaiting the OCRWM-wide

public participation policy, which has been released for public comment but has not as yet been finalized. Thus, there is no OCRWM or YMSCP site-specific public participation policy currently in place.

According to YMSCO's Office of Public Affairs, members of its office were instrumental in drafting the DOE public participation policy and implementation guidance, and as such, these individuals have a good appreciation for the Department's policy. Nevertheless, the absence of a hard-copy, site-specific, widely-disseminated, public participation statement for OCRWM and YMSCP represents a significant concern in the eyes of the Review Team. Without such a policy, DOE managers, M&O personnel, and other Project participants are ill-equipped to fashion a working relationship with the Stakeholders.

Implementation of Public Participation Policy. Despite the significant concern that there is no written site-specific public participation document, the YMSCO's Office of Public Affairs administers a number of programs designed to capture the intent of the Secretary's public participation guidance. These programs include three major areas of concentration: (1) public outreach, (2) product development, and (3) intergovernmental programs and media relations.

The public outreach effort consists of numerous activities, including the operation of three Yucca Mountain Science Centers located in Las Vegas, Beatty and Pahrump, Nevada. Also included are various educational programs including site tours, public school programs, speakers' bureau programs, and other community interactions.

The second area of concentration is the Office of Public Affairs product development effort. This activity includes the development of periodic newsletters and numerous publications which are readily available to the public through regular mailings or by special request. These brochures and publications are also available through the science centers.

The third area of concentration is intergovernmental programs and media relations. Among other things, this effort includes providing information to elected officials with Stakeholder constituencies and conducting quarterly meetings with the AUG. The AUG meetings are also attended by representatives from the State of Nevada, local municipalities, Native American tribes,

special interest groups, and interested members of the public. Also included in this area of concentration is the media relations function.

In assessing the effectiveness of its various Stakeholder programs, YMSCO's Office of Public Affairs monitors statistics such as the number of tours given, the number of visitors at the science centers, the number of public school programs conducted, etc. While such statistics are helpful, there is no formal assessment of Stakeholder programs that includes Stakeholder feedback. The Secretary's public participation guidance document states, ". . . the effectiveness with which each site/program implements the Department's Public Participation Policy will be assessed annually, and these assessments must include the views and recommendations of Stakeholders." YMSCO's Office of Public Affairs acknowledges that it has not yet complied with this element of the Secretary's guidance.

DOE Public Participation Successes. Overall, YMSCO's Office of Public Affairs does a good job in providing general information to the public via its outreach and product development programs. In the area of intergovernmental programs, the quarterly AUG meetings provide a positive foundation to intergovernmental relations. In addition, two public participation initiatives deserve special mention: (1) the Nye County protocols, and (2) the site suitability process.

The "Protocol Addressing Procedures for Nye County On-site Representation During Yucca Mountain Project Site Characterization Activities" and other protocol agreements (commonly and collectively referred to as the Nye County Protocols) establish a negotiated understanding between Nye County, Nevada, and OCRWM regarding the procedure to be followed to implement Sec 117(d) of the Nuclear Waste Policy Act (NWPA), as amended, authorizing the County to supplement its oversight responsibilities through on-site representation. Specifically, the Protocols establish procedures for a Nye County representative to attend DOE meetings and to gain access to DOE personnel, Program and Project documents, DOE sites and facilities, and site-related scientific samples. The protocols also provide for socioeconomic monitoring and assessment, principles and procedures for interaction, and a framework for formal interactions. In addition, the agreements provide access and procedures for Nye County to conduct independent on-site verification and testing, including an independent drilling initiative. Both OCRWM and Nye County agree that the Nye County Protocols represent a positive example of constructive DOE/Stakeholder relations.

Another area where YMSCP has exhibited good intent in its Stakeholder interaction is in the various public discussions regarding the development of the site suitability process, in particular, the Stakeholders' future role in nominating individuals for consideration by the National Academy of Science (NAS) to serve as NAS peer reviewers. The Review Team noted that many Stakeholders appreciated YMSCP's efforts to inform them of the site suitability process as it was being developed. Stakeholders continue to desire a greater role in the decisional process, but they also understand that ultimate decisional accountability must be retained by the DOE. Accordingly, Stakeholders continue to work to formalize additional access points for predecisional input so such input can be objectively considered in the decision-making process.

DOE Public Participation Shortfalls. Despite genuine efforts by those in YMSCO's Office of Public Affairs to advance the intent of the Secretary's public policy guidance, OCRWM's and YMSCP's efforts fall short in a number of areas. A significant concern is the failure to meet the requirement of the Secretary's public participation guidance regarding the development of a site/program public participation policy. Other failures include a demonstrated lack of Stakeholder sensitivity exhibited by OCRWM and YMSCP managers, and the poor handling of significant media issues.

The lack of a site-specific public participation policy as previously discussed is not only a failure to implement DOE's own internal public participation guidance, but more significantly, it presents a major obstacle in establishing an effective operational relationship with Stakeholders. Before Stakeholder relations can improve, OCRWM and YMSCP must clearly define its vision of Stakeholder relationships. Absent such a vision, Stakeholder interactions will be conducted in an ad hoc fashion, lacking consistency of structure and direction. In fact, this is exactly what the Review Team has observed. The result is Stakeholder dissatisfaction.

Another significant shortfall is the lack of institutional awareness and Stakeholder sensitivity demonstrated by key OCRWM and YMSCO managers. The Review Team observed numerous instances where high-level Program and Project DOE managers demonstrated disrespect or insensitivity to Stakeholders:

- During a video-conferenced presentation on Environmental Justice, a high level OCRWM manager left the room shortly after introducing the Environmental Justice speaker. The

camera did not close in on the speaker, but instead remained fixed on the speaker and the vacant chair of the absent OCRWM manager. The message to the viewing Stakeholder audience in Las Vegas was that OCRWM management lacked commitment to the program.

- During a special Stakeholder meeting regarding the NAS peer review process for site suitability, a YMSCO leader displayed overbearing control and lacked willingness to listen to Stakeholder input. Stakeholders were visibly angered.
- At the Winter Meeting of the Nuclear Waste Technical Review Board in Beatty, Nevada, a DOE Assistant Manager casually gestured to a Stakeholder audience while making a comment that the general public lacked the ability to understand complicated technical issues. The highly knowledgeable and well-informed Stakeholder audience resented the condescending insult.
- At the same NWTRB meeting, a high level OCRWM manager made careless reference to site-altering activities at Yucca Mountain which severely insulted Native American Indians in the audience. This display of institutional insensitivity and cultural arrogance angered one Native American so much that he publicly denounced the OCRWM manager and excluded him from an invitation to visit his reservation to meet with tribal leaders.

The frequency with which the Review Team observed such infractions, and the fact that in most cases the DOE managers were unaware of such occurrences even in retrospect, clearly underscores the need for additional training of key managers in issues of Stakeholder concerns. More significantly, however, these episodes reinforce the Review Team's conclusion that OCRWM and YMSCP lack a "corporate culture" that recognizes the importance of Stakeholder involvement.

Another shortfall in public relations involves YMSCP's handling of the media. During the observation period, the Review Team witnessed an incident where an immediate local response was required to media inquiries about potential safety concerns regarding the storage of nuclear waste at Yucca Mountain. Because of restrictions and controls placed on YMSCP by DOE headquarters, the local YMSCP media relations group was only approved to release a rather dry public statement from DOE Headquarters. The local media was largely dissatisfied. In summary, an unwillingness by DOE Headquarters to relinquish control to YMSCO, possibly due to a lack of confidence in YMSCP's ability to handle the local press, resulted in significant local damage to Project credibility.

Public Trust and Confidence

The following discussion explores the somewhat broader issue of Public Trust and Confidence. Specifically, the following NARUC-specified scope of work question is addressed:

- *What has DOE done to implement the recommendations of the Secretary's task force on public trust and confidence? [NARUC C.5.3]*

In order to fully address this question, a brief background is provided on the Secretary's Energy Advisory Board Task Force on Radioactive Waste Management report on public trust and confidence which was released in November 1993. The major recommendations of the report are listed, followed by a brief discussion of what DOE has done to implement the report recommendations.

Background. In November 1993, the Secretary of Energy Advisory Board Task Force on Radioactive Waste Management published their final report entitled "Earning Public Trust and Confidence: Requisites for Managing Radioactive Wastes." The report summarized the findings from a comprehensive 27-month study. Input was received from nearly 100 representatives of state and local governments, nongovernmental organizations, senior DOE Headquarters and Field Office managers, the National Academy of Sciences, and the National Academy of Public Administration.

Task Force Recommendations. The findings and recommendations of the Task Force are founded on the fundamental premise that public trust and confidence is a requisite for DOE's successful completion of its stated mission. The Task Force report makes reference to the foundations of its work as ". . . the elements that form the lens through which the Task Force viewed its charge . . ." The report identifies three elements as follows:

. . . Public trust and confidence is not a luxury. DOE not only has an obligation to earn it, but it also has a compelling need to do so.

. . . Public trust and confidence is not a one-way street. DOE must trust the public before it can expect the public to trust it. By the same token, the public and its representatives must be held to a standard of behavior that is itself trustworthy.

. . . Under almost all circumstances currently relevant to DOE's waste management programs, it is preferable to make decisions in an open, pluralistic forum than in a closed one that excludes actual or potential Stakeholders.

The Task Force recommendations are organized into two groups: those that address how DOE should interact with external parties in order to build trust and those that pertain to how the department should conduct its internal operations in order to build confidence.

With respect to interaction with external parties, the report recommends that DOE commit itself to:

- Early and continuous involvement of state and/or local advisory groups as well as national advisory bodies on which a broad range of Stakeholders . . . are represented. That involvement would be characterized by frequent contact, complete candor, rapid and full response to questions, use of at least some suggestions, and assistance in increasing the technical and oversight skills of the community;
- Carrying out agreements unless modified through an open process established in advance;
- Consistent and respectful efforts to reach out to state and community leaders and to the general public for the purpose of informing, consulting, and collaborating with them about the technical and operational aspects of Departmental activities;
- Active, periodic presence of very high-level agency leaders making themselves visible and accessible to citizens and their representatives;
- Unmistaken agency and program residential presence in the locality that contributes its energies to community affairs and pays through appropriate mechanisms its fair share of the tax burden; and
- Assuring the availability of negotiated benefits for the community along with the resources to affect host and corridor communities that might be needed to detect and respond to unexpected costs.

With respect to internal operations and programmatic choices, the report recommends that DOE commit itself and require its contractors to:

- Maintain a high level of professional and managerial competence, continually honed by rigorous training;
- Establish and meet reasonable technical performance measures and schedule milestones that are dictated by a project's intrinsic scientific requirements;

- Pursue technical options and strategies whose consequences can be persuasively communicated to broad segments of the public;
- Reward honest self-assessment that permits the organization to get ahead of problems by identifying them and airing them and resolving them before they are discovered by outsiders;
- Develop tough internal processes that include Stakeholders for reviewing operations and discovering potential and actual errors; and
- Institutionalize responsibility for promoting and protecting the internal viability of efforts to sustain public trust and confidence throughout the organization.

DOE's Implementation of Task Force Recommendations. When asked what actions have been taken to implement the recommendations of the Task Force Report, YMSCO's Office of Public Affairs refers to its institutional programs discussed above, including its outreach, product development, intergovernmental, and other programs. YMSCO's Office of Public Affairs states that it has not taken action designed to specifically implement one or more of the Task Force recommendations, but rather has strived to promote public trust and confidence through its current internal practices and Stakeholder programs.

Summary of Stakeholder Relations

While acknowledging the difficulty in involving the array of perspectives and opinions of Stakeholders, the Review Team is generally of the opinion that Stakeholder relations are inadequate. OCRWM and YMSCP have not defined a clear operational relationship with Stakeholders, nor have they accepted the fundamental premise advanced by the Public Trust and Confidence Report that public acceptance is a requisite for long-term success of the Project. As a result, there is no comprehensive Stakeholder plan, current Stakeholder interactions lack structure and direction, and Stakeholders are dissatisfied.

Reluctance to open the Project to greater Stakeholder involvement is understandable, especially in view of current pressures to demonstrate measurable progress within an extremely optimistic Project budget and schedule. The unspoken fear is that increased Stakeholder involvement will open the door to short-term complications and schedule delays. The Review Team appreciates this legitimate concern, but reluctance to implement a site-specific public participation policy is inconsistent with the Secretary's desire to break with past practices and to adopt a new culture of openness and

service. Clinging to the historical culture of limited and carefully controlled public involvement only serves to further undermine the long-term public confidence that is critical to the ultimate success of the project.

Options for Consideration

The Review Team offers the following options for consideration relative to the observations above:

- OCRWM and YMSCP must accept the fact that excellent technical and scientific investigations are of no use if the public distrusts those conducting such investigations. OCRWM and YMSCP have no choice but to accept the fact that public trust and confidence is a fundamental requisite to the successful completion of long-term Program and Project objectives.
- OCRWM and YMSCP must clarify its vision of Stakeholder involvement. A clear vision of exactly what role Stakeholders will play in the long-term success of the Project must permeate through all levels of the organization, including DOE managers, the M&O, and Project participants. This vision must become the core of a new "corporate culture" of openness and service.
- A key component of the new "corporate" Stakeholder vision should be a clearly written Stakeholder Plan, which among other things, identifies specific decisions requiring early Stakeholder input and sets forth detailed procedures for objective and meaningful consideration of such input. This plan must be highly visible and consistently implemented. On one hand, Stakeholders must realize that DOE cannot abrogate its decisional responsibilities. On the other hand, OCRWM and YMSCO must objectively consider constructive Stakeholder input as beneficial in accomplishing its ultimate long-term mission of resolving the nuclear waste dilemma.

SECTION FIVE
FINANCIAL AND CONTRACT MANAGEMENT

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SECTION FIVE FINANCIAL AND CONTRACT MANAGEMENT

This section presents the Independent Management and Financial Review Team's (Review Team) analysis of financial and contract management issues as they pertain to the Yucca Mountain Site Characterization Project (Project). There are four issue categories addressed as follows:

- Change Control
- Contract Management and Controls
- Financial Management and Fiscal Control
- Infrastructure Costs

Each of these categories contains one or more issues to be addressed as defined by the National Association of Regulatory Commissioners (NARUC)-specified scope of work.

CHANGE CONTROL

In the Change Control category, the following two issues were identified for analysis:

- Criteria for Reductions in Scientific Work

Specifically, what are the criteria, processes and/or mechanisms used by DOE to make reductions in previously planned scientific work? What should be the criteria? [NARUC A.3.2]

- Roles of Change Control Boards

What roles do the various change control boards play in assuring that any decision to reduce or eliminate scientific studies is based on scientific rather than cost or schedule considerations? [NARUC A.3.3, in part]

The above issues are discussed below followed by a summary and options for consideration relative to Change Control.

Criteria for Reductions in Scientific Work

The work scope addressed is as follows:

- *Specifically, what are the criteria, processes and/or mechanisms used by DOE to make reductions in previously planned scientific work? What should be the criteria? [NARUC A.3.2]*

In answering this question, the Review Team assumed that the term "previously planned scientific work" refers to the Site Characterization Plan (SCP). Based on interviews performed and written comments received regarding the Review Team's Preliminary Report, it appears that there is agreement among several parties such as the Department of Energy (DOE), the Nuclear Waste Technical Review Board (NWTRB), certain Affected Units of Local Government (AUG), and others, that reductions in the scope of the SCP as well as additions to the scope of the SCP may be justified. There does not appear to be consensus among all parties involved, however, as to what the criteria for changing the scope of the SCP should be. The ultimate judge as to what scope changes, if any, are appropriate will be the Nuclear Regulatory Commission (NRC) when it reviews the application for a license to construct a repository at Yucca Mountain (if the site is deemed to be suitable) in accordance with Section 114(d) of the Nuclear Waste Policy Act of 1982, as amended (NWPA).

The DOE has represented to the Review Team that the scope of work as outlined in the SCP has not been reduced, but has, in fact, been deferred to the license application or performance confirmation periods. The actual extent to which scientific work has been added, changed, reduced, or deferred will not be known until the DOE completes the new technical baseline scope of work for the Project later this year. This new baseline will, most likely, undergo the scrutiny of the NWTRB, the NRC, the National Academy of Sciences (NAS), and others when it is completed.

In order for the Project to comply with 10 CFR Part 960, 10 CFR Part 60, and the criteria for changes in SCP scope of work, there should be the general acceptance of the scope changes by those respected in the scientific community such as the NAS, the NWTRB, and the NRC. The NRC may be reluctant, however, to formally comment on the appropriateness of changes at this stage of site characterization due to its role as a regulator.

To answer the question stated above, given the DOE's representation to the Review Team that the SCP scope of work has not been reduced, the Review Team addressed the issue of prioritization and deferral of scientific work from a long-term strategy perspective as well as a current fiscal year planning perspective.

Long-Term Changes in Scientific Work. The issue of long-term changes in scientific work and the criteria used to determine those reductions is particularly relevant considering that in 1994 the DOE Office of Civilian Radioactive Waste Management (OCRWM) initiated a significant change in its site characterization strategy for the Project. According to Volume II of the Civilian Radioactive Waste Management Program Plan (Program Plan), OCRWM restructured the Yucca Mountain Site Characterization Program to permit phasing of activities to achieve a priority of

objectives. This new strategy for site characterization is part of the new OCRWM strategy which is referred to as the Program Approach.

To analyze the criteria, processes, and/or mechanisms for prioritizing scientific work used by OCRWM in its Program Approach, the Review Team reviewed documentation relative to the development and underlying principles of the Program Approach. In addition, the Review Team interviewed several DOE and M&O representatives responsible for the development and implementation of the Program Approach. The succeeding paragraphs present a summary of the Program Approach and the Review Team's evaluation of the Program Approach as it pertains to prioritization and deferral of work from a long-term perspective.

Summary of the Program Approach. According to the Program Plan, the Program Approach does not require completion of all measurements and analyses identified in the SCP before evaluating site suitability, selecting a final design for the repository, and submitting a license application. The Program Approach prioritizes investigations into the following categories:

- Investigations required for early evaluation of technical site suitability.
- Investigations required for a license application and the completion of a cost-effective repository design.
- Investigations required for confirmation of repository post-closure performance.

OCRWM's plan under the Program Approach is to evaluate early technical site suitability by 1998 and apply in 2001 for a license to construct a repository. Specific milestones associated with the new Program Approach are as follows:

- 1998 Technical Site Suitability Evaluation
- 1998 Draft repository Environmental Impact Statement (EIS)
- 2000 Final repository EIS
- 2000 Site Recommendation Report for the President
- 2000 Record of Decision
- 2001 License Application to Construct a Repository
- 2004 Construction Authorization
- 2008 License Application Update to Receive and Possess Waste

- 2010 License to Operate a Repository

According to the Program Plan, OCRWM performed an analysis of regulatory developments and observations accumulated as a result of site characterization activities at Yucca Mountain. Several scientific tasks including confirmation of the bases for bounding water contact with waste packages, the design of long-life waste packages, bounding the dissolution of the waste form and transporting radionuclides from the repository, and establishment of the nature of dilution of radionuclide concentrations in the aquifer below the repository, among others, were identified as being required to demonstrate that a repository at Yucca Mountain can effectively isolate radioactive waste. According to the Program Plan these scientific tasks are important for early determination of technical site suitability.

In order to serve the requirements of a license application in the year 2001, and subsequent interaction with the NRC, OCRWM plans to perform subsequent site characterization activities such as extensive thermal testing to sharpen the understanding of processes, further constrain bounding values, and permit development of more cost-effective repository and waste package designs. OCRWM plans to perform confirmatory testing within the repository during repository construction and during repository operation for up to 100 years.

OCRWM plans to focus initially on scientific activities critical to early site suitability determination and licensing issues. If the site appears to be suitable (as determined by the guidelines discussed below), OCRWM's emphasis will shift to the scientific activities required to support a license application for construction authorization from the NRC.

The evaluation of site suitability by OCRWM is subject to pre-closure and post-closure guidelines set forth in 10 CFR Part 960, Subparts C and D. Copies of the Program Plan tables summarizing these guidelines can be found in Section Six. According to the Program Plan, OCRWM's technical site suitability evaluation in 1998 will be based upon higher-level findings that are identified in the waste isolation post-closure guidelines and radiological safety and technical feasibility pre-closure guidelines. OCRWM plans to complete the evaluation of the remaining guidelines addressing environmental quality, socioeconomic impacts and transportation by the year 2000. This evaluation will be based on information developed through the National Environmental Policy Act (NEPA) process to support the final Repository EIS by the year 2000. As part of its interim evaluation of early site suitability, OCRWM plans to issue the following reports which will provide a basis for interactions among OCRWM, Stakeholders, and peer reviewers:

<u>Fiscal Year</u>	<u>Activity Description</u>
1995	Surface Processes Interim Evaluation and Technical Basis Report
1995	Intermediate Unsaturated Zone Hydrologic Framework Model
1995	Reports on Regional Seismic Reflection, Basaltic Volcanism, Repository Pre-closure Safety Analysis (Preliminary), Calico Hills Data Needs and Access Study, Rock Mechanics Data (Summary), Recommended Repository Layout Concepts Report, Repository Waste Handling Building Final Conceptual Design and Waste Package Conceptual Design
1995	Integrated Hydrological/Geochemistry/Radionuclide Transport Model Based on Prototype 3-D Integrated Geologic Model
1995	Drilling of Deep Borehole SD-12
1995	Site Investigations Relative to Unsaturated Zone Hydrology, Saturated Zone Hydrology, Radionuclide Transport, and Climate Thermal Effects in Support of License Application Development
1996	Pre-closure Rock Characteristics Interim Evaluation and Technical Basis Report
1996	Reports on Probabilistic Seismic Hazards, Bulk and Fracture Mineral Distribution, Geochemical Alteration, and Ground-Water Chemistry Model
1996	Hydraulic and Tracer Testing at C-Wells Complex
1996	Excavate Two Access Drifts to the Ghost Dance Fault
1997	Tectonics Interim Evaluation and Technical Basis Report
1997	Reasonably Available Technology Interim Evaluation and Technical Basis Report
1997	Geochemistry and Post-closure Rock Characteristics Interim Evaluation and Technical Basis Report
1997	Pre-closure Radiological Safety Interim Evaluation and Technical Basis Report
1997	Thermal Loading Study
1998	Geohydrology and Transport Interim Evaluation and Technical Basis Report
1998	Total System Performance Assessment Interim Evaluation and Technical Basis Report
1998	Technical Site Suitability Evaluation
1998	Establish Performance Confirmation Program - Post-closure Tectonics
1999	Ground-Water Chemistry Model
1999	Continue Performance Confirmation Program - Post-closure Tectonics
1999-2000	Environmental, Socioeconomic and Transportation Interim Evaluations and Technical Basis Reports
2000	Continue Performance Confirmation Program - Post-closure Tectonics
2000	Site Recommendation Report

- Surface Processes
- Pre-closure Rock Characteristics
- Tectonics
- Reasonable Available Technology
- Pre-closure Radiological Safety
- Geochemistry/Post-closure Rock Characteristics
- Geohydrology/Transport
- Total System Performance Assessment

The above interim evaluations are required by 10 CFR Part 960. OCRWM plans to evaluate technical site suitability following the results of the higher-level study findings associated with the above-cited documents.

In Fiscal Years 1999 and 2000, subsequent to OCRWM's planned technical site suitability evaluation and the planned Site Recommendation Report to the President; OCRWM plans to issue its technical basis reports on qualifying and disqualifying issues addressing environmental quality conditions, socioeconomic conditions and transportation conditions. OCRWM plans to issue its Site Recommendation Report in Fiscal Year 2000. These evaluations are required by 10 CFR Part 960.

The criteria, processes and/or mechanisms used by OCRWM to determine what scientific work is deferred, are inferred in the Program Approach. Based on the Program Approach objectives and the requirements of 10 CFR Part 960, OCRWM will determine which activities must be performed prior to a technical site suitability determination and which activities can be deferred. Activities which are required for the technical site suitability evaluation will have priority over activities required for license application, repository design and confirmation of repository post-closure performance. The Program Plan identifies certain major Project activities that are scheduled for completion in the fiscal year ended September 30, 1995 (FY95) as well as activities scheduled to be completed subsequent to FY95. The table is as follows:

It should be noted that a number of the above activities, such as technical basis reports, are interim evaluations and are subject to further analysis beyond the year 2000 during the license application, performance confirmation, repository construction, and repository operation periods.

Review Team's Evaluation of the Program Approach Criteria for Prioritizing and Deferring Previously Planned Scientific Work. The Program Approach prioritizes activities related to the determination of site suitability, both early evaluation of technical site suitability and final site recommendation to the President, over activities related to the application for licenses to construct and operate a repository. On the surface, based on this prioritization, the criteria, processes and/or mechanisms utilized by OCRWM in its Program Approach to prioritize work appears reasonable and consistent with the overall legislative objective of site characterization.

The Review Team, however, has several concerns regarding the technical application of the Program Approach and the related inherent risks. The Program Approach represents a significant deviation from the SCP in terms of the timing of work performed. In this regard, the NRC has the final responsibility for insuring the safety of the repository and one must assume that they will not grant a license to construct or operate a repository if they are not satisfied that the site characterization activities and the results of those activities demonstrate a safe site. Given this fact, there is a risk of OCRWM expending funds for site characterization and then having the NRC reject the site. On the other hand, under the Program Approach, OCRWM could avoid expenditures for subsequent costs of license application if a site disqualifier is found early. Also, the Program Approach relies on the approval by the NAS of the eight Technical Basis Reports. To date, the NRC has not made a commitment to accept or reject the Program Approach. Because of the deferral of some studies, the Program Approach is a higher risk approach compared to the SCP in terms of the likelihood that the NRC, and possibly the NAS, will accept the results of site characterization. Many tests and studies are being deferred until future years due to funding constraints. Many of these studies such as thermal loading are critical to the determination of site suitability. Delays in the completion of these tests could result in a delay in the completion of site characterization and, therefore, a potential for increased costs.

OCRWM has not, based on interviews conducted by the Review Team, reconciled the Program Approach technical scope of work with the SCP. As a result, the NWTRB, the NRC, and Stakeholders in general do not really know what has changed from the SCP. In addition, the Review Team believes that such a reconciliation could increase public trust and confidence and reduce the risk of opposition and intervention during the licensing process.

Current Fiscal Year Reductions in Scope of Work. To determine the criteria, processes and/or mechanisms OCRWM utilized to make reductions in previously planned scientific work, the Review Team analyzed the process employed by OCRWM in its planning for FY95. To obtain an understanding of the process, the Review Team interviewed OCRWM Yucca Mountain Site Characterization Office (YMSCO) and Management and Operating Contractor (M&O) personnel and reviewed relevant planning and budgeting documentation for FY95. The Review Team had no basis for comparison of the FY 1995 planning and budgeting documentation. However, this information was reviewed only to gain an understanding and evaluate the process of prioritization for making reductions in previously planned scientific work. In other words, the objective of this part of the review was to determine whether a systematic method of prioritization was in place, not whether the application of such a method produced the "best" scientific result. The latter evaluation was not deemed to be within the scope of this review. As with the previous discussion of the Program Approach and the prioritization and deferral of work from a long-term perspective, the succeeding paragraphs present a summary of the Program Approach and the Review Team's evaluation of the Program Approach as it pertains to prioritization and deferral of work from an annual fiscal year planning perspective.

Summary of Fiscal Year Planning and Prioritization under the Program Approach.

The Project's planning for FY95 occurred during a transitional time for the Program. During the FY95 planning and budgeting time frame, January 1994 through September 1994, OCRWM developed a new strategy which resulted in the new Program Approach. A central theme to the Program Approach was the prioritization of goals, objectives and activities for the Program as a whole and the Yucca Mountain Project specifically. This new prioritization is reflected in the allocation of resources to scientific activities in the FY95 budget and work plan.

OCRWM developed four major products within which it has planned long-term activities, and grouped activities and related budget amounts for FY95. These products are site suitability, the NEPA process, repository licensing, and management and compliance. The budget and schedule priority assigned to any Project activity by OCRWM is based on its contribution to meet the objectives of the four major products. This prioritization is based on an assessment of both technical and programmatic risks by OCRWM. The Program Plan indicates that decisions that affect technical site suitability considerations are considered a higher priority at this time than decisions affecting the institutional acceptance of the site-specific EIS or the NRC's acceptance of portions of the license application. OCRWM believes that technical risk will decrease as the Project proceeds from site suitability determinations to performance confirmation within the licensing period.

According to the Program Plan, programmatic risk has to do with the availability of Project resources to allow OCRWM to make timely technical decisions, anticipate future technical issues and allocate the appropriate resources to achieve the stated objectives. Although site suitability has the highest priority, certain activities associated with the NEPA and licensing process are required by law and must be performed concurrently with appropriate shifts in emphasis, over time, to ensure that schedule commitments are properly supported.

To better illustrate the criteria used by OCRWM to determine which scientific activities are performed in a fiscal year and which activities are deferred, the succeeding paragraphs will summarize some of the activities and prioritization carried out by OCRWM in its planning process for FY95.

According to a presentation handout prepared by the Yucca Mountain Assistant Manager for Suitability and Licensing, entitled "FY1995 focus of AMSL Activities" and related to a June 1994 YMSCO meeting conducted to examine priorities and activities planned for FY95, the following activities are the primary focus for suitability and licensing activities in FY95:

- Higher level finding report on surface level processes.
- Licensing.
 - Annotated Outline Rev. 5
 - Seismic topical reports 2 and 3
- Performance assessment calculations in support of technical site suitability, environmental impact statement and license application.
- Complete revision of cost/schedule/technical baseline.
- Assist in increasing the effectiveness of site and design activities.

The goal, stated in the presentation handout, was to develop Project baseline data for tracking of progress toward site suitability and license application. The presentation handout indicated that Project activities must directly or indirectly support technical site suitability, site recommendations, a draft EIS, or a license application/annotated outline. The overall Project-level priorities were identified as follows:

- Meet regulatory, statutory and compliance requirements.
- Provide Project support necessary for Multipurpose Canister (MPC) design and development into the repository Program.

- Determine site suitability early.
- Complete the NEPA process.
- Prepare for NRC licensing and for submittal of the license application to the NRC.
- Increase scientific peer interactions and Stakeholder involvement.
- Improve management efficiency and human resource utilization.

According to a similar handout, developed by the Yucca Mountain Assistant Manager for Environment, Safety and Health, entitled "Fiscal Year 1995 Project Goals and Planning Assumptions - Environment, Safety and Health Programs," the following Environment, Safety and Health priorities were presented in the June 1994 meeting:

- Maintain a sound environmental, safety and health program including regulatory and statutory compliance, site suitability and exploratory studies facility/surface based testing support, environmental monitoring and collection of otherwise irretrievable data.
- Prepare the following EIS-related documents:
 - Planning documents
 - Notice of intent
 - EIS scope
 - Associated environmental studies

A September 1994 YMSCO budget review meeting handout developed by the Yucca Mountain Assistant Manager for Scientific Programs and entitled, "WBS 1.2.3 Scientific Programs," addressed the need to prioritize and defer scientific work. The presentation highlighted the following key assumptions for planning FY95 work:

- Preferred Activities
 - Modeling, synthesis and analysis of existing information
 - Testing and monitoring in existing drillholes
 - Long lead critical path activities
- Deferred Activities
 - Collection of new information
 - Drilling new boreholes
 - Activities with schedule float

In addition, specific modeling, synthesis and analysis activities that support site suitability were identified, as were field and laboratory activities which support site suitability.

Furthermore, key deliverables and milestones associated with the required technical basis reports were presented. The handout indicated that the programmatic priorities of site suitability and licensing were expected to be achieved under current funding with varying degrees of risk. Various unfunded requirements and related risk were presented. Some of these requirements related to the thermo-hydrologic model/test peer review and boreholes SD7 and UZ7a. These activities were ultimately funded in FY95 as additional funds became available due to underruns in other areas of the Project. Remaining requirements, critical for the higher-level finding report on geohydrology/transport, are scheduled to be completed in FY96.

In regard to OCRWM's planning and prioritization of scientific activities for future years, a DOE handout during a YMSCO September 1994 budget review meeting identified key activities that must be completed in the fiscal years 1996 through 2000. These activities, listed on the following page, represent OCRWM priorities and provide the criteria by which scientific work is to be evaluated. Work that supports the accomplishment of the above metrics is of the highest priority.

The draft Technical Implementation Plans (TIP) for WBS 1.2.1 Systems Engineering, WBS 1.2.3 Site Investigations and WBS 1.2.6 Exploratory Studies Facility for the fiscal year ending September 30, 1996, (FY96) were analyzed by the Review Team to determine OCRWM's approach to prioritization of activities. The Review Team determined that OCRWM is utilizing the same four products in its planning for FY96 and later years that it used in the FY95 planning process.

Key: Major Metrics FY 1996 - 2000

Site Suitability

Higher Level Findings

1. Preclosure Rock Characteristics
2. Postclosure Tectonics DSQ
Preclosure Tectonics QC/DSQ
3. Reasonably Available Technology
4. Human Intrusion/Natural Resources DSQs
Preclosure Radiological Safety
5. Postclosure Geohydrology DSQ
6. Postclosure Systems Guideline QC and QCs
for Tectonics, Geohydrology, Erosion, Geochemistry, Rock Characteristics, & Human Intrusion

Exploratory Studies Facility

1. Complete Excavation of North Ramp/
Start Main Excavation
2. Complete Excavation of 1st Ghost
Dance fault Exploratory Drift
3. Complete Excavation of 2nd Ghost
Dance fault Exploratory Drift
4. Complete Main Excavation/Start South
Ramp Excavation

NEPA

NEPA Process Milestones

1. EIS Implementation Plan
2. Baseline Data Reports
3. Preliminary Draft EIS
4. Draft EIS
5. Comment Response Document
6. Final EIS
7. Record of Decision

Suitability Determination

1. Technical Site Suitability
2. Site Recommendation Report

Performance Assessment

1. TSPA 1995 Summary Report
2. Waste Package/EBS PA
3. TSPA 1997 Summary Report

Repository/Waste Package Design

1. Final Advanced Conceptual Design/
Subsurface Final Conceptual Design
2. Preliminary Waste Form Report
3. Preliminary Materials Report
4. Initial Repository LAD/Waste Package
Final Title I Design

Licensing

Annotated Outline/Topical Reports

1. Annotated Outline Revision 1
2. Ground-water Travel Time Topical Report
Third Seismic Hazard Methodology Topical Report
3. Initial Burnup Credit/LT Criticality Topical Report
4. Annotated Outline Revision 2
5. Process Models Topical Report
6. Interim Burnup Credit Topical Report
7. Annotated Outline Revision 3
8. Subsystem Models Topical Report
9. Final Burnup Credit Topical Report
10. Dose Assessment Radiological Release
Methodology Topical Report
11. Annotated Outline Revision 4
Total System Performance Assessment Models T.R.
12. Waste Package Topical Report

Scientific Programs

1. Human Intrusion/Postclosure Rock Characteristics
& Geochemistry Technical Basis Report
3-D Model of Yucca Mountain
2. Preclosure Rock Characteristics Technical Basis
Tectonics Technical Basis Report
Preliminary Integrated Geol/Hydrol/Geochem. Model
3. Potential Effects of Postclosure
Climate Report
4. Interim Integrated Geol/Hydrol/Geochem. Model
Ground water Travel Time Technical Basis Report
5. Geohydrology/Transport Technical Basis Report

Scientific Programs

1. Seismic Design Input to Repository ACD
2. Near Field Environment & Altered Zone Rpts
3. Intermed. Update of Geol/Hydrol/Geochem Model
4. Final Update of Geol/Hydrol/Geochem Model
5. Climate Report
6. Radionuclide Transport Model & Altered Zone Rpt
UZ Model for License Application
SZ Model for License Application
Near-Field Environment Report
7. Final Update of Geol/Hydrol/Geochem Model

Performance Assessment

1. PA Recommendation to Site Characterization/Testing
2. PA Recommendation to Site Characterization/Testing
3. TSPA 1999 Summary Report
4. Final Report Waste Package/EBS PA
5. TSPA for License Application

Construction/Testing

1. Complete Excavation Heater Test #1
2. Complete South Ramp/Daylight
3. Complete Excavation Heater Test #2

Design

1. Final LAD

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OCRWM has also identified product area goals for three of the products. Management and Compliance is related to the infrastructure and management of the Project and does not lend itself to the certain discrete goals as in the other product areas. The product area goals for site suitability are identified in the following interim evaluation reports:

- Surface Processes
- Pre-closure Rock Characteristics
- Tectonics
- Reasonable Available Technology
- Pre-closure Radiological Safety
- Geochemistry/Post-closure Rock Characteristics
- Geohydrology/Transport
- Total System Performance Assessment

These goals are in accordance with 10 CFR Part 960, to provide a basis for interactions with Stakeholders and peer reviewers.

The product goals associated with the NEPA process include the issuance of a Notice of Intent, EIS Implementation Plan, Draft EIS, Final EIS/Record of Decision and the performance of associated EIS studies. Licensing goals include the Annotated Outline/Draft License Application, and various Topical Reports.

Review Team's Evaluation of Fiscal Year Planning and Prioritization under the Program Approach. Based upon the Review Team's discussions with project management and our observation of the budgeting process, the following important points were confirmed by the Review Team. The planning and budgeting process at OCRWM relative to prioritization of scientific work is adequate and consistent with the criteria used in developing the Program Approach Long-Range Plan in that OCRWM appears to consistently prioritize work based upon the work's contribution to technical site suitability, NEPA and the licensing process. For example, the Solitario Canyon horizontal drill hole and tests in the unsaturated zone as well as surface facilities drillholes were deferred until after FY95 because these activities were more related to license application than to technical site suitability.

The Review Team believes, contrary to OCRWM's assertion that technical risk will decrease as the Project proceeds, that technical risk cannot be accurately assessed until the Program Approach technical baseline is reconciled with the SCP and the new baseline is accepted within the scientific community. The result of the FY95 Planning and Budget Prioritization Process is that many activities were deferred to FY96 and beyond due to budget constraints. Specific deferred activities will be identified later in this section under the topic "Negotiation Between the YMSCO and Participants Regarding Scope, Schedule, Budget and Deliverables." The risk exists, in the Review Team's opinion, that if scientific tests are deferred because of budgetary constraints, data critical to the site suitability decision and license application process may not be received in a timely manner. The resulting impact could be schedule delays and increased costs for the Project. See Section VI for a discussion of schedule delays and impacts.

Roles of Change Control Boards

The work scope addressed is as follows:

- *What roles do the various change control boards play in assuring that any decision to reduce or eliminate scientific studies is based on scientific rather than cost or schedule considerations? [NARUC A.3.3]*

To address this scope of work, the Review Team studied OCRWM and YMSCO procedures governing the change control process and interviewed OCRWM personnel in Washington, DC and YMSCO personnel in Las Vegas, Nevada. In addition, several change requests were reviewed to ensure that scientific and/or technical issues were adequately addressed. The succeeding paragraphs present a summary and evaluation of the change control process.

Summary of the Change Control Process. According to change control procedures reviewed and related interviews, there are five levels of change control boards within DOE. The five change control boards and the thresholds which determine the involvement of the appropriate change control board are summarized as follows:

<u>Control Board Description</u>	<u>Cost Threshold</u>	<u>Schedule Threshold</u>
Energy System Acquisition Advisory Board (ESAAB) Change Control Board	Over \$50 Million	Any Change to Secretarial Milestones and/or Schedule Changes Over Six Months
Program Change Control Board	Up to \$50 Million	Any Change to Program Milestones and/or Schedule Changes Over Three Months
Project Change Control Board	Up to \$25 Million	Any Change to Project Milestones and/or Schedule Changes Over 30 Days
Field Change Control Board	Defined in Job Package	Schedule Changes up to 30 Days
Participant Change Control Board	Up to \$100,000 per Participant	Schedule Changes up to 30 Days

The ESAAB Change Control Board, which also has jurisdiction over all technical changes that impact key Program strategy decisions, consists of the following senior-level DOE representatives:

- Undersecretary - Acquisition Executive
- Assistant Secretary for Environment, Safety and Health
- General Counsel
- Chief Financial Officer
- Director of Administration and Human Resources Management
- Director of Procurement, Assistance and Program Management

The OCRWM Change Control Board, which also has jurisdiction over all technical changes that impact the Program-level technical baseline, consists of the OCRWM Director as Chairperson and the following OCRWM individuals as members:

- Director, Office of Quality Assurance
- Project Manager, Yucca Mountain Site Characterization Office
- Director, Office of Program Management and Integration
- Director, Office of Waste Acceptance, Storage and Transportation

- Director, Office of Human Resources and Administration

The YMSCO Change Control Board also has jurisdiction over all technical changes which impact the Project technical baseline, regulatory requirements, waste isolation, or the ability to characterize the site. This board is comprised of the YMSCO Project Manager as Chairperson with the following YMSCO personnel as members:

- Assistant Manager for Environment, Safety and Health
- Assistant Manager for Administration
- Assistant Manager for Engineering and Field Operations
- Assistant Manager for Scientific Programs
- Assistant Manager for Suitability and Licensing
- Director, Office of Public Affairs
- Director, Office of Quality Assurance
- Project Controls Team Leader
- Site Manager

The Field Change Control Board consists primarily of the Assistant Managers' delegates in the field. The responsibilities of this change control board are being transitioned to the Participant Change Control Board which is comprised of M&O contractor representatives. This modification is the result of the M&O's expanding role as managers and integrators of the Project.

When a change proposal is initiated, the originator is required to define the scope of the change, and provide as a minimum the following:

- Document/drawing preparation, review and comment resolution for initial baselines, revisions of baseline changes in accordance with applicable administrative or quality assurance procedures.
- Identify documents affected by the change.
- Concise statement justifying the need for the proposed change.
- Description of the impact if the change is not made.
- Clear statement describing the current baseline prior to the change and the baseline as it would be reflected after the change. This statement includes attributes of physical items.

- Technical impact analysis with descriptions of impacts, if applicable, to:
 - Site Characterization
 - Waste Isolation Capability
 - Performance Assessment
 - Quality Assurance
 - Licensing
 - Permitting
 - Project Plans and Procedures
 - System Performance
 - Design Activity
 - Logistical Support
 - Operational Documentation, Computer Programs and Other Considerations
- Cost impact analysis
- Schedule impact analysis
- Analysis of impacts to organizations external to OCRWM, DOE programs external to OCRWM, current contractual obligations and other documents.

Change requests are also to be reviewed and assessed by affected participants. According to procedures reviewed, the change control board members ensure the above analyses are adequately performed before approving or disapproving a change.

In the course of the Review Team's analysis, several specific change requests were reviewed to determine the extent to which change requests are reviewed for scientific and technical merit. During this review, the Review Team did not note any change requests which did not undergo an adequate scientific and technical review in accordance with OCRWM change control procedures. In an attempt to confirm this conclusion, the Review Team analyzed several changes from the Field Change Control Board to ensure that technical impacts as well as cost and schedule impacts were being addressed properly at the YMSCO.

The very format of the change control process at the YMSCO emphasizes the potential impacts on the technical aspects of the Project by changing the scientific studies as projected in the SCP. Although schedule and cost are also evaluated by the Field Control Board, the emphasis is still on the technical issues. The first step in the evaluation process is where the board members evaluate the proposed change request using the following criteria:

- Has the change been adequately described?
- Have adequate technical, institutional, quality, safety, cost, and schedule analyses been performed to justify the change?

- Have all functional and physical interfaces been considered and discrepancies resolved?
- Have impacts on regulatory requirements or licensing issues been adequately considered and documented?
- Has the Change Document been correctly classified?
- Have the changes, justification, and analyses been sufficiently documented and necessary supporting information been made available for disposition or implementation of this change?
- Have all controlled documents affected by the change and proposed change actions been identified?

The individual board members will, based on the above, request additional investigation with explanations; approve the change request; approve the change request with conditions and with explanations; disapprove the change request with explanations; or take no action with explanations. At the same time, schedule and cost impacts are also evaluated. With a consensus approval, the Secretary of the change control board will sign-off on a Change Evaluation Summary. Final approval is then authorized by the Chairperson of the change control board by issuing a change directive. In accordance with QA/QC procedures, all appropriate and affected documents impacted by these changes are adjusted, if applicable.

Examples of scientific and technical changes are:

- Addition of three large hydraulic gradient boreholes to the Yucca Mountain Site Characterization Program Baseline. This was basically an expansion of the Program requirements to satisfy criticisms over the lack of data relating to groundwater gradients at the site.
- Change in objectives for activities 1 and 4 of Yucca Mountain United States Geologic Service (USGS) study plan 8.3.2.1.4 (Regional Hydrologic System Synthesis and Modeling). This change clarifies and amplifies the importance of considering alternative and existing hypotheses in the conceptual model.
- Extend Phase I drilling depth beyond approximately 1,000 feet in borehole USW SD-9. This original Phase I hole depth was 1,000 feet, but due to the fact that drilling was ahead of schedule and under budget, it was requested that the hole be extended to 2,175 feet.

Most of the change requests reviewed were cost and schedule changes as opposed to technical changes.

Review Team's Evaluation of the Change Control Process. Based upon a review of the various change control board procedures, validation of the practices employed by each change control board, discussions with OCRWM/YMSCO and M&O personnel, and the Review Team's experience with the activities of engineering change control boards in general, there appears to be adequate separation of duties and responsibilities between and among the change controls boards as evidenced by the different levels of change control boards that must review a proposed change depending on the technical, cost, and schedule impact of the change, and the fact that the majority of change control board members are independent from the person(s) proposing the change. Based on this separation of duties and responsibilities and the specific changes reviewed, the Review Team concludes that the change control boards appear to play an adequate role in assuring that decisions to reduce or eliminate scientific studies are based on scientific rather than cost or schedule considerations. Major changes remain under the scrutiny of the NWTRB and others, and the ultimate approval by the NRC.

Summary of Change Control

Change control involves the criteria utilized by DOE in changing the scope of the original SCP in developing the Program Approach and the process utilized by DOE to review and approve scope changes. The DOE has recently adopted the Program Approach as its new strategy for the Project. The Program Approach establishes strategic objectives and priorities and a phased approach for accomplishing those objectives and priorities. The DOE's short-term annual planning is consistent with the long-term objectives of the Program Approach.

The change control process within the DOE does appear to provide a thorough review of scope changes for scientific and technical impacts as well as cost and schedule impacts. Scientific and technical impacts are analyzed thoroughly before a change is approved to ensure that the scientific and technical integrity of the project is not compromised.

Significant questions remain unanswered, however, regarding the technical scope of the Program Approach and how it differs from the SCP. Among those unanswered questions are: (1) Is there consensus among key parties as to the scope changes from the SCP to the Program Approach?; (2) What is the longer term impact of such changes? For the Program Approach to succeed and gain credibility and acceptance, the DOE must take steps to address the questions and concerns that exist or may arise regarding the Program Approach. Not to do so could result in increased risk that the site could be rejected by the NRC during license application, increased risk of opposition and

intervention by opponents of the project and concerned Stakeholders, and resulting cost impacts and schedule delays.

Options for Consideration

- In order to increase public trust and confidence and reduce the risk of opposition and intervention during the licensing process, OCRWM should reconcile the Program Approach technical scope of work baseline with the original SCP and explain deviations from the SCP and the criteria used in making the deviations.
- OCRWM should then seek acceptance of the revised technical baseline by those respected in the scientific community such as the NAS, NWTRB, and NRC. Feedback should also be sought from Stakeholders.

CONTRACT MANAGEMENT AND CONTROLS

The contract management and controls category contains one issue and has the following stated scope of work:

- *Analyze the DOE financial and contractual management systems to assess techniques and controls to manage contractors. [NARUC A.1]*

To properly analyze the DOE's contract management techniques and controls the following issues were analyzed:

- Contracting methods.
- Negotiations between OCRWM and participants regarding scope, schedule, budget and deliverables.
- Performance monitoring and management.

In the course of this analysis, the following tasks were performed:

- Conducted interviews of DOE contract management personnel,
- Identified and reviewed the relevant written documentation,
- Reviewed the contracting system and practices for selecting contractors including scope of work, schedule, budget and deliverables, and
- Reviewed the financial and management systems for managing contractor activities including performance monitoring and management criteria and application.

These issues are addressed below, followed by a summary and options for consideration relative to contract management and controls.

Contracting Methods

Contracting methods were considered relevant by the Review Team because the type of contract sets the framework by which the contractor can and should be managed. The type of contract defines the extent to which performance and/or scope-related risk is being assumed by the contractor or by DOE. The type of contract also defines the manner in which the contractor will be compensated for its work and the responsibilities of both parties. The succeeding paragraphs present a summary of contracting methods at Yucca Mountain, a summary of the Contract Reform at the DOE and the Review Team's evaluation of contracting methods at Yucca Mountain.

Summary of Contracting Methods at Yucca Mountain. According to the February 1994 report of the DOE Contract Reform Team entitled, "Making Contracting Work Better and Cost Less," historically the DOE has relied principally on three types of cost-reimbursable contracts:

- Cost-Plus-Award Fee
- Cost-Plus-Fixed Fee
- Cost-Plus-No Fee

The first two types of contracts are used with "for profit" companies while the third type is used with "not-for-profit" institutions.

The type of contract varies depending on the participant involved. The primary participant on the Project is the M&O contractor. The M&O contractor initially consisted of a team of TRW Environmental Safety Systems, Inc. (TRW) and ten other subcontractors. OCRWM reorganized the Project to consolidate most of the other participants under the M&O as subcontractors or teammates as of April 1, 1995.

Some participants were not consolidated under the M&O. These participants include USGS and KENROB. USGS is a governmental agency and cannot be a subcontractor to the M&O. KENROB is a support services contractor which operates the computerized information management system for the YMSCO under a cost-plus-fixed-fee contract. KENROB, a support services contractor, serves as an extension of DOE staff.

In addition, REECO and EG&G are contractors to the Nevada Test Site and their contracts with DOE will expire December 31, 1995. OCRWM plans for the M&O and its subcontractors to assume much of the scope of work currently being performed by REECO and EG&G, including

Tunnel Boring machine (TBM) excavation, drilling and procurement. As of April 1, 1995, the vast majority of Project scope and cost will be performed by the M&O; therefore, the Review Team focused on the M&O contract for purposes of analyzing contracting methods.

The M&O contract initially provides for an initial term of five years, which includes start-up and ramp-up periods during transition and a performance evaluation by the DOE at the end of three years. In June 1994, the Director of OCRWM concluded in a decision memorandum that ". . . Although there is still room for improvement, it is unlikely that recompetition of this contract will result in award to a successor whose performance will be materially better off than the incumbent. I believe the incumbent has demonstrated the technical and managerial expertise required to succeed in fulfilling its mission. In view of these facts, it is my decision that the contract with TESS [TRW] should be continued." As a result of this decision, the M&O contract with TRW was extended for another five years to the year 2001.

The M&O contract with DOE is a Cost-Plus-Award-Fee contract, which provides for reimbursement of costs plus a base fee and an award fee. Reimbursable costs are determined in accordance with the DEAR and FAR regulations. The contractual provisions governing the base fee and the award fee spell out the guidelines by which the performance evaluation/award fee plan operates. The M&O, based on its performance, can either lose up to 50 percent of its base fee for poor performance or earn its full base fee plus an award fee for good performance. The M&O and DOE are to negotiate the available base fee and award fee prior to each fiscal year. The specifics of the performance evaluation/award fee plan is addressed in our analysis of performance monitoring and management.

The M&O scope of work, in general, is contained in the statement of work (Revision 1 dated October 1, 1994). The statement of work clearly specifies DOE and M&O responsibilities. DOE responsibilities include compliance with the NWPA, management of the M&O and other DOE prime contractors, establishment of overall policies and technical and programmatic requirements, approval of cost, schedule and technical baselines and changes thereto, work scope assignment and other ancillary tasks. M&O responsibilities include reporting to DOE, providing technical, schedule and budget direction to contractors performing work on the Project, submitting deliverables, and assisting DOE in interactions with NRC, and other Federal agencies and entities identified in the NWPA as amended. The statement of work also describes the macro-activities to be performed by the M&O during the course of the contract.

The specific scope of work, deliverables, schedule and budget for the M&O in a given fiscal year is outlined in a Work Authorization Directive (WAD). The contract provision governing work control systems states the following:

... (f) Budget Negotiations: Prior to the authorization to proceed with the performance of any work under this contract, the Contractor and the DOE shall mutually establish a budget of estimated costs for each contract line item and corresponding schedules of performance for the Statement of Work provided to the Contractor for that fiscal year....

(g) Work Authorization Directives (WADs): The WADS authorizing the Contractor to proceed with performance of the annual Statement of Work, shall be provided in writing to the contractor by the Contracting Officer. Each WAD so issued will include the following:

- (1) Authorization number and effective date
- (2) Description of Work
- (3) Contract line item number
- (4) The total estimated cost for the work to be performed under this authorization and current budget if the WAD performance schedule exceeds the current fiscal year.
- (5) Appropriate schedule and milestone dates
- (6) Cost, schedule and all other reporting requirements
- (7) Date of issue
- (8) Contractor's signature
- (9) Contracting Officer signature

...(i) Modification: The Contracting Officer may at any time and without notice issue WADs within the Scope of Work of this contract requiring additional work, or directing the omission of, or changes to the Statement of Work of this contract. A proposal for adjustment in the budget of estimated costs and schedule of performance of work established in accordance with paragraph (f) of this clause shall be submitted by the Contractor as mutually agreed upon with the Contracting Officer.

(j) Expenditure of Funds and Incurrence of Cost: The performance of work and the incurrence of cost in the execution of the Statement of Work of this contract shall be initiated only when authorized in accordance with the provisions of this clause. The expenditure of monies by the contractor in the performance of all authorized work shall also be governed by the provisions of Clause B. . . , Obligation of Funds and Section I, Clause 13, DEAR 970.5204-15 Obligation of Funds. The Contractor shall notify the Contracting Officer whenever the cost incurred to date plus the projected cost to complete on any WAD is expected to vary plus or minus ten percent from the WAD's estimated costs.

(k) **Remuneration:** An annual fee shall be negotiated in accordance with the provisions of Section I, Clause 87, Award Fee for the performance of work authorized to be performed pursuant to this clause. The six month evaluation plans will be developed in accordance with the contract clause entitled "Award Fee" and shall include such factors as milestones, evaluation criteria, and allocated portions of fee assigned to each of the contract line items. In accordance with the contract clause entitled "Changes," when a WAD results in a material change in the negotiated budget of total estimated cost character of the Statement of Work, an equitable adjustment of the fee shall be made in accordance with the agreement of the parties and the contract shall be modified in writing. . . .

The WAD specifies the maximum financial obligation that the DOE has to the M&O for the fiscal year in question. The contract also provides for the recovery of avoidable costs from the M&O due to negligence or willful misconduct by the M&O if the work was clearly within the sole and exclusive control of the M&O and DOE is not responsible in any way for the act or omission that resulted in the additional costs. This recovery, however, is limited by the contract to the amount of award fee earned by the M&O during the six-month period in which the additional costs were incurred. The M&O contract includes standard DOE stop work order and termination for convenience clauses.

Contract Reform at the DOE. In February 1994, the DOE Contract Reform Team issued a report entitled "Making Contracting Work Better and Cost Less." (Contract Reform Team Report) The Contract Reform Team Report's principal focus was on M&O contracts. The Contract Reform Team Report included recommended changes which would result in a "Performance-Based Management Contract" as opposed to the traditional M&O contract. The Contract Reform Team Report presented an evaluation of the traditional M&O contract and its associated problems and developed features of a performance-based contract which would, at least in part, alleviate those problems. The table below summarizes this evaluation:

Problem	Traditional M&O Contract	New Performance-Based Management Contract
Management contractor is not always the best entity to do the work.	Presumes the manager will be the operator.	Management contractor will not necessarily perform most operations, especially when specific functions can be subcontracted at a lower cost to a specialized contractor.

Problem	Traditional M&O Contract	New Performance-Based Management Contract
Loose accountability for performance. Few quantitative controls to ensure funds are spent on highest priorities.	Broad, subjective statement of work. Department oversees inputs.	Well-defined, objective performance, criteria and measures for Program activities; environment, health and safety requirements; and financial and management objectives. Periodic updates. Department measures outputs.
Few cost controls.	Cost reimbursement.	Fixed-price contract (with limited work-change orders) or cost-sharing arrangements preferred.
Federal employees "check checkers" and manage costs. Inadequate staff.	No meaningful incentives to reduce costs.	Incentives to reduce costs through such measures as sharing costs and cost savings and strictly enforced performance criteria and measures. Fewer federal "checkers" with better skills.
Fee awards have not properly reflected the quality of performance.	Compensation based on criteria applied in post-performance review process. Relatively little input from Program Offices.	Compensation based on measurable objective criteria established in the contract. Strong programmatic input, with comparisons throughout Department.
Insufficient fee incentives for excellence; fees tied to scale of operations.	Levels of total contract funding unrelated to contractor performance.	Year-to-year contract funding more dependent on contractor performance. High-performance Programs get more discretionary research funds.
Government reimburses costs that it should not.	Fines and penalties, third-party claims, and similar costs typically allowed.	Fines and penalties and third-party claims unallowable, with well-defined exceptions where prudent business judgement is exercised.
Insufficient competition for contracts.	Contracts typically extended, rarely recompeted.	Ordinarily recompeted at least every ten years. Procurement process streamlined.

Problem	Traditional M&O Contract	New Performance-Based Management Contract
Strong bias for existing contractors.	Contractor selection heavily emphasizes prior work at the facility.	Stresses selection of contractors recognized as "best in class."
Insufficient financial accountability.	Financial oversight by review of annual cost vouchers.	Enhanced financial data management system provides meaningful oversight tools, emphasizing comparison to Program, Departmental, other agency, and private-sector benchmarks.

The Contract Reform Team Report included the following recommendations for implementing the necessary changes:

- Review current M&O contracts and identify discrete tasks for fixed-price contracts and sub-contracts.
- Develop and implement performance criteria and measures which encompass the following:
 - Policy-oriented, programmatic objectives.
 - Business, management, and other financial objectives, such as financial accounting, cost containment, human resources, public responsiveness, and promotion of small and minority businesses.
 - Environment, safety and health objectives.
- Develop an incentive program for contractor cost-reduction/cost-avoidance programs.
- Require management contractors to prepare "make-or-buy" plans.
- Except in unusual circumstances, automatically rebid management contracts after no more than one extension.
- Negotiate the terms of the extended contract before making the decision to extend, and make the decision-making process open to public scrutiny.
- Reduce support service contracting by at least ten percent in Fiscal Years 1995-1997.
- Initiate Department-wide benchmarking of various indirect-cost categories against the "best in class" of public and private businesses, and initiate planning for specific goals for reducing indirect costs.

Review Team Evaluation of Contracting Methods at Yucca Mountain. The Review Team believes that the recommendations of the Contract Reform Team Report represent a positive step toward improving the accountability, cost effectiveness and efficiency of the DOE's contractors. The Contract Reform Team recognized that while some version of a cost reimbursable contract may be appropriate for situations where the scope of work cannot be well defined, there are many cases where fixed or unit-price contracting can be used as well as performance-based contracts.

For the most part, OCRWM has begun to implement the recommendations of the Contract Reform Team. There are, however, three areas where OCRWM has not adequately addressed the Contract Reform Team's recommendations.

- OCRWM extended its contract with the M&O for five years without attempting to modify the contract so that it more truly represents a "performance based contract."
- OCRWM has not developed, to-date, an incentive program for cost-reduction/cost avoidance programs.
- OCRWM has not, as of the completion of the Review Team's analysis, proposed or executed any contract changes to incorporate fixed-prices or fixed-unit prices.

In June 1994, OCRWM extended the contract of the M&O to 2001. The Review Team understands the OCRWM Director's rationale that recompetition of the contract would most likely not result in material improvements in performance over what is achieved by TRW. Continuity of the M&O contractor is an important component of a successful Program. The Review Team, however, believes that OCRWM missed an opportunity to negotiate changes to the M&O's contract which could have increased the M&O's accountability and provided incentives for cost-effective performance of work. OCRWM was aware of the Contract Reform Team's recommendations at the time of contract extension and could have pursued contract amendments which would incorporate many of the performance-based contracting principles such as fixed-price contracting and incentive programs for cost reduction and avoidance.

The Review Team noted no strong desire by the project representatives interviewed to change the structure of contracts for work performed by outside contractors. While some of the reasons given were valid, such as "the difficulty in identifying the scope of work," there are ways to avoid inappropriately penalizing the contractor while still shifting significant accountability for performance to the contractor. DOE has not adequately explored these options.

Opportunities exist currently at Yucca Mountain for the institution of fixed-price contracting on a limited basis. Possible candidates for fixed-price or fixed-unit-price contracting at the Project level are the Kiewit/Parsons-Brinkerhoff (Kiewit) subcontract to REECo for TBM excavation and the REECo drilling scope of work. Fixed price or fixed unit price contracts are those on which performance risks are substantially shifted to the contractor, thus putting the burden of performance on the contractor, within certain parameters. For example, under a fixed price excavation contract, a contractor may be paid a flat or fixed amount over the life of the contract for excavating five miles of tunnel. Another example could be where a contractor is paid a fixed unit price for excavating so many units of rock. A unit may be defined as a ton, or cubic yard or some other measure.

As mentioned earlier, the REECo contract with DOE expires December 31, 1995. For OCRWM to successfully convert these contracts to fixed-price or unit-price subcontracts, the TBM excavation and drilling scope of work must be assigned to the Project M&O and not the Nevada Test Site contractor that will replace REECo. To ensure the proper segregation of costs between fixed-price contracts and cost-reimbursable contracts, OCRWM should not contract with the same company for fixed-price work and cost-reimbursable work.

Critics of fixed-price contracting at the Project have indicated that the scope of work is not adequately defined for fixed-price contract work to be successful. An example cited is the ESF Project that is not so much a tunnel, but a laboratory, therefore, the excavation work may be stopped periodically for scientific testing.

The Review Team believes that scope uncertainties can be dealt with via a unit-price contract. Under a unit-price contract, the YMSCO retains the risk relative to scope issues and the contractor assumes the unit price performance risks. If the contractor is productive and efficient it stands to make more profit than if the participant is not productive. Therefore, the contractor has an incentive to control costs and improve productivity. Examples of how a tunneling subcontract and a drilling subcontract might be constructed are described in the following paragraphs.

Tunnel Excavation Unit-Price Subcontract. The method or structure of unit-pricing a subcontract for a tunnel excavation does not change significantly if the YMSCO procures the TBM or if the subcontractor procures the TBM. The total contract value, however, would obviously be different. Under a unit-price subcontract for tunnel excavation, the subcontractor could be paid a lump sum price for mobilization and demobilization and unit-prices for other aspects of tunnel

excavation. The Project probably has had enough experience now with rock conditions to be able to classify the rock that the TBM encounters into a number of categories or zones. Depending upon the zone encountered, such as hard rock or a fault zone, the subcontractor would bid and be paid a specific unit-price per meter excavated for each type of zone encountered. Different unit-prices could exist in the contract for each zone. Other aspects of tunnel excavation such as steel set installation, rock bolt installation, shotcreting and stand-by time in excess of an anticipated amount could be paid at the bid rates established for each commodity. Alcoves could have their own pricing structure including a lump-sum portion, a cubic yard price for excavation and set unit-prices for support steel, rock bolts, shotcrete and stand-by time. Determination of the zone, for pricing purposes, could be established by scientists on the site.

Drilling Unit-Price Subcontract. The method or structure of unit-pricing a subcontract for drilling is similar to the structure for tunnel excavation work. Under a unit-price subcontract for drilling, the subcontractor could be paid a per-hole price for mobilization and demobilization and unit-prices for other aspects of the drilling program. The Project probably has had enough experience now with rock conditions to be able to classify the rock encountered into a number of categories or zones. The subcontractor would be paid a specific unit-price per linear foot drilled for each zone encountered. Other aspects of drilling such as obtaining samples, hole abandonment and stand-by time in excess of an anticipated amount could be paid for at set rates per sample, hole and hour respectively. As with tunnel excavation, determination of the zone for pricing purposes could be determined by scientists on the site.

Other opportunities for fixed-price contracting or unit-pricing such as geophysical logging and other services at the site may exist. It is the Review Team's opinion that given the ever increasing costs of the Project and the likelihood that the Nuclear Waste Fund (discussed in Section Seven) will be inadequate to pay for the total life cycle costs of a repository at Yucca Mountain, OCRWM should make the institution of fixed-price and performance-based contracting a top priority. OCRWM should consider pursuing changes to its current contracts to include fixed and unit-prices where appropriate and incentives for cost-effective performance.

Negotiations between the YMSCO and Participants Regarding Scope, Schedule, Budget and Deliverables

Negotiations between the YMSCO and participants regarding scope, schedule, budget and deliverables are critical for developing management and controls on the Yucca Mountain Project. The process by which the YMSCO and the participants establish baseline criteria for performance monitoring is a crucial consideration. To evaluate the process by which the YMSCO and participants negotiate scope, budgets, schedules and deliverables, the Review Team analyzed the YMSCO's planning and budgeting process for FY95 to identify the central negotiation issues between the YMSCO and participants.

Planning and budgeting for FY95 consisted of a lengthy process by which OCRWM began establishment of priorities for the fiscal year, the issuance of guidance to participants, and negotiations between the YMSCO and participants regarding the work plan and related budgets. The establishment of OCRWM priorities is addressed in other sections of this report. The succeeding paragraphs focus on the guidance given to participants and the negotiations that ensued between the YMSCO and participants. An overall evaluation of the participant negotiation process will follow.

Issuance of Guidance to Participants for FY95 Planning and Rebaselining. In July 1994, the YMSCO Project Manager transmitted guidance for FY95 planning and rebaselining to the M&O, Reynolds Electronic & Engineering Company, Inc. (REECo), Science Applications International Corporation (SAIC), the national labs and USGS. The participants were directed to plan their work based on a stated scope of work, specifically identified deliverables and completion criteria, and to then prepare detailed schedules and budgets to support the deliverables. The participants were informed that if the price of the planned work exceeded the congressional appropriation, it may be necessary to rescope or move work to the next fiscal year, but only after consideration was given to Project priorities. The participants were directed not to adjust staffing levels or initiate procurements until the FY95 scope was finalized.

The participant data sheets provided detailed information regarding scope, deliverables and completion criteria. The YMSCO previously had prepared its own estimate for the planned work; however, this was not included in the participant guidance information and the participants generally were unaware of the YMSCO's initial estimate.

Submission of Budget Proposals by Participants. In mid-August 1994, the participants submitted their budget proposals for FY95. The following table presents the YMSCO's top-down estimate, the participants estimate, and the final budget values for FY95 by third-level work breakdown structure (WBS) accounts.

**Participant and YMSCO Budget Proposal Amounts
Compared to Final Budget Amounts for FY 1995**

WBS	Description	YMSCO Estimate	Participant Estimate	Final Budget	YMSCO v. Part.	Part. v. Budget
1.2.1	Systems Engineering	\$ 13.00	28.01	9.10	115%	208%
1.2.2	Waste Package	15.20	16.73	9.40	10%	78%
1.2.3	Site Investigations	119.58	140.67	85.78	18%	64%
1.2.4	Repository	21.85	20.14	9.40	-8%	114%
1.2.5	Regulatory	31.70	37.08	26.65	17%	39%
1.2.6	Exploratory Studies Facility	108.42	147.82	99.90	36%	48%
1.2.7	Test Facilities	23.29	21.01	12.20	-10%	72%
NTS	NTS Allocation	3.00	3.00	3.00	0%	0%
1.2.9	Project Management	20.27	24.51	16.45	21%	49%
1.2.10	Financial Assistance	29.20	29.20	26.20	0%	11%
1.2.11	Quality Assurance	9.38	11.57	9.59	23%	21%
1.2.12	Information Management	21.75	21.40	15.01	-2%	43%
1.2.13	Environmental Safety & Health	20.14	22.00	19.10	9%	15%
1.2.14	Institutional	5.96	4.77	4.50	-20%	6%
1.2.15	Support Services	26.72	34.70	28.99	30%	20%
Total		\$469.46	562.61	375.27	20%	50%

The majority of the YMSCO estimates and participant estimates listed above were obtained from a YMSCO budget review meeting handout dated September 22, 1994. In some instances additional information was obtained which differed from the budget review meeting amounts. If the additional information appeared to be more complete and in more detail, the Review Team utilized those estimates instead. The final budget amounts were obtained from the FY95 TIPs.

As the above table indicates, the participants estimates were significantly higher than what OCRWM had estimated for FY95. What was finally negotiated between OCRWM and the participants was significantly lower than even OCRWM's estimate. Between mid-August and late September extensive negotiations were conducted between OCRWM and the participants. Once work scope, schedule, deliverables and budget were agreed upon, OCRWM and the participants signed the participant planning sheets. This signoff represented the agreed-upon scope of work, schedule, deliverables and budget between OCRWM and the participant. This agreed-upon scope of work was also executed in the form of a WAD which was signed by OCRWM and participants. The WAD represents an official contract document which identifies work to be performed by the participant and the maximum cost that can be charged for that work.

The Review Team analyzed significant variances between the participant estimates and the final budget for the following WBS accounts:

- WBS 1.2.1 Systems Engineering
- WBS 1.2.3 Site Investigations
- WBS 1.2.6 Exploratory Studies Facility (ESF)
- WBS 1.2.9 Project Management
- WBS 1.2.13 Environmental Safety & Health
- WBS 1.2.14 Institutional
- WBS 1.2.15 Support Services

The succeeding paragraphs will describe the Review Team's analysis of the above WBS accounts and discuss the reasons for variances between the participant estimates and the final negotiated budget.

WBS 1.2.1 - Systems Engineering. As the above estimate and budget comparison indicates, the original participant estimates for the guidance scope of work was \$28 million. The final budget was \$9.1 million. Of the \$18.9 million estimate variance, \$17.8 million is due to differences between the original M&O estimate of \$26.2 million and the final budget for the M&O of \$8.1 million. The Review Team, for purposes of examining the effectiveness of the participant/DOE negotiation and prioritization process, focused only on the M&O portion of WBS 1.2.1 Systems Engineering.

According to sources within the YMSCO and the M&O, the majority of the differences between the original participant estimates and the final budget were due to insufficient guidance from the YMSCO. This lack of guidance resulted in interpretation problems and a lack of a thorough M&O review of its estimate before presenting it to the YMSCO. In addition to unclear guidance, the M&O was instructed to identify any other work that it believed necessary for FY95. As a result, the scope of work encompassed in the M&O estimate was significantly greater than the scope of work finally agreed upon.

In September 1994, after submission of its original estimate, the M&O revised its estimate to a "no impact plan" of \$12.7 million. Much of the difference between the revised estimate and the final budget is due to prioritization of activities. Some of the reasons for the differences between the M&O's revised estimate and the final budget are:

- The final budget for systems engineering coordination and planning incorporates a lower level of staffing and resulting level of effort to be maintained by the M&O than what the M&O originally estimated. These activities were deferred with no impact to the current fiscal year.
- The requirements allocation and traceability scope of work for the ESF was reduced to exclude the north ramp extension, the thermal test area and specifications for the 5.5 meter diameter tunnel boring machine (TBM) and the mechanical excavator. According to discussions with YMSCO representatives, this work was deferred because the design work it was supporting was postponed. The scope of work was identified by the YMSCO and M&O in regard to potential impacts to the ESF and licensing. The conclusion was reached that the work could be streamlined and performed at a later date in concert with the advanced conceptual design. According to the same YMSCO sources, there is still a question as to whether the north ramp extension of the ESF will actually be developed.
- The site characterization plan to license application design transition plan was excluded from the final scope of work. The M&O was later authorized and funded to do a major revision of the site characterization Program baseline and to archive obsolete documents at a cost of \$130,000. According to sources within the DOE, although the scope of work was reduced, the critical requirements were met and there is no technical impact.
- The final budget for systems integration incorporates a lower level of staffing and resulting level of effort to be maintained by the M&O in the design review activities for the north ramp extension of the exploratory studies facility, and the thermal test area. These activities were absorbed by the design groups for WBS 1.2.2, 1.2.4 and 1.2.6 with no impact to the project.
- The development of requirements for the performance confirmation program, short duration "what-if" studies, a thermal goals reevaluation study, and design requirements for the thermal test area have been deferred. According to sources at the Project, the deferral of requirements development for the performance confirmation program increases the risk that the performance confirmation program will not be complete in time for licensing. What-if studies were performed at the direction of the OCRWM Director

to respond to congressional inquiries. These activities were funded by areas related to the subject matter of the studies. The thermal goals reevaluation study and the development of design requirements for the thermal test area can be reevaluated concurrent with thermal testing. Actual data and test results can be used for the reevaluation.

- The participant configuration management and change control boards were not funded by the YMSCO. The M&O is absorbing these costs in WBS 1.2.9.2 Project Controls.
- The total systems life cycle cost analysis level of staffing and resulting level of effort to be maintained by the M&O is reduced.
- The advanced conceptual design logistics, safeguards and security specialty engineering functions were deleted from the final negotiated scope and budget. The YMSCO did fund this activity but not with the M&O. Outside consultants were brought into the Project Management Organization (PMO) to start this work.
- The determination of importance evaluations scope of work for the exploratory studies facility was reduced to exclude the north ramp extension, the thermal test area and specifications for the 5.5 meter diameter TBM and the mechanical excavator. These activities were deferred with no impact because existing evaluations could be expanded and used.

The above comparison between the original participant guidance, the M&O's estimate, and the final technical implementation plan, showed significant changes in scope from what was originally expected to be performed and what was finally approved in the work plan and budget.

Based on the Review Team's analysis of YMSCO/participant negotiations for WBS 1.2.1 Systems Engineering for FY95, it appears that the YMSCO did not adequately communicate its expectations to the M&O regarding the scope of work to be performed. This disconnect is either due to miscommunication on the behalf of the YMSCO or unrealistic planning and budgeting assumptions. The result was an inefficient use of resources in resolving the budget discrepancies. It is the Review Team's opinion that contract management controls would be enhanced if the YMSCO ensured that the required scope of work, related deliverables and completion criteria were adequately communicated to the participants prior to the participants submitting their proposed work plans and budgets for each fiscal year. This will be discussed in detail at the end of the participant negotiations issue.

WBS 1.2.3 - Site Investigations. The table comparing the participant estimates with the final budget for the entire Project shows the original participant estimates for the guidance scope of work totaled \$140 million. The final budget was \$85 million. Since the magnitude of difference in the WBS 1.2.3 Site Investigations was so significant, the Review Team focused on individual

WBS accounts (lower than fourth-level) which experienced variances in excess of \$1 million between an individual participant's estimate and the final budget.

The bulk of the differences between the participant estimates and the final budget and work plan were due to reductions in the drilling program and the number of alcoves in the ESF. Other work was deferred because it was not necessary to perform the work this year to meet the technical site suitability objective. The remainder of the differences were due to participant estimated work being performed and funded under different WBS codes and the YMSCO reducing LLNL's geostatistical logging scope due to poor performance.

LLNL performed Project geophysical logging during all of FY94. LLNL's performance, according to sources at the YMSCO, was technically unacceptable and financially costly. In July 1994, LLNL submitted a proposal for geophysical logging for FY95. The proposal was technically unacceptable and too expensive, so the YMSCO elected to subcontract the services through its technical and management support services (T&MSS) contractor SAIC.

LLNL attempted to retain geophysical logging work scope for FY95 by repeatedly adding logging costs back to the PACS planning documents through late September 1994 even though it was informed by the YMSCO that the work scope was no longer theirs. After extensive lobbying by LLNL, and negotiations between the YMSCO, LLNL, and the M&O, the decision was made to award LLNL only the ESF related logging work which amounted to \$200,000. This was a significant reduction from the prior year's scope of work. The YMSCO is subcontracting the remainder of the logging scope to the private sector through SAIC and the M&O. In the handling of the negotiations with LLNL, the YMSCO demonstrated resolve and decisiveness.

Based on the review of the variances between participant estimates and the budgets for FY95 and the YMSCO's explanation of those variances, it appears as if the participant negotiations aspect of contract management controls for WBS 1.2.3 was reasonable for FY95. The Review Team, however, is concerned about the magnitude of the variances between the final budget and the original YMSCO estimate and the original participant estimate. As with WBS 1.2.1, it appears as if the YMSCO may have been unrealistic in its planning and budgeting assumptions for FY95. The total YMSCO estimates and Participant estimates far exceeded what was reasonably expected to be received in an appropriation from Congress. This will be discussed in detail at the end of the participant negotiations issue.

WBS 1.2.6 -Exploratory Studies Facility. As indicated in the table comparing the participant estimates with the final budget for the entire Project, the original participant estimates for the guidance scope of work totaled \$148 million. The final budget was \$100 million. Since the magnitude of difference in the WBS 1.2.6 Exploratory Studies Facility was so significant, the Review Team focused on individual WBS accounts which experienced variances between an individual participant's estimate and the final budget in excess of \$500,000.

The primary reason for the differences between the participant estimates and the final budgets was the reduction and deferral of work scope for FY95. The procurement of certain capital equipment such as a 25 MVA transformer, a 15.6 MVAR switch capacitory system, a 5.5 meter diameter TBM, a mechanical excavator and other common equipment was deferred until FY96 or later. Also the excavation schedule within the ESF with the existing TBM was reduced from station 15+70 to station 12+80.

Based on the review of the variances between participant estimates and the budgets for FY95 and the YMSCO's explanation of those variances, it appears as if the participant negotiations aspect of contract management controls for WBS 1.2.6 was reasonable for FY95. The Review Team, however, is concerned about the magnitude of the variances between the final budget and the original YMSCO estimate and the original participant estimate. As with WBS 1.2.1 and WBS 1.2.3, it appears as if the YMSCO may have been unrealistic in its planning and budgeting assumptions for FY95. The total YMSCO estimates and Participant estimates far exceeded what was reasonably expected to be received in an appropriation from Congress. This will be discussed in detail at the end of the participant negotiations issue.

WBS 1.2.9 - Project Management. As indicated in the table comparing the participant estimates with the final budget for the entire Project, the original participant estimates for the guidance scope of work totaled \$24 million. The final budget was \$16 million. Selected variances for which the Review Team could obtain participant estimate information were discussed with YMSCO personnel who are responsible for various aspects of Project management. As a result of these discussions, the primary reasons for the significant variances were the consolidation of the M&O with other participants and OCRWM's directive to reduce the cost of infrastructure.

On the surface, it appears as if the participant negotiations aspect of contract management and controls, as it pertains to WBS 1.2.9 Project Management, was effective. However, events subsequent to the development of the FY95 work plan and budget may render much of the staffing and cost reductions achieved during negotiations ineffective. According to sources

at the YMSCO and the M&O, the M&O requested additional funding at the mid-year budget review because it was directed by YMSCO management not to lay off any workers even though the work plan called for staffing reductions in certain areas. This indirect change by the YMSCO may not yield a reduced infrastructure cost, and is, in the opinion of the Review Team, a critical management flaw. The YMSCO's directing the M&O to reduce infrastructure and then restricting its ability to accomplish the YMSCO directive is a prime example of the DOE's micromanagement of the M&O. This issue is addressed in more detail in Section Four under the issue Contractor Relations.

WBS 1.2.13 - Environment, Safety and Health. As indicated in the table comparing the participant estimates with the final budget for the entire Project, the original participant estimates for the guidance scope of work totaled \$22 million. The final budget was \$19 million. Selected variances for which the Review Team could obtain participant estimate information were discussed with YMSCO personnel who are responsible for various aspects of environment, safety and health. As a result of these discussions, the primary reasons for the significant variances were the reallocation of work scope and minor reductions in work scope. The differences between the participant estimate for environment, safety and health were not major. Based on this review, it appears as if the YMSCO/participant negotiations for environment, safety and health were effectively managed and resulted in adequate contract management and controls in this area.

WBS 1.2.14 - Institutional. As indicated in the table comparing the participant estimates with the final budget for the entire Project, the original participant estimates for the guidance scope of work totaled \$4.8 million. The final budget was \$4.5 million. Selected variances for which the Review Team could obtain participant estimate information were discussed with YMSCO personnel who are responsible for various aspects of the institutional program. As a result of these discussions, the primary reasons for the variances were the reallocation of work scope and minor reductions in work scope. The differences between the participant estimate for institutional were not major. Based on this review, it appears as if the YMSCO/participant negotiations for institutional were effectively managed and resulted in adequate contract management and controls in this area.

WBS 1.2.15 - Support Services. As indicated previously in the table comparing the participant estimates with the final budget for the entire Project, the original participant estimates for the guidance scope of work totaled \$35 million. The final budget was \$29 million. Selected variances for which the Review Team could obtain participant estimate information were discussed with YMSCO personnel who are responsible for various aspects of support services. As a result of these discussions, the primary reasons for the significant variances were the deferral of the science

center expansion, new motor pool vehicles, and OCRWM's directive to reduce the cost of infrastructure. Based on this review, it appears as if the YMSCO/participant negotiations for support services were effectively managed and resulted in adequate contract management and controls in this area.

Review Team Evaluation of Participant Negotiations at Yucca Mountain. In the Review Team's analysis of participant negotiations at Yucca Mountain for FY95, a number of issues relative to management controls arose. These issues are as follows:

- The YMSCO as a whole appears to be unrealistic in its annual planning assumptions and guidance that it gives participants.
- Some WBS managers are more realistic in their annual planning assumptions than others.
- The DOE, by micromanaging the M&O in certain areas, may render much of the annual planning and budgeting ineffective.
- The ultimate impact of deferring scientific work beyond FY95 will not be known until the technical baseline is complete and a "bottom-up" schedule is finished.

During the course of the Review Team's analysis of YMSCO/participant negotiations, it was noted that both the YMSCO and participant budget estimates for FY95 were significantly higher than the targeted budget for FY95 and the final agreed-upon budget for FY95. As early as February 1994, and again in May 1994, the YMSCO assistant managers and WBS managers were made aware that the estimated budget for the Project in FY95 was \$381 million. The YMSCO estimates prepared in June 1994 were nearly \$500 million and the participant estimates submitted in August 1994 were nearly \$600 million. This disconnect between the estimated budget and the work plan estimates appears to result from unrealistic planning by the YMSCO and participants and unclear guidance regarding scope from the YMSCO to the participants. As a result, significant unproductive time and effort was expended by the YMSCO and participants in trying to resolve the budget discrepancies. As is indicated in the analyses of individual WBS elements, some WBS managers did a better job of anticipating and planning their respective scopes of work. Most of these WBS elements were infrastructure related where the scope of work was based to a large extent on a level of effort.

The DOE, as is evidenced in the discussion of WBS 1.2.9, can render much of the M&O's infrastructure efforts ineffective by interfering with M&O decisions. This micromanaging by the DOE can undermine the authority of the M&O and result in disruption to the project and ineffective contract management.

YMSCO and M&O representatives have indicated to the Review Team that the deferrals of scope to future years, for the most part, do not represent an inordinate amount of risk to the Project. It is the Review Team's opinion, however, that the true risk of deferring work will not be known until the new technical baseline is complete. This issue was addressed in more detail in the Change Control issue analysis.

Performance Monitoring and Management

To determine the YMSCO's methods of monitoring and managing Project performance, the Review Team analyzed internal OCRWM and YMSCO documentation, interviewed OCRWM and YMSCO personnel and attended OCRWM and YMSCO meetings. As a result of this effort, the Review Team determined that methods for monitoring and managing performance vary from Program-wide meetings to individual meetings and reports from YMSCO WBS managers. The succeeding paragraphs describe some of the major performance monitoring and management tools utilized by OCRWM and the YMSCO, many of which are interrelated, followed by an overall evaluation of performance monitoring and management by OCRWM and the YMSCO.

Project Management System Guidelines. DOE Draft Order No. 4700.XX (unnumbered), dated December 19, 1994, establishes OCRWM's policy for Project management systems. This draft order is intended to replace DOE Order No. 4700.1, Project Management System. The purpose of the order is to establish a single policy for OCRWM that sets forth the minimum requirements for a project management system for all projects from pre-conceptual activities to close-out.

The draft order describes authorities and responsibilities, including specific delegation and decision authority requirements and assignment of responsibility. The following broad policy requirements are set forth in the draft order as the basis for establishing specific, detailed requirements for the Project:

- Project management system.
- Organize Project management activities into Project phases.
- Specific Project execution criteria which are similar to the Project control guidelines discussed in succeeding paragraphs.

This order provides generic guidelines and most of the specific requirements are duplicated in other orders or procedures. This order, and DOE Order No. 4700.5 described in the succeeding

paragraphs, serve as the foundation of the Project management and control system at Yucca Mountain.

Project Control System Guidelines. DOE Order No. 4700.5 establishes OCRWM's policy for applying control systems for the overall management of projects. A review of the policy indicates the following:

- Accountable project managers are responsible for the appropriate application of overall project controls.
- An essential element of accountability is overall project control of technical scope, cost, and schedule baselines.
- This policy directs a cost effective, graded approach to application of project controls, providing flexibility in application to all projects and contracts.
- The guidelines are assembled into three primary categories:
 - Baseline Development
 - Project Performance
 - Change Management
- The guidelines shall be applicable to DOE contractors performing DOE project work, including M&O contractors.
- The Lead Program Secretarial Officer (Director of OCRWM) shall ensure development of a project control system guidelines implementation plan for the cognizant DOE field office. The PACS system description serves as the implementation plan for the YMSCO.
- Project managers are responsible for the determination of the degree of applicability of guideline elements to their particular project and selected contracts therein and to prepare a project management plan using the work breakdown structure and the technical, schedule and cost baselines as the basis for guidelines implementation. The Project management plan at the Yucca Mountain Project was developed in 1990 before the M&O arrived, and therefore, is not current. The plan is being revised in this fiscal year.

The Order includes specific guidelines relative to baseline development, Project performance and change management. The baseline development category includes management actions necessary to define Project scope and responsibilities, establish technical, cost and schedule baselines and plan the Project. The Project performance category includes management actions after work commences that are necessary to monitor Project status, report and analyze performance, and manage risk. The change management category includes management actions necessary to ensure adequate control of Project baselines, including the performance measurement baseline.

Director's Program Review. The Director's Program Review (DPR) is a video-conference of OCRWM, YMSCO managers and selected M&O counterparts held on a bi-monthly basis to review progress, issues that need to be resolved, and other action items for each area of OCRWM. The Review Team witnessed the December 8, 1994, and February 9, 1995, DPR process. Specific topics addressed at the DPR meetings are as follows:

- Open action items from previous DPRs
- Program Overview
- FY 1994 Year-End Close-Out
- Yucca Mountain Project Overview
 - Major Issues
 - Site Suitability Accomplishments, Issues and Concerns
 - Licensing Accomplishments, Issues and Concerns
 - NEPA Accomplishments, Issues and Concerns
 - Management Compliance and Oversight Accomplishments, Issues and Concerns
 - Yucca Mountain Project Cost Performance
- Waste Acceptance, Storage and Transportation Overview
- Planning Overview
- Program Management and Integration Overview
- Regulatory Overview
- Systems Engineering Overview
- Human Resources and Administration Overview
- Quality Assurance Overview
- Program Support Variance Analysis

A bi-monthly Managers Project Review (MPR) is conducted at Yucca Mountain on alternate months from the DPR meetings. The MPR is conducted by the YMSCO Project Manager and/or Deputy Project Manager and involves the Assistant Managers and representatives of the M&O and participants. The format and subject matter is similar to the DPR with the exception that the focus is exclusively on Yucca Mountain.

Award Fee/Performance Evaluation Plan. The M&O contract is a cost-plus-award-fee contract. In this type of contract, the contractor is reimbursed for its costs incurred plus a base fee

and an award fee. The contractor is rated by OCRWM semi-annually. In each rating period, depending upon the rating score, the contractor can earn zero award fee and lose half of its base fee or it can retain all of its base fee and be awarded the entire award fee. Neither extreme has happened to date. The M&O achieved a good rating for the period April 1, 1994, through September 30, 1994, with a rating score of 86.1. As a result, the M&O earned an award fee of \$476,466.

OCRWM significantly changed its performance evaluation plan (PEP) in conjunction with the development of the Program Approach and in response to recommendations regarding performance measurements in the report of the DOE Contract Reform Team. The evaluation criteria were changed from functional-based input criteria to output-based criteria tied to the overall Program objectives. In addition, OCRWM developed new criteria in an attempt to increase the objectivity of the evaluation through the introduction of metrics. The succeeding paragraphs discuss the PEPs for the semiannual periods ending March 31, 1995, and April 30, 1995, respectively.

The PEP for the period October 1, 1994, through March 31, 1995, is made up of two parts; the first part is a basic plan, and the second part includes strategic goals, criteria and measurement standards. In addition to addressing the scope and objective of the PEP, the basic plan addresses the organizational structure and responsibilities of PEP administration, the method for determining the award fee, the process for monitoring and assessing performance, award fee process documentation, and changes in plan coverage.

To determine the award fee, the performance evaluation committees for OCRWM's four performance areas evaluate their respective performance areas and issue their reports. The four performance area weighted scores are added and the combined score represents the overall performance score. This score is compared to a conversion chart to determine the overall adjective rating. In addition to the performance evaluation committee ratings, the contractor performs a self-assessment that is considered in the overall evaluation. At the end of the evaluation period, the OCRWM award fee board prepares a report based on the inputs from the performance evaluation committees and the contractor's self-assessment. The fee determination official may or may not base the award fee on the award fee board's report. Other factors may be used as well. The following is a summary of the award fee conversion chart:

- Outstanding (96 percent and above) - 100% of the award fee is earned.
- Good (86 percent to 95 percent) - Between 30 percent and 94 percent of the award fee is earned.

- Satisfactory .
 - (81 percent to 85 percent) - Between five percent and 25 percent of the award fee is earned.
 - (76 percent to 80 percent) - No award fee is earned.
- Marginal (66 percent to 75 percent) - Between five percent and 50 percent of the base fee is refunded.
- Unsatisfactory (65 percent and below) - 50 percent of the base fee is refunded.

OCRWM has attempted to apply objectivity, or metrics, to its PEP evaluation process. The following is a summary of an analysis performed of the PEP to determine the percent of criteria weighting that is based on metrics. It should be noted that, while OCRWM is utilizing metrics to determine quality of performance and the numerical rating, subjective judgement is still used to determine if the requirements of the criterion have been satisfactorily met. In addition, subjective judgement is used to pick a numerical rating from the rating range for the quality level achieved. For example, the rating range for a good quality level may be between 86 and 95 and the performance monitor must choose which specific rating score to award.

The Review Team acknowledges that in an evaluation such as this, a portion of the evaluation will be subjective. The evaluation of whether or not a contractor satisfactorily meets a performance criterion may be difficult to express in metric terms in some cases. The subjectivity used in picking a numerical rating from a rating range, however, could be reduced. The current system of subjectivity can result in significant variation in the potential award fee earned by the contractor. As mentioned above, the portion of the award fee earned increases from 30 percent with a rating score of 86, to 94 percent with a rating score of 95. To minimize this, all aspects of the evaluation that can be reduced to metric standards should be stated in terms of objective, easy to measure metric standards.

The Review Team determined the overall metric portion of the PEP. This analysis, which is included in the Appendix, is summarized as follows:

<u>Performance Area</u>	<u>Weight Based on Metrics</u>
Policy Development	5 %
Management	17 %
Waste Acceptance, Storage and Transportation	25 %
Geological Disposal System (Yucca Mountain)	<u>42 %</u>
Total	<u>89 %</u>

The policy development performance area consists of two strategic goals. These strategic goals are as follows:

- Lead the collaborative development and implementation of national policy for the disposal of high-level radioactive waste.
- Participate actively in key deliberations which affect disposal of DOE nuclear materials.

The performance criterion for achieving the above goals stated simply that the M&O will support OCRWM's actions to meet the above strategic goals, and identified seven requirements for specific measurement of the M&O's effectiveness in meeting them. The requirements consist of activities related to interactions with the Nuclear Waste Technical Review Board, Program planning, contingency planning, OCRWM's analysis of Repository Impacts of Plutonium Disposition, evaluation of the feasibility of accepting additional DOE waste, regulatory integration and NEPA strategy development. The measurement standards for policy development are based on the number of requirements effectively addressed. The M&O achieves a marginal rating by effectively meeting three of the requirements and achieves an outstanding rating by effectively meeting all seven of the requirements. The satisfactory and good ratings are based on effectively meeting four and five of the requirements respectively.

The management performance area consists of two goals: (1) strengthen fiscal and Program management practices and (2) enhance effective use of human resources. There are seven performance criteria for achieving the first goal and two performance criteria for achieving the second goal. Of the nine criteria, the four most significant are presented in the following paragraphs.

The first criterion includes specific requirements relative to cost control which are as follows:

- Ten percent reduction in the M&O's overhead rate for FY 1995

- Cost reduction studies and recommendations
- Value engineering
- Infrastructure cost reductions through streamlining of processes
- Cost reduction efforts within the M&O
- Establishment of a site purchasing office in Las Vegas by January 31, 1995
- Implement "make-or-buy" program

The second criterion is concerned with improving the usefulness of the performance measurement baseline or budget. The M&O must reduce the level of effort portion of its performance measurement baseline to less than or equal to 70 percent to achieve a marginal rating. The maximum level of effort percentages acceptable for satisfactory, good and outstanding ratings are 55 percent, 50 percent and 45 percent respectively.

The third criterion is concerned with Project control functions such as developing a draft Program WBS, creating the schedule interface between Yucca Mountain and Waste Acceptance, Storage and Transportation, updating and cost loading program summary schedules, funding impact analysis, and total system life cycle cost assumptions.

The fourth criterion has specific requirements regarding the management of the Yucca Mountain technical cost and schedule baseline, development of a plan to better integrate funds management, PACS budget and cost reporting, development of Yucca Mountain cost estimating guidelines, monthly PACS reporting and Project schedule updates.

The geologic disposal system performance area consists of two goals which are to determine site suitability for the Yucca Mountain candidate repository site and to provide for timely waste emplacement in the disposal facility. There are eleven performance criteria for achieving the first goal for this performance area and three performance criteria for achieving the second goal.

Given that the award fee is a tool used to motivate and reward the M&O and that a desirable objective is cost-effective performance by the M&O, the Review Team assessed the PEP criteria and measurement standards to determine to what extent cost-effective or within-budget performance is considered in the evaluation process. Based on this review and the weighting factors assigned to each criterion, the Review Team determined that only 26 percent of the effective weight of the award fee criteria considers cost-effective performance in the determination of the rating given to the M&O.

The Review Team believes this is inadequate. Cost effective performance is very important and should carry a larger percentage of the effective weighting for award fee determination. Within the limitations of this review, the Review Team could not determine what the cost performance weighting should be, but we believe that it could be significantly increased. For instance, while the first criterion for the determination of site suitability of the Yucca Mountain site appears to effectively address safety and health issues, it does not require the M&O to develop economic cost-effective solutions to ensure that while the workplace is safe and healthy, productivity and efficiency are not affected adversely. Very few of the criteria dictate that the M&O is to perform its required work within budget. The Review Team believes that cost-effective performance by the M&O could be enhanced if it were a requirement within the performance evaluation criteria and thus critical to the determination of the award fee. Examples of measurement standards that could define the degree to which the M&O is cost-effective are as follows:

- Outstanding - Planned Work is Completed Ahead of Schedule *and* Under Budget.
- Good - Planned Work is Completed Ahead of Schedule *or* Under Budget.
- Satisfactory - Planned Work is Completed on Schedule *and* Within Budget.
- Marginal - Planned Work is Completed on Schedule *or* Within Budget.
- Unsatisfactory - Planned Work is Completed Behind Schedule *and* Over Budget.

The above measurement standards could easily be applied to the majority of the performance criteria by OCRWM. OCRWM has, in fact, used similar measurement standards for selected criteria within the PEP.

The seventh and ninth criteria for the determination of site suitability of the Yucca Mountain site are concerned with the preparation of the annual technical implementation plans. As is discussed in the evaluation of the planning and budgeting process, the FY95 planning/budgeting process was far from efficient. Significant resources were expended to determine priorities, work scope, and to negotiate with participants. The participants estimates exceeded \$500 million versus the final budget of \$375 million. For example, the participant estimates for site investigations exceeded \$140 million versus the final budget of \$85 million. Significant duplications of scope occurred between one WBS account and another and between one participant and another. Given the M&O's new role in the overall management and integration of the Project, the evaluation of this criterion could be enhanced if the measurement standards or requirements addressed this problem.

The PEP for the period March 1, 1995, through September 30, 1995, is made up of the same two parts as the previous plan. The basic plan, including committee membership and award fee performance score ratings have not changed. The weighting of the performance areas, however, is slightly different as follows:

- Policy Development (5 percent of total weight)
- Management (24 percent of total weight)
- Waste Acceptance, Storage and Transportation (24 percent of total weight)
- Geological Disposal System (Yucca Mountain) (47 percent of total weight)

OCRWM has attempted to apply metrics to its PEP evaluation process. The following is a summary of an analysis performed of this particular PEP to determine what percent of criteria weighting is based on metrics. The criteria weighting based on metrics for this period declined to 81 percent from 89 percent in the six-month period ending March 31, 1995.

The performance criteria for this period did not change significantly from the previous period. The same issues pertain to this evaluation period as applied to the previous evaluation period. Only 24 percent of the total weighting criteria included cost-effectiveness as a measurement standard. This is actually a decrease from the prior period. The performance criteria for this period, the period in which planning for FY96 occurs, does not address efficiency and effectiveness in the planning and budgeting process in terms of participant estimates being in-line with the probable funding level for the Project.

In summary, the PEP system appears to be a reasonable performance monitoring and management tool in that it communicates to the M&O what the strategic goals of the Program are, what the criteria for meeting those goals are, and what the requirements to meet the criteria are. The priorities of the PEP appear to change each period to adjust to the changing priorities and requirements of the Program and what needs to be accomplished in the Program. The PEP is focused on output/results as opposed to focusing on the level of effort applied to the M&O. The PEP appears to reward the M&O for successes through the awarding of additional fee. Conversely, the M&O can be penalized through the loss of up to 50 percent of its base fee for unsatisfactory work. There are, however, specific examples where the DOE has failed to implement additional steps which the Review Team believes would enhance their ability to control the activities of the project. Examples include:

- While OCRWM has begun to apply objective criteria (metrics) to the PEP evaluation process, Subjectivity is still used to a large extent. Objective criteria is used in many cases to determine if the M&O achieves a unsatisfactory, satisfactory, good or outstanding rating. The numerical rating given, which is weighted with numerical ratings from other performance areas to determine the award fee earned, is still subjectively determined by the rater within a prescribed range. Depending upon the numerical score granted and the ultimate weighted average, the award fee earned can vary significantly.
- Currently, between only 24 and 26 percent of the effective weight of the award fee criteria considers cost-effective performance by the M&O. In order to provide the M&O incentive to be cost-effective and efficient in the accomplishment of Program and Project objectives, the measurement standards for the performance criteria, in most cases, should include a criteria measuring cost-effectiveness relating to schedule and cost performance. Examples of possible measurement standards are as follows:
 - Outstanding - Planned Work is Completed Ahead of Schedule *and* Under Budget.
 - Good - Planned Work is Completed Ahead of Schedule *or* Under Budget.
 - Satisfactory - Planned Work is Completed on Schedule *and* Within Budget.
 - Marginal - Planned Work is Completed on Schedule *or* Within Budget.
 - Unsatisfactory - Planned Work is Completed Behind Schedule *and* Over Budget.
- As mentioned in the analysis of participant negotiations, the participant estimates significantly exceeded the previously communicated funding profiles and the final budget for FY95. The cause of this disconnect was unrealistic funding expectations by the DOE and poor communication of scope to the participants. Significant duplications of scope occurred between one WBS account and another and between one participant and another. Currently the performance evaluation criteria do not address reasonableness in the area of planning and budgeting. In order to provide the M&O incentive to be reasonable in its planning and budgeting and to provide incentive for the M&O to encourage its team mates and subcontractors to do the same, the PEP should include criteria which require the M&O to ensure that its budget proposal for a fiscal year is reasonable and consistent with the communicated funding profiles for the Project and is consistent with guidance given by OCRWM regarding priorities and scope of work.

Failure by the DOE to implement such controls may have resulted in both negative schedule and cost variances in the past or could result in negative schedule and cost variances in the future.

Planning and Control System. The YMSCO planning and control system (PACS) is a Project-wide system for planning and controlling Project scope, schedules and cost at a summary level. The primary objectives of PACS are to confirm that Project activities are proceeding as planned and to identify cost and schedule performance that deviates significantly from approved plans. Subsequent analysis is used to recommend corrective action and to update the forecasted Project costs and schedules.

PACS is an integrated set of operating procedures and information management systems designed to meet the applicable requirements of DOE Order No. 4700.1 for establishing a Project

cost and schedule control system and for generating Project-level summary reports. PACS is used for the following activities:

- Identifying, organizing and defining Project work
- Planning, scheduling, budgeting and authorizing Project work
- Accounting for the costs of Project work
- Analyzing and reporting performance
- Revising plans, milestones and the Project WBS

PACS uses "earned value" to measure performance and analyze progress. Earned value analysis measures project and participant progress and performance by evaluating variances from planned schedules and budgets. Variances that exceed preestablished limits are identified and analyzed to determine the cause of the variance and the effect of the variance on project cost and schedule performance.

Earned value is calculated at the lowest level of the WBS, the participant summary account. The participant summary account represents discrete activities that the participant performs in accordance with its scope of work. The earned value for a summary account is the budgeted value of the work performed in that account. It should be noted that PACS does not calculate earned value for "level of effort" summary accounts. The only variances reviewed are actual costs versus planned expenditures.

Project performance measurement and analysis is conducted by examining variances resulting from the comparison of the following:

- Budgeted Cost for Work Scheduled
- Budgeted Cost for Work Performed
- Actual Cost for Work Performed
- Budget at Completion
- Estimate at Completion
- Latest Revised Estimate

Monthly cost performance reports present the above information for the current month, fiscal year to-date and estimates at the completion of the fiscal year for the various levels of the WBS and the participant planning and summary accounts. Monthly cost and schedule performance measurement reports identify planning and summary accounts that exceed established variance limits. For those variances that exceed established limits, the planning and summary account manager prepares a variance analysis narrative that includes the following:

- Nature and Cause of the Problem
- Impact on Schedule, Cost and Latest Revised Estimate
- Corrective Actions Planned or Taken and Schedule for Accomplishment

Completed variance analyses are reviewed by the participant's management and the affected YMSCO WBS manager. Variance analyses also serve as input for the consolidated variance analyses narrative submitted with the YMSCO Project Manager's monthly progress report.

Current thresholds for variance reporting, according to YMSCO procedure YAP-30.7 entitled "Project Cost, Schedule, and Variance Reporting, and Preparation of Scheduled Reports," are as follows:

- Cumulative To-Date Cost Variance: +/- \$100,000 and +/- 10 percent of Cumulative To-Date Budgeted Cost for Work Performed
- Cumulative To-Date Schedule Variance: +/- \$100,000 and +/- 10 percent of Cumulative To-Date Budgeted Cost for Work Scheduled
- Variance at Completion: +/- \$50,000 and +/- 10 percent of Budget at Completion.

Other Methods of Monitoring and Managing Performance. In addition to the Program-wide and Project-wide performance monitoring/management activities, the various YMSCO personnel responsible for contractors' work at Yucca Mountain provide additional performance monitoring and management activities. Different individuals perform different activities depending upon the nature of work for which they are responsible, their needs, and their individual management style. These activities can be summarized as follows:

- Daily conversations and briefings with both YMSCO and M&O WBS managers regarding progress and the status of deliverables.

- Weekly staff meetings where performance and issues requiring corrective action are discussed.
- Weekly briefings on deliverables.
- Briefings on cost and schedule variances prior to MPRs and DPRs.
- Monthly reports by the M&O and other participants on performance, schedule and cost.

One example of YMSCO monitoring the status of deliverables and taking action to resolve unacceptable performance involves WBS 1.2.3 Site Investigations and LLNL. In November 1994, as a result of LLNL failing to complete 14 of 40 FY94 deliverables associated with geochemistry, LLNL's failure to complete all four FY94 deliverables associated with the altered zone study, and LLNL's failure to provide corrective action, the YMSCO Assistant Manager for Scientific Programs directed the YMSCO Assistant Manager for Administration to withhold funding for the affected LLNL work.

In January 1995, LLNL responded to the funding suspension by developing a recovery plan to complete the FY94 deliverables without impacting the completion of FY95 deliverables. The LLNL Technical Project Officer acknowledged that LLNL was accountable for the work promised and that he would ensure that future performance improved dramatically. In March 1995, after receiving most of the delinquent deliverables from LLNL, the YMSCO Assistant Manager for Scientific Programs directed that the funding be restored for the remainder of FY95.

In this example, the YMSCO monitored LLNL's performance and managed LLNL's performance through withholding funding to achieve Project objectives.

Review Team Evaluation of Performance Monitoring and Management at OCRWM and the YMSCO. OCRWM and the YMSCO utilizes an interrelated system of guidelines, performance reporting and analysis, meetings and performance evaluation plans to monitor and manage performance of contractors within the Program and the Project. The Project Management System and Project Control System guidelines lay the foundation for project management and controls by identifying the requirements of a system. PACS meets the project cost and schedule control system requirements of the guidelines by providing status reports of cost and schedule and requiring analyses of significant variances by project participants. The PACS data is utilized in DPRs which are interactive meetings in which performance and progress is monitored and evaluated, variances are dealt with and issues resolved. The PEP system provides a method by which the contractor is evaluated semi-annually and is rewarded according to its performance. Finally, the managers at

Yucca Mountain utilize the PACS data and other data provided by project representatives in periodic informal meetings to deal with and resolve performance issues.

The performance monitoring and management system at Yucca Mountain appears to be somewhat effective in controlling contractors, however, management control weaknesses exist in the subjectivity of the process which assigns numerical ratings and in performance criteria that do not effectively address cost-effectiveness and reasonableness in planning and budgeting.

Summary of Contract Management and Controls at Yucca Mountain

The type of contract establishes the foundation for contract management and controls as it defines the extent to which performance and/or scope-related risk is assumed by the contractor or by the DOE. The type of contract also defines the manner in which the contractor will be compensated for its work and the responsibilities of both parties. The primary method of contracting at Yucca Mountain, through cost-reimbursable contracts, provides little incentive for contractors to excel and minimizes the ability of the DOE to properly manage and control its contractors.

The Review Team observed a somewhat disjointed planning and budgeting process at the DOE, in that, planning and budget estimates are developed independently of anticipated funding amounts. The result is significant unproductive time spent trying to bring DOE and participant plans in line with the available funding.

The performance monitoring and management system at Yucca Mountain provides meaningful information to YMSCO managers and their M&O counterparts and variances are analyzed and corrective action taken. DPRs represent a productive and interactive meeting in which performance is evaluated and issues are resolved. At times, the YMSCO has demonstrated decisiveness in dealing with unacceptable performance by participants.

Options for Consideration

As a result of its review of contract management and controls at OCRWM and the YMSCO, the Review Team presents the following options for consideration:

- Given the ever increasing costs of the project and the likelihood that the Nuclear Waste Fund (discussed in Section Seven) will be inadequate to pay for the total life cycle costs of a repository at Yucca Mountain, OCRWM should make the institution of fixed-price and performance-based contracting a top priority and pursue opportunities for changing existing contracts.

- DOE should direct the Nevada Test Site that the tunnel excavation subcontract, the drilling portion of the REEC contract, and possibly other similar critical work be assigned to the OCRWM M&O as subcontracts when the REEC contract at the Nevada Test Site expires December 31, 1995.
- OCRWM should convert the tunnel excavation scope of work and drilling scope of work to lump-sum unit-price contracts which take into account the variable site conditions at the Project and periodic stand-by time.
- The YMSCO should develop the scope of work for its fiscal year planning and budgeting in such a way that the resulting YMSCO estimate is reasonably close to the expected target budget. The guidance to participants should be clear enough to ensure minimal misunderstanding regarding the scope of work to be performed and the related deliverables and milestones. If the YMSCO believes that additional funding over and above the estimated funding may be received, additional scope can be planned over and above the base scope. This scope should clearly be separated from the base or core scope of work.
- The performance criteria and measurement standards under the OCRWM/M&O PEP should be modified to include measurement standards that address the cost effective accomplishment of Program and Project objectives. Examples of possible measurement standards are as follows:
 - Outstanding - Planned Work is Completed Ahead of Schedule *and* Under Budget.
 - Good - Planned Work is Completed Ahead of Schedule *or* Under Budget.
 - Satisfactory - Planned Work is Completed on Schedule *and* Within Budget.
 - Marginal - Planned Work is Completed on Schedule *or* Within Budget.
 - Unsatisfactory - Planned Work is Completed Behind Schedule *and* Over Budget.
- The PEP should include criteria which requires the M&O to ensure that its budget proposal for a fiscal year is reasonable and consistent with the communicated funding profile estimates for the Project and is consistent with guidance given by OCRWM regarding priorities and scope of work.
- OCRWM should increase the objectivity of the numerical rating system within the PEP process. Evaluators should not have the discretion to subjectively determine a numerical rating within a broad range.

FINANCIAL MANAGEMENT AND FISCAL CONTROL

In the Financial Management and Fiscal Control category, the following two issues were identified for analysis:

- Prioritization of Funds in the Planning/Budgeting Process

Determine how DOE organizes and manages the Project to maximize the use of available funds on scientific and technical activities that are essential to determining site suitability/licensability. [NARUC A.2.1]

- Cost Reduction

Assess steps taken by DOE to reduce the cost of site characterization, and additional steps which might be taken in this regard, without jeopardizing scientific studies? [NARUC A.2.2]

The above issues are discussed below followed by summary and options for consideration relative to financial management and fiscal control.

Prioritization of Funds in the Planning/Budgeting Process

The work scope addressed is as follows:

- *Determine how DOE organizes and manages the Project to maximize the use of available funds on scientific and technical activities that are essential to determining site suitability/licensability. [NARUC A.2.1]*

This question is concerned with a number of issues. The first issue is the prioritization of activities to ensure that all required scientific and technical activities are performed to determine site suitability and licensability. As addressed previously in the section under the topic Change Control, the DOE developed a new strategy for the Project in 1994. This new strategy, referred to as the Program Approach, contains the criteria, processes and/or mechanisms used by the DOE to prioritize work in accordance with its objectives of determining site suitability and licensability. OCRWM's plan under the Program Approach is to evaluate early technical site suitability by 1998 and, in 2001, apply for a license to construct a repository.

The Program Approach represents a significant deviation from the SCP in terms of the timing of work performed. DOE has represented to the Review Team that original SCP work has not been reduced, but has, in fact, been deferred from site characterization to the license application and performance confirmation periods. The Review Team has previously mentioned its concerns about the Program Approach in that the NRC, which has the final authority to approve or reject a license application, has been silent on the Program Approach and that the deferral of work increases the risk of work not being completed in time for a site suitability decision in 1998.

Apart from the above concerns, the Review Team determined that the planning and budgeting process at the Project relative to the prioritization of scientific work is adequate and consistent with the criteria used in developing the Program Approach Long-Range Plan. The YMSCO appears to consistently prioritize work based upon the work's contribution to technical site suitability, licensing and the NEPA process.

Another issue is the organizational structure of the Project. Once the Project strategy and priorities have been established, the Project must be organized and managed in a way to ensure that the strategy and priorities are accomplished. This is frequently referred to as "form following function." As is more fully described in Section Four under the topic "Organizational Structure," DOE has developed a matrix organizational structure for the Project with the primary intent of ensuring all the required scientific activities are represented.

The disadvantages of designing such an organizational structure to ensure that all the science is accounted for is that the structure is a "three-dimensional matrix" that can become cumbersome and inefficient if not properly managed. Such inefficiencies can manifest themselves in poor integration and duplication of activities which can undermine the objective of maximizing funds for scientific and technical activities. Historically, DOE has failed to manage the Project to maximize available funds for scientific and technical activities. This is one area of such a failing.

In order for this type of organizational structure to cost-effectively ensure adequate scientific coverage, it must be effectively managed by clearly communicating Project priorities and objectives to all resource users and providers on a continual basis.

Once priorities have been established and the organizational structure is in place, to maximize resources for scientific and technical purposes, one must determine what the available resources are and allocate those resources to those who are going to carry out Project objectives.

Resources are allocated to the Program on an annual basis via Congressional appropriation. The Congressional appropriation is then allocated to the Project and ultimately the various activities and participants of the Project, by Program and Project management via an annual plan and budget. The planning and budgeting process is a lengthy process which begins with a budget target for the Program from the Office of Management and Budget (OMB) approximately two years before the beginning of the fiscal year in question, and culminates with the final plan and budget allocation for the project shortly before the beginning of the fiscal year. The following table summarizes the major events that occur during the planning and budgeting process and the respective budget estimates for the Program and the Project.

<u>Date</u>	<u>Planning/Budgeting Activity</u>	<u>Total Program (Thousands)</u>	<u>Yucca Mountain (Thousands)</u>
November 1992	OMB submits Program-wide budget target to OCRWM.	\$415,814	N/A

April 1993	OCRWM divides the OMB target between Program activities.	\$415,814	\$290,822
June 1993	OCRWM submits the Internal Review Budget to the DOE Chief Financial Officer for review:		
	- Original OMB Target	\$415,814	\$290,822
	- Reduced Funding Scenario	\$353,442	\$245,753
	- Planning Request	\$625,780	\$461,100
February 1994	DOE submits its Congressional Budget Request to Congress	\$532,230	\$381,228
February 1994	The Administration Funding Proposal is discussed in a Planning and Budgeting Meeting for FY95.	\$537,300	\$381,300
February 1994	A Level Funding Outlook is discussed in a Planning and Budgeting Meeting for FY95.	\$387,000	\$258,000
May 1994	Planning Guidance is issued to the YMSCO Assistant Managers.	N/A	\$381,000
July 1994	YMSCO develops its "Top-down" Estimate for FY95	N/A	\$469,460
August 1994	Participants submit their "Bottom-up" Estimates for FY95	N/A	\$562,610
September 1994	YMSCO and the Participants negotiate a final budget for FY95	N/A	\$375,270

During the FY95 planning period from February 1994, when the Congressional Budget Request was submitted and the Administration Funding Proposal was presented to the Project, to the finalization of the budget in September 1994, the priorities of the Project were communicated, discussed and refined. Planned activities were prioritized based on their contribution to the requirements of site suitability, licensability and compliance with NEPA. These priorities were communicated to participants in the form of meetings and formal guidance documents.

There appears to be a void between the planning and budget guidance provided and the budget and planning estimates provided by the YMSCO Assistant Managers and the Participants. As early as February 1994 and again in May 1994, the Assistant Managers were aware that the most likely funding scenario for FY95 was \$381 million. Yet, in spite of this knowledge, the Assistant Manager's "top-down" estimate approached \$500 million and the participant's estimates, which were based on guidance from YMSCO Assistant Managers, approached \$600 million. These estimates were significantly higher than the funding estimate of \$381 million and the ultimate budget of \$375 million.

This disconnect in the planning and budgeting process appears to be caused, at least in part, by the bottom-up and top-down planning/budgeting process. While this approach has many strengths, these strengths can be negated by the inefficiencies and unproductive work that are required to reconcile the differences and negotiate a final budget which is in line with realistic funding expectations. Better planning and communication, in terms of what priorities are and what can realistically be achieved with available funding, would improve this process while still ensuring that funds for scientific and technical activities are maximized the fullest extent possible.

The result of the FY95 planning and budgeting process is that funds were prioritized as follows:

Site Suitability	\$230,324,000
License Application	15,970,000
NEPA Process	28,718,000
Management and Compliance	<u>100,258,000</u>
Total FY95 Budget for Yucca Mountain	<u>\$375,270,000</u>

The YMSCO and the M&O are currently planning for FY96. The process appears to be simplified now that the Program Approach is in place. Much of the planning for FY96 performed in conjunction with the planning for FY95 is being used. The priorities have not changed from FY95 planning. The priorities have been, in fact, enhanced with the addition of product goals. These product goals were identified previously under the issue "Criteria for Reductions in Scientific Work." The most significant change is that much of the work previously performed by YMSCO assistant managers and their WBS managers will now be performed by the M&O, with the YMSCO only providing guidance and oversight. The DOE and the M&O should work together in the planning for FY96 to ensure that the disparity in budget estimates is mitigated. Priorities and available resources should be thoroughly analyzed and clearly communicated to all users and providers of resources.

In addition to setting priorities, organizing the Project and allocating resources, funds for scientific and technical activities can be maximized by increasing cost-effectiveness and reducing infrastructure or management and compliance costs. Given the "zero-sum game" scenario that involves allocating appropriated funds for a given fiscal year, if funds can be freed up by improving efficiency, eliminating unnecessary work and reducing the cost of infrastructure, additional scientific and

technical activities which are required for site suitability and licensing can be funded. Cost reductions and infrastructure costs are addressed in the remainder of this section.

Cost Reduction

The work scope addressed is as follows:

- *Assess steps taken by DOE to reduce the cost of site characterization, and additional steps which might be taken in this regard, without jeopardizing scientific studies. [NARUC A.2.2]*

OCRWM has approached reducing the cost of site characterization in two ways. The first, and probably the most significant, way in which OCRWM plans on reducing the cost of site characterization is the Program Approach. The second way in which OCRWM is approaching cost reduction is through specific cost reduction committees and studies. The succeeding paragraphs discuss each of OCRWM's approaches to cost reduction, followed by an overall evaluation of cost reduction at Yucca Mountain by the Review Team.

Program Approach. OCRWM changed its strategy and approach towards site characterization in 1994. Instead of attempting to answer all of the questions relating to the issue of site characterization by one date, it has elected to phase the scientific investigations in such a way as to allow a determination of site suitability and the application for a license at an earlier date (1998) and for less cost. If the site is determined to be suitable, additional confirmatory tests would be conducted during licensing and repository operation. If the site is determined to be unsuitable, much of the cost associated with full-scale scientific investigations can be avoided.

The Review Team has previously expressed its concerns regarding the Program Approach and its inherent risks. Refer to the beginning of this section under the analysis of change control issues for a further discussion of the Review Team's concerns and the risks associated with the Program Approach.

OCRWM has estimated site characterization cost savings of \$1.3 billion as a result of changing from the previous strategy to the Program Approach. As mentioned in the change control discussion at the beginning of this section, the DOE has represented to the Review Team that the scope of the original SCP has not been reduced under the Program Approach but has been deferred instead. Given this representation, it is the Review Team's opinion that the Program Approach will not reduce the Total Life Cycle Costs of the Program by deferring work. Work scope and the costs

associated with that work scope have been deferred from site characterization to the licensing and performance confirmation periods of the project. Cost savings will only be achieved if the site is determined to be unsuitable and licensing and performance confirmation does not occur.

Cost Reduction Committees and Studies. The current cost reduction effort at Yucca Mountain was initiated with the Mission 2001 Study. The Mission 2001 Study was conducted between March and August 1992 to validate the scope, cost and schedule for submitting a license application by the year 2001. In order to determine the optimum spending profile for the time period through 2001, a Cost Reduction Study was directed by the YMSCO Project Management in October 1992. The objective of the study was to review the work scopes and budget estimates prepared in the Mission 2001 study to identify work scopes that could be reduced or eliminated. After using the work scopes and budgets as starting points, recommended changes in approaches that could result in cost reductions were identified and evaluated.

To further evaluate the specific cost-reduction recommendations, a Cost Reduction Steering Committee (Committee) was established in the summer of 1993. The mission of this Committee was to evaluate and recommend specific cost reduction measures to WBS managers at YMSCO and/or participants in each of the following areas:

- Testing
- Infrastructure
- Design, Construction and Operations
- Early Decisions
- Regulatory
- Environmental

The Committee, facilitated by the M&O, included representatives from each major participant. The Committee was chartered to identify specific cost-reduction topics that should be addressed further in each WBS element. A series of action teams was established to address each cost-reduction opportunity. Each action team consisted of a team leader and representatives from affected organizations and WBS elements. The action teams were to confirm the cost-reduction potential of its assigned topic, develop specific action plans to implement cost reductions, and prepare summary reports for the Committee that document the following:

- Rationale
- Affected WBS Elements
- Estimated Cost Savings
- Estimated Schedule Savings
- Approvals Required to Implement the Change(s)
- Proposed Schedule and Action Items Required to Implement the Change(s)

Specific cost reduction options being considered by the Committee are presented in the following table, by category, with OCRWM's estimated cost savings and potential impacts:

<u>Description</u>	<u>Estimated Cost Savings</u>	<u>Potential Impact</u>
Testing: Drilling consolidation through multipurpose boreholes	\$6.5 million Total	None Identified
Design Construction/ Operations Relocation of muck storage area	\$6.2 million Total	None Identified
Infrastructure Information Resource Management consolidations and efficiencies	\$6.5 million Total	None Identified
Improvements in the efficiency of the change control process, reduction of the number of items subject to change control and reduction in the approval level of change control items	\$0.6 million per Year	None Identified
Environmental Environmental and Regional Program Cost Reduction	\$0.1 million Initially and \$0.3 million per Year	None Identified

The drilling consolidation has been approved and is incorporated in the overall drilling program. Implementation of the muck storage area relocation has also been started. In regard to

the information resource management consolidation and efficiencies, recommendations have not been implemented. In regard to change control, the first two recommendations have been implemented for an annual savings of \$0.3 million. The environmental and regional program cost reductions have been implemented.

All of the above cost reduction initiatives initially underwent an impact analysis to ensure the scientific and technical objectives of the Project were not adversely affected. There were some initiatives previously considered which were not implemented because they would have adversely impacted Project scientific and technical objectives. For example, the Committee considered downsizing the ESF to eliminate the north ramp extension and direct access to Calico Hills. The results of the cost reduction evaluation indicated that even though a major cost savings could have been obtained, the estimated savings do not offset the adverse effects to the Project objectives. The downsizing would have had a significant adverse effect on the collection of data needed to support the license application.

Other cost reduction activities initiated by the YMSCO are value engineering studies, establishment of an Infrastructure Reduction Assessment Team and some overall "belt tightening" activities.

According to the YMSCO "Cost Reduction Initiatives Summary Report" prepared by the Committee and dated April 7, 1995, nine value engineering studies have been performed which could result in almost \$30 million in savings. As with the cost reduction options identified above, no adverse impacts were found for the following specific value engineering recommendations presented in the following table:

<u>Study</u>	<u>Recommendation</u>	<u>Estimated Cost Savings (in thousands)</u>
TBM Starter Tunnel	Rewrite of drilling and blasting specification.	\$ 531
Standby Power Generation	Downsize to three generators.	1,910
North Portal Box Cut Concepts	Use highway underpass unit.	640
Integrated Data System	Combined data collection system.	7,816
ESF Subsurface Sensors	Sensing at the alcoves and mobile sensing at the TBM.	1,623

Canyon Power Distribution	Original system design with a circuit breaker, no transformer change and reduced capacitor bank.	7,100
North/South Portal Power Distribution	All pole mounted transformers 15 kv overhead line to South Portal eliminating building 5010 switchgear and lease generators with option to purchase.	7,267
ESF Communications	Defined the types of data to be handled and prioritized by their relative importance. Both above and below ground communications were examined.	1,425
Electrical Niches & Walkways	Eliminate all walkways, mantrip at shift change, stay put at work station, place electrical cabinets at track level.	<u>1,382</u>
Total Value Engineering		<u>\$29,694</u>

Implementation has begun on the TBM starter tunnel and canyon power distribution. Value engineering recommendations have been accepted and implementation is planned for the north/south portal power distribution, electrical niches (not walkways) and ESF communications. The other recommendations are still under consideration. While the above recommendations, may in-fact reduce the cost of site characterization, the Review Team is unsure of the ultimate impact on total system life cycle costs. Some of the scope reductions may only be scope deferrals until a second TBM for the south portal of the ESF is employed (if it is employed), or if the site is deemed suitable, and the repository is constructed.

The Infrastructure Reduction Assessment Team has initiated the following efforts to reduce infrastructure costs and streamline processes involved in conducting work in the field:

- Issuance of a draft procedure on field work planning, authorization and control to ensure adequate control for planning, authorization and implementation of field work at Yucca Mountain.
- Formation of a Field Work Improvement Team to develop and implement an effective and efficient process to plan, coordinate, implement, monitor and control field work at Yucca Mountain.

It is unclear what the difference is between the above efforts as they both address planning and implementation of field work at Yucca Mountain. The actual savings to be achieved, if any, are also unclear.

Specific belt tightening measures initiated by OCRWM and cost savings are as follows:

- A reduction in the number of TBMs from four in the Mission 2001 Study to two in the Program Approach is estimated to achieve a \$25 million savings.
- A scaled back power upgrade is estimated to achieve a \$15 million savings.
- Doubling the LM300 drilling depth per shift by integrating information from the bit testing program, better drilling controls and improving team work is estimated to achieve an unspecified savings.
- A reduction in the number of single purpose boreholes by working with designers and scientists to jointly pick the location of multipurpose boreholes, using the first 1,200 feet of borehole SD-12 to provide ESF design data, and using the lower 900 feet to provide samples for geostatistical sampling is estimated to achieve a savings of \$0.5 million per hole.

The Review Team understands the two TBMs referred to in the Program Approach to mean the current 25-foot diameter TBM being used in the ESF and the 18-foot diameter TBM planned for the Calico Hills North Ramp Extension. The Review Team is only aware of one other TBM originally planned, this being another 25 foot diameter TBM for the ESF. The Review Team questions the actual savings achieved by reducing the number of TBMs as the Project schedule is probably delayed as a result. The other belt-tightening measures appear reasonable.

Review Team Evaluation of Cost Reduction Efforts at Yucca Mountain. The only confirmable cost reduction efforts identified by the Review Team are the specific cost reduction initiatives implemented by the Cost Reduction Steering Committee. The cost savings associated with the Program Approach are, for the most part, not cost savings but scope and cost deferrals.

The specific cost reduction initiatives are necessary to the successful completion of the project as currently defined. However, they are not enough. According to current estimates (covered in Section Seven of this report) costs are estimated to substantially exceed the revenue estimates in the Nuclear Waste Fund. If the project is to be completed within reasonable cost estimates, the DOE must find other areas in which to reduce costs. On the other hand, if additional cost reduction efforts are not undertaken and the current program plan remains as contemplated, the Review Team believes that the costs may substantially increase beyond even today's estimates and this additional cost increase will become a reality in order to complete the tasks as defined in the plan.

The key question in the minds of the Review Team is whether DOE has properly identified the tasks necessary, and only those tasks necessary, to characterize the site, apply for license to

construct a repository and comply with NEPA, and other regulations. The next question is: "Having accomplished this, are the cost estimates required to complete those tasks realistic?" Significant cost reductions, are unlikely without an in-depth analysis of the necessary activities of the Project and their related costs to determine what the true cost-drivers are. It is through this analysis that the cost impact of scheduling and scoping decisions as well as the performance of nonvalue-added activities can be identified.

Summary of Financial Management and Fiscal Control at Yucca Mountain

Effective financial management and fiscal control requires well thought-out goals, objectives and priorities that are well communicated and accepted. Once the project strategy and priorities have been established, the project must be organized and managed in a way to ensure that the strategy and priorities are accomplished. Once priorities have been established and the organizational structure is in place to maximize resources for scientific and technical purposes, one must then identify the key resources required to carry out the Project objectives.

As mentioned in the evaluation of contract management and controls, the Review Team observed a disconnect between the "top-down" planning and budgeting process and the "bottom-up" estimating process at the DOE, in that, planning and budget estimates are developed independent of anticipated funding amounts. The result is significant unproductive time spent trying to bring DOE and participant plans in line with the available funding.

Effective financial management and fiscal control requires continually identifying nonvalue-added activities which can be eliminated and identifying other areas for improved cost effectiveness and efficiency. DOE has initiated some cost reduction efforts; however, it is not enough. According to current estimates (covered in Section Seven of this report), costs will substantially exceed the revenue estimates in the Nuclear Waste Fund. If the Project is to be completed within reasonable cost estimates, the DOE must find other areas in which to reduce costs. DOE has failed to adequately identify and quantify the major cost drivers of the project.

Options for Consideration

- As previously stated in the Review Team's analysis of contract management and controls, The YMSCO should develop the scope of work for its fiscal year planning and budgeting in such a way that the resulting estimate is reasonably close to the expected target budget.

- In order to effect significant cost reductions and distinguish between critical activities and nonvalue-added activities, OCRWM should perform a systematic analysis of root cost-drivers. The need for a cost-driver analysis is discussed in detail in the Review Team's analysis of infrastructure issues.

INFRASTRUCTURE COSTS

In the Infrastructure Costs category, the following two issues are to be analyzed:

- The Cost of Internal DOE Requirements

Determine to what extent Project funds are being used to satisfy internal DOE requirements, and whether some of these regulatory requirements could be waived or adjusted to conserve Project funds. [NARUC C.1.2]

- Historical Funding Allocations

Assess the allocation to date of funds between scientific and technical activities, and those used to support the Project's infrastructure, and evaluate alternative funding allocations which would better achieve the Project's objectives. [NARUC D.2.1]

The above issues are discussed below followed by a summary and options for consideration relative to infrastructure costs.

The Cost of Internal DOE Requirements

The work scope addressed is as follows:

- *Determine to what extent Project funds are being used to satisfy internal DOE requirements, and whether some of these regulatory requirements could be waived or adjusted to conserve Project funds. [NARUC C.1.2]*

The Review Team's approach to this issue was to review YMSCO TIPs for the FY95 to determine activities and their related budgeted costs which may be the result of internal DOE requirements. The Review Team interprets internal DOE requirements to mean internal DOE, OCRWM and YMSCO orders, policies and procedures. The TIP is DOE's planned activities for the fiscal year, including budget, scope of work, deliverables and schedule. Within the TIP, the budget is allocated to four major product areas. These product areas and their respective share of the budget are as follows:

<u>Major Product Area</u>	<u>Budget (Thousands)</u>
Site Suitability	\$230,324

<u>Major Product Area</u>	<u>Budget (Thousands)</u>
National Environmental Policy Act (NEPA) Process	15,970
Repository Licensing	28,718
Management and Compliance	<u>100,258</u>
Total Yucca Mountain	<u>\$375,270</u>

The TIP describes the Site Suitability product area as "... activities required to support the Technical Site Suitability evaluation scheduled for 1998, and if the site is found technically suitable, to prepare a site recommendation report by the end of Fiscal Year 2000. . . ." (U.S. DOE, OCRWM, Yucca Mountain Site Characterization Project, "Project Technical Implementation Plan, Fiscal Year 1995, Revision 0," December 1994, p. 12.)

The NEPA Process is described as "... activities required to collect, interpret, and analyze data required for, and the preparation of, the draft and final EIS in fiscal years 1998 and 2000, respectively, and the review of these documents, followed by issuance of a Record of Decision. . . ." (U.S. Department of Energy, OCRWM, Yucca Mountain Site Characterization Project, "Project Technical Implementation Plan, Fiscal Year 1995, Revision 0", December 1994, p. 12.)

Repository Licensing includes, according to the TIP, "... activities required to ensure that required information will be available to develop a license application for submission to the NRC in Fiscal Year 2001, if the site is suitable. . . ." (U.S. Department of Energy, OCRWM, Yucca Mountain Site Characterization Project, "Project Technical Implementation Plan, Fiscal Year 1995, Revision 0," December 1994, p. 12.)

Finally, Management and Compliance is described as "... normal management activities required for direction and control of the Project and special allocations required to support external agencies and the public in their review and interactions with the Project. . . ." (U.S. Department of Energy, OCRWM, Yucca Mountain Site Characterization Project, "Project Technical Implementation Plan, Fiscal Year 1995, Revision 0", December 1994, p. 12.)

Many of the activities associated with the first three product areas are required by specific laws and regulations (i.e.; 10 CFR Part 960, 10 CFR Part 60, 10 CFR Part 70, NEPA, and the NWPA) rather than DOE's own internal requirements. The Review Team, therefore, focused on management and

compliance activities for purposes of determining costs which, at least in part, are due to DOE's internal requirements.

Management and Compliance includes two subelements: general management and compliance. General management includes overall Project direction, planning and coordination, baseline development and change management, support services, facilities, vehicles, utilities and security, and information management. In addition, general management includes the Nevada Test Site Allocation, which is a mandatory payment for the Yucca Mountain portion of facilities and services provided by the test site to the Yucca Mountain Project.

Compliance includes functions necessary to comply with federal, state and local statutes and DOE orders, as well as the NWSA requirements for conducting site characterization in an open and informative manner. Also included in compliance are 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 NWSA.

To identify activities which may be related to compliance with DOE requirements, the Review Team analyzed specific participant summary account planning sheets for the WBS elements which contain significant Management and Compliance costs. Accounts that appeared to be potentially related to DOE orders were segregated for further review. The succeeding paragraphs discuss specific WBS elements and the review of the related scope of work and costs for DOE requirements.

WBS 1.2.7.3 Field Operations Center. One aspect of this activity which may be related to internal DOE requirements is site tours. REECOs summary account number OR7300L50, Field Operations Center, includes the following statement of work: "Two dedicated REECOs Admin/Clerical support personnel to provide arrangements for and scheduling of matrix support personnel to support YMSCOs tours and logistical activities. This support is estimated for 5 days per week, 8 hours per day. Tours are estimated at 10 public Open House tours averaging 205 people and 135 other tours averaging 31 people." The budget for this activity for FY95 is \$780,000. In addition, the field operations center summary account for the T&MSS contractor includes tour coordination among other activities. The total budget for this activity is \$1.9 million.

WBS 1.2.9 Project Management. The bulk of the activity in this WBS is performed in compliance with OCRWM 4700 series orders. These orders, discussed previously in relation to the

performance monitoring and management issue, require Project management and control systems at major DOE projects to ensure accountability, traceability and integration. The bulk of the work performed in this WBS is related to the operation of the PACS system, coordinating planning and budgeting, and performance monitoring and analysis, configuration management and change control. As a rule, without an in-depth analysis of the Project management activities and related cost-drivers, which was not in the Review Team's scope of work, it is not possible to determine which portion of the Project management costs are related to compliance with DOE requirements and which portion represents sound business practices which are required on a project of this magnitude. The Review Team did, however, identify certain activities which are required by other DOE orders. These activities are discussed in the following paragraphs.

WBS 1.2.9.1.1 for the M&O includes an activity entitled "Draft Compliance Reviews." The scope of this activity includes the development of approximately ten draft compliance reviews as required by DOE Order No. 1000.3B. According to sources within the PMO, this scope of work consists of one PMO individual who assists the YMSCO in the performance of internal assessments. Internal assessments are similar to internal audits in that they review certain areas within the Project for compliance with business and administration procedures. The cost of this activity is approximately \$140,000 per year. The Review Team questions whether or not it is prudent for DOE to pay the PMO, which is affiliated with the M&O, to do compliance reviews. By having the PMO involved in these reviews, it appears as if independence is impaired. Additionally, the Review Team questions whether or not the activity is even needed. Compliance reviews to ensure compliance with DOE procedures do not appear to be value-added activities but simply administrative oversight to ensure bureaucratic compliance.

WBS 1.2.12 Information Management. According to discussions with YMSCO personnel, the bulk of the Information Management activities are required to support the Project's information management needs or to comply with NRC licensing record keeping requirements. Many of the DOE orders that apply to information management are merely interpretations for implementation of regulations promulgated by other federal agencies or by Congress. As a rule, without an in-depth analysis of the information management activities and related cost-drivers, which was not in the Review Team's scope of work, it was not possible to determine which portion of the information management costs may be related only to compliance with burdensome DOE requirements, and which portion is required to support the core information management needs of the Project and/or comply with regulations external to DOE.

WBS 1.2.13 Environment, Safety and Health. According to discussions with YMSCO personnel, the bulk of the Environment, Safety and Health activities are required to support the NEPA process or comply with the requirements of other governmental agencies. Many of DOE orders that apply to Environment, Safety and Health are merely interpretations for implementation of regulations promulgated by other federal agencies such as the EPA, NRC, and Occupational Safety and Health Administration or by Congress. As a rule, without an in-depth analysis of the Environment, Safety and Health activities and related cost-drivers, which was not in the Review Team's scope of work, it is not possible to determine which portion of the Environment, Safety and Health costs may be related only to compliance with unnecessary DOE requirements and which portion is required to support the core Environment, Safety and Health needs of the Project and/or comply with regulations external to DOE.

WBS 1.2.14 Institutional. According to discussions with YMSCO personnel, the bulk of the Institutional activities are performed to comply with the requirements of the NWPA regarding Stakeholder involvement and interactions with the State of Nevada and Affected Units of Local Government or to carry out the Secretary of Energy's policy regarding Stakeholder involvement which is over and above the requirements of the NWPA. Therefore, it was not possible to identify specific costs related to DOE requirements that could be reduced or avoided.

WBS 1.2.15 Support Services. Support Services includes procurement and property management, reference center services, clerical and technical support, audio/visual services, facilities management, security and training. Two areas where costs may be excessive due to internal DOE requirements are procurement and security. Based on interviews with YMSCO personnel, the internal DOE requirements relating to procurement and property management procedures are extensive and cumbersome. An example of costs being excessive due to internal DOE requirements is the DOE's property and equipment reporting requirements. According to YMSCO sources, the reporting requirements of the DOE in this area are over and above standard business practices.

Discussions with DOE management relative to these excessive requirements disclosed that there were no ongoing evaluations by DOE or others to identify and eliminate these types of cost consuming nonessential activities, such as restructuring their procurement practices. DOE should continually monitor itself, its M&O, and other contractors to identify and eliminate nonessential activities. To achieve better control and accountability of these types of activities, DOE should

consider improving cost accounting practices to better identify and scrutinize the real cost of these activities.

In regard to security, costs at Yucca Mountain are significantly higher than is necessary because part of the Yucca Mountain Site is on the Nevada Test Site. As a result, the YMSCO must incur the same types of security costs as the Nevada Test Site.

In summary, while there may be Project costs which are related specifically to burdensome requirements internal to DOE, the cost records at the YMSCO are not in sufficient detail to enable the quantification of those costs. The lone exceptions are the tour costs and the cost of compliance reviews. An in-depth analysis of activities and cost-drivers would be necessary to determine the true cost of internal DOE requirements versus the cost of complying with regulations external to DOE and the normal cost of doing business.

Historical Funding Allocations

The work scope addressed is as follows:

- *Assess the allocation to-date of funds between scientific and technical activities, and those used to support the Project's infrastructure, and evaluate alternative funding allocations which would better achieve the Project's objectives. [NARUC D.2.1]*

There are two issues encompassed in this scope of work. The first issue is concerned with the allocation to-date of funds between scientific and technical activities and those used to support the Project's infrastructure. The second issue is concerned with alternative funding allocations to achieve Project objectives. The Project objectives in the context of this question were assumed by the Review Team to be financial objectives for reducing the relationship of infrastructure costs to scientific and technical costs. The succeeding paragraphs discuss each of these issues.

Allocation To-date of Fund Expenditures. To determine the allocation to-date of fund expenditures, the Review Team summarized the year-end DOE financial information system (FIS) reports for each year from the fiscal year ended September 30, 1983, through the current fiscal year ending September 30, 1995 (through March 31, 1995). The FIS reports are organized by program (i.e. Nuclear Waste Fund), subprogram (i.e. First Repository), category (i.e. Yucca Mountain Site Characterization Project) and task (i.e. Site Investigations).

After summarizing fund expenditures to-date by program, subprogram, category and task, the Review Team allocated the fund expenditures to-date into the following cost categories:

<u>Cost Category</u>	<u>Expenditure</u>	<u>Percent</u>
Scientific/Technical	\$1,483,478,071	34.3%
Systems Engineering/Repository	705,910,028	16.3%
Monitored Retrievable Storage	140,831,563	3.3%
Multipurpose Canister	92,292,772	2.1%
Transportation	31,136,885	0.7%
Regulatory	304,090,063	7.0%
Infrastructure		
Quality Assurance	58,775,267	1.4%
Institutional	59,102,608	1.4%
Financial Assistance	182,861,683	4.2%
Land	2,485,107	0.1%
Management	978,217,405	22.6%
Support	<u>286,713,688</u>	<u>6.6%</u>
Total Infrastructure	<u>1,568,155,758</u>	<u>36.3%</u>
Total Nuclear Waste Fund Expenditures	<u>\$4,325,895,140</u>	<u>100.0%</u>

Schedules supporting the above allocation are included in the Appendix. Some of the above cost categories are self-explanatory. Some of the categories, however, would benefit from further explanation and are described as follows:

- The Scientific/Technical category includes costs associated with site investigations, exploratory shafts and studies facilities, research and development, facility siting and development, environment, safety and health, and international waste management technology.
- The Systems Engineering/Repository category includes costs associated with systems engineering and integration, waste package design and development, repository design and development, and repository technology development.
- The Infrastructure Support category includes costs associated with test facilities, information management, support services, technical support, financial management systems, interest expense, and contractual services.

Of the \$4,325,895,140 spent through March 31, 1995, on the nuclear waste disposal program, \$1,923,217,692 has been expended on the Yucca Mountain Site Characterization Project. The Review Team allocated the fund expenditures to-date into the following cost categories:

<u>Cost Category</u>	<u>Expenditure</u>	<u>Percent</u>
Scientific/Technical	\$ 859,559,832	44.7%
Systems Engineering/Repository	298,395,410	15.5%
Monitored Retrievable Storage	0	0.0%
Multipurpose Canister	0	0.0%
Transportation	0	0.0%
Regulatory	155,640,978	8.1%
Infrastructure		
Quality Assurance	22,835,740	1.2%
Institutional	9,328,742	0.5%
Financial Assistance	134,472,677	7.0%
Land	1,351,762	0.1%
Management	313,529,497	16.3%
Support	<u>128,103,054</u>	<u>6.7%</u>
Total Infrastructure	<u>609,621,472</u>	<u>31.7%</u>
Total Yucca Mountain Expenditures	<u>\$1,923,217,692</u>	<u>100.0%</u>

As shown above for the Yucca Mountain Project, scientific/technical costs comprise approximately 45 percent of the to-date expenditures while infrastructure costs comprise nearly 32 percent. Inherently, this infrastructure rate appears abnormally high, however, the Review Team is aware of no comparable program from which to benchmark these activities. During the course of our review, it became apparent that DOE had no objectives for the relationship of infrastructure costs to scientific /technical costs. They expressed a global objective of reducing infrastructure costs by 10 percent yet prevented the M&O from making the necessary staffing reductions. The Review Team believes that the DOE will have extreme difficulty in reducing infrastructure costs by ten percent without some corresponding personnel reductions.

Alternative Funding Allocations. This portion of the scope of work requires the evaluation of alternative funding allocations which would facilitate achievement of the Project's objectives. Without an extensive analysis of Project cost-drivers, the Review Team was unable to determine the optimal allocation of fund expenditures. It can be concluded, however, that scientific and technical

activities should consume a larger share of Project expenditures than infrastructure, and that the Yucca Mountain Site Characterization Project should consume the largest portion of total fund expenditures. The achievement of the optimal allocation of funds between scientific and technical activities and infrastructure is dependent on the performance of a systematic analysis of root cost-drivers.

A systematic analysis of root cost-drivers is an analysis that links, using cause/effect relationships, primary causes with ultimate effects. Primary causes are those that, when identified and isolated, can lead to basic "but for" analyses. In other words, "but for" this event/occurrence, the project would have cost this much less or have been completed this much earlier. The ultimate effects are measurable in incremental cost or schedule overruns. No such analysis has been found to exist for the Project, and as a result, no primary cost-drivers have been identified, much less analyzed or quantified. All project problems addressed to date have been directed toward more easily recognized superficial symptoms without the systematic attention to the potential root causes of the performance problems.

The benefits of an analysis of cost-drivers are twofold:

- It would be expected to identify targets for streamlining incremental operations at the project. It is important to note that the intent of "streamlining" is not to compromise the acquisition of quality scientific knowledge or the pursuit of environmental integrity, but to identify areas where greater performance efficiencies might be realized. In the current fiscal year 1995, for example, the budgeted cost for the Yucca Mountain Project is \$370 million, which is approximately \$1,500,000 per working day. Of that amount, arguably \$1,000,000 per working day is time dependent cost. Any item of work on the Project's critical path schedule which is delayed for one day by any cause would result in an increased project cost of \$1,000,000. Conversely, any operation that affects the Project critical path that could be streamlined to cause a one-day earlier completion would result in a savings of \$1,000,000, most likely at a fraction of that cost (for the small incremental cost of the streamlining effort).
- While the analysis of cost-drivers would focus its attention on historical information, the benefits would be prospective, in that the study would provide a quantitative basis for validating the effectiveness of project management techniques currently being pursued during the transition period into the Program Approach. Although criticism has been directed toward Program/Project management in the past, the Office of Civilian Radioactive Waste Management and TRW managers state that management and financial control mechanisms are now in place to effect improvements to Project performance. While these statements appear to have some degree of qualitative validity, the analysis of cost-drivers would provide the basis for the much needed quantitative validation.

The ultimate effects are relatively easier to quantify as they correspond to cost overruns and schedule delays. These effects and their immediate causes have been the focus of prior, well-

publicized criticism. The primary or root causes have not been the focus of any publicized, quantifiable criticism. Some of them may have been stated as problems, but publicized reports are silent as to quantification. Other stated problems may have a basis of reality, but may not have any significant consequence in terms of cost increase or schedule slippage.

The direct cost portions of the cost-tracking system currently employed by the Department of Energy and its M&O contractor is known as a form of an "Activity-Based" cost accounting system. That is to say that project activity costs are estimated for predefined work breakdown structure activities and tracked as actual costs are incurred and managed through budget, schedule, and deliverable quantities activities. The current tracking and management style employed by the OCRWM and the YMSCO managers has been implemented for less than one year. This experience lacks analyses along what is known as the "value chain." An analysis of cost-drivers would explain reasons for the root or primary, cost-driven variances for the major Work Breakdown Structure activities, and identify any nonvalue-added items along the value chain.

Figure V-1, presented on the next page, shows an incremental window of a model which could be developed as the basis for a cost-driver study. Along the bottom of this graphic display (from left center to bottom center) are the primary causes. At the right-hand side are the ultimate effects. In between are the intermediate effects and secondary causes, arranged in a systematic multiple-matrix fashion showing sequences of cause/effect relationships. While cause/effect is demonstrated from left-to-right, the quantification of cost allocation would be accomplished by examining each increment of ultimate effect cost in a "backward pass" from right-to-left.

The example depicted graphically is only illustrative of the process. The actual model would have many subdivisions in every dimension of the matrix; one for every discernable cost or time-related event.

Primary Causes

Delayed Access to Primary Scientific Information

Delayed Completion to ESR Construction

Etc.

Etc.

Intermediate Effects

Additional Direct Cost of Alcove Development

Additional Direct Cost of Tunnel Development

Additional Delay-Impact Cost

Additional Delay-Impact Cost

Etc.

Etc.

Ultimate Effects (Negative Activity-Based Cost Accounting)

Additional Delay-Impact Cost

Additional Delay-Impact Cost

Etc.

Etc.

Figure V-1

Yucca Mountain Project

Sample (Window) Cost-Driver Study

Figure V – 1
Yucca Mountain Project

Sample (Window) Cost-Driver Study

Examples of primary causes could potentially include the following:

- Funding decisions or changing funding priorities.
- Environmental compliance or safety issues.
- Procurement delays.
- Contractor performance deficiencies.
- Strategic errors.
- System definition delays or errors.
- Program/Project management decision delays and/or errors.
- Unforeseen conditions and Acts of God.
- Stakeholder-initiated actions.
- Executive, legislative, or judicial actions (federal or State of Nevada).

To determine whether or not infrastructure expenditures at Yucca Mountain are increasing or decreasing as a percentage of total Project expenditures, the Review Team analyzed the allocation of Yucca Mountain expenditures to the above cost categories for each year from FY92 through FY95. To enhance the accuracy of the allocation, the Review Team based the cost allocation on the PACS cost reports for the Project. The PACS reports were utilized because the WBS detail enabled the Review Team to identify additional management costs such as coordination and planning for site investigations. This detail is not available in the FIS reports. Schedules supporting this analysis are included in the Appendix. The analysis started with FY92 because that was the year the PACS system was implemented. Since FY95 is not complete, the Review Team established the cost allocation based on the latest revised estimate for FY95. The following table summarizes this analysis:

<u>Cost Category</u>	<u>FY92 Costs</u>	<u>FY92 Percent</u>	<u>FY95 Costs</u>	<u>FY95 Percent</u>
Scientific/Technical	\$ 48,426	26.5%	\$190,530	46.6%
Systems Engineering/Repository	10,971	6.0%	26,951	6.6%
Regulatory	23,664	12.9%	25,869	6.3%
Infrastructure				
Quality Assurance	10,060	5.5%	7,951	1.9%
Institutional	2,727	1.5%	3,919	1.0%
Financial Assistance	18,711	10.2%	32,200	7.9%
Land	159	0.1%	0	0.0%
Management	38,862	21.2%	60,469	14.8%
Support	<u>29,401</u>	<u>16.1%</u>	<u>61,110</u>	<u>14.9%</u>
Total Infrastructure	<u>99,920</u>	<u>54.6%</u>	<u>165,649</u>	<u>40.5%</u>
Total Yucca Mountain Project	<u>\$182,981</u>	<u>100.0%</u>	<u>\$408,999</u>	<u>100.0%</u>

As the previous tables indicate, the Review Team classified infrastructure costs as quality assurance, institutional, financial assistance, land, management and support. In evaluating the infrastructure expenditures for the Program and the Project, the nature of some of the costs must be considered. Financial assistance is appropriated annually by Congress and many of the activities associated with the quality assurance and institutional cost categories are mandated by NRC regulations and the NWPA. Although infrastructure expenditures increased from FY92 to FY94, the increase was not as significant as the increase for scientific/technical activities, financial assistance or the Project as a whole. Total infrastructure increased by 66 percent from FY92 to FY95, but the percentage increases for scientific/technical activities and the Project as a whole were 293 percent and 124 percent respectively. While it may be that the infrastructure portion of Project expenditures is still too high, without an in-depth analysis of the activities and how costs are driven, the Review Team was not able to identify specific nonvalue-added activities and their respective costs which could be eliminated.

The Review Team performed a similar analysis of total Nuclear Waste Fund (NWF) expenditures from FY92 to the present time frame. As a result of this analysis, it was determined that the infrastructure portion of fund expenditures decreased from 44 percent in FY92 to 40 percent for FY94. The infrastructure share of fund expenditures for the first six months of FY95 was 44 percent. The infrastructure share of expenditures for FY95 to-date can be misleading because the timing of expenditures such as financial assistance may vary. During the same time period the

scientific and technical portion of fund expenditures increased from 22 percent to 39 percent for FY94 and 40 percent for FY95 to-date.

The Yucca Mountain Project's share of total fund expenditures has increased steadily from a low of 58 percent in FY92 to a high of 75 percent in the first six months of FY95.

Yucca Mountain spending more than doubled between FY92 and FY95. However, the DOE has yet to evaluate the adequacy of the SCP, which was the basis for tasks performed prior to the implementation of the Program Approach, and is the basis for the tasks being performed under the Program Approach today. Without a clearly defined and implemented set of program objectives including specific tasks to meet those objectives, it is difficult to determine whether the increased or decreased spending is warranted or has been wasteful. The Review Team believes that the DOE will have difficulty in measuring its possible successes or identifying its failures in the absence of clearly identified and well-defined objectives.

Summary of Infrastructure Costs

The DOE has focused little management effort on certain aspects of the management function of the Project. From a control and monitoring standpoint, certain activities are incorporated with larger budget items and are obscure from individual oversight. In addition, the DOE has failed to establish clear target goals or objectives for reducing infrastructure costs and bringing such costs in a more reasonable relationship with scientific/technical costs. Recognizing that this Project is a unique undertaking, and no comparative financial data exists on which to benchmark, suggests that the DOE should be diligent about establishing the most optimal relationship of infrastructure costs to scientific/technical costs.

Options for Consideration

- The DOE should establish some clear objectives for measuring the relationship between infrastructure costs and scientific/technical costs. Such objectives should be supported by steps to reduce the absolute costs of infrastructure.
- The DOE should implement methods and procedures to identify and control perceived minor tasks to avoid the possibility that they will become major obstacles for completion of the Project.
- As stated earlier in this report, such methods and procedures for controlling and minimizing costs should be implemented in conjunction with a systematic analysis of root cost-drivers.

**SECTION SIX
SCHEDULES AND CREDIBILITY
OF MILESTONES**

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SECTION SIX SCHEDULES AND CREDIBILITY OF MILESTONES

This section presents the Independent Management and Financial Review Team's (Review Team) analysis of issues pertaining to schedules and the credibility of milestones. There are four categories of issues in this section as follows:

- Funding Impacts on Scheduling and Reasonableness of Schedules and Milestones
- Contingency Planning
- Fatal Flaw Analysis
- Scheduling Impacts on Scientific Investigations

Each of these categories contains multiple issues to be addressed as defined by the National Association of Regulatory Utility Commissioners (NARUC)-specified work statement.

FUNDING IMPACTS ON SCHEDULING AND REASONABLENESS OF SCHEDULES AND MILESTONES

In this category, five issues are to be analyzed:

- Reasonableness of Schedules and Milestones
- Funding at Existing Levels
- Constrained Funding
- Enhanced Funding
- Reduction of Costs

The schedule is probably the most important tool available for the management of a major development such as the Yucca Mountain Site Characterization Project (Project). In a well-run effort, the schedule is the common thread that sets the direction for the work, ties together the various components of the Project, provides early warning of potential problems, and furnishes the system to facilitate resolution or mitigation of those problems. The importance of the schedule cannot be overemphasized, nor the importance of the various managers' roles in using the schedule to manage their portion of the Project. The Review Team's experience indicates that a primary philosophy for a successful project requires establishing a reasonable, but aggressive, schedule, and then managing to that schedule.

This subsection will concentrate on the reasonableness of the Project schedule for technical site suitability and license application with respect to the current Program Approach. The scope of work as it relates to the schedule, the role of the established major milestones for the Project, and the potential risks envisaged in meeting those milestones will all be addressed. The report will also address the various alternative funding scenarios developed by the Department of Energy (DOE) in 1994 as the Program Approach was being established and their relationship to high level Project milestones. Variations to current funding will also be addressed, including the relationship between scientific testing and the current level of funding as well as the effects that constrained or enhanced funding would have on the schedule. Potential reduction of costs for the drilling program and cost reduction measures in general will also be included in this subsection.

Reasonableness of Schedules and Milestones

The following scope of work item is addressed:

- *What is the reasonableness of program schedules and milestones for each alternative funding scenario developed by the DOE in 1994? [NARUC B.2]*

Alternative Funding Scenarios. In conjunction with preparation of the Program Approach, three funding scenarios were considered for the Project. Scenario A was based upon the best estimate of funding that Congress might authorize, assuming that it would be greater than the funding granted in past years. As reported in Volume I of the Program Plan, this estimated funding for the Project amounted to approximately \$375 million for fiscal year 1995, increasing to a maximum of \$533 million in fiscal year 1997, and then decreasing in subsequent years. Scenario A was the option that was selected for the funding basis of the Program Approach. The reasonableness of the milestones associated with this funding and the work to be accomplished under the Program Approach are discussed in detail later in this subsection of the report.

According to a DOE report and interviews with DOE personnel, Scenario B was a contingency plan in the event that the then developing Scenario A, or Proposed Program Approach, was not viable. Scenario B investigated the potential benefits that might accrue from changes in the statutes and/or regulations that apply to the nuclear waste program. Some of the features of this scenario included the option for a limited term (300 years) operating license under 10 CFR 60 and limited site characterization prior to license application, as opposed to the technical site suitability evaluation of the Program Approach. Completion of the data gathering to satisfy final site evaluation and post-closure requirements was planned to take place during the operational phase, with final closure

commencing in 2303. Specific definition of the limited site characterization, to the best of the Review Team's knowledge, was never developed.

Scenario B also assumed a one-step licensing process including initial construction authorization and operation which would allow for the early acceptance and surface storage of nuclear waste soon after the repository construction authorization was received. A later variation on this scenario addressed the construction of a surface storage pad at Yucca Mountain while the NRC reviewed the license application.

The objective of Scenario B was to achieve early acceptance of waste at Yucca Mountain, if suitable, but was predicated upon the ability to modify or remove legislation or regulatory impediments in reaching that goal. However, because there were numerous assumptions that could be made regarding potential changes to legislation and regulation, it was difficult to establish a solid baseline for the option. As strategic planning evolved within OCRWM, it became increasingly apparent, according to the DOE, that the potential benefits that might result from Scenario B were far outweighed by the difficulty of changing applicable statutes and regulations. For these reasons, the DOE suspended further work on Scenario B in early 1994.

According to a DOE draft report, Scenario C assumed that funding would remain constant at approximately the amount approved for fiscal year 1994, at least through the completion of technical site suitability evaluation. Following technical site suitability evaluation, the intent was to seek a higher, but undefined, level of funding for the NEPA and license application activities. The focus of Scenario C was to concentrate on site characterization and then move on to the NEPA and license application requirements in a sequential order, as opposed to the parallel progression of the Program Approach.

With these funding assumptions in place, determination of technical site suitability evaluation, according to preliminary studies, would not have occurred until 2003 versus the current Program Approach date of 1998. Although specific studies were not performed to establish a date for license application and the start of repository operations, rough estimates indicated approximately 2014 and 2023 respectively. Management felt that a program extending the milestones to these dates lacked credibility; therefore, Scenario C was not pursued further.

From the foregoing, the Yucca Mountain Site Characterization Office (YMSCO) decided to base its revised approach on funding as per Scenario A. The Review Team agrees that this represented a reasonable choice for the basis of a new approach, but this does not infer that the Review Team

necessarily agrees or endorses the scope of work, specific funding assumptions, or schedule milestones established for the Program Approach. These items are all discussed elsewhere in this report. The Review Team does agree that basing funding on approximate levels that Congress appeared willing to approve at the time was conceptually a reasonable choice compared to Scenarios B and C.

The numerous options of Scenario B, coupled with the lack of assurance that a specific option could be implemented, in the opinion of the Review Team, would not have provided a reasonable base from which to launch a new approach. The reduced funding for Scenario C would have significantly lengthened the duration of the Project, with progress accomplished at a rate reduced from the Project's capabilities. The Review Team believes projects working at less than their optimal potential run the risk of increased overall cost and the tendency to not meet the desired milestones. However, there is no guarantee that Congress will continue to fund the Program at the rate assumed by the Program Approach, and reduced funding might be a reality. For this reason, the Review Team feels that the YMSCO was remiss in not completing a funding scenario that would have assumed a decrease from currently proposed levels even though this might not be the most effective approach in reaching Project objectives. Should funding be diminished by Congress, it is difficult to estimate the degree of reduction, but a complete study based on a funding level consistent with 1994 would at least have shown the impacts to the Project's resources and schedule for that scenario. Therefore, the Review Team believes the YMSCO should consider performing a complete analysis based on reduced funding.

Scope of Work. The reasonableness of the schedule for any project is largely dependent on the completeness and accuracy of the scope of work for that project. If the scope of work is well defined, a good basis from which to prepare a schedule is provided. If the scope of work is not well defined, or is incomplete, then any schedules prepared from such a scope are at risk. In general, the Review Team feels that the concept used to derive the scope of work for the Program Approach is reasonable; however, the following concerns are presented regarding the process for that concept and the potential impact it might have on the schedule.

Site Characterization Plan. The basis for the scope of work for the Project is the Site Characterization Plan. This is a 7,000-page document that was prepared in response to the requirements of the Nuclear Waste Policy Act as amended [Section 113(b)(1) and (2)]. The Site Characterization Plan presents the DOE's approach to conduct the technical studies required to characterize the Yucca Mountain site for suitability as a repository. It lays out a series of programs for the geosciences to develop a database of information and identify a methodology for

characterization. Under the philosophy of this document, the geological and other data representative of the site will be identified and placed in a database. Using this database to build models, the effects of imposing stored nuclear waste at the site will then be analyzed, and these analyses then evaluated within the guidelines of both 10 CFR 60 and 10 CFR 960 to determine suitability.

From the information collected by the Review Team, the Site Characterization Plan appears to be generally accepted by the DOE, NRC, and Nuclear Waste Technical Review Board (NWTRB) as the base document containing the scope of work to determine site suitability. Although the Review Team did not study the Site Characterization Plan in any detail, from interviews conducted with the above organizations, the M&O contractor and other involved parties, the Site Characterization Plan appears to be a very inclusive document. If all of the steps in it were completely followed, most parties believe there would be a minimal risk in determining whether or not Yucca Mountain would be suitable as a repository. The Site Characterization Plan is generally accepted as the only document addressing the scope of work. It will be used by all involved parties as the basis against which to compare the details of the Program Approach which are currently under preparation through DOE's rebaselining effort.

Based on discussions relating to the Program Plan and interviews held with Project personnel, the Program Approach distinguishes between tests that provide information for evaluating the suitability of the site; tests required to support licensing, and repository and waste package design; and tests required to confirm the safety of the repository before closure. It has been represented to the Review Team by YMSCO senior management that the Program Approach is based upon applicable legislation and regulations, and reflects the intent of the Site Characterization Plan. It has also been represented by YMSCO senior management that the Site Characterization Plan portrays a near zero risk program, and until the current approach was developed, planning for the Project assumed that most, if not all, studies contained in the Site Characterization Plan would be completed before the suitability of Yucca Mountain was evaluated. The Program Approach represents a change in the site development approach. According to the YMSCO, the Program Approach recognizes that the resources to carry out such a Program have not been and are not likely to be available. Therefore, in order to maintain a reasonable set of milestones and reach Project objectives in an effective manner, the YMSCO's proposed Program Approach assumes that not all tests, studies, and other items specified in the Site Characterization Plan (SCP) will be completed prior to technical site suitability evaluation and license application. This does carry a certain element of risk regarding both site characterization and license application. Decisions will be made regarding these items that conceivably could be reversed by the receipt of additional information from the postponed activities. According to the YMSCO, the proposed risk is relatively insignificant and represents a prudent

strategy toward earlier technical site suitability and license application. They also point out that the postponed activities will be completed prior to permanent closure.

Rebaselining. The three volumes of the Program Plan discuss the scope of work for the Project, and outline, in summary form, the effort expended. At the present time, a rebaselining effort is underway to expand and detail the summary scope of work contained in the Program Approach. Rebaselining is a project management process whereby, on a periodic basis, segments of work scope are reviewed, possibly redefined (based on scientific findings to date), and then rescheduled and rebudgeted accordingly in observance of overall project objectives in terms of time and cost impacts and available funding considerations. The rebaselining will detail the scope of work required for the technical site suitability evaluation and license application as well as the scope of work for ongoing evaluation of the performance of the repository prior to final closure. According to the YMSCO, this will be in accordance with the intent of the Site Characterization Plan. Included in this scope will be the identification of the data and information to be collected, the tests to be conducted on that data, the analyses to be performed, and other specifics leading to the Project objectives. Also included in the revised baseline will be a detailed schedule for performing the work and a cost estimate of the various elements. The result of this effort will be a revised technical baseline. The rebaselining is necessary to provide a plan that reflects the intent of the Program Approach. Although the previous technical baseline would have generally included the same scope of work since both are based on the Site Characterization Plan, the organization, sequencing, and timing for the Program Approach are different, thereby necessitating the rebaselining effort. The rebaseline will require review and approval by ESAAB, and this is scheduled for late fiscal year 1995.

When the summary scope of work for the Program Approach was derived, an element of risk was included relative to the amount of work required to reach technical site suitability evaluation and license application. The degree of this risk is a critical component of the Program Approach. When questioned about the definition of risk that the YMSCO intended to include in the rebaselining effort, the personnel interviewed were not able to give specific answers, or refer to guidelines. They indicated that the amount of risk taken, although bounded by the philosophy of the summary scope of work, was to a large extent up to the professional judgement of the person detailing the scope of work.

The Review Team believes that it is acceptable to trade off a prudent amount of risk in the technical baseline against the possibility of significant improvement to the milestone for a Project goal. However, the Review Team has not assessed the Program Approach nor the rebaselining effort to

determine, in its opinion, whether the degree of risk taken in the Program Approach is acceptable. For the Review Team to make this assessment, the same effort would have to be expended as is already planned by YMSCO and its contractors. Therefore, the Review Team neither endorses nor condemns the general scope of work included in the three volumes of the Program Plan and the sequencing of that work. There is only agreement with the concept that prudent risk might be acceptable.

Assuming that the degree of risk the YMSCO initially established is acceptable, it is of extreme importance that the risk be properly controlled and maintained as the rebaselining effort proceeds. The YMSCO must manage the risk so that it is consistent across the entire work scope and compatible with senior management's intent. For the reasons stated above and on the previous page relative to the technical baseline process, there is some concern as to whether this is occurring.

The amount of risk that a project accepts has a significant bearing on the schedule, not only for the duration of the various activities, but also the manner in which those activities fit together. All projects are comprised of numerous and sometimes diverse elements. As these elements are brought together in the schedule, it is important that they represent a coordinated and unified whole. If the parts are comprised of nonuniform levels of effort, such as variance in the amount of risk taken, in the Review Team's experience, that project will be difficult to manage from a schedule, cost, and quality point of view.

Although it is a goal to produce the technical baseline as soon as possible, the YMSCO is encouraged to review the question of risk as an item of importance to ensure that consistency and intent are being met.

Underlying Criteria Development. The second observation regarding the scope of work addresses the preparation of the scope for the technical baseline versus the continuing development of underlying criteria. For most projects, underlying criteria are well-established at the time the project commences. If a commercial building were being constructed, the footprint would be known, the wind loadings for local conditions would have been assessed, the soils information would be available, the type of frame would have been established, and other considerations would have been evaluated. During the course of design and construction, it would be unusual for these parameters to significantly change. Compared to this, however, site characterization and licensing for Yucca Mountain represents a much greater challenge.

The Review Team has two thoughts in this regard. As exploration of Yucca Mountain continues, the findings from that work could identify the need for alteration in the Project direction. Therefore, the scope of work being prepared through the rebaselining effort, the assignment of work to the contractors, and the detailed schedules and cost parameters are all subject to potential change. While the Program Approach must be well structured and disciplined to meet its objectives, it must also remain flexible to accommodate the inevitable alterations that will occur. From the observations of the Review Team, it is believed that it is management's intent to maintain this needed flexibility. However, the current structure and content of the schedule, as discussed later in this subsection, may not allow the required changes without significant impacts to the milestones.

The second thought has more serious implications. The details of the Program Approach are being prepared against other uncertainties even more complicated than those described above. The issues of (1) thermal loading, (2) the extent of fracturing and faulting, and (3) the movement of water through the unsaturated zone, all have significant unknowns associated with them. In the opinion of the Review Team, progress toward addressing these issues and identifying the impacts they will have on the Project has not been as effective or timely as would be expected.

The Review Team believes that the thermal loading issue is most critical regarding potential significant scope changes and corresponding impacts to both the schedule and budget. Of the three issues, this requires the most work from a technical standpoint. It is possible that a definitive answer regarding thermal impacts to the repository will not be available until after license application has been submitted. For example, the results of the thermal loading studies could impact the size of the repository. Depending upon the results of the thermal loading studies, it is possible that the present footprint of the repository will not be of sufficient size to store up to the planned 70,000 metric tons of waste. To accommodate this amount, the size of the repository would then have to be increased. However, this would take additional characterization studies. If for some reason, the size of the footprint cannot be increased, it may not be economically feasible to build a repository that would store something less than the 70,000 metric tons planned, particularly if it is significantly less. There is also the question of thermal loading and the generation of moisture and its potential impact to the integrity of the waste canisters and subsequent transport of released radionuclides vertically downward to the saturated zone. Until the thermal loading studies are complete, the effect that moisture generation may have on the canisters is pending. Therefore, the Review Team concludes that the results of the thermal loading studies could have serious consequences to the schedule and budget. Until these studies, which are not scheduled to be completed until 1997, are completed, there remains significant unknowns to the scope of work.

The extent of fracturing and faulting refers to the Calico Hills formation that underlies the repository and its use as a natural barrier to vertical migration of radionuclides into the saturated zone. If the extent of fracturing and faulting is greater than anticipated, secondary permeability issues could affect the scope of work for characterization. In the opinion of the Review Team, the open items here represent an intermediate threat to the schedule.

The movement of water through the unsaturated zone appears to be well developed from a technical standpoint. Mathematical models calibrated from both field and laboratory tests have provided reliable data. However, there is still the potential to significantly impact the schedule.

Therefore, the YMSCO is currently preparing a technical baseline which will include a detailed scope of work and a comprehensive set of schedules. But, underlying these details are significant unknowns, and the YMSCO now finds itself in the position of preparing details within a fluid base of unreliable conditions. To a certain extent this is understandable for a project tasked with determining the suitability of a site for the first nuclear repository and preparing a license application for the construction of that facility. There is very little historical experience with a project of this nature and this will lead to some uncertainties. Furthermore, there are significant underlying issues that remain to be addressed. While the Review Team agrees with management's approach that it is necessary to continue with the scope of work and schedule preparation as outlined in the Program Plan, these issues present a very significant risk to the Project schedule and costs. The potential impacts are far greater than the built-in flexibility within the Program and, therefore, must be given greater in-depth evaluation.

NRC Interface. The third observation regarding the scope of work relates to the interface with the Nuclear Regulatory Commission (NRC). According to the Program Plan, the scope of work that is being developed through the rebaselining effort and implementation of that work will depend on the NRC having adequate confidence that the Program Approach for site characterization will provide sufficient information for evaluation of a license application, should one be filed for the Yucca Mountain site. In developing this scope of work, there is an element of uncertainty involved as to whether or not the NRC will be satisfied that the level of risk inherent in the Program Approach is acceptable, and the rebaselining effort is consistent with the intent of the Site Characterization Plan and other factors leading to licensing.

During discussions with the NRC, they expressed an understood responsibility to provide sufficient guidelines to the DOE such that the license application is adequate. The Review Team understands that the NRC's role during the precicensing period is one of guidance rather than specific approval;

and hopefully it would, as a service to the general public, provide appropriate and timely advice to OCRWM if it knew that the Program Approach would not meet its requirements for license application. The Review Team also believes that it is incumbent on the DOE to work with the NRC to reach general agreement regarding the Program Approach, or in the absence of such agreement to reach accord on the required changes.

In the opinion of the Review Team, both parties are well aware of their responsibilities and realize that the success of the work leading to license application is dependent upon their ability to reach general consensus. However, until the rebaselining effort is complete, and the details of the Program Approach are reviewed by the NRC, the scope of work represented by the rebaselining effort is subject to change. This consequently puts the schedule at significant risk. Project personnel interviewed who were familiar with the scope of work felt this was one of the major vulnerabilities facing the Project and the Review Team concurs. There does not appear to be any room in the current Project schedule to absorb more than a minimal increase to the scope of work leading to license application. Should the NRC feel a lack of confidence that the Program Approach will provide sufficient information for a license application, the Review Team believes the schedule is certain to slip. At the present time this is an unknown and extremely critical element.

Project Milestones. For the Yucca Mountain Project, there are four levels of milestones to be submitted for approval. Level 0 are those milestones controlled by the Secretary and are proposed to include such items as Secretarial approval of the Program Approach baseline, submittal of the site recommendation report to the President, submittal of the license application to the NRC, or other items that the Secretary may wish to track. Level 1 milestones are those controlled by the Program. Proposed examples include technical site suitability evaluation, higher level findings, the WP Title 2 final report, and the Mined Geological Disposal System draft environmental impact statement.

Level 2 milestones are generally the responsibility of the DOE business centers and will include items such as topical reports, technical basis reports, and updates to the annotated outline. Level 3 and lower milestones generally belong to the M&O organization. These milestones are also important to the project's success; however, for the purposes of this discussion, the report will concentrate on the Level 0 through Level 2 milestones.

It is the understanding of the Review Team that the proposed major milestones were established at the same time that the summary scope of work for the Program Approach was developed. This being the case, these milestones were derived by a "top-down" method, meaning that they were

reviewed from a conceptual level to establish their reasonableness as opposed to a "bottom-up" method, which would take the details leading to a milestone and schedule those details to arrive at the milestone date. As a part of the rebaselining effort, a "bottom-up" approach is underway to verify that the proposed Level 0 through Level 2 milestones are reasonable.

The YMSCO's approach to management of these major milestones represents that the dates are firm and all efforts must be employed to meet them. Major milestones can be changed, but only for extremely good reasons and only after all alternatives for mitigation have been exhausted.

The Review Team agrees with the general approach that the YMSCO is taking to achieve the proposed major milestones. The number of levels seems reasonable and the content of the milestones seems appropriate for the individual level specified. However, there are several observations that the Review Team feels are important. The "top-down" method of establishing milestones is acceptable, but this is normally reserved for the types of projects that are replicas of the past and where a history exists that can be applied to develop major milestones. Again, the site characterization and licensing at Yucca Mountain is unique, and there is little experience from which to draw. Although the Review Team understands that a conscientious effort was put forth to establish the proposed major milestones, they were derived in a short time period without the benefit of a detailed scope of work and under intense outside pressure to show progress for the Project. Therefore, in the opinion of the Review Team, there is a risk that some of the "top-down" milestones may not be reasonable.

This being the case, the rebaselining effort that is currently underway must reveal these anomalies as the schedule milestones are prepared. Through the interviews, the Review Team perceived that many of the Project people view the proposed major milestones as firm and unchangeable. So much emphasis has been given to the importance of these dates, that the people who are deriving the schedules through the rebaselining effort, and their managers, may be very reluctant to suggest changes, even if the rebaselining shows that changes to major milestones are necessary.

In the opinion of the Review Team, the following the scenario has a high probability of happening. Suppose that through the rebaselining effort, it is shown that a major milestone cannot be met. Suppose the individual responsible for that milestone retains the proposed date, but reduces the level of effort required to meet that milestone. This then puts the scope of work for that milestone in jeopardy due to an inconsistent level of effort and/or an assumption of risk outside the parameters that senior management is willing to accept. Another scenario would occur if the rebaselining effort showed that a milestone could not be met, but the individual responsible for that milestone retained

the "top-down" date due to the pressures to meet milestones, knowing full well that the date could not be met.

The Review Team believes that verification of the major milestones through the rebaselining effort is one of the most important issues that the Program Approach must address. Management must be firm in adhering to milestones and motivate people to meet the proposed milestones. On the other hand, if the Program Approach is to be successful, the milestones now being established must be attainable. Project personnel must feel free to challenge the dates of the proposed milestones, if in fact the rebaselining effort shows that they cannot be met. During interviews conducted by the Review Team, concerns were expressed regarding the very firm position on established major milestones. In this regard, the Review Team observed that people do not feel free to challenge the milestones. This could put management in a position of not even knowing there is a problem. The Review Team believes this is a very significant issue that must be addressed.

Also important to the concept of milestones is the issue of ownership. Managers normally accept ownership of milestones if they are involved in the development of the schedule which established the milestones, believe that the milestones are reasonable, and believe that they have the authority to implement the work. The Review Team's experience indicates that, if a manager does not have ownership in a milestone or the underlying schedule, there is a substantial risk that the milestone will not be met. From the interviews held, it is the Review Team's belief that both the DOE and the M&O managers will accept ownership of reasonable milestones and will be accountable for achieving those milestones. In this regard, there appears to be some ambivalence among managers as to exactly who controls certain milestones. Where schedule matters were discussed in the interviews, some of the interviewees were not specifically aware of the Level 0 through Level 2 milestones in their areas. From discussions during the February 21, 1995, schedule review meeting, there were also questions as to who controls certain milestones, specifically when a lower milestone impacts a higher milestone, and questions over which level should be assigned to certain milestones. The YMSCO is well aware of these problems and has instituted action to resolve them.

Once the identified issues are resolved, the Review Team feels that the YMSCO will have a good milestone philosophy. However, it cannot be overemphasized that during the rebaselining exercise, a major effort must be made toward establishing reasonable, but aggressive, milestones that will become the goals by which the Project will be managed.

Risks to the Project Schedule. At the time of this review, the rebaselining effort was underway. As part of the rebaselining, schedules were being prepared to correspond to the scope

of work being developed. Drafts of the "top-down" Project schedule had been produced and the first revisions were underway. The first drafts of the "bottom-up" schedules were being prepared as data was being gathered for this report. Since the schedules relating to the Program Approach were only in draft form, it did not seem appropriate to thoroughly critique them. This is best done at the time the schedules are completed, or at the earliest, when a final draft is available. However, through the data collected, the meetings attended, and the interviews held, the Review Team does have certain observations regarding the schedules as they relate to the milestones.

Reasonableness of Milestones. The reasonableness of milestones in a schedule is directly related to the amount of risk that is imposed upon that schedule. Risk can be categorized into several areas.

- Completeness and soundness of the scope of work. This is treated as a separate subject earlier in this subsection and the concerns of the Review Team are addressed there.
- Aggressiveness of the schedule. This covers items such as duration of individual activities, allowance for contingencies, and actual productivity.
- Potential impacts that could affect the schedule, specifically those outside the control of the Project.
- Management of the Project as it relates to the schedule including items such as the ability of Project personnel to use the schedule, and the effectiveness of the interrelationship between the M&O contractor and the DOE.

For the reasons stated in the following paragraphs, the Review Team believes that the Project schedule currently under preparation will be overly aggressive. In addressing the aggressiveness of the schedule, durations for the specific activities are of prime importance. Durations are usually derived from a combination of past performance, where it is available and applicable, and current assessments of the proposed schedule activities in context of the specific project under consideration. This leads to a wide variety of choices from the very conservative to the very optimistic. Therefore, an individual preparing a schedule could use durations that tend to be long if productivity is assumed to be poor, or could use shorter durations if maximum productivity is assumed. The Review Team believes that projects work best in an atmosphere where there is challenge, and, therefore, prefers to see reasonably aggressive schedules that tend toward the higher end of productivity. On the other hand, schedules must be reasonable or project personnel will not use them. Assigning durations based on optimum productivity would probably not be prudent.

From the observations and discussions with Project personnel regarding the rebaselining effort, the Review Team perceives that the schedules being prepared are overly aggressive. Every individual

with whom this was discussed conveyed the same impression. The schedules were described as very tight, aggressive, optimistic, and ambitious. The majority commented that there was very little or no float in the schedules. Others described the schedules as results and success oriented where everything must go exactly to plan with no unforeseen events. Another individual described the task as trying to fit all of the work into the "established" milestones. Although management has made the statement that there is some contingency in the summary schedules, preliminary review of the schedules and information received through the interviewing process suggests that very little or no contingency has been provided.

DOE personnel conveyed that they were trying very hard to fit all of their work into the milestones, and they were assuming that their areas would operate in an optimum mode with near perfect conditions. When asked if their milestones could be met, there was a reluctance to answer. Here again, the Review Team has the impression that most people feel the major milestones cannot be met. They also seem to be very uncomfortable to challenge the major milestone dates.

Although realizing that the schedules available were all in preliminary form, the Review Team did check the float on a draft schedule for the Project and compared the number of activities with 30 days or less float (critical in the opinion of the Review Team) to the total number of activities as shown below.

<i>Schedule Analysis</i>	
Percent of Activities with 30 Days or Less of Float	
Activity	Percent
Technical Site Suitability Evaluation	53 %
NEPA	49 %
Licensing	29 %

In the opinion of the Review Team, these are unusually large percentages of items to be critical, but it does fit with the other observations regarding the aggressiveness of the schedules.

In drawing all of this together, there is significant concern over the ability of the Project to meet the major milestones due to these tight schedules. The experience of the Review Team shows that

projects starting with extremely tight schedules, specifically where this is acknowledged by Project personnel, very seldom meet those schedules. The typical conditions observed for these types of projects in the past are very similar to what has been observed for the Yucca Mountain Project.

After the durations are established for the various activities in a project schedule, progress is measured against those durations. To a large extent, it is too early in the Program Approach to determine actual productivity. However, the Review Team does have some preliminary observations regarding both the drilling rig and the tunnel boring machine. The problems with the drilling rig are well known. It has been approximately ten months since the drilling rig has been operational and this definitely has schedule impacts. However, the Project has mitigated this by combining certain boreholes and reducing the amount of core taken. Also the Program Approach scope of work has reduced the number of boreholes required to reach technical site suitability evaluation and license application. Where the original program envisioned 63 boreholes for the foregoing activities, the number has now been reduced to 54. Analysis of the scientific effort contained in the Program Approach is not within the scope of work of the Review Team, but according to the DOE, no scientific elements have been deleted due to this reduction. The results of the rebaselining effort will confirm whether this is correct. Consolidation of boreholes is further discussed in this subsection under the heading of Reduction of Costs.

In the opinion of the Review Team, given the past problems and lack of performance of the LM300, using this drill rig alone will not collect sufficient information to support site characterization and license application. The LM300 will most likely have to be supported by conventional dry drill rigs. If this is the case, it may be necessary to take comparable cores with the new drill rigs adjacent to the existing boreholes of the LM300 to compare results. If the results are significantly different, and it is determined this was due to differences in drilling as opposed to differences in laboratory testing, then the YMSCO will have some serious decisions to make regarding the drilling program. All of this has a potential impact to the schedule that should be considered in conjunction with the detailed schedules that are now under preparation.

Regarding the tunnel boring machine, there is little that one can conclude from activities to date. Progress for tunnel boring machines is normally slow as they get started, and this is the case with the Yucca Mountain Project. Additionally, just after tunneling began, the Bow Ridge Fault was encountered with its poor ground conditions. As of May 7, 1995, the tunneling operation was approximately three weeks behind schedule after adjusting the plan for not excavating test alcove #2. Progress from the middle of February to the beginning of April was better than planned, and progress from the third week in April through May 7, was approximately as planned. During the first

three weeks in April, the tunneling operation was basically nonproductive due to poor ground conditions. As the operation moves ahead, the planned rate of progress increases. It remains to be seen if actual progress can match the planned rate; however, the period from May 1995 through October 1995 should give a good indication of tunneling productivity and what effect this might have on the schedule.

Other areas of productivity cannot really be assessed at this time. It remains to be seen how successful the Project will be in matching actual progress against the aggressive schedules set for the above items as well as other data collection, testing, analyzing, reporting, and decision making that leads to technical site suitability evaluation and license application.

Interdependence and Milestone Activities. Another set of issues that could affect the schedule relates to the interdependence of activities within the Yucca Mountain Project as well as logic ties between the Project and other areas of the Program. All project schedules consist of a network of activities tied to one another. To the extent possible, a project should be organized such that a group of activities, or subnet, leading to a major deliverable or milestone, is the responsibility of a single manager. This fosters ownership in both the deliverable and the network of activities leading to the deliverable. The objective is to place the means to reach the deliverable in the hands of the responsible manager. The Review Team feels that the YMSCO has taken the correct approach in structuring its organization along the lines of the deliverables. However, the uniqueness of this Project, as compared to other projects, subjects the schedule to a considerable number of interdependencies wherein the various managers are accountable to each other for information and actions leading to their deliverables. This is acceptable as long as those interdependencies are well recognized and properly managed.

In reviewing this issue, the perception of the Review Team is that the Project, to date, has not paid close attention to the management of these ties. When interviewing Project personnel, there did not appear to be a good understanding of how activities in one area relate to activities in other areas. This condition applied both internally to the technical site suitability evaluation and license application work as well as to the ties between this work and Office of Waste Acceptance, Storage, and Transportation (OWAST). Additionally, it was also obvious in some of the preliminary schedules reviewed and in discussions held at the schedule review meeting on February 21, 1995, that ties had not been adequately addressed. The YMSCO is well aware of this and has taken steps to remedy it. It is important to point out the significance of ties between the various sections of the Project and the need to give these serious consideration during the development of the detail schedules associated with the rebaselining effort. It is again emphasized that the schedule is the

communications link that holds a project together. It is also an effective means to promote teamwork within a project and discourage individual efforts. The interdependencies are a major part of this concept and without their due emphasis, major milestones could be at risk.

In addition to interdependencies internal to the schedule, there are also external issues and parties that are sources of potential impact. Interface with the NRC has been discussed previously in this subsection, but other entities to consider are the National Academy of Sciences (NAS), the Environmental Protection Agency (EPA), and the NWTRB.

The NAS has two roles in the Project. The first involves review of technical basis reports. Preliminary schedules that were viewed allowed five to six months for the NAS to review each of the technical basis reports, and those reviews were on the critical path to meet the higher level findings milestones. YMSCO has no control over the NAS and should it take more time than that allotted by the schedule, the higher level findings milestones will not be met. Although the Review Team agrees with the involvement of the NAS to critique the technical basis reports, its ability or dedication to meet projected review durations is unknown. In the opinion of the Review Team, this presents a moderate risk to the schedule.

The second role of NAS involvement is the EPA environmental standard for a Yucca Mountain repository. It is the understanding of the Review Team that the EPA must promulgate a new standard within one year of receipt of findings and recommendations from an NAS study. This study relates to the issues of a health-based standard applicable to individual members of the public. After promulgation, the NRC must then modify, within one year, the technical requirements and criteria in Regulation 10 CFR Part 60, to be consistent with the NAS recommendations and the new EPA standard. The NAS recommendations were due in December 1993. They are now expected prior to June 1995. The Program Approach and the corresponding schedules assume that there will be no significant changes to standards and regulations; however, this uncertainty is also an area of potential risk.

The Nuclear Waste Technical Review Board (NWTRB), established by the amendments of 1987 to the Nuclear Waste Policy Act, was formed to independently evaluate the DOE's activities regarding radioactive waste disposal. The NWTRB has been critical of OCRWM and YMSCO activities and states that DOE often ignores their recommendations. The NWTRB feels the Project is moving too slowly on the major issues of thermal loading, the extent of fracturing and faulting, and the movement of water through the unsaturated zone. They also feel the Project is poorly organized and have concerns over the checks and balances in place for major decisions. On the other hand, the

Project feels that NWTRB members act as individuals, each with his or her own agenda, as opposed to making recommendations as an entity. The Project also feels that the NWTRB is heavy on criticism, but light on constructive recommendations. It is not within the scope of this review to comment on the allegations of either party; however, it appears that the relationship could stand substantial improvement. Certainly the NWTRB is an excellent resource that should be used. An improved professional, "arms length," relationship between these two would be beneficial to both the Project schedule and the Project as a whole.

Schedule Management. The final set of observations regarding risks to the schedule has to do with the human element. A project can have excellent schedules and still be subject to risk if the schedules are not properly used, or if management does not emphasize the importance of schedules to the success of the project. The interviews held with senior management and the observations of them at work shows that senior management understands the importance of schedules, including what a good schedule can do for a project, and how to use it. However, the impressions of the Review Team are that the other middle and lower-level managers and personnel in the organization are somewhat weak regarding scheduling skills. This is based upon discussions involving activity logic, float and the use of float, ties to other managers' areas where there is mutual activity, consolidation of contractors' schedules into higher level schedules, resource and cost loading, and other important considerations. The Review Team also believes that there is a mentality wherein managers tend to consider their own section of the schedule or their own individual milestones in isolation from the Project as a whole. The project schedule should be used as the tool to promote teamwork and set the overall direction and tone, but it is felt that this is not happening. Senior management has a challenge to bring the level of schedule understanding, knowledge and use to a higher plane than currently exists.

Although it is again realized that the schedules are only in draft form, and that the details of the Program Approach are just being worked out, the Review Team would have expected the schedules to be more comprehensive and sophisticated than they are. A number of issues that are currently outstanding on the schedules included ownership of milestones, levels of milestones, logic ties internal and external to the Project, reporting of critical issues, consistency in format between the various portions of the schedule, and general use of the schedules to manage the Project. The YMSCO is well aware of these items and has taken positive steps to address them. However, in the opinion of the Review Team, for a project that has been underway for over ten years, these types of philosophy items should have been resolved long ago.

The final thoughts regarding management of the schedule relate to the role of the M&O contractor and the relationship that exists between the M&O contractor and the DOE. DOE management has stated that their role should be one of providing guidance and oversight to the Project, and that management and implementation of the work should rest with the M&O contractor and the subcontractors. The Review Team agrees with this concept and urges its implementation, but observations show that the Project does not operate in this manner, nor are there indications that it is moving in this direction. In the opinion of the Review Team, the DOE is too heavily involved in day-to-day operations.

How does this relate to the project schedule? Ownership of assigned work is a key element to schedule management. With that in mind, it is important that the M&O contractor feels ownership in the schedules to a relatively high level. If the Project is to truly operate with the philosophy of the DOE providing general guidance and direction only, then DOE must allow the M&O to take charge of the schedule process at the highest level consistent with granted authority. If the DOE is involved to a degree where the M&O contractor merely responds to DOE instructions rather than having responsibility and accountability for a scope of work, then the concept of ownership will be lost. When this occurs, the experience of the Review Team indicates that schedules (and costs) suffer. An organization, or manager, who feels it is being micromanaged quickly loses incentive, initiative, and accountability for results. Although it may seem insignificant when compared to other risks to the schedule, in the opinion of the Review Team, this is a critical issue that the YMSCO must deal with.

The following are comments from DOE personnel regarding interface between the two organizations. Some DOE personnel indicated that there has already been too much delegation downward to the M&O contractor. Others indicated that they did not feel good working through the M&O contractor and could not understand why they could not directly tell other contractors what to do. Some individuals noted they were unsure as to the level of monitoring of subcontractors that should be turned over to the M&O contractor. It was suggested that the DOE should consider increasing its support staff so that DOE managers could maintain more control rather than giving that responsibility to the M&O contractor. Others managers wished the DOE had greater depth and ability so there was less reliance on the M&O contractor and the subcontractors, while some indicated that the Project is struggling with how much responsibility should be granted to the M&O contractor on the critical issue of how much science is enough.

One of the most common reasons given for significant DOE involvement was that DOE personnel are responsible for progress reporting, interpretation of results, and explanations of actions and

recommendations to outside parties. If DOE personnel were not directly controlling the work, then they would not be able to adequately handle these functions. In the opinion of the Review Team, an owner/manager can be very well informed without directly controlling the work.

Although in the minority, there were several DOE individuals who stated that the M&O contractor could run the project more efficiently than the DOE, and that the DOE should give more responsibility to the M&O contractor.

For the reasons mentioned above, it was clear to the Review Team that below the DOE senior management level there is considerable reluctance to turn over responsibility to the M&O contractor. When the M&O contractor was questioned as to functions it might have a year from now that it does not have today, the reaction was somewhat mixed. The general consensus was that the DOE would be slow to turn over responsibility, such as greater control of the subcontractors and greater participation in the decision process. The M&O contractor lacked confidence that the DOE would give it the means it considers necessary to make its role effective. But M&O comments were, "We will make it work."

The Review Team also asked DOE personnel if they had been given guidance by their management regarding the intent to turn over more responsibility to the M&O contractor. Most people indicated they had received no guidance, with a few responding that they had been told the DOE was going to step back and provide guidance rather than being significantly involved in managing.

The Review Team also has some concerns regarding the level at which the M&O and DOE organizations interact, specifically as it relates to scheduling. The Level 3 schedule is controlled by the M&O contractor and consists of highly-detailed contractors' schedules. The Level 2 schedule, controlled by the DOE, is a summary of the Level 3 schedule and contains considerable detail with respect to technical site suitability and license application activities. The Level 2 schedule is regarded as the working schedule for the Project. In the opinion of the Review Team, the organization managing the Project should control and manage the schedule. As addressed in Section Four of this report, an objective of the DOE is to step back from specific management direction and allow the M&O contractor to manage the Project while the DOE provides guidance and oversight. To be consistent with this concept and with the other levels of M&O contractor authority that the Review Team has recommended elsewhere in this Report, the Review Team believes that the M&O contractor should manage and control the Level 2 schedule within the guidelines established by the DOE. The DOE has the responsibility to set the major milestones, and monitor the performance of the M&O contractor to ensure that objectives are attained. The Review Team believes that the DOE

should exercise a strong influence in this area. However, the actual implementation of the scheduling process, including derivation within DOE guidelines, management, and updating of the Level 2 schedule should be the responsibility of the M&O contractor. This is analogous to a private sector approach wherein the Chief Executive Officer directs and has ultimate authority (the DOE) and the line officers manage with responsible charge (the M&O contractor).

It is the belief of the Review Team that the above observations regarding the M&O contractor represent a significant problem and a threat to the progress of the project. DOE senior management is aware of this problem, but in the opinion of the Review Team, has been slow to resolve it. It appears that the interface between the two organizations requires significantly better definition. After this is accomplished, management of both organizations has a challenge to provide guidance and nurture relationships so that the M&O contractor is used in a more effective manner.

In addition to site suitability and licensing application issues, the Review Team is of the opinion that not enough emphasis is being placed upon the transportation issue. This concern also relates to the lack of attention the DOE has placed on the ties between the various elements of the Program/Project. Extensive studies have been conducted within the Department of Energy, however, a more intensive review is necessary. Critical transportation issues should be presented to Stakeholders and the public at large to initiate constructive comments. There are many potential obstacles associated with this issue that the DOE has yet to address.

The transportation issue, in the Review Team's opinion, can be an Achilles heel to the Program/Project. Unless the Stakeholders and the public at large are convinced that transportation of high-level radioactive waste will be conducted in a safe manner, that property values along transportation routes will not suffer as a result of these activities, and that adequate and responsible emergency preparedness plans are effective, then the Program/Project may face many obstacles that will effect schedule, cost, and acceptance.

Funding at Existing Levels

The following scope of work item is addressed:

- *What studies would be deleted if funding is constrained to the existing level? [NARUC A.5]*

According to the DOE, site characterization prior to the Program Approach called for extensive testing to obtain a comprehensive understanding of the Yucca Mountain Site which would allow

decisions to be made of site suitability, licensing, and repository design and performance issues. The Program Plan states that simultaneously, within the overall site technical program, the Program Approach provides tests to evaluate site suitability, tests required to support licensing and define a cost effective design, and tests required to confirm the safety of the repository before closure. This distinction permits phasing of tests to achieve an earlier evaluation of whether Yucca Mountain appears to be suitable and to preserve the schedule for licensing, constructing, and operating the repository if the site is found suitable. It also accommodates available resources.

The Program Plan goes on to state that scientific investigations and engineering activities deemed necessary and sufficient to support a technical site suitability evaluation in 1998 are currently ongoing at Yucca Mountain. At the same time, site characterization data and analyses will be incorporated into documents submitted to the NRC for review and guidance as to sufficiency of the data and analyses for licensing. If the site appears to be technically suitable, site characterization activities after 1998, including in-situ thermal testing, will focus support on the development of a license application and more cost effective repository and waste package designs. Results will provide input to the repository environmental impact statement in 2000, to the license application in 2001, to interactions with the NAS regarding Technical Basis Reports, the NRC during the licensing process, and to an amended license application in 2008. Confirmatory testing, including tests in selected drifts of the underground facility, will continue through the construction and operation of the repository to ensure that the repository performs as predicted. Testing to confirm the performance of the repository will continue until closure, a period of at least 50 years and possibly up to 100 years.

Until the Program Approach was developed, planning for the Yucca Mountain project assumed that most, if not all, studies contained in the Site Characterization Plan would be completed before the suitability of Yucca Mountain was evaluated. The Program Approach represents a change to this. It recognizes that the resources required to carry out such a program have not been and, furthermore, are unlikely to be available. Therefore, under the Program Approach and the funding associated with the Program Approach, the DOE represents that they are not deleting studies that were included in the Site Characterization Plan, but that they are rearranging those studies over a longer period of time. Certain studies that were scheduled to be performed prior to the technical site suitability evaluation are now postponed until after that event, but they will be performed prior to permanent closure. This of course does present some risk regarding site characterization. It is possible that the later studies, specifically the results of hydrologic modeling, could disqualify Yucca Mountain as a repository. However, the DOE feels this is unlikely and that the level of risk they have taken is prudent. The details of which specific studies will be accomplished prior to site characterization

evaluation and those which will be performed later will come from the rebaselining effort that is currently underway. The rebaselining will also indicate if any studies have permanently been deleted as well as whether or not the new technical baseline essentially contains the same requirements as the Site Characterization Plan.

There are at least three external sets of checks and balances on the rebaselining effort and the related risk assumed by the DOE. One is the peer review that the NAS will conduct on the technical basis reports. The second is the dialogue that is ongoing with the NRC to give reasonable assurance that the Program Approach is sufficient to allow adequate evaluation of the license application and the third is the role of the NWTRB. It is important to note that until the rebaselining effort is complete, reviews performed, and opinions offered by the applicable parties, there is no assurance that the concept of the Program Approach is acceptable. This remains a major concern.

Therefore, to answer the question raised, it is not the DOE's intent to delete studies if funding is constrained to existing levels, but the completion of some studies, such as hydrologic modeling, thermal loading, and post-closure tectonics, will be postponed until after technical site suitability evaluation has been established. The observations from the Review Team indicate that the DOE is following this concept; however, this cannot be confirmed until the rebaselining is complete. In considering this subject, it is also important to understand that funding is not the prime mechanism that drives the studies to be performed. The prime driver is the need for the study to satisfy the requirements of the Project. Funding may dictate when studies are done, but not whether they are done.

Constrained Funding

The following scope of work item is to be addressed:

- *Assuming constrained funding, how long will it take to complete the work that must be done to determine the suitability/licensability of the site? [NARUC A.6.1]*

Previously in this subsection, under the heading of Alternative Funding Scenarios, a discussion was included regarding the effects of constrained funding if funding were projected at the approximate levels of fiscal year 1994. Under this scenario, technical site suitability evaluation would not be attained until 2003, and rough estimates for license application indicated 2014. According to the Review Team's information, this was the only study ever done on constrained funding.

When annual budgets are prepared, alternative scenarios, including minor increases or decreases, are then considered, but these would be thought of as refinements to the proposed funding for the Program Approach as opposed to studies that would significantly differ from the funding envisaged by the Program Approach.

If funding were to be constrained, the scope of work could not be reduced, nor could any significant amount of testing, as defined by the Program Approach, be delayed until after technical site suitability evaluation. Given the aggressiveness of the schedule, should funding be constrained to less than the Program Approach objectives, the Level 0 and Level 1 milestones most likely would slip.

As a note, the YMSCO presently does the various budget scenarios manually. However, a computer model is being developed which will greatly assist in this effort, and makes it possible to review a wider range of variations.

Enhanced Funding

The following scope of work item is addressed:

- *Assuming the budget is enhanced beyond that proposed by the Administration for fiscal year 1995, how long will it take to complete the work that must be done to determine the suitability/licensability of the site? [NARUC A.6.2]*

To the best of the Review Teams's knowledge, the project has never performed any studies for enhanced funding above that anticipated for the Program Approach. Determining the effect that enhanced funding would have on the major milestones of technical site suitability evaluation and license application would require a rescheduling and costing effort beyond the scope of this review. However, it is appropriate to make certain observations regarding an enhanced funding scenario.

In the opinion of the Review Team, selected enhanced funding (approximately ten to 20 percent above the Program Approach assumptions) could contribute to minor improvement toward meeting either technical site suitability evaluation or license application, but that significant enhancement (possibly 25 to 50 percent or greater) would not give significant improvement to the major milestones. The latter is felt to be correct for several reasons, the first of which involves the logic of the schedule. There is an orderly manner in which activities must be done. For example, data and samples must be obtained, tests run, analysis completed, and recommendations made in the form of technical basis or topical reports. The reports must then be submitted and reviewed. This order of events must be followed and it is basically independent of funding. Enhanced funding will not

alter the sequence in which activities occur or allow sequential items to be performed in parallel. Therefore, the sequence, or logic, of the schedule largely controls the time taken to reach project milestones.

Looking at the activities themselves, it could be argued that increasing the resources for each activity would shorten that activity and hence the chain of events. This is true to a certain extent. For example, the tunnel boring machine is already scheduled at three shifts per day, so collection of data from that operation could probably not be accelerated. Additional tunnel boring machines above those already envisaged could be purchased; however, considering periods for specification, procurement, fabrication, setup, and ramping as compared to the relatively short period of three years to technical site suitability evaluation, it is the opinion of the Review Team that the Project would only gain several months, and that at a significant cost. Accelerating the purchase of a second tunnel boring machine from that shown in the preliminary Program Approach schedule, to start at the north ramp extension for Calico Hills, or elsewhere, would provide additional information for site characterization, but would probably not bring forward the technical site suitability evaluation date. If it is assumed that all of the information being collected by the first tunnel boring machine is necessary, then the activities of the first tunnel boring machine are the restraining time path to reach technical site suitability evaluation. An earlier start of a second tunnel boring machine will not change this.

Another scenario would be to accelerate the purchase of the second tunnel boring machine and start its operation at the south ramp instead of the north ramp extension. This has the benefit of a contingency plan in the event that the tunnel boring machine currently excavating from the north ramp would not meet its planned production and, therefore, delay technical site suitability evaluation. However, since this would require a different diameter from the Calico Hills machine, it has the same effect as buying a new machine rather than accelerating a currently planned machine. In the opinion of the Review Team, this option would also not bring forward the date of the technical site suitability evaluation more than a couple of months due to the lead time required as discussed earlier in this paragraph, unless perhaps a commercial supplier could provide "tunnel" at a rate faster than the YMSCO can purchase a tunnel boring machine and operate that machine. On the other hand, if the second tunnel boring machine for either scenario revealed data that would cause an early disqualification of the site, then an accelerated purchase would have been beneficial.

The same scenario would hold for the purchase of additional drill rigs above that currently envisioned. Although the above examples might be somewhat exaggerated, the Review Team believes that enhanced funding to increase the hardware for collection of data would not have a

significant effect on the technical site suitability evaluation date. If improvement were possible, it would more likely occur to the license application date.

Another consideration is increasing personnel for testing, analysis, and preparation of findings. However, here again it is doubtful that the significant addition of people would substantially reduce the durations to the major milestones. There are a set number of tasks that must be completed for the Project. Oversaturating those tasks with people will not necessarily shorten the length of time taken. Specifically, in the area of analysis and preparation of findings, continuity of people in the process is important. It may not be possible to divide certain analyses and preparation of findings into small pieces because the loss of human continuity would be undesirable. Additionally, if a large number of people were added to the Project, it is felt that the majority of their effort would tend toward more science rather than the accomplishment of initial specified requirements. Even if there were a benefit in adding significantly more people, there is a question as to whether the build up of additional people could be done fast enough to have any great effect, specifically toward improvement of the technical site suitability evaluation date.

Outside activities would also have to be considered. For example, if the technical basis reports submitted to the NAS were accelerated such that they were required to review multiple reports at any one time, such a requirement might inundate their resource capabilities. The same is true regarding topical reports and other areas of the NRC interface.

In the opinion of the Review Team, the Program Approach appears to fit within the Project's framework of natural cadence and rhythm leading to technical site suitability evaluation and license application. Attempting to accelerate the project above the optimum performance mode just for the sake of acceleration, in the opinion of the Review Team, would probably be an ineffective use of funds. Although a schedule analysis has not been performed to demonstrate this, the perception is that enhanced funding would not make a significant difference in the major milestones. The Review Team also feels that enhanced funding may even encourage doing science for the sake of science rather than contributing to the enhancement of the project.

This is not to infer that some level of additional funding would not be beneficial. There are certain to be areas in the Project where additional staff are required or where accelerated capital expenditures would be prudent. This additional funding, possibly in the range of ten to 20 percent, might contribute to some improvements in the schedule (possibly up to several months), would probably be worthwhile, and should be implemented if possible. Examples might be acceleration of selected testing or selected additional personnel for analysis should this not break the continuity

of findings. However, pouring substantial amounts of money into the Project will probably not realize significant results.

Reduction of Costs

The following scope of work item is addressed:

- *In view of the different funding scenarios, what has the Project Office done to reduce the projected drilling program while still acquiring essential data and considering the potential impact on suitability/licensing requirements? [NARUC B.4.2]*

Reviewing the number of drill holes required to meet the Project's needs has been an ongoing evaluation since 1993. A group was convened during that year to examine the current drilling program to identify ways to make it more cost effective. Two approaches were considered. The first was to look for opportunities to consolidate tests/samplings proposed for two separate boreholes into a single borehole, thereby reducing the number of boreholes to be drilled. For example, the possibility existed to consolidate borehole G-8 in the geological program with borehole WT-19 in the water table program, and borehole SD-6 in the statistical program with H-7 in the hydrology program. In addition to consolidations, as a part of the Program Approach and the rebaselining effort, reviews were performed to determine which boreholes could be postponed until after the technical site suitability evaluation has been completed. The original plan called for 63 deep boreholes. Through efforts to reduce this, now only 54 deep boreholes are required to technical site suitability evaluation and licensing application. The second approach involved examination of the amount of core required in each of the drilling programs. Recommendations were made for core reductions in certain boreholes and these reductions are currently under consideration. Therefore, the project has addressed cost reductions in the drilling program and has made progress in this area.

Although the savings in the drilling program are important, there is a wider issue to be considered; that of overall Project cost reduction. Through the Cost Reduction Steering Committee, designated teams were appointed to look for Project cost reduction measures that could reasonably be accomplished. Following a meeting on March 7, 1995, a report has gone out to the DOE with a number of cost reduction recommendations from this committee. Typical examples of recommendations included consolidation and downsizing of the ESF testing, acceleration of thermal testing, relocation of the muck storage area, consolidation and/or elimination of certain Information Resources Management resources, Licensing Support System reductions, plus a series of value engineering proposals.

Thus far, the majority of cost reduction studies have concentrated on value engineering and the ESF, with other areas of the Project not receiving the cost reduction attention that they require. However, the YMSCO appears to be moving in a direction to make cost reduction more of a project-wide goal. At recent strategic planning meetings it was decided to promote a cost-conscious culture for the Project and consider further incentives for the M&O contractor to reduce costs.

Another positive effort noted was the attempt to review certain operations, for example the tunneling, and compare those operations as they presently exist with similar commercial operations. If the Project operations are less productive and/or more costly than similar commercial operations, then a review would be conducted to determine the reason for the difference and recommendations would be made to bring Project operations more in line with a commercial benchmark.

It appears that in the past, the cost reduction program was somewhat limited and not very visible. This does appear to be changing, and the Review Team completely agrees with and supports the increased activity toward cost reduction. However, when personnel were questioned in the interviews regarding a cost reduction program, there was a noticeable lack of knowledge. Quite a few people talked to were not aware that a cost reduction program even existed. Others stated they believed there was such a program, but that it was not active at the present time. An option for consideration would be placing additional emphasis on this program and significantly increasing its level of visibility.

Summary of Funding Impacts on Scheduling and Reasonableness of Schedules and Milestones

The reasonableness of the Project's schedules and milestones, and the impact that funding has had on scheduling, have been major topics of discussion associated with the Yucca Mountain Project. It is no secret that the Project has been accused of being schedule driven, and as such, has encountered significant performance critique due to its historical inability to meet major milestones. It is the opinion of the Review Team that projects should operate under the philosophy of establishing a reasonable, but aggressive, schedule and then managing to that schedule. The schedule should be aggressive enough to be challenging, yet it must not be so optimistic that the milestones cannot be reasonably met. If a proper balance is attained, there is a good probability that major milestones will not slip and they will be reached in the shortest time possible (which also means cost efficiency).

From the review of the draft schedules and related interviews with Project personnel, the Review Team believes that the schedule being prepared is very tight with almost no room to accommodate unforeseen events. The schedule is represented in terms of success-oriented, optimistic durations, with little or no float. In the opinion of the Review Team, the targets that have been set are very

aggressive. Additionally, it is not known at this point whether the durations established for the various activities can actually be met. Considering the potential risks to the schedule (including unresolved issues such as thermal loading, amount of testing required, etc.), in the opinion of the Review Team, there is a small chance of meeting the technical site suitability evaluation milestone, and only a slightly greater chance of meeting the proposed date for license application. It is believed that these proposed milestones represent overly optimistic goals and therefore, are not reasonable. If the project establishes such milestones subsequent to the rebaselining effort, and continues to maintain an overly aggressive schedule, there could be a pattern of continuing slippage. This is exactly what the Project does not need. Hence, the YMSCO must set reasonable milestones and manage to them.

In addition to managing schedules effectively, projects generally operate more efficiently when the funds provided match the project's resource capability. In regard to anticipated funding levels, it is the Review Team's observation that the Program Approach does not intend to delete studies or deviate from the intent of the Site Characterization Plan. Instead, completion of certain studies will be rescheduled until after the technical site suitability evaluation and license application; but none would be deleted. This would be the case even in the event of a constrained funding scenario. Due to the logic of activities and sequence of related events, which are independent of funding, it is difficult to determine the specific impact that constrained funding would have on the Project's schedule and the work that must be done to determine suitability/licensing. However, it is likely that less information will be available when the Secretary makes the site determination decision and for license application than would have been available under either of the two previous approaches.

If funding were significantly enhanced, it is believed that there would not be a corresponding reduction in the durations leading to major milestones. The Review Team feels that the Project is operating close to its optimum natural rhythm where funding and Project resources are compatible. This is not to infer that some level of additional funding would not be beneficial. Minor increased funding in the approximate range of ten to 20 percent could result in minor improvement to the schedule and this scenario should be reviewed. However, significant funding increases (50 percent or greater) would more than likely just increase the overall cost or lead to more science than is arguably necessary, with only minor schedule benefit. One element of funding that could be very beneficial to the schedule is to provide a more consistent level of funding from year-to-year.

In addition to the risks associated with Site suitability and licensing application issues, the Review Team is of the opinion that there are potential high-(schedule)-risk activities associated with transportation issues. As such, a more intensive review of critical transportation issues is necessary.

Without such review, the Program/Project is subject to many unknown obstacles that could effect schedule and cost.

Options for Consideration

- Establish reasonable milestones and then manage to meet those milestones.
- During the rebaselining effort, Project personnel must feel free to challenge the established milestones if they believe they cannot be met as shown by the "bottom-up" schedule. Senior management must address this issue so that people feel free to make this challenge. There is concern that so much effort has been placed on the "top-down" milestones that people will be reluctant to recommend change even though they feel change is necessary.
- During the rebaselining effort, senior management must ensure that the amount of risk assumed by the personnel involved in the effort is consistent and in accordance with the intent of the Program Approach.
- Senior management needs to bring the level of schedule understanding, knowledge, and use to a higher level than currently exists.
- The DOE and the M&O contractor should jointly prepare the Level 2 schedule with the DOE retaining ultimate authority and the M&O contractor responsible for managing the work to the schedule.
- The M&O contractor should be given more responsibility, such that the DOE's role is to provide guidance and oversight only, rather than to manage the Project.
- Identify areas where enhanced funding could be beneficial to the Project and pursue funding for those areas.
- Additional emphasis should be placed on the cost reduction program.

CONTINGENCY PLANNING

In this category, two issues are to be analyzed:

- Project Contingency Planning
- Sunk Costs for Alternative Programs

The Project Contingency Planning portion of this subsection will discuss the DOE's strategy for contingency planning and the effectiveness of its implementation. The Sunk Costs for Alternative Programs will address expenditures for previous programs and identify approaches and efforts pursued in the past, that may not be applicable to the current Program Approach.

Project Contingency Planning

The following scope of work item is addressed:

- *What is the DOE's strategy for contingency planning?* [NARUC B.1]

Contingency planning normally takes place at several levels within a project. For the Yucca Mountain site characterization work, contingency planning could consist of three levels—higher, intermediate, and lower. This discussion will focus on the intermediate level. Events to be considered for intermediate contingency include those that would severely disrupt the work leading to technical site suitability evaluation and license application, but would not be so severe as to terminate the Program. An example might be the response necessary if the tunneling operation, due to poor ground conditions, were proceeding so slowly that insufficient data to support technical site suitability evaluation and license application were received. This would significantly delay those milestone dates. The Review Team distinguishes intermediate contingency planning from fatal flaw analysis, or higher level contingency events, which identifies a condition that disqualifies the site or terminates the Program. Contingency planning relates to scenario development to identify significant elements which may occur and how to deal with them cost effectively.

Higher level of contingency planning would involve the failure of Yucca Mountain to qualify as a repository site. According to the DOE, there is currently no contingency planning taking place at this level. The Nuclear Waste Policy Act states that, "If the Secretary at any time determines the Yucca Mountain site to be unsuitable for development as a repository, the Secretary shall report to Congress not later than 6 months after such determination the Secretary's recommendations for further action to assure the safe, permanent disposal of spent nuclear fuel and high-level radioactive waste, including the need for new legislative authority." Therefore it appears that the DOE is only at liberty to formulate recommendations for further action, as opposed to taking any action. The DOE should consider whether it formulates these recommendations only after a determination of unsuitability is made, or whether they are formulated in advance. The lower level of contingency planning represents those items that managers handle on a day-to-day basis as a normal part of implementing any project plan. These again are important, but are not the specific subject of this review.

Returning to the intermediate level of contingency planning, the Program Plan indicates that risk management is to be an important systems engineering activity that is performed in conjunction with program integration and planning. However, the Review Team is not aware of any risk

management, or contingency procedures that are in use on the Project, nor did there appear to be any evidence of a contingency planning strategy.

If a project does not have a contingency planning strategy, both schedule and costs could be at risk. When an impact occurs, there is no means to address that impact, and time is lost while a contingency plan is developed. Time relates to money. While the plan is being developed, standby and overhead costs accrue.

Notwithstanding the above, the Review Team did encounter several areas where contingency planning had taken place. The studies conducted on the drilling operation that led to the consolidation of certain boreholes between drilling programs, and the studies that led to reduced core being taken, in the opinion of the Review Team, are examples of intermediate contingency planning. Another example is the possible use of data from the "P" tunnel if the Calico Hills formation cannot be adequately investigated.

There was also evidence in one area where contingency planning had been done in connection with the Project schedule. Several scenarios were identified that could be implemented in the event that significant delays occurred in selected areas. Each event had been thought through, and a contingency plan developed to maintain milestones. In the opinion of the Review Team, this was good intermediate contingency planning.

However, the examples cited above were in the minority. The vast majority of the people interviewed were not aware of a specific Project contingency planning strategy, had never been asked by their managers to consider contingency planning, nor were they doing contingency planning on their own. Several individuals indicated that they had no budget for contingency planning. Input was also received that contingency planning should be limited to the DOE, and that the M&O contractor should not be involved. The impression conveyed was that contingency planning only interferes with the M&O contractor's work.

Some people believed that there is a perceived downside to contingency planning. If a Project has contingency plans, they would argue that this represents a lack of dedication to the program at hand. Either management feels the current program is not achievable, and therefore, requires a possible change in direction, or that management is not dedicated to the current plan and has other agendas. On the other hand, it could be argued that a project without a contingency planning strategy "has blinders on" and is not being realistic in regard to potential problems.

In the opinion of the Review Team, the Project should implement an intermediate contingency strategy which includes the selection of several specific events that could likely occur and would cause significant delay to one or more major milestones or significantly disrupt the Program in other ways. It is appreciated that this could be carried to extremes, and dozens, if not hundreds, of scenarios could be identified. This is not being suggested, but an option is that approximately six situations be considered for contingency planning. As mentioned above, examples of the type of items might include significant problems with the tunneling operation that could cause a major delay (say six months or more) to the technical site suitability evaluation milestone, or potential regulatory changes with no "grandfather" provision.

In regard to some of the specific comments we received, if funds are not available for implementing a contingency strategy, consideration should be given to making them available at the earliest opportunity. Consideration should also be given to significantly involving the M&O contractor in intermediate contingency planning. M&O input and participation is just as important, if not more so, than the DOE's. As far as contingency planning representing a perceived lack of dedication to the program at hand, it is the Review Team's belief that a well-planned contingency strategy will dispel this allegation.

Sunk Costs for Alternative Programs

The following scope of work item is addressed:

- *For each alternative program selected by the DOE, what are the sunk costs? [NARUC B.1]*

By accounting definitions, sunk costs are those expended to date for a particular activity associated with a project. Also, in certain instances, sunk costs represent work effort achieved but later abandoned. The issue then becomes how much money has been spent for the original program, for Mission 2001, and for the current Program Approach; and how much money has been spent in each element of these programs for work that could not be carried forward to the succeeding program, and therefore, lost.

The Project has not recorded costs that specifically relate to the three programs, so there is no easy way to determine the amount of money spent in each of the efforts, or to determine the amount of money spent in one program where the results of that expenditure could not be used in a succeeding program. The only way to retrieve this is to start with the raw costs, payrolls, invoices, and other cost records, then create a cost structure oriented to obtain the desired information. For the effort

involved, the Review Team does not believe this would be cost effective or provide beneficial results.

However, an attempt was made to identify areas, both technical and management oriented, where there could be significant cost expenditures relating to previous programs that were not applicable to the succeeding program. The general conclusion is that the technical work, to date, has not been significantly impacted by the program changes. Although for reasons other than program changes, there will be alterations to technical work as any development proceeds. Projects start as an idea. They then move to a conceptual stage, and ultimately reach a specific and well-defined structure. During this process, numerous alternatives and options might be considered, some of which are later discarded. This is normal and is all part of the process culminating in a final detailed product. The Yucca Mountain Site Characterization Project is no different from others in this respect. As the Project moves to finalize its scope of work leading to technical site suitability evaluation and license application, it has undoubtedly considered ideas and options that were later discarded. An example might be the initial concept to use shafts to gather subsurface information. This approach was subsequently changed to a tunneling method to achieve more comprehensive data. Therefore, the costs to explore this possibility and the costs of any preliminary design work that may have been done, could be considered sunk costs not applicable to future operations. However, this appears to represent the development of ideas and a process rather than the result of a change to a program approach.

The initial intent of the Project relative to the technical work was to gather data, analyze that data, prepare findings, and propose recommendations. Although the approaches to the Program have changed and the time frame may be different, the basic work to be done remains the same. Therefore, the Review Team believes that to date there are relatively few areas where costs have been expended for technical work that has been discarded or significantly disrupted due to the various approaches taken to the Program.

There have been costs relating to the LM300 and the tunnel boring machine that could represent sunk costs. Both of these activities have had operational problems and standby time that could be considered sunk costs. However, these costs have no relationship to changes in the program strategy.

On the management side, there are costs representing certain efforts that cannot be carried forward from one program strategy to another. The most obvious is the personnel effort expended in deriving the concepts for each approach, preparing the details for those concepts, promoting the

revised program, and making the necessary changes to implement it. Although there are sunk costs in these areas, the accounting system does not provide for them to be retrieved. A very rough order of magnitude estimate might indicate several million dollars or more of personnel costs associated with each program change.

Although the above management costs are significant, we consider that the lack of definition of certain underlying technical issues currently represents a much greater risk for sunk costs. As discussed previously in this section, the issues of thermal loading, the extent of fracturing and faulting, and the movement of water through the unsaturated zone all have unanswered questions. Though not a result of a program change, depending on the resolution of these issues, there could be substantial modification to the process leading to technical site suitability evaluation and license application that could render certain approaches and work performed no longer applicable. Examples might include modeling work and tests performed that are no longer required, or potential changes to the level of effort of work currently underway. Therefore, efforts that are being pursued today could lead to future sunk costs. This emphasizes the importance of resolving these outstanding issues at the earliest opportunity.

Summary of Contingency Planning

In the opinion of the Review Team, contingency planning at all levels is an important aspect of any project as it generally reduces risks associated with schedules and costs. For purposes of this discussion, contingency planning is limited to the intermediate level (as opposed to the higher level, or fatal flaw analysis). Although the Program Plan alludes to contingency planning, no evidence was visible that a Project-wide contingency planning strategy was in place at any level. Nonetheless, there were several examples of contingency planning scattered throughout the Project such as the review of the drilling program, and possible use of data from the "P" tunnel. People interviewed confirmed that there was no overall contingency strategy in operation, and the majority said they were doing no contingency planning on their own. In the opinion of the Review Team, contingency planning (despite its merits) has, in effect, not been performed. Consequently, the YMSCO should address this weakness.

Regarding sunk costs, the Review Team has addressed the issue of program expenditures, where the efforts from those expenditures may not carry forward to a succeeding program due to a change in program approach. There were two aspects of cost to consider in this regard, technical and management. As all projects develop, various technical alternatives are evaluated as the project moves from a conceptual stage to final design. This is also the case with the Yucca Mountain Site Characterization Project work. There were undoubtedly numerous schemes that were considered and

then dropped throughout the development of the Project, and these could be considered by some to represent sunk costs. However, in the opinion of the Review Team, this is the normal evolution of a project and there was no significant evidence found of any technical work that was disrupted or discarded due to changes occurring from various program approaches. On the other hand, changes to program approaches do carry a cost relating to the management effort. Personnel cost required to derive the concepts of a new program and carry them through could be significant. Although these types of costs are not retrievable within the financial system, a very rough order of magnitude estimate indicates expenditures of possibly several million dollars or more for each program change.

Even though the foregoing personnel costs may be significant, there is a greater concern over the possibility of sunk costs relating to the unresolved technical issues of thermal loading, extent of fracturing and faulting, and movement of water throughout the unsaturated zone. Technical efforts that are being pursued today could lead to sunk costs in the future until such issues are resolved.

Option for Consideration

- Establish and implement a formal contingency planning strategy. Select approximately six intermediate level scenarios and identify contingency plans to be employed should the events in these scenarios occur.

FATAL FLAW ANALYSIS

In this category, two issues are to be analyzed:

- Site Disqualification
- Identification of Disqualifying Conditions

Within this subsection, site disqualification criteria will be discussed as they relate to 10 CFR 960 as well as other external factors that could contribute to site disqualification. Additionally, the methods by which the Project might identify early disqualifying factors will be reviewed as will the means to focus on those factors.

Site Disqualification

The following scope of work item is addressed:

- *What are the criteria that would disqualify the site? [NARUC D.7]*

As stated from the Program Plan, the criteria for determining whether the Yucca Mountain site is suitable or not suitable will be in accordance with the DOE's siting guidelines in 10 CFR Part 960. Each guideline contains qualifying conditions, and in some instances disqualifying conditions. These conditions are presented in Table VI-1. To recommend the site as suitable requires a positive higher level finding for each qualifying and disqualifying condition. A positive higher level finding can be supported when a disqualifying condition can be shown not to be present, or a qualifying condition can be shown to be present, and that additional information is unlikely to change these conclusions.

The guideline descriptions consist of two sections, pre-closure issues and post-closure issues. Post-closure issues will be considered first. The post-closure guidelines address the ability of the geological 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 nine technical guidelines. System guidelines concern the overall performance of the geological repository system after permanent closure, while the technical guidelines refer to specific aspects of the geological setting of the site.

The pre-closure 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 pre-closure guidelines consist of three system guidelines and ten technical guidelines.

The objective of the site suitability program is to conduct those site studies and perform those analyses and evaluations necessary to reach findings for the qualifying and disqualifying conditions, and if the site appears to be suitable, to develop a Site Recommendation Report by fiscal year 2000. To reach this, a technical site suitability evaluation is scheduled to be completed by fiscal year 1998 that will examine the post-closure guidelines related to waste isolation and the pre-closure guidelines related to radiological safety and technical feasibility. Evaluation of the remaining guidelines, which address environmental quality, socioeconomic impacts, and transportation issues, will be completed in fiscal year 2000.

**Table VI-I
SITING GUIDELINES
10 CFR PART 960**

POSTCLOSURE GUIDELINE DESCRIPTIONS

Guideline	Condition	Description
System Guidelines	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 VI-I
SITING GUIDELINES
10 CFR PART 960**

POSTCLOSURE GUIDELINE DESCRIPTIONS (continued)

Guideline	Condition	Description
Human Interference Natural Resources	Qualifying Disqualifying	Natural resources are not likely to cause interference activities that could lead to releases greater than regulatory limits. 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.

PRECLOSURE RADIOLOGIC SAFETY GUIDELINE DESCRIPTIONS

Guideline	Condition	Description
System Guideline	Qualifying	Preclosure exposures meet applicable safety standards.
Technical Guidelines		
Population Density and Distribution	Qualifying Disqualifying	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. 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.

**Table VI-I
SITING GUIDELINES
10 CFR PART 960**

PRECLOSURE RADIOLOGIC SAFETY GUIDELINE DESCRIPTIONS (continued)

Guideline	Condition	Description
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.
PRECLOSURE EASE AND COST OF SITING, CONSTRUCTION, OPERATION, AND CLOSURE GUIDELINE DESCRIPTIONS		
Guideline	Condition	Description
System Guideline	Qualifying	Repository siting, construction, operation, and closure will be feasible using reasonable available technology.
Technical Guidelines		
Surface Characteristics	Qualifying	Can be accommodated using reasonably available technology.
Rock Characteristics	Qualifying	<ol style="list-style-type: none"> 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.

**Table VI-I
SITING GUIDELINES
10 CFR PART 960**

PRECLOSURE EASE AND COST OF SITING, CONSTRUCTION, OPERATION, AND CLOSURE GUIDELINE DESCRIPTIONS (continued)

Guideline	Condition	Description
Hydrology	Qualifying	<ol style="list-style-type: none"> 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.
PRECLOSURE ENVIRONMENTAL QUALITY - SOCIOECONOMIC IMPACTS - TRANSPORTATION GUIDELINE DESCRIPTIONS		
Guideline	Condition	Description
System Guideline	Qualifying	Public and environment are adequately protected.
Technical Guidelines		
Environmental Quality	Qualifying	Environmental quality is adequately protected.
	Disqualifying	<ol style="list-style-type: none"> 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.

**Table VI-I
SITING GUIDELINES
10 CFR PART 960**

**PRECLOSURE ENVIRONMENTAL QUALITY - SOCIOECONOMIC IMPACTS -
TRANSPORTATION GUIDELINE DESCRIPTIONS (continued)**

Guideline	Condition	Description
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	<ol style="list-style-type: none"> 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.

** It is noted that no specific disqualifying conditions appear for "Transportation." This can be interpreted to mean that all "qualifying" conditions must be met.

Technical site suitability evaluation will be conducted through a series of technical basis reports and guideline compliance assessments. Each of these will address a set of one or more of the system or technical guidelines. The technical basis reports will provide the data and results of analyses conducted as part of site characterization that support the evaluation of the relevant qualifying and disqualifying conditions. Each technical basis report will be submitted for NAS review. Following this review and the public comment process, a guideline compliance assessment will be conducted to determine whether the higher level findings on qualifying and disqualifying conditions can be supported. The technical basis reports along with the guideline compliance assessment will provide the basis for the technical site suitability evaluation in 1998.

The above is a summary from the Program Plan of the process that leads to the technical site suitability evaluation. The criteria to determine site suitability are the guidelines contained in 10 CFR 960, specifically, the qualifying and disqualifying conditions. However, in addition to these guidelines, there could be soft disqualifying conditions. A soft disqualifying condition would be an event separate from the criteria of 10 CFR 960 that would lead to the inability to confirm Yucca Mountain as a repository, or would make the cost and/or completion date such that Yucca Mountain would no longer be acceptable. An example might be significant disagreement coming from the NAS's review of the technical basis reports. Another example might be the inability to collect sufficient data from the ESF at an acceptable cost due to extremely poor ground conditions, a stuck tunnel boring machine, or other major flaws. A third might be a successful lawsuit against the DOE over the Yucca Mountain Site. Yet another might be limitations upon the repository capacity such that an amount of waste significantly less than the 70,000 metric tons contemplated could be stored there. The Review Team has no indication that any of these, or similar flaws, are present, but attention is brought to the fact that conditions other than the inability to meet the requirements of 10 CFR 960 could affect site suitability.

Identification of Disqualifying Conditions

The following scope of work item is addressed:

- *How efficiently and effectively have funds been expended for activities that could facilitate identification of features that would disqualify the site? [NARUC D.7]*

A major objective of the Program Approach is to determine the suitability or unsuitability of Yucca Mountain as a repository at the earliest possible date. The process of gathering data, analyzing that data, and preparing technical reports leads to higher level findings. This process is somewhat constrained by the logic of the schedule and influenced by the requirements of 10 CFR 960 and 10

CFR 60. The Project is currently organized such that the testing program supports the technical basis reports and higher level findings with a goal to reach technical site suitability evaluation in 1998. Assuming that testing could be prioritized, and if the Project were organized such that testing was done strictly in a manner to support early findings of disqualification, the schedule logic emanating from this, in the opinion of the Review Team, would most likely extend the current major milestone dates.

The Program Approach can be considered a prioritization of testing issues. One of the major objectives of the Program Approach, as compared to previous approaches, is the potential early identification of technical site suitability as a repository. The goal of the Program Approach is to achieve this objective by 1998. Therefore, prioritizing the remaining tests to an extent greater than already available through the rebaselining effort would result in more of a fine tuning to the Project rather than a major departure from the current process. The Review Team believes that the farther the Project progresses, the more difficult it will be to prioritize the remaining testing program. From discussions with Project personnel, it appears that prioritizing and scheduling tests in an effort to identify the earliest disqualification is being accomplished to the extent possible through the rebaselining effort. This will be confirmed after the revised technical baseline is complete. Although opportunities may present themselves for further prioritization, it is important that the effort and funds expended conform to the benefits gained, bearing in mind that at this point in the Project prioritization is probably somewhat limited.

In January 1994, the Integrating Test Evaluation Framework for Prioritizing Tests for the Yucca Mountain Site Characterization Project (ITE) was published and addressed the issue of priorities. The report attempted to rank tests according to the highest probability to detect unsuitable conditions. However, the Review Team found little evidence that this had been used. With the advent of the Program Approach and the rebaselining effort, the results of this study are probably out of date. As part of the rebaselining effort, the Project should consider updating this portion of the report and using it in conjunction with the preceding discussion. If an unsuitable condition is present, this study could contribute to earlier detection than would occur otherwise.

Earlier in this section the role of enhanced funding was discussed, and it was suggested that allocating substantial amounts of money to the Project would probably not yield significant results toward improved dates for the major milestones. On the other hand, moderate enhancement of funding in selected areas could be beneficial to the Project. Should there be opportunities for further prioritization of tests, moving certain tests forward to a time frame before site evaluation has been completed would be an example of how enhanced funding might be effectively used. Likewise,

enhanced funding to accelerate, where possible, the testing program prior to site evaluation also might be useful. However, in both cases, the Project would need to ensure that the accelerated testing would be beneficial. Gathering data in an accelerated or earlier time frame without the ability to incorporate that data into the analysis and conclusions prior to site evaluation may not be a prudent use of enhanced funding.

Summary of Fatal Flaw Analysis

Fatal flaw analysis centers around site disqualification criteria and the identification of disqualifying conditions. The criteria for determining whether Yucca Mountain is suitable or not for a repository site is in accordance with the DOE's siting guidelines in 10 CFR 960. These guidelines address both pre-closure and post-closure issues and contain qualifying conditions, and in some cases disqualifying conditions. To recommend the site as suitable requires a positive higher level finding for each qualifying or disqualifying condition. The DOE's technical basis reports will provide the data and analysis to support the evaluation of the relevant qualifying and disqualifying conditions. In addition to the aforementioned, there could also be soft disqualifying conditions. A soft condition would be an event separate from the criteria of 10 CFR 960 that would lead to the inability to select Yucca Mountain as a repository, or an event that would make the cost and/or completion date no longer acceptable. For example, a successful lawsuit against the DOE in opposition of the Yucca Mountain site, or the inability to collect sufficient data from the ESF at an acceptable cost (due to poor ground conditions, a stuck tunnel boring machine, etc.) might be considered soft disqualifying conditions.

In regard to the use of funds for activities that could facilitate identification of features that would disqualify the site, an early suitability evaluation is a prime objective of the Program Approach and is being attempted through the rebaselining effort. Therefore, the Program Approach in its own right is an effective use of funds to reach this objective. The Review Team feels that additional opportunities for early identification of disqualification are somewhat diminished and would represent a fine tuning of the Program Approach rather than any major readjustments. Determination of funds specifically spent for early detection of disqualifying features cannot be made as the Project does not record costs in a manner that would allow these to be retrieved.

Options for Consideration

- Consider the use of available enhanced funding to bring forward certain tests if that would benefit earlier disclosure of disqualifying conditions.
- Consider updating the portion of the ITE report that addressed the ranking of tests according to the highest probability to detect unsuitable conditions.

SCHEDULING IMPACTS ON SCIENTIFIC INVESTIGATIONS

In this category, five issues are to be analyzed:

- Relationship of Mission 2001 to the Program Approach
- Impact of Deletion of Work
- Schedule Constraint of Scientific Investigations
- Ability to Reach Site Suitability and Licensing
- Ghost Dance and Sundance Faults

Within this subsection, the concept of the work scope for the Program Approach will be summarized and the potential impact of data availability in meeting the technical site suitability evaluation in 1998 and the license application in 2001 will be discussed. This subsection also includes a discussion relating to the concept of a schedule-driven project through self-imposed schedules; what might constitute a self-imposed schedule, and what the risks might be to the Yucca Mountain Project if the schedules are self-imposed. Additionally, there is a discussion concerning data gathering at the Ghost Dance and Sundance Faults and the considerations of surface mapping.

Relationship of Mission 2001 to the Program Approach

The following scope of work item is addressed:

- *Is there a relationship between the work identified in the Mission 2001 study that would/could be deferred and the work to be deferred under DOE's new site characterization approach? [NARUC A.3.1]*

There appears to be little relationship between the Mission 2001 study and the Program Approach, except that both concepts use the Site Characterization Plan as their base and both assume license application will occur in 2001. The Mission 2001 approach supposes that all of the elements of the Site Characterization Plan will be accomplished prior to license application and site evaluation. The Program Approach assumes that technical site suitability will occur in 1998, which is earlier than that identified within Mission 2001. However, the Program Approach allows some activities within the Site Characterization Plan to be completed after site evaluation and license application. Because Mission 2001 assumed all activities would be complete by 2001, there were really no postponements. The Program Approach, as discussed previously in this report, does not follow that same concept.

Impact of Deletion of Work

The following scope of work item is addressed:

- *How would the deletion of such studies and the unavailability of that data impact site suitability and license determination? [NARUC A.5]*

The above subject is a follow-on question from an item appearing earlier in this section under the title of Funding at Existing Levels. In this prior discussion, the concept of the Program Approach was reviewed. Previous site characterization plans called for extensive testing to obtain a comprehensive understanding of the Yucca Mountain site to allow simultaneous decisions regarding site suitability, licensing, and repository design issues. However, the Program Approach distinguishes between tests required to evaluate site suitability, tests required to support licensing and define a cost effective design, and tests required to confirm the safety of the repository before closure. In the process of developing the Program Approach, it was not the intent to delete tests or studies, but only to reorganize them to lead to an earlier evaluation of site suitability while preserving the schedule for licensing, constructing, and operating the repository if the site is found suitable.

Therefore, some studies that were scheduled to be performed prior to technical site suitability evaluation and license application have been rescheduled to a later date. This represents a certain element of risk. As discussed previously, it is possible that the unavailability of certain data and the lack of ensuing tests prior to the technical site suitability evaluation could conceivably disqualify Yucca Mountain at a later time frame as the site for a repository or disrupt the licensing process. The DOE feels that this is unlikely and the amount of risk they have taken regarding the availability of data is within acceptable risk limits. While the Review Team agrees with the DOE's concept of taking prudent risk, the amount of such risk cannot be finally evaluated, other than possibly within the DOE's organization, until the rebaselining effort is complete. Assuming that the risk taken is in line with that represented by the DOE, is prudent for this particular project, and is acceptable to the NRC, NWTRB, and NAS, then, in the opinion of the Review Team, the concept of the Program Approach should represent negligible vulnerability to the adequacy of technical site suitability evaluation and the license application.

The system of checks and balances for the risk evaluation within the Program Approach lies with the reviews of the technical basis reports by the NAS, interface with the NRC, and input from the NWTRB. However, the time for this all to occur also carries risk to the schedule. Additional testing could be required as a result of final peer reviews; if it is, this could impact major milestone dates.

Schedule Constraint of Scientific Investigations

The following scope of work item is addressed:

- *How would DOE's self imposed schedules constrain scientific investigations? [NARUC B.3]*

There has been much discussion on this Project over the concept of Program-imposed schedules and whether or not the Project is schedule-driven. The Project and the Program have not had a good history of meeting their major schedule dates. This has left an impression with some of the public and certain Stakeholders that the Program is schedule-driven. With the advent of the Program Approach it is important to maintain credibility and cost effectiveness by establishing a reasonable but aggressive schedule that the Project and Program will be able to attain.

A self-imposed schedule presumably is one where constraints, or milestones, have been established without sufficient regard to the work that must be accomplished to attain the milestones. The Review Team believes there can be several effects from this. If a milestone is constrained to the extent that there is no opportunity to perform all of the work required to reach an acceptable result, and if a conscious decision is made to not lengthen the durations to perform that required work, then the affected tasks may revert to a level of effort alternative. This, in the Review Team's belief, will result in a de facto self-imposed schedule. For example, suppose a schedule allows three months to perform a series of tests required to support a finding. However, it will actually take four months to perform the tests. If the schedule for this activity is not adjusted, then only 75 percent of the testing will be done. This becomes a self-imposed schedule and probably results in a constraint to scientific investigations.

Another effect relates to the situation where a level of effort is not an option. Suppose that the design for a project requires placing 1,000 cubic yards of concrete in a portion of a structure. If a self-imposed schedule does not allow sufficient time to accomplish this, there is most likely not an alternative to allow the use of only 800 cubic yards of concrete. The entire amount must be placed in the structure. In this case, a self-imposed schedule will ultimately result in missed milestones.

A project in which these, or similar, effects occur would be a schedule-driven project. Numerous parties, including the General Accounting Office, Nuclear Energy Institute, NWTRB, and Stakeholders, have indicated that the site characterization of Yucca Mountain is a schedule-driven project. However, most of these comments have been general in nature, and we have not seen analysis to support the opinions. The concept of the Program Approach should not contain

conditions leading to a schedule-driven project. The Program Approach attempts to categorize the tasks required to reach certain Project goals. In doing this, it assumes that technical site suitability evaluation can be reached in 1998 without performing, by that date, all of the tasks included in the Site Characterization Plan. As discussed previously, this does introduce an element of risk. Management of the Project feels that the extent of the risk taken is acceptable. If this is correct, and if the "bottom-up" schedules that are being prepared indicate that the work to be accomplished to reach the technical site suitability evaluation are within the milestones previously established from the "top-down" approach, then this Project would not be schedule driven.

However, those who are suggesting that the Project is schedule-driven might really be saying they disagree with the concept of the Program Approach and the postponement of certain investigations until after technical site suitability evaluation has been completed. Because the schedule does not allow time for these prior to the 1998 evaluation milestone, their opinion is that the Project is schedule-driven, and may not allow sufficient scientific investigations to obtain an adequate evaluation in 1998.

At this time it cannot be determined whether the schedule inhibits scientific investigations. The question comes back to the prudence of the risk taken in the Program Approach, and the vulnerabilities discussed previously in this section. The Review Team's general impression is that, in theory, this should not be a schedule-driven project. In a schedule-driven project, milestones would have been intentionally set without regard to the scope of work or there would have been an intent to delete required work scope for the purpose of meeting milestones. It is not believed that either is occurring in the Program Approach. However, this cannot be verified until the rebaselining effort is complete, schedules prepared, and the peer reviews accomplished.

On the other hand, there is a fine line between what may not be a schedule-driven project in theory and what may be a schedule-driven project in practice. This section of the report has previously discussed the potential problem of "top-down" scheduling. If the rebaselining effort identifies that the "top-down" schedules cannot be met, but the preestablished milestones are not changed, then this will be a schedule-driven project. In the opinion of the Review Team, there is a good possibility of this happening. The report has also identified numerous risks to the Project schedule. These include the possibility of overly optimistic durations, potential significant changes to the scope of work due to the open status of several major issues, and the reaction of the NRC to the details of the Program Approach currently under preparation. Any of these or the other schedule items discussed could be considered to establish a schedule-driven project.

The first subsection of this section of the report indicated that, in the opinion of the Review Team, the project has a 25 percent chance or less of meeting the technical site suitability evaluation milestone. Considering the above discussion and the rather small chance of meeting the characterization milestone, the Review Team concludes that this is a schedule-driven project. As this affects the scientific work, there are several areas regarding control of the work that we feel should be addressed.

Upon completion of the rebaselining effort, the scope of work for the Program Approach will have been defined. However, there still may be differences of opinion over the details of how much science is enough to accomplish the Project's objectives. At the Technical Program Review Meeting held in early 1995, there was significant disagreement among the participants in coming to a consensus of the level of effort required to address the issues contained in 10 CFR 960 and 10 CFR 60. Continuing differences of opinion in this area are to be anticipated. Balancing the degree of effort sometimes felt necessary by the scientific community against the concept of the Program Approach and the demands of the schedule will be a continuing challenge to the management of the Project. The Project has indicated that they are struggling with this conflict, specifically as to who should control when enough science is adequate and how to ensure its consistency of application. In the past it appears that the DOE has primarily managed this, but increased involvement for the M&O contractor regarding management of this issue is under review. Until the method of control is established and the involved parties identified, the issue of effective management of what represents enough science remains somewhat ambivalent. The Review Team has recommended in Section Four that the position of Chief Scientist should be filled. It is believed that this individual could play a valuable role in this area by setting the criteria and guidelines relating to the sufficiency of the scientific effort.

As noted in the discussions regarding the reasonableness of schedules, durations of activities appear to very tight with little or no float available. In the event that the planned duration for an activity is in jeopardy, the Review Team agrees with the Project objective that workarounds should be identified to allow the planned activity duration to be met. A workaround is an alternative approach to meeting a schedule objective, where the original approach is no longer viable. In the opinion of the Review Team; however, workarounds should not be at the expense of the scientific investigations as defined by the Program Approach, nor should a tight activity duration drive scientific investigations where workarounds are not available. Should these conditions arise, management must be judicious in handling the requirements of the schedule versus the needs for scientific investigations.

On the other hand, there is a feeling among some participants that an aggressive schedule helps to control the scientific effort and keep it at the appropriate level. The Review Team agrees with this, not only from the point of view of scientific investigations, but all activities on a Project schedule. Previous experience of the Review Team shows that work tends to fill the time available and this is detrimental to time and cost effectiveness. As stated previously, it is the belief of the Review Team that people work most efficiently when they are well challenged. Therefore, it is felt that aggressive but reasonable schedules will assist in the control of the scientific effort.

Ability to Reach Site Suitability and Licensability

The following scope of work item is addressed:

- *Do such constraints impair DOE's ability to reach site suitability and licensability determinations? [NARUC B.3]*

Potential restraints to DOE's ability to reach site suitability and licensability determinations has been discussed previously in this section; however, the following is a summary of the Review Team's analysis on this subject.

The concept of the Program Approach assumes that not all of the investigations and testing outlined in the Site Characterization Plan would be completed prior to technical site suitability evaluation and license application. Those items that were not completed prior to these events would, however, be completed prior to permanent closure of the repository. Although there is some risk involved in this if later findings were to indicate that the site was not suitable, the DOE feels that the risk taken in the Program Approach is reasonable when compared to the earlier dates that can be reached for technical site suitability and license application. When the rebaselining effort is complete and the Program Approach is presented, the NRC, NWTRB, and NAS will all have opportunities to give their opinions regarding the sufficiency of the planned investigations and tests to adequately reach an evaluation statement by 1998 and a license application by 2001. Should these parties concur that the Program Approach would accomplish this, then it seems reasonable, in the opinion of the Review Team, to assume that the DOE's ability to reach site suitability and licensability has not been impaired. The drawback is that immediate opinions from the above agencies will not be available. The Review Team believes that the NWTRB will most likely be the first to respond. The NRC will probably respond as the work proceeds through the annotated outline, and the NAS as they conduct their reviews of the technical basis reports. Therefore, considerable time may elapse, with significant work completed that may have to be revised, before a final judgement is reached over the adequacy of the Program Approach. This is a significant concern.

The schedule also has some bearing on this discussion. If it is assumed that the scope of work contained in the Program Approach to reach technical site suitability and license application is acceptable, and if the schedule allows sufficient time to accomplish this, then the schedule is not a factor in constraints to scientific investigations. The preparation of the schedule through the rebaselining effort should indicate whether or not the milestones previously set through the "top-down" approach can be met. If they cannot be met, it is the responsibility of the parties involved in the rebaselining effort to make that known to their management. An inherent risk factor is involved in this scenario. As discussed previously, there is a perception that the major milestones for the Project must be adhered to and there is little chance of changing them. This may encourage people who are preparing the scope of work for the rebaselining to reduce the scientific effort so that a milestone can be met. The review of the rebaselining effort and the schedules produced from it must be carefully done to ensure that the level of risk taken is appropriate to the risk that management of the Project intended to take when the Program Approach outline was conceived.

Assuming that the scope of the work and the schedule are compatible, once implemented, the scope of work should remain constant. If there is a delay in obtaining scientific data that would affect milestones, and there is no workaround for that delay, then the milestone, in the opinion of the Review Team, would have to slip. Once established, we believe that work scope should not be reduced for the sake of meeting a milestone unless it can be clearly demonstrated that there is no impairment in the ability of reaching a sound decision regarding technical site suitability and license application.

Ghost Dance and Sundance Faults

The following scope of work item is addressed:

- *What are the implications for funding and schedules of uncertainty about Ghost Dance and Sundance Faults? Specifically, had DOE considered whether it would be prudent to study the remainder of the surface areas of Yucca Mountain where the repository would be sited in the same way that the U.S. Geologic Survey is examining these faults, and, if so, what would be the implications of such studies on funding and scheduling?*
[NARUC D.5]

Until the scientific investigations of the Ghost Dance and the Sundance Faults are completed, there are uncertainties regarding implications to funding, costs, and schedules. The greatest risk from these uncertainties appears to be to the design aspects. If the faulting is not as anticipated in either structure or location, it is reasonable to expect that additional data would be necessary for further studies. Depending on the results of those studies, design of the repository, or possibly the canisters,

may have to change. These factors would most likely impact funding, costs, and schedule; however, the extent of impact cannot be reasonably estimated at this time.

Further to the above, there has been some comment by stakeholders concerning the amount of surface mapping planned for the Project. It is the Review Team's understanding that the DOE feels that much greater geotechnical site information will be provided from the ESF program than from surface mapping; and they prefer the underground method of data collection for this project. Therefore, the underground investigations become the primary source of information. If surface mapping were done, it would be considered a refinement as opposed to a primary source of information. Surface mapping to a further degree of detail than currently exists would be expensive, and, in the opinion of the Review Team, would probably not add significant value. However, should the underground investigations show something unusual or questionable in a particular area, it may be advisable to surface map that area to obtain further verification.

Summary of Scheduling Impacts on Scientific Investigations

The concept of self-imposed schedules and a schedule-driven project, as well as their associated impact on scientific investigations, has received substantial attention. The Review Team does not believe there is a conscious intent on the part of YMSCO to apply self-imposed schedules that would lead to a schedule-driven effort. If the risk assumed in the Program Approach concept scope of work is prudent, and if the "bottom-up" schedules confirm that the scope of work can be performed within the "top-down" milestone dates, then the schedule for this Project should not be self-imposed. However, should the personnel preparing the detail scope of work for the rebaselining effort feel that the milestones cannot be met under the concept of the Program Approach and reduce the amount of scientific work to be performed, then a self-imposed schedule and a resulting schedule-driven project would occur. Likewise, should the personnel involved in the rebaselining effort be overly optimistic regarding the amount of work that can be performed during a specific time period, the result will be a schedule-driven project. From observations gathered regarding the tightness of the schedules, the lack of float, and the concept of a success driven/no problem scenario, the Review Team believes that this is a schedule-driven Project. As such, tasks may be reduced to a level below that which is necessary to adequately complete the required scope of work. Furthermore, substantial risk may materialize when adequate data is not obtained for base studies and findings relating to technical site suitability evaluation and license application. Until the rebaselining effort is complete, the potential inhibitions on scientific investigations and the associated risks cannot be determined.

Regarding the subject of the Ghost Dance and Sundance Faults, until these areas are investigated, any potential funding, costs, and schedule impacts upon the Project will not be known. There is a

risk that if more extensive faulting is found than anticipated, the design of the repository may be impacted. The Review Team agrees with YMSCO that the primary means to collect data for these faults, and the Project as a whole, is through the ESF program. Further surface mapping would only appear to be a refinement, and should probably be limited to those instances where underground exploration shows something unusual or questionable.

Options for Consideration

- Clearly identify the process to determine when enough science has been accomplished. The position of Chief Scientist could provide an effective role in this area.
- After the scope of work is established through the rebaselining effort and schedules prepared that are consistent with that work, the scope of work should not be compromised for the sake of meeting a milestone.
- Surface mapping should be limited to those instances where underground exploration shows something unusual or questionable. scope of work. Further, substantial risk may be realized as adequate data may not be obtained upon which to base studies and findings relating to technical site suitability evaluation and license application. Until the rebaselining effort is complete, however, potential inhibitions on scientific investigations, nor the amount of risk taken as a result, can be determined.

**SECTION SEVEN
FUNDING LEVELS AND
FUNDING PRIORITIES**

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SECTION SEVEN FUNDING LEVELS AND FUNDING PRIORITIES

This section presents the Review Team's analyses of issues pertaining to funding levels and funding priorities. There are four categories of issues as follows:

- Level of Funding
- Programmatic Funding Priorities
- Revolving Fund
- Total System Life Cycle Cost Analysis

Each of these categories contains multiple issues to be addressed as defined by the NARUC-specified work statement.

INTRODUCTION

Funding may be one of the most critical aspects of the complex Nuclear Waste Disposal Program. The reason for its criticality is obvious. Simply stated, without funding, all other aspects of the Program cease. It is because of this criticality that funding is oftentimes the focus of scrutiny. Many have questioned whether the use of funds to date has been effective and efficient. The Government itself pays close attention to the level of appropriations afforded the Program as compared to other competing governmental programs. Despite having the funds allocated specifically for the purpose of disposing of nuclear waste, there is an additional consideration relating to whether the funds are being effectively and exclusively used for that purpose. Others have questioned whether there will be enough funding to fully support the costs of the Program over its full life cycle. These and many other questions exemplify the concerns, problems and performance issues typically raised when the topic of funding is addressed.

The following analysis provides a closer look at the DOE's uses of funds in connection with the objectives of the Nuclear Waste Disposal Program and the priorities established by the agency. The sources of funds, as well as the fiscal administration, are also discussed. Finally, the funding level required to pay for the Program and ensure full cost recovery is evaluated.

LEVEL OF FUNDING

In the Level of Funding category, three issues are to be analyzed:

- Budget Requests and Appropriations

Why were DOE's budget requests to implement the "logical sequencing of activities to accomplish license application" as stated in the Executive Summary of the Mission 2001 exercise approximately \$900 million less for fiscal years 1991-1994 than approved cost, schedule, and technical baselines for the Project? [NARUC A.3.5]

- DOE's Funding Assumptions

What assumptions led DOE to believe that adequate funds would be provided once the sequencing of activities to accomplish the tasks needed for license application were outlined in the Mission 2001 plan? [NARUC A.3.6]

- Consistency of Project Objectives

Are Project objectives consistent with the funding profile in a constrained budget environment and the legislative requirement to characterize a site versus construct a repository? [NARUC D.2.2]

Each of these three issue categories are discussed below followed by the Review Team's summary of findings relative to Level of Funding.

Budget Requests and Appropriations

The work scope addressed is as follows:

Why were DOE's budget requests to implement the "logical sequencing of activities to accomplish license application" as stated in the Executive Summary of the Mission 2001 exercise approximately \$900 million less for fiscal years 1991-1994 than approved cost, schedule, and technical baselines for the Project? [NARUC A.3.5]

To answer this question, the Review Team has focused not so much on the budget requests related to the Mission 2001, but budget requests in general and the reasons why differences may exist between such requests and approved budgets as well as schedule and technical baselines. The Review Team also addressed the impact that such differences have had or may have on the Project.

Budget Process. Under the Nuclear Waste Policy Act (NWPA), the Secretary of Energy is required to submit the budget of the Nuclear Waste Fund (NWF) along with the budget of the Department of Energy to the Office of Management and Budget (OMB) triennially for authorization. The OMB manages and administers the Budget of the United States Government of which the DOE's budget is a component and the NWF is a subcomponent. The DOE's budget request for the NWF is generally based on estimates of necessary expenditures for the management and disposal of the Nation's spent nuclear fuel and high-level radioactive waste. The Secretary is authorized to make expenditures from the NWF, subject to appropriations which remain available until expended. Once the appropriations are received, funds are allocated to the various Program elements including the Yucca Mountain Project and site characterization activities, Waste Acceptance and Storage, the Transportation System, and other ancillary Program features.

The NWF has historically been subject to competitive forces from other DOE programs. Therefore, despite having a separate fund for nuclear waste disposal activities, the OMB with Congressional guidance, controls budget allocations among all Department of Energy programs. Further, the DOE's overall budget is under similar constraints relative to the Budget of the United States Government. Due to the above constraints and other considerations, the DOE has often had difficulty receiving the funds needed to accomplish its waste disposal mission. In fact with the exception of 1995, appropriations have historically been significantly lower than the DOE estimates of the funds needed to maintain its schedule and accomplish its waste disposal mission.

Budget Requests. The budget request approach is an iterative process involving DOE Project and Program managers and directors, the M&O, subcontractors, the OMB, Congress and others. Over the years, the process has been approached from both a bottom-up approach (i.e., build-up of necessary expenditures) as well as a top-down approach (i.e., tailor expenditures to a defined target number provided by the OMB). DOE's requests under both approaches have been subject to Congressional budget constraints and competitive DOE Program forces and as a result, have created "funding shortfalls" when compared to the original baseline cost and schedule. As of 1994, the Project's funding shortfall was approximately \$900 million. Competition among nuclear waste disposal program elements based on established priorities can also be viewed as an integral part of the budget request and funding process.

Additional considerations regarding the reasons why funding shortfalls have occurred involve assessing whether the original baseline was appropriate and whether the DOE has been requesting funds according to this baseline. With a number of changes to the Program's overall approach and related activities over time (i.e., from the Site Characterization Plan to the Mission 2001 plan to the new Program Approach), it is questionable whether the original baseline cost and schedule was appropriate. It has been noted, however, that the DOE's original baseline was possibly unrealistic. This potentially being the case, the approved cost baseline may have been overstated thereby creating a variance with the eventual budget request amount. However, the differences in requested versus approved baseline amounts may not have had as significant an effect on the Project as they otherwise would have (i.e., if approved cost, schedule and technical baselines were appropriate).

The General Accounting Office (GAO) has indicated that in the past the DOE has in fact requested only about one-half of the money it had estimated it would need. In this case, a funding shortfall would be created because funds were simply not requested according to the approved baselines. The funding shortfall phenomena under this scenario is generally believed to be driven by the budgeting process and constraints described above, rather than DOE's inability to estimate and appropriately request the amount of funds it requires. Nevertheless, shortfalls have occurred in the Program and Project, and the DOE must develop ways or methods of dealing with such funding challenges in the future.

Funding Level Determinations. In order to avoid funding shortfalls in the future, DOE's (specifically OCRWM's) 1995 budget request was based on a new funding approach for the waste management and disposal program. Under this proposal, a special fund would be created from utility fee receipts in excess of the President's discretionary budget for the waste management and disposal program. More specifically, the DOE proposed that one-half of the annual balance from these excess receipts be available for the Program. The additional funding from this special fund is anticipated, by DOE, to be used to accelerate scientific and engineering activities at the Yucca Mountain repository site. Funding would also continue to be requested from the NWF and the Defense Nuclear Waste Disposal Fund under this proposal. (See Section titled "Revolving Fund" for more information regarding DOE's funding proposals.)

While approval of this new funding proposal has not formally been granted, the DOE has received a boost in its 1995 appropriation. Under the Energy and Water Development Appropriation Act of 1995, Congress enacted a total appropriation of \$522 million to the Program in order to carry out its purpose. The \$522 million, comprised of \$393 million from the Nuclear Waste Fund and \$129 million from the Defense Waste Disposal Fund, is 83 percent of the \$626 million that DOE internally planned for and originally requested. In dollar terms, the \$522 million enacted appropriation was approximately \$100 million less than the DOE's original request and approximately \$100 million more than the initial OMB target. In years past, the DOE's waste disposal program received on average approximately 60 percent of the funds it internally estimated it needed. In dollar terms, this translates into an approximately \$300 million difference between approved appropriation and estimated funding needs. Regarding Yucca Mountain specifically, this difference has been more significant. As of the end of fiscal year 1994, there was a cumulative difference between planned and actual funding of approximately \$900 million. On average, the Yucca Mountain Project received approximately 40 percent of estimated funding needs during fiscal years 1992 through 1994. In past years, enacted appropriations for the waste disposal program were generally only several million dollars variant from the OMB-targeted budgeted figure, however. It would appear then that the DOE has allowed the top-down approach to take precedence in relation to its budget requests.

Many attribute the 1995 level of appropriation as a vote of confidence in the Program under the direction of the current Program Director and Deputy Program Director. With continued consistency at the 1995 appropriation level or the enactment of proposals regarding additional funding, the Program may get the financial support it needs to accomplish its waste management mission. This scenario seems unlikely, however, in light of the estimated budget levels currently under discussion in Congress. If the financial support is not committed, the Program could continue to move along at a pace which would extend the time frame for completion of key events even further, increase total costs, and potentially, jeopardize the accomplishment of the mission. As recently as March of 1995, for example, the House Commerce Committee threatened to reduce funding levels in 1996 and/or make funds available to nuclear power plants for on-site storage capabilities if certain Program objectives are not met. This stance may be valid if the Program does not perform at its desired level. Only time will tell how well the Program will respond to this year's level of appropriation. Furthermore, certain legislation proposed during the course of the Review Team's

work would not only impact the level of funding, but also the continuation of the Department of Energy and its waste management office as we know it today.

Comparison of Funding Levels. As mentioned earlier, actual funding compared to planned funding for the Yucca Mountain Project represents approximately a \$900 million shortfall through fiscal year 1994. This shortfall for the most part has been created by budgetary constraints, competition among DOE programs, competition among specific waste management program elements, and the retention of an aggressive schedule. The DOE has responded to this shortfall by proposing to receive additional funding from special accounts, and developing a program approach that shifts the focus to earlier determination of technical site suitability. The DOE hopes the result of both of these measures will be to accelerate scientific and engineering activities at the Yucca Mountain site.

Other potential factors that could be attributed to the \$900 million shortfall would include an original overestimation on the DOE's part (and in Congress' view) regarding the scientific and technical activities necessary to accomplish its mission; and DOE's decision to request funds it felt would be approved and appropriated given past funding uncertainties. None of the above factors were confirmed independently, but the Review Team suggests that taken as a whole, they are all additional possibilities that may have contributed to the Project shortfall.

DOE'S Funding Assumptions

The work scope is addressed as follows:

What assumptions led DOE to believe that adequate funds would be provided once the sequencing of activities to accomplish the tasks needed for license application were outlined in the Mission 2001 plan? [NARUC A.3.6]

It should be noted that the Review Team focused on recent steps taken by the DOE (and related assumptions) to secure adequate funds in the future rather than focus on the outdated Mission 2001 to answer this question.

Steps Taken by the DOE. The DOE is aware of continued funding uncertainties in this long-term, high dollar, high visibility Program/Project. Thus, it has taken steps in attempts to ensure consistent funding. Outside of providing proposals for additional funding (which could help to "recapture" some of the shortfall), the DOE has attempted to display its own commitment and has solicited commitment from Congress through the development of new Program plans and approaches. Although some have criticized the management of the Waste Disposal Program in general, there have been signs of progress related to the management of the Program including improved strategic planning efforts, innovative performance and management tools, and cost reduction efforts. The most current example of many of these efforts can be witnessed in the development of the new Program Approach.

The Program Approach is an attempt to clearly define and communicate objectives to achieve certain key milestones while at the same time increasing confidence among the government, Stakeholders, and its own managers in the scoping of work, and related budget and schedule considerations. With a clear focus on achieving milestones along with confidence in the Program, the DOE hopes to create a fervor that will ultimately result in consistent financial support and commitment to the Program. Given the diversity of players involved and entities affected, the magnitude of dollars contemplated, the seriousness of the issue, etc., this is a tall order.

Different from the Mission 2001 Plan, the Program Approach has restructured the Yucca Mountain Project and to some extent, the entire waste disposal program. For the most part, the Mission 2001 Plan was a revised Site Characterization Plan under separate cover. The Program as described in such plans could not be accomplished with the funding levels that were being appropriated. Realizing this, the current Program Director decided to completely restructure, replan and reorganize the Program/Project. As a direct result of this effort, the new Program Approach has emerged. More specifically, the Program Approach was created to provide a Program that is "simpler, more visible and understandable to management and external oversight, and more flexible to respond to future changes." Under the new approach, many, including Congress, are expecting a more streamlined Program that is capable of showing demonstrable progress at reduced cost. By demonstrating such progress, the Department hopes to reduce the risk of wasting financial resources, and provide a "road map" for achieving major Project milestones such as a license application submittal by 2001. Given this new direction of the Program, the DOE feels that it will be able to

secure adequate funding in the future. At this point in time, however, there is no tangible evidence available to determine if DOE's goals will be met. It should also be pointed out that the DOE may be posed with significant risk in this approach as the Nuclear Regulatory Commission (NRC) (and others in the scientific and regulatory community) may not accept the reduced scope of information that is to be provided for license application.

Consistency of Project Objectives

The following scope of work item is addressed:

Are Project objectives consistent with the funding profile in a constrained budget environment and the legislative requirement to characterize a site versus construct a repository? [NARUC D.2.2]

Project Objectives. The DOE has often been criticized for attempting to achieve dual objectives of equal priority. The competing objectives have historically included: (1) to begin accepting utilities waste in 1998 and (2) to begin permanently disposing of waste in a repository in 2010. With these two objectives came a host of complicated, disorganized and sometimes ambiguous tasks to be accomplished. Furthermore, the level of funding appropriated was insufficient to support the level of planned tasks to meet these equally ranked objectives. Thus, the disposal Program and the Project struggled to show significant progress. This lack of progress created a stream of criticism from a number of affected parties and led to an overall lack of credibility for the Program/Project.

Legislative Requirements. The purpose of the NWPA is to: (1) establish a schedule for the siting, construction, and operation of repositories that will provide a reasonable assurance that the public and the environment will be adequately protected from the hazards posed by high-level radioactive waste and such spent nuclear fuel as may be disposed of in a repository; (2) establish the Federal responsibility, and definite Federal policy, for the disposal of such waste and spent fuel; (3) define the relationship between the Federal Government and the State governments with respect to the disposal of such waste and spent fuel; and (4) establish a Nuclear Waste Fund, composed of payments made by the generators and owners of such waste and spent fuel, that will ensure that the costs of carrying out activities relating to the disposal of such waste and spent fuel will be borne by the persons responsible for generating such waste and spent fuel.

In order to achieve the above objectives, the Act outlines the following requirements with respect to site characterization:

In general, the Secretary shall carry out, in accordance with the provisions of this section, appropriate site characterization activities at the Yucca Mountain site. Before proceeding to sink shafts at the Yucca Mountain site, the Secretary shall submit for such candidate site to the Commission and to the Governor or legislature of the State of Nevada, for their review and comment-

(A) a general plan for site characterization activities to be conducted at such candidate site, which plan shall include-

(i) a description of such candidate site;

(ii) a description of such site characterization activities, including the following: the extent of planned excavations, plans for any on-site testing with radioactive or nonradioactive material, plans for any investigation activities that may affect the capability of such candidate site to isolate high-level radioactive waste and spent nuclear fuel, and plans to control any adverse, safety-related impacts from such site characterization activities;

(iii) plans for the decontamination and decommissioning of such candidate site, and for the mitigation of any significant adverse environmental impacts caused by site characterization activities if it is determined unsuitable for application for a construction authorization for a repository;

(iv) criteria to be used to determine the suitability of such candidate site for the location of a repository; and

(v) any other information required by the Commission;

(B) a description of the possible form or packaging for the high-level radioactive waste and spent nuclear fuel to be emplaced in such repository, a description, to the extent practicable, of the relationship between such waste form or packaging and the geologic medium of such site, and a description of the activities being conducted by the Secretary with respect to such possible waste form or packaging or such relationship; and

(C) a conceptual repository design that takes into account likely site-specific requirements.

Based on these legislative requirements, it would appear that the focus of the Program is to characterize the site. The construction of the repository would be performed later, based on the results and progress of site characterization activities. Therefore, activities to accomplish this objective should be in accordance with the law as well as the regulations dictated by the Nuclear Regulatory Commission.

Historical Funding Profile. As noted previously, the historical funding profile has shown a significant difference in planned funding as compared to actual funding. The reasons for this discrepancy include budget constraints among DOE programs and among specific waste disposal Program elements, an aggressive, possibly unrealistic cost and schedule baseline based on the all-inclusive Site Characterization Plan, and a lack of financial commitment to the Program due to its complexity, ambiguity and lack of credibility. Since Program inception, the cumulative difference between planned funding and approved funding is approximately \$1 billion to date. As noted previously, however, the amount of 1995 approved funding establishes a positive trend and potentially enables the funding gap to begin to get closer.

Assessment. Prior to the development of the Program Approach, the simple answer to the question posed, "*Are Project objectives consistent with the funding profile in a constrained budget environment and the legislative requirement to characterize a site versus construct a repository?*" is no. The activities performed under the Site Characterization Plan and its objectives were focused "on site characterization after extensive data gathering to satisfy as many of the scientific issues as could be contemplated." The Program Approach, however, is an attempt to streamline the Program by (1) setting goals and schedules that are consistent with the resources that can be allocated to the Program/Project; (2) developing a Program that has a reasonable probability of being successful by setting appropriate goals; and (3) resolving disconnects between Program expectations and the ability to achieve them. There are also plans to rebaseline schedules and milestones based on proposed funding levels which will, from the DOE's point of view, hopefully have the effect of bringing planned funding more in line with actual future funding. The plan is to use the combination of a top-down approach to analyze the rebaseline, estimate schedules, milestones and funding requirements and ultimately request funds on an ongoing basis. Despite its intent, the Program Approach still raises the question as to whether it will meet legislative and regulatory requirements. Moreover, because the Program Approach will be relying upon less information to make technical site suitability, site recommendation, and license application decisions, it increases the risk that the approach will be found unsatisfactory to key decision-makers. From a management perspective, however, the Program Approach appears to be conceptually sound (especially as compared to previous strategic plans) but effective implementation remains to be seen.

The long-term Program objective under the Program Approach, simply stated, is to provide for nuclear waste disposal in a geologic repository. The short-term Program objective described in the Program Approach is to provide for the timely acceptance and safe interim storage of spent nuclear fuel generated by commercial reactors. Unlike the Mission 2001 and other previous Program plans, the new Program Approach provides a "road map" for accomplishing the near-term and long-term objectives. For example, to achieve specific Project objectives, such as evaluating whether Yucca Mountain appears to be technically suitable for development as a geologic repository by the end of 1998, the Program Approach defines specific and distinct tests to evaluate site suitability, to support licensing and define a cost-effective design, and to confirm the safety of the repository before closure. According to the plan, "this distinction permits phasing of tests to achieve an earlier evaluation of whether Yucca Mountain appears to be suitable and to preserve the schedule for licensing, constructing, and operating the repository if the site is found suitable. It also accommodates available resources." This approach defers some of the requirements of the Site Characterization Plan which called for "extensive testing to obtain a comprehensive understanding of the Yucca Mountain site to allow decisions to be made simultaneously on site suitability, licensing and repository design issues."

The Program Approach was created to address the "disparities among the Program's plans and schedules, the resources it was actually receiving, the work it was actually doing, and stakeholder expectations for results." While it appears to be more in line with anticipated funding profiles and newly established Project objectives, it is questionable whether it will meet the requirements of the NWPA.

Summary of Level of Funding

Due to budgetary constraints, competition among DOE Programs, competition among specific waste management Program elements and for other reasons, a funding shortfall exists in the Program/Project. Depending on one's view, the funding shortfall created by differences in budget requests and approved baselines, as well as planned and actual funding levels, may or may not have had significant implications on the Program/Project. Despite its impact and the reasons behind the shortfall, the fact of the matter is that a difference exists and the DOE must deal with ways to minimize this difference in the future. By reducing and/or eliminating inconsistencies among funding, as well as among Project objectives, the DOE's new Program Approach is an attempt to

create a strong, successful Program/Project. Given the latest discussions in Congress regarding funding levels, as well as the risks associated with the Program Approach from a legislative standpoint, the future of the Program/Project remains uncertain.

Options for Consideration

The Review Team's options for consideration regarding level of funding issues are as follows:

- As the Program Approach appears to be a conceptual improvement over previous strategic plans with hopes of moving the Program/Project forward, and showing real progress, OCRWM and YMSCO personnel ("internal players") should embrace the approach and work as a team to implement the strategies and plans contained therein. The DOE should also make valiant efforts to get the public's (and other affected entities') support of this approach with hopes of creating a confidence and commitment in the Program/Project from these key "external players."
- The DOE should continue to focus its attention on rebaselining the Project cost and schedule in order to establish realistic expectations and gain performance credibility with all Program/Project players.
- The DOE should continue its attempts to secure consistent funding for the Program/Project with hopes of recapturing monies lost through the historical lack of funding and related schedule slippages.

PROGRAMMATIC FUNDING PRIORITIES

There are five issues in the Programmatic Funding Priorities category as follows:

- Programmatic Priorities

Is it prudent to expend large sums of money to develop a multipurpose cask without the benefit of thermal testing and other crucial information on aspects of the proposed repository, and in the absence of a legal determination as to the obligation of the Federal government to provide storage for civilian nuclear wastes by 1998? [NARUC D.4.2]

- Cost Effectiveness Related to Program Elements

Assess the cost-effectiveness of using a multipurpose cask, in the absence of a monitored retrievable storage facility. [NARUC D.4.1]

- Allocation of Funds Among Program Elements

What is the historical and current allocation of funds between the Yucca Mountain Project, the monitored retrievable storage facility and the transportation system? [NARUC D.6.1]

- Impact of Programmatic Allocation of Funds

Has this allocation retarded the site characterization process? [NARUC D.6.2]

- Proper Balance with Waste Management Mission

Is this allocation balanced properly relative to DOE's waste management mission? [NARUC D.6.3]

Each of these five issue categories are discussed below followed by the Review Team's summary of findings relative to Programmatic Funding Priorities.

Programmatic Priorities

The work scope addressed is as follows:

Is it prudent to expend large sums of money to develop a multipurpose cask without the benefit of thermal testing and other crucial information on aspects of the proposed repository, and in the absence of a legal determination as to the obligation of the Federal government to provide storage for civilian nuclear wastes by 1998? [NARUC D.4.2]

Background. The Nuclear Waste Policy Act, as amended in 1987, authorized the DOE to develop a Monitored Retrievable Storage (MRS) facility to store waste on an interim basis until a repository was ready for permanent disposal of such waste. Under the original Policy Act of 1982, it was anticipated that a repository would be available for waste acceptance and disposal as early as 1998. Also under the amended Policy Act, the MRS facility was linked to the licensing of a repository. In order to prevent the MRS facility from becoming a replacement for the repository, the amended Act required that the DOE receive the NRC's approval of its license application for repository construction before being able to construct the MRS facility. Based on the current status of the MRS Program (and current law), there is serious doubt that an MRS facility will be available to accept waste in 1998. In fact, under the Program Approach, the DOE has abandoned the idea of developing an MRS facility. The inability to accept waste at an MRS facility leads to further questions regarding the DOE's obligation to store civilian nuclear power plants' waste by January 31, 1998, and the need to develop casks in the short term. Additionally, in the absence of an MRS

facility altogether, there is question as to the utilization of multipurpose casks, the cost effectiveness of the development of these containment issues, and the logistics for on-site, at reactor, storage which has been proposed by the DOE as a means for satisfying waste acceptance by 1998.

Programmatic Logistics/Integration. The development of casks, both multipurpose and transportation-specific, is an integral part of the Waste Disposal Program. By the same token, it is one of many parts that must be integrated to accomplish the safe disposal of radioactive waste and spent nuclear fuel. This requires a full and comprehensive understanding of the entire Program and a clear, logical direction among the Program elements. It also requires a strong integration strategy, since decisions or conclusions derived in one Program element may affect decisions in another element. To date, there is some question as to how successfully the Program has handled this concept of integration. In fact, there still remain unresolved issues related to the multipurpose casks (MPCs), the MRS facility, waste acceptance, the transportation system, and site suitability and license application for the repository that ultimately affect all Program elements. There also appears to be a lack of communication and consensus among those responsible for these key elements of the Program.

To date, the DOE has made efforts to develop transportation casks and overpacks for the transporting of spent fuel elements, as well as develop MPCs for the multipurpose role of spent fuel receipt, storage, transport, and disposal. The development of MPCs has been more recent. Under the Program Approach, the DOE is planning to provide MPCs to utilities for the purpose of loading spent nuclear fuel and storing waste at on-site facilities. According to the DOE, "Once fuel is loaded into an MPC, it can be placed in an overpack suitable for dry storage (at reactor sites) or transportation, and at the repository in a waste package overpack for disposal." Because of changes in strategy over time regarding waste acceptance, interim storage and transportation, it is important to note the above distinction between transportation and multipurpose casks.

In years prior to the concept of the multipurpose cask, the DOE spent a considerable amount of effort developing transportation casks. A brief history of its development may provide some meaningful background information. In a report entitled, "Follow-up Audit of the Cask Development Program" dated March 1994, the DOE's Office of Inspector General observed that their recommendations to the Program for "establishing minimum criteria that each [transportation] cask

would have to meet in order to qualify for further development funding, was not adequately implemented. Because this criteria was not developed, significant contract funds were expended on these casks before the contracts on five cask designs were eventually terminated." They also commented that under the plans in place at that time, "the Department will spend an estimated \$143 million on this (transportation cask development) Program and receive only two cask designs that were originally scheduled to cost \$26 million." As a result, they concluded that the (transportation cask development) Program was "over budget, several years behind schedule, and continuing to struggle with engineering and design-related problems that are stalling the further advancement of the cask development." This being the case, it is clear that large sums of money have been expended in the development of casks and there is an apparent question as to the effectiveness of the transportation cask development Program to date.

With hopes of satisfying its waste acceptance obligation by 1998, the DOE has undertaken an MPC development program. The Review Team submits that, for the "final" design of MPCs to be developed in a cost-effective manner, determinations regarding waste acceptance, the repository design, and transportation methods must be made. According to the Program Approach, such key determinations will be made on an ongoing basis resulting from the technical studies that are performed and evaluated. Certain significant operational and technical issues regarding the Program/Project must be resolved prior to the design of MPCs; however, it is also possible that certain parts of the multipurpose cask development and design could be performed concurrently with some of these operational and technical issues. Two of the major issues to be resolved include "thermal loading" and the form of interim storage.

Projected thermal loading of the Yucca Mountain site with emplacement of the MPCs has a significant effect on the design and development of MPCs. Ultimately, the thermal loading issue will dictate the volume of waste that can be accommodated by the repository. As such, the type ("hot" or "cold"), size, and number of spent fuel rods will be directly affected by the thermal loading issue. In addition, the use of the MPCs can also be related to the thermal loading issue. All of these factors could have a significant impact on the cost and schedule of the MPC development program. Other outstanding issues that would affect the design of the MPCs would include transportation mode (i.e., truck versus rail), length of time required for storage (i.e., 50 years, 100 years or longer), and safety precautions.

The "form" that interim storage will ultimately take will have an effect on MPC development and design criteria. Interim storage could be interpreted as surface, at-reactor storage; some form of surface or subsurface storage in tribal lands; or storage at or near Yucca Mountain or some other location. Any of the above could require a different design of an MPC for interim storage. Furthermore, it could also require a different design than that needed for permanent repository disposal. Program management must decide whether it will design the MPC to accommodate all of the above interim storage scenarios or favor one form over the other so that research and design work can progress. Program management needs to evaluate whether it is feasible to develop one "robust" design to accommodate interim storage, transportation and disposal in the final repository.

Studies that should be performed, which are not yet performed, and/or data that should be collected in order to design and develop MPCs will ultimately affect the costs and schedule associated with MPCs. Some of those studies and/or data would include but are not limited to: (1) the hydrogeologic, geochemistry and thermal loading effects on the MPCs after disposal, (2) the effective handling of MPCs from reactor sites to an MRS facility or a repository, and (3) the type of material or combination thereof for construction of the MPCs to withstand long-term transport and disposal. These are just some additional considerations that must be incorporated by the Program in order to effectively address the design and development of the MPCs. In order to avoid falling into the same trap that it encountered previously with the transportation cask development Program, the DOE should take heed of the Inspector General's recommendation and consider the many issues discussed above.

Status of Legal Determination/Pending Litigation. The current status of the litigation against the DOE regarding its "legal obligation" to accept nuclear waste absent an operational repository or other facility is uncertain and pending at this time. Ironically, a General Accounting Office (GAO) report dated September 1991 provided some insightful and somewhat clairvoyant comments regarding this situation. In the report entitled, "Operation of Monitored Retrievable Storage Facility is Unlikely by 1998," the following was commented:

"The Congress knew, when it linked the MRS facility to the repository, that the type of linkage being imposed would almost certainly prevent DOE from accepting spent fuel by 1998. For that reason and others, it is questionable whether DOE is legally bound by that

date. Although there are a number of ways a court might interpret DOE's legal responsibilities under NWPA and its disposal contracts, it is impossible to predict the outcome of potential litigation with any precision. Further, if an MRS facility is not operating by January 31, 1998, DOE will be unable to meet what the utilities consider to be a commitment to store or dispose of spent fuel from utilities by that date. NWPA, as amended, the relevant legislative history, and DOE's disposal contract with utilities are not clear on what the potential implications of this occurrence would be. However, if DOE cannot store and/or dispose of utilities' spent fuel by 1998, they may sue DOE."

In its report, the GAO also offers the following regarding possible court interpretations of DOE's legal responsibilities:

- (1) An operating repository is a necessary condition for DOE to meet both requirements stated in NWPA (i.e., accepting title to waste and disposing of waste). In other words, accepting title to the waste is a prerequisite to "disposal" and emplacement in a repository. Under this interpretation, DOE would not be obligated to accept title to or dispose of nuclear waste until a repository is operating.
- (2) The two requirements might be interpreted as separate and distinct. Under this interpretation, DOE would not be obligated to accept title to nuclear waste until a repository is operating but would be responsible for disposing waste beginning in 1998.
- (3) The requirement to dispose of waste could be interpreted as a modification of the obligation to accept title to waste. This interpretation would require DOE to accept title to the waste beginning no later than January 31, 1998 and dispose of it accordingly, but not necessarily at a repository or MRS facility.
- (4) The requirement to dispose of waste could be interpreted as not being restricted solely to the statutory term "disposal." Under this interpretation, the court might find that NWPA's direction to dispose of the waste by a certain date, refers to DOE's overall responsibility to enter into contracts by that date that would obligate DOE to provide "disposal" services.

As initially intended in the NWPA, the two requirements (i.e., accepting waste and disposing of waste) were not in conflict because it was originally anticipated that a repository would be operating by or before 1998. Due to slippage of an operating repository's schedule to 2010 at the earliest, the two requirements are no longer compatible.

With the clear uncertainties regarding this overall situation (i.e., ability to provide waste acceptance by 1998, actual date that the DOE is bound to accept waste, court interpretations of the legal responsibility to accept waste, etc.) only time will tell how it will ultimately be resolved and

what impact it will have on the Program. It should be noted that this whole issue may be moot, however, as under the Program Approach the DOE is attempting to design, develop, obtain certification for, and arrange to make available multipurpose canisters for interim storage of spent nuclear fuel at utility reactor sites.

Assessment. There would appear to be some reasonable level of development that can and should be performed without the benefit of desired information but with hopes of meeting the requirement to store waste on an interim basis (assuming this is necessary). By planning to arrange for multipurpose canisters to be used by utilities, the DOE may have already made a decision regarding its "legal obligation" and the necessity of arranging for interim storage. To accomplish this task, it would appear the DOE has placed some of the burden on the utilities to store waste until a repository is built. (Assuming the DOE is not obligated to provide a separate interim storage facility and funds are not provided to utilities.) This development further begs the question as to how long utilities can store spent fuel and whether a separate interim storage facility will still be needed if a repository is significantly delayed or, in fact, not built. Another consideration may relate to whether the permitting process by individual states will allow for this proposed form of additional interim storage.

In essence, since considerations about the investigation of Yucca Mountain (permanent storage) are difficult to separate from considerations about the temporary storage of nuclear waste until a repository has been developed for permanently disposing of waste, and since the status of litigation regarding the DOE's legal obligation to accept waste is uncertain, the Program risks developing and designing an MPC that may be inadequate and/or obsolete for disposal purposes. Thus, the Program should continue to lay a groundwork for MPC development and do what it can to accomplish waste acceptance by 1998, but not expend significant monies for design and development until operational and technical issues related to the repository have been resolved and the status of interim storage, both legally and logistically, has been determined.

Cost Effectiveness Related to Program Elements

The work scope addressed is as follows:

Assess the cost-effectiveness of using a multipurpose cask, in the absence of a monitored retrievable storage facility. [NARUC D.4.1]

History of Cask Development Program. In order to meet its responsibility for developing a transportation and storage system for civilian nuclear waste, the DOE launched a Program to develop a series of new transportation casks. As early as 1987, the Office of Inspector General audited the transportation cask development Program and criticized management for not establishing minimum criteria that each cask design must meet to qualify for additional development funding. Per the GAO, in early 1990, the DOE decided to develop one type of truck cask and one type of rail/barge cask after reviewing the number of designs provided by select contractors. Final designs of the selected truck and rail/barge casks were expected to be completed in 1992 and submitted to the NRC for approval. Further, the DOE expected to begin fabricating prototypes in 1995 at a cost of between \$1.3 to \$1.5 million each for the 32 to 54 truck casks and \$2.0 to \$3.0 million each for the 18 to 24 rail/barge/casks. The cask development Program to the point of fabrication was anticipated to have a cost of about \$54 million.

With changes in Program strategy, the DOE has now shifted its focus to the development of a multipurpose cask. There are a number of factors to be considered in the design and development of the multipurpose casks. Some of these factors are independent to the development of the repository and interim storage facility while others are very much interdependent. It is the interdependent factors such as capacity constraints, storage conditions, and thermal loading that significantly affect the design, development and ultimate cost of the multipurpose cask.

Status of Cask Development Program. Under the Program Approach, the DOE is continuing to design and develop MPCs with hopes of obtaining certification and ultimately, providing MPC's to utilities for purposes of at-reactor storage. Current estimates would indicate that approximately \$90 million has been spent on the transportation and multipurpose cask development programs to date. It is difficult, if not impossible, to make a distinction between the two programs from a historical cost allocation perspective, however, as the DOE did not separate such costs in its

accounting system during the early years of the Program. The 1995 budget has allocated approximately \$11 million for the transportation cask development program and approximately \$30 million for the multipurpose cask development program in the current fiscal year.

History of MRS Facility. Under the NWPA, Section 141(a), Congress found that long-term storage of high-level radioactive waste or spent nuclear fuel in monitored retrievable storage facilities is an option for providing safe and reliable management of such waste or spent fuel. Furthermore, the disposal of such waste or fuel in a repository developed under the Act should proceed regardless of any construction of a monitored retrievable storage facility. As such, the Act sets forth stipulations for the siting, planning, licensing, construction and operation of a monitored retrievable storage facility. In accordance with the Act, on March 31, 1987, the DOE submitted a proposal to build a monitored retrievable storage facility on the Clinch River near Oak Ridge, Tennessee. Due to intense opposition from Tennessee officials, the 1987 amended Act nullified the Oak Ridge siting proposal. The amended Act also called for additional stipulations including the establishment of the MRS Commission to evaluate current status, and the requirement that selection of an MRS facility could not occur until the Secretary had recommended to the President a site for development of a repository. Furthermore, any license consideration for an MRS facility had to provide that the construction of the facility would not begin until a license for the construction of a final repository was issued. By linking the MRS facility to the repository's schedule, the Act provided assurance that an MRS facility would not become a "de facto" repository.

Status of MRS Facility. To date, the MRS Project has expended approximately \$160 million, including infrastructure costs. Furthermore, the DOE has allocated approximately \$30 million for additional Project activities. Regarding the design and operational costs of the MRS facility, the DOE has expended approximately \$20 million to date but has not allocated funds for this activity in its 1995 budget. In fact, the Program Approach does not acknowledge the development and operation of an MRS facility. Under the NWPA, however, the MRS facility still remains linked to the submission of a license application for the construction and general scheduling of a final repository.

Assessment. The DOE must consider its options for providing interim storage and/or disposal in the absence of an MRS facility. The current "interim storage" concept under consideration is at-

reactor storage for 50 to 100 years. This approach, at a minimum, could allow for further study of either an MRS facility or a repository; however, the permanent storage concept is a repository. In the absence of an MRS facility, then, MPCs would primarily be developed for use in at-reactor storage sites or for use in a repository, or both. The schedule and associated cost of MPC development (which has been noted to take approximately five years for design, development, certification and fabrication) should follow the schedule of one of the above options. The DOE, as mentioned, is currently planning to adopt the at-reactor concept and therefore has initiated the development of multipurpose casks that it believes will serve not only at-reactor storage purposes but will also be compatible with the transportation and disposal systems. This concept may create a conundrum, however, as certain interests come into play: (1) Stakeholder acceptance of at-reactor storage may hinge on a single-purpose design to store spent fuel rods; and (2) The "robust" design that can accommodate at-reactor storage needs may not, in fact, be applicable for transportation and disposal needs. This concept depends on the results of ongoing scientific, technical and operational studies relative to these Program elements and, therefore, is not fully explored. Uncertainties facing the MRS facility, transportation system and disposal system will continue to affect the cost of MPC development. The many variables affecting its design (i.e., thermal loading, rail/barge versus truck, wet versus dry storage) create an equation of great complexity, requiring major systems analysis attention.

Allocation of Funds Among Program Elements

The work scope addressed is as follows:

What is the historical and current allocation of funds between the Yucca Mountain Project, the monitored retrievable storage facility and the transportation system? [NARUC D.6.1]

Background. Early in the Nuclear Waste Disposal Program, priorities among Program activities were generally viewed in the following descending order of priority: (1) infrastructure—to maintain continuity; (2) MRS facility and transportation—to allow for waste acceptance by 1998; and (3) site investigation activities—to allow for ultimate disposal of wastes. Many have suggested that because of this priority statement, funds have not been used effectively and the Program has suffered because of it. In 1992, for example, according to the GAO, of the total Program expenditures, the infrastructure accounted for approximately 40 percent, MRS facility/transportation/other Program

activities accounted for approximately 40 percent, and scientific and technical activities 20 percent. By contrast, without a segregation of infrastructure activity, the Yucca Mountain Project expenditures were 58 percent of total 1992 Program expenditures while other Program activities including the MRS facility and transportation made up approximately 40 percent.

The Review Team has also performed an evaluation of Program costs and the allocation of funds between the Yucca Mountain Project, the Monitored Retrievable Storage Project, and the Transportation System. The following are observations based on this analysis:

- Of the approximately \$4.3 billion dollars spent to date (i.e., through March 1995) in the Program, approximately 44 percent has been allocated to the Yucca Mountain Project, 4 percent to the Monitored Retrievable Storage Project and 4 percent to the Transportation System. The remaining costs were distributed among the following categories: Other first repository costs - 24 percent, second repository costs - 2 percent, waste acceptance - 1 percent, Program support - 19 percent, and capital equipment - 2 percent.
- Over the period 1983 to 1994, the allocation of funds to the Yucca Mountain Project range from a low of 19 percent in 1985 to a high of 64 percent in 1994. Likewise, the Monitored Retrievable Storage Project shows a low of 2 percent and a high of 8 percent in 1992, and the Transportation System reflects a low of 1 percent and a high of 7 percent.
- Of the approximately \$4.3 billion dollars spent to date, approximately 34 percent has been classified as scientific/technical activities and 36 percent infrastructure. The remaining 30 percent was spread across systems engineering, regulatory, and other Program costs.
- Yucca Mountain Project-specific costs were 45 percent scientific/technical and 32 percent infrastructure; the remaining 23 percent was comprised of 15 percent systems engineering and 8 percent regulatory costs. Likewise, 22 percent of total Monitored Retrievable Storage Projects costs were classified as infrastructure, while 20 percent of total Transportation System costs were infrastructure costs.

Under the Program Approach and 1995 budget, over 65 percent of the Nuclear Waste Fund appropriation is anticipated to be applied to the Yucca Mountain Site Characterization Project. Some would argue that essentially all of the funds appropriated for the disposal Program should be committed to site characterization (as opposed to other Program elements or the disproportionate amounts that have historically been expended on infrastructure). The DOE's Program Approach is an attempt to prioritize site characterization activities and keep infrastructure costs to a minimum through more stringent control. (Refer to Section Five regarding more details on financial management.)

Impact of Programmatic Allocation of Funds

The following scope of work item is addressed:

Has this allocation retarded the site characterization process? [NARUC D.6.2]

Limited Progress at Yucca Mountain. The limited progress of the site characterization process has traditionally been blamed on the DOE's lower priority treatment of site investigation activities and an inappropriate allocation of funds to scientific and technical activities. While these factors may play a part in the limited progress, there are many other factors that should also be considered and evaluated. Some of these factors or events include:

1. The stringent requirements, as set forth in the NWPA as amended regarding the Yucca Mountain site, the MRS, the MPCs and associated issues.
2. The rigidity of the regulations as defined in 10 CFR Part 60 (NRC) and 10 CFR Part 960 (DOE).
3. The aggressive expectations of all participants that the objectives of the Site Characterization Plan could be achieved in a timely and cost effective manner.
4. The continuous "road blocks" and interventions of various Stakeholders' interests regarding the Program.
5. DOE's inability to clearly articulate the mission of the Project/Program resulting in a loss of confidence and distrust.
6. The inability by the DOE and/or the M&O to effectively and efficiently manage the Program's scientific/engineering participants and their related activities.
7. Contractor's inability and/or reluctance to adopt DOE's concept of a national radioactive waste disposal policy.
8. Discontinuity between OCRWM directors/managers and Project directors/managers and staff.
9. Contracting and procurement problems with the M&O and other participants.
10. The fact that repository development is the "first of a kind" ever attempted by the United States. Furthermore, the Program/Project has inherent complexities of emotional, political, socioeconomic and scientific considerations.

Assessment. When these other considerations are brought to bear, it is not as clear cut to determine whether or not the site characterization process has been significantly impacted by the allocation of funds alone. It can be said that it is a significant factor, but certainly not the only factor or necessarily the driving force. The DOE appears to be addressing several of these issues, including the appropriate allocation of funds, within the Program Approach concept.

Proper Balance with Waste Management Mission

The following scope of work item is addressed:

Is this allocation balanced properly relative to DOE's waste management mission? [NARUC D.6.3]

DOE's Dual Program Objectives. The DOE's general mission statement is as follows:

The Department of Energy, in partnership with our customers, is entrusted to contribute to the welfare of the Nation by providing the technical information and the scientific and educational foundation for the technology, policy, and institutional leadership necessary to achieve efficiency in energy use, diversity in energy sources, a more productive and competitive economy, improved environmental quality, and a secure national defense.

This general mission statement does not specifically address waste management. The waste management mission, as defined in a strategic planning review conducted by the DOE in 1994, is in OCRWM's mission statement and is as follows:

To manage and dispose of the Nation's spent nuclear fuel and high-level radioactive waste. We will provide leadership in developing and implementing strategies that assure public and worker health and safety, protect the environment, merit public confidence, and are economically viable.

More specifically, however, the purpose of the NWPA and its amendments, the DOE's implied mission is to "establish a schedule for the siting, construction, and operation of repositories that will provide a reasonable assurance that the public and the environment will be adequately protected from the hazards posed by high-level radioactive waste and such spent nuclear fuel as may be disposed of in a repository."

The DOE has historically viewed its responsibility to achieve dual Program objectives of equal rank as follows:

- To begin accepting waste in 1998 (build an MRS facility).
- To begin the permanent disposal of waste in a repository in 2010 (characterize and construct a repository).

It has been the pursuit of these ensuing Program objectives (as opposed to the more general mission statement or waste management mission statement) that have come under close scrutiny and criticism by many observers, and have created a problem with focus and funding for the DOE. Beginning in the early years of the Program through the early 1990s, the DOE was attempting to accomplish the "dual objectives of equal rank" without an effective, well-communicated strategic plan of action. This lapse of management attention led to cost overruns, schedule slippages, disproportionate funding allocations, lack of progress, and lack of overall control. Consequently, the DOE created the appearance of being out of balance not only with its waste management mission but the NWPA's implied mission, much to the discontent of utilities, Stakeholders, and other affected parties.

Assessment. The recent establishment of Program priorities and funding allocations now appear consistent with the waste management mission. Prior to the Program Approach and at the DOE's own admission, priorities and funding allocations were out of balance with the waste management mission. Under the Program Approach, site characterization activities, including key technical and scientific studies, are noted to be of primary focus and importance. The DOE is also trying to meet near-term objectives relating to waste acceptance by 1998. The question remains as to whether enough funds will be made available to investigate Yucca Mountain, meet appropriate short-term objectives of the Program, and ensure the long-term solvency of the Nuclear Waste Fund. But at least over the next five years, if the Program Approach is implemented as promised, there is an effort to monitor, allocate and expend funds in a logical manner. The DOE has initiated an effort to restructure, replan, and refocus its efforts to create confidence in the Program and potentially increase the efficiency with which it uses the funds allotted to the site investigation, as well as potentially minimize the duration and cost of the investigation.

Summary of Programmatic Funding Priorities

The establishment of effective programmatic funding priorities is critical to the success of the waste disposal Program. In this regard, Program elements need to be carefully managed in terms of time, money and resources, and in addition evaluated in the context of other Program elements. This requires effective communication among program managers, as well as the development of logistics and contingency plans to coordinate known activities and handle unforeseen events. Without such systems or plans in place, and communicated, the DOE runs the risk of spending money carelessly and for unwarranted expenditures. For example, by designing and developing casks without the benefit of thermal testing (or other key scientific and technical studies) or the determination of the form of storage, the DOE may create a situation of requiring significant and substantial change to the casks by the time they are actually required for use. A continued focus on the waste management mission, and on an effective "road map" established for accomplishing such a mission, is also important in a Program of this magnitude, complexity and visibility.

Options for Consideration

The Review Team's options for consideration regarding programmatic funding priorities are as follows:

- DOE should continue to resolve technical and operational concerns of the repository that directly relate to or affect the design and development of multipurpose casks. If a "robust" design can be accomplished and satisfy waste acceptance, the MPC program should continue. If a "robust" design cannot be accomplished, the MPC should be designed primarily for ultimate disposal at a repository. In the latter case, the associated cost and schedule of MPC development should follow the time frame established for permanent disposal at a repository.
- The DOE should consider the establishment of more effective integration strategies and activities among Program elements in order to increase awareness, communication, and overall management effectiveness.
- As alluded to in the Program Approach, the DOE should continue to search for, and ultimately identify, ways to streamline operations, specifically as related to infrastructure costs. The DOE must also maintain a focus on the mission, strategies, plans, etc., contained therein in order to increase its chance of effective implementation.

REVOLVING FUND

In the Revolving Fund category, three issues are to be analyzed:

- Benefits and Risks of Revolving Fund

What are the benefits and risks of DOE's proposal for the establishment of a revolving fund which would be used to fund part or all of the financial requirements of the Project? [NARUC D.3.1]

- Utilization of Additional Funds

Where would additional funds from the proposed revolving fund be spent? Can the Project absorb the increase in funding with a high degree of efficiency? [NARUC D.3.2]

- Stability of the Project Created by a Revolving Fund

Would establishment of a revolving fund lead to a greater stability of the Project from one Administration to another? [NARUC D.3.3]

Each of these three issue categories are discussed below and are followed by the Review Team's summary of findings relative to the Revolving Fund.

Benefits and Risks of Revolving Fund

The following scope of work item is addressed:

What are the benefits and risks of DOE's proposal for the establishment of a revolving fund which would be used to fund part or all of the financial requirements of the Project? [NARUC D.3.1]

Nuclear Waste Fund. To enable the Secretary to perform his/her functions under the Nuclear Waste Policy Act, a "separate fund" called the Nuclear Waste Fund (NWF) was established. The NWF, which is maintained in the Treasury of the United States, consists of (1) all receipts, proceeds and recoveries resulting from payments of fees to the Secretary pursuant to contracts with persons who generate or hold title to high-level radioactive waste, or spent nuclear fuel of domestic origin; (2) any Congressional appropriations made to the NWF; and (3) any unexpended balances for functions or activities necessary or incident to the disposal of civilian high-level radioactive waste or civilian spent nuclear fuel. Generally speaking, the NWF annually receives about \$600 million

from waste generation fee payments and earns between \$300 to \$400 million in interest through Fund investments. Additionally, the NWF received funds in the form of one-time fee payments from utilities. This source of funding continues to be received based on the longer term payment method selected by some of the utilities upon the enactment of the NWPA.

Under the NWPA, the Secretary may make expenditures from the NWF only for purposes of radioactive waste disposal activities including (1) the identification, development, licensing, construction, operation, decommissioning, maintenance and monitoring of any repository, monitored retrievable storage facility, or test and evaluation facility constructed; (2) the conducting of nongeneric research, development, and demonstration activities; (3) the administrative costs of the radioactive waste disposal program; (4) any costs incurred in connection with the transportation, treating, or packaging of nuclear spent fuel or high-level radioactive waste to be disposed of in a repository, monitored retrievable storage facility, or test and evaluation facility; (5) the costs associated with acquisition, design, modification, replacement, operation, and construction of facilities at a repository site, monitored retrievable storage site, or test and evaluation facility site; and (6) the provision of assistance to States, affected units of local government and Indian tribes.

Expenditures are subject to appropriations which may require reauthorization on a triennial basis but generally remain available until expended. To receive such appropriations, the Secretary is required to submit budget estimates of the NWF, along with the budget of the Department of Energy, to the Office of Management and Budget (OMB) which manages and administers the Budget of the United States government. Thus, money received from this separate fund known as the Nuclear Waste Fund, is in reality subject to budgetary constraints within the Department of Energy as well as any constraints in the overall Budget of the United States government. Further, the Secretary of the Treasury, who holds the Nuclear Waste Fund, annually reports to Congress regarding the financial condition and operations of the Fund during the previous fiscal year. The Secretary of Energy provides the necessary consultation and documentary support for the Secretary of Treasury's report to Congress.

Revolving Fund Proposal. As a means of avoiding competition with other DOE programs for funds and possibly providing increased funding to carry out his/her responsibilities, the Secretary of Energy has proposed legislation over the past several years that would establish a Nuclear Waste

Revolving Fund. In essence, the proposed revolving fund would move funding for the nuclear waste disposal program "off-budget" (i.e., removed from the Budget of the United States government and deficit reduction activities). This legislation was believed to result in "an appropriate level of funding for the disposal program."

In May 1993, the Secretary's proposal requested that the Office of Management and Budget approve the establishment of a separate account in the Treasury known as the Nuclear Waste Revolving Fund. This revolving fund was to be created in the beginning of fiscal year 1994 by crediting all income realized on the total face value amounts in the Nuclear Waste Fund to a separate account. Additionally, and on an ongoing basis beginning in fiscal year 1995, all fee generation revenues and income realized on these revenues was to be credited to the revolving fund account. The account was to be exclusively used by the Secretary for waste disposal activities and would not be subject to the appropriation process. Further, should balances in the revolving fund account be insufficient for purposes of carrying out waste disposal activities, the Secretary could draw upon the Nuclear Waste Fund by requesting an appropriation. A similarly structured fund was proposed in March 1994 for fiscal year 1995. (Refer to Section titled "Level of Funding" regarding 1995 budget request and funding proposal.)

The latest proposal for legislation to amend the NWPA and create a new funding approach for the disposal program was submitted by the Secretary in February 1995. It was noted by the Secretary that "this legislation is needed to enable the program to move forward on a timely schedule." As discussed in previous sections of the Review Team's report, funding shortfalls in the early years of the program created some scheduling challenges and has been noted as one of the reasons for limited progress in Program activities. The Secretary further indicated that "in order for the Nation to meet the challenge of creating a repository for nuclear waste within a reasonable period of time, an increase in funding is necessary. This legislation would provide a schedule of funding that would enable orderly progress toward that goal."

The newly proposed legislation is tied to the administration's goal of privatizing the United States Enrichment Corporation by fiscal year 1996. It is anticipated that the U.S. Enrichment Corporation will manage highly enriched and natural uranium for the Department of Energy. More specifically, the proposed legislation would provide that the net proceeds from the sale of U.S.

Enrichment Corporation stock be used by the Department of Energy for radioactive waste disposal activities during the years 1996 through 1998. In those years, such proceeds would be deposited in a special fund in the Treasury and made exclusively available to the waste disposal Program in amounts not to exceed \$432 million, \$540 million, and \$628 million, respectively. These funds would not be subject to the appropriation process and would be in excess of funds appropriated from the Nuclear Waste Fund.

Benefits of Proposed Revolving Fund. There are certainly obvious benefits to moving the Nuclear Waste Fund off-budget or creating some other new funding approach as proposed by the Secretary. One of the most obvious reasons is flexibility. Any of the approaches proposed by the Secretary over the past few years would provide additional flexibility for the Department of Energy's Program for the disposal of spent nuclear fuel and high level radioactive waste, and for other purposes. Although the funds would generically have to be used for waste disposal activities, they would not be subject to competition from other Department of Energy Programs or left to the discretion of the Secretary of Treasury. The Secretary of Energy would have the flexibility to use the funds when and where he/she desired within the confines of the Act and the definition of lawful expenditures.

Along with the idea of flexibility comes accessibility. By eliminating the competition and budgetary constraints associated with the Nuclear Waste Fund, additional funds would be available for carrying out the specific purpose of nuclear waste disposal activities. Additional funding may potentially enable the DOE to play "catch up" (due to the funding shortfalls experienced early in the Program) and also may potentially allow the Program to proceed more expeditiously in its site characterization activities. The benefits of being able to proceed in this manner may be viewed in two different ways. On one hand, an increased level of activity may allow the Program to enhance its schedule under the Program Approach; thereby potentially providing for more timely waste acceptance and ultimate disposal of wastes in the long-term. On the other hand, an increased level of site characterization activities may disclose disqualifying criteria sooner in the process versus later; thereby providing savings in future downstream costs. Unfortunately for the DOE, however, additional money does not always translate into a more efficient, cost-effective Program. Furthermore, there is currently no evidence that additional funding would help accelerate Project activities.

Risks of Proposed Revolving Fund. The major risk associated with the proposed revolving fund or any new funding approach can be summed up in one word; control (or the lack thereof). If the Department of Energy were ever able to get its proposed legislation enacted, many questions would arise regarding how the money would be utilized and who would monitor or oversee the efficient and effective use of funds. As proposed, the funding approaches would significantly reduce or virtually eliminate Congressional oversight and control. The ultimate control of funding flows would be out of the hands of the Secretary of Treasury, the Office of Management and Budget, and Congress (via appropriations), and in the hands of the Secretary of Energy and to some extent the current administration. As flexibility and accessibility of funds is increased, it would be imperative that the Secretary of Energy use the utmost discretion in monitoring Program expenditures in order to preserve the long-term financial health and integrity of the Program.

Additional major risks associated with the revolving fund or other new funding approaches would include a potential increase in the federal deficit resulting from the inability to utilize the Nuclear Waste Revolving Fund monies as a source for balancing the National Budget; and a potential financial debacle such as the Savings and Loan situation (i.e., excessive or inappropriate use of funds in early years to develop a system that has no financial support in the out years). These risks, however, are associated with significantly decreased governmental control, and may be minimized to some extent by incorporating some precautionary measures which include maintaining in place some form of monitoring by an objective, independent entity.

Utilization of Additional Funds

The following scope of work item is addressed:

Where would additional funds from the proposed revolving fund be spent? Can the Project absorb the increase in funding with a high degree of efficiency? [NARUC D.3.2]

Use of Additional Funds. As stated before, the primary use of additional funds is to move the schedule forward to attain the stated goals for waste acceptance and disposal. More specifically, this could mean that the Department of Energy would use the additional funds to perform additional scientific and technical activities associated with site characterization or other areas that received less than planned funds in the past. Given the difference between planned and budgeted activity in the

early years, the Department could potentially use the additional funds to perform any outstanding "make-up" work, as well as reserve excess funding in a given year to ensure that adequate funding is available for short-term future years planned levels of Program activity. Furthermore, the Department would be wise to allow additional funds in the short-term to accumulate and earn interest in order to support the more long-term life cycle costs associated with the Project. This could be critical, especially in light of recent articles published regarding the potential long-term funding shortfall and uncertainty regarding the long-term financial health of the Program/Project. (Refer to Section Six - Funding Impacts on Scheduling regarding more information on enhanced funding.)

Assessment. Given the Department of Energy's performance track record and certain criticisms regarding the effective and efficient use of funds to date, it is somewhat questionable how the Department would react to, in essence, a "blank check" from year to year. One would like to believe that this government agency, with the important task of disposing of the Nation's nuclear wastes, could do so in a responsible, efficient and effective manner. History tells us, however, that caution and prudence should be exercised. Hence, the jury may still be out as to whether the Department of Energy has or can prudently manage an increase in funding with a high degree of performance efficiency. Given the benefits of the proposed revolving fund, and the importance of the nuclear waste Program in general, it may be beneficial to either give the Department of Energy some level of additional funds on a trial basis, and/or pass legislation with the stipulation that some level of monitoring or oversight be put in place at least for a trial period. Other variations or hybrids of the proposed legislation could also be designed which would increase the benefits and reduce the associated risks.

Stability of the Project Created by a Revolving Fund

The following scope of work item is addressed:

Would establishment of a revolving fund lead to a greater stability of the Project from one Administration to another? [NARUC D.3.3]

Project Stabilities and Instabilities. Stability can be defined as the strength to endure or the firmness to maintain a desired condition. In this Program, stability or instability, for that matter, can be witnessed in many ways. For example, the fairly recent appointment of a permanent (versus acting) project manager was viewed by many as providing a sign of stability to the Yucca Mountain

Project. Others view certain Project successes as providing stability. The day the tunnel boring machine made its initial cut into the side of the mountain, for example, gave many a feeling of progress and, therefore, of stability and security. There have also been certain Project failures that have provided a feeling of instability as to the outcome of the Project and overall Program.

As changes in the administration take place, certain stability issues must be examined. Stability (or instability) associated with administration changes can be reflected in signs of commitment to the Program, through verbal communication, appointments of key, strong individuals to head a program, the degree of financial support and funding allocated to a particular program, and other stabilizing events. Stability in this sense can change dramatically from one administration to the next, to a new political party, and totally new players. It is, therefore, difficult to maintain a high degree of stability as a consequence of the changes identified. Furthermore, given the complex, controversial nature of the Nuclear Waste Disposal Program and the number and diversity of entities, groups and individuals involved, providing stability is, at best, difficult.

Assessment. Establishment of a revolving fund in and of itself would not lead to greater stability of the Project from one administration to another. Since there are so many other factors that affect stability in general, it is difficult to assess even the degree of stability that would be created by the establishment of a revolving fund. The revolving fund, in essence, would alleviate some of the political pressures associated with the expenditure of Nuclear Waste Fund monies. In this respect, the use of the fund for the disposal of nuclear waste would be at the discretion of the Secretary. The effective and efficient use of the fund, on the other hand, would be the responsibility of the Secretary of Energy under the proposed Nuclear Waste Revolving Fund scenario and would reflect the importance of the Program from administration to administration.

Summary of Revolving Fund

Given the history of funding shortfalls in this Program, the idea of a revolving fund sounds like a reasonable proposition for ensuring the appropriation of desired levels of funding. However, given the perception that the DOE has not historically spent funds effectively and efficiently, a problem is created in that this notion of a revolving fund would relinquish the control of an oversight body. A revolving fund clearly has both advantages and disadvantages that must be given serious consideration before a reasonable and well-informed decision can be made.

Options for Consideration

The Review Team's options for consideration with respect to the revolving fund are as follows:

- Congress must decide/determine whether benefits outweigh the risks (or vice versa) relative to the revolving fund proposal. The approval/disapproval process must also consider other Program recommendations in conjunction with the revolving fund proposal.
- While it is not certain that a revolving fund in and of itself would provide needed stability to this Program, it is in the best interest of Congress to consider the revolving fund and any and all recommendations or proposals affecting the stability of the Program.

TOTAL SYSTEM LIFE CYCLE COST ANALYSIS

Of great importance to the success of the Nuclear Waste Disposal Program, is the ability to pay for its total system life cycle costs. Based on the analysis described in the following pages, the Review Team has found that under any reasonable combination of cost and funding scenarios, the Nuclear Waste Fund is inadequate as currently defined, i.e., an ongoing constant fee of one mill per kilowatt hour to support the Program. As such, and in order to avoid a potential financial debacle, the DOE must address, confront, and resolve this issue with great attention and vigor. Serious consideration should be given to various recommendations provided by many involving this issue, including the Review Team, the General Accounting Office, Planning Information Corporation, and other agencies, organizations, and Stakeholders.

In the Total System Life Cycle Cost Analysis category, two issues are to be analyzed:

- Total System Life Cycle Cost Analysis

Provide a total system life cycle cost analysis of the overall mission and Program that identifies the costs of the functional elements of the Program (including actual expenses incurred through fiscal year 1994, or through fiscal year 1993 if 1994 data is not available, and the additional costs necessary to complete characterization of the Yucca Mountain site, as described in Section 113(c) of the NWPA under the current Program plan and any proposed Program plan currently being considered by DOE) and the funding levels needed in the Nuclear Waste Fund to pay for a repository through the time it has reached closure under the current Program plan and proposed Program plans currently being considered by DOE? [NARUC D.1.1]

- Fee Adequacy Analysis

Does the total system life cycle cost analysis provide data precise enough to insure the integrity of the Nuclear Waste Fund and the adequacy of the fees charged through utilities to their customers? [NARUC D.1.2]

Each of these two issue categories are discussed below and are followed by the Review Team's summary of findings relative to Total System Life Cycle Cost Analysis.

Total System Life Cycle Cost Analysis

The following scope of work item is addressed:

Provide a total system life cycle cost analysis of the overall mission and Program that identifies the costs of the functional elements of the Program (including actual expenses incurred through fiscal year 1994, or through fiscal year 1993 if 1994 data is not available, and the additional costs necessary to complete characterization of the Yucca Mountain site, as described in Section 113(c) of the NWPA under the current Program plan and any proposed Program plan currently being considered by DOE) and the funding levels needed in the Nuclear Waste Fund to pay for a repository through the time it has reached closure under the current Program plan and proposed Program plans currently being considered by DOE? [NARUC D.1.1]

Definition of Total System Life Cycle Cost Analysis. In general terms, life cycle cost can be defined as "the cost to buy, operate, maintain, and dispose of equipment." The Federal Acquisition Regulation at 7.101 describes life cycle cost as "the total cost to the Government of acquiring, operating, supporting, and (if applicable) disposing of the items being acquired." Yet another source indicates the following: "The life cycle costing methodology takes into account the sum total of the direct, indirect, recurring, nonrecurring and other related costs incurred, or estimated to be incurred, in the design, development, production, operation, maintenance and support of a major system over its anticipated useful life span."

Given the above definitions, the two most important components of a life cycle cost analysis are the total costs and the useful life period. Assumptions and/or applications concerning these two important components can have a major impact on the analysis. A program with many uncertainties affecting the estimate of total costs, the unpredictability of its useful life, and other complexities and uncertainties of related key elements (such being the case with the Nuclear Waste Disposal Program

and Yucca Mountain Project) can be very difficult to analyze from a total life cycle cost standpoint with any reasonable degree of certainty. Dan Dreyfus, Program Director, may have said it best when he characterized the total system life cycle cost (TSLCC) analysis in the following manner: "Deciding how much this program is going to cost over the next 100 years is a game in metaphysics." Thus, it is important to recognize the potential shortcomings of such an analysis as related to a Program of great magnitude, complexity, and ever changing performance criteria.

History of DOE's Total System Life Cycle Cost Analysis. Under the NWPA, the Secretary is required to annually evaluate whether the fees collected in the Nuclear Waste Fund will provide sufficient revenues to offset the life cycle costs of the Nuclear Waste Disposal Program. Per Sec. 302 (a)(4), "In the event the Secretary determines that either insufficient or excess revenues are being collected, in order to recover the costs incurred by the Federal Government (for radioactive disposal waste activities),...the Secretary shall propose an adjustment to the fee to ensure full cost recovery." The total system life cycle cost analysis, in essence, is one of three analyses that must be performed in order to evaluate the adequacy of fees charged to utilities and funding levels required to be maintained in the Nuclear Waste Fund to pay for the Program. In addition to estimating total system life cycle costs, an analysis of future revenue projections based on nuclear power plant capacity or nuclear waste estimates, and a fee adequacy assessment comparing costs to revenues over time must be performed. The latter analysis would ultimately allow the DOE to make conclusions regarding potential shortfalls or excesses in funding. Further, such analysis would enable the DOE to assess the fee adjustment required to avoid any shortfalls in the future, thereby ensuring full cost recovery.

Since the Program's inception, the DOE has not proposed a change in the fee structure described above. In fact, the DOE's most recently published fee adequacy assessment dated November 1990 concluded that the Nuclear Waste Fund would have a positive balance of \$3 billion assuming a single repository, 4 percent inflation and 3 percent real interest rates ("the base case"). The DOE is expecting to publish a 1995 fee adequacy assessment based on its 1995 TSLCC analysis, currently in draft form, and anticipated revenue streams. The Preliminary Draft of the TSLCC analysis, dated April 10, 1995, (received by the Review Team during the public hearings in June) estimates the total costs of a single repository system at \$34.6 billion (in 1994 dollars). A second repository was not considered in their analysis. Dan Dreyfus has suggested that, "at this time, there

is nothing in the preliminary TSLCC numbers to indicate that we cannot finance the program with rational fee collections not out of line with what the utilities pay now."

Prior to 1995, the DOE had not published a total system life cycle cost analysis since December 1990. Total system costs at that time were estimated to range from \$25.6 billion (in 1988 dollars) for a one repository system to \$33.6 billion (in 1988 dollars) for a two repository system. These costs were significantly increased from the original estimate of \$14.8 billion (in 1982 dollars) contemplated at the Program's inception for the construction and operation of two repositories. Likewise the 1995 TSLCC estimate, which is representative of new Program developments and assumptions, is a substantial increase from the 1990 estimate.

Since the DOE has not published a total system life cycle cost analysis since 1990, it is difficult to pinpoint exactly how total costs have changed over the last five years. Changes to certain Program elements and assumptions have caused increases to total costs, while changes to other elements have caused decreases. For example, the inclusion of a major MPC development program, with hopes of providing waste acceptance by 1998, has created an overall increase to the Program while the exclusion of an MRS facility has caused a slight decrease. DOE personnel informed the Review Team that total cost analyses have been performed informally every year since 1990; however, the results have not been published. Specific reasons for not publishing the analyses (and/or performing it informally) were not disclosed. General reasons may include the exorbitant cost of performing the more comprehensive analysis, its perceived importance in relation to other Program issues, a reluctance to face the potential implications of the results, a perception that results have not changed significantly, and the degree of analysis deemed necessary due to major Program changes (or nonchanges). It would appear, for instance, that the level of analysis performed during the last five years does not appear to be on the same level or as comprehensive as the 1989, 1990 or draft 1995 analyses. Furthermore, a briefing on the total system life cycle cost estimate dated May 11, 1994, updated the 1990 summary estimates to 1993 dollars in order to arrive at a range of \$29 billion for a one-repository system to \$39 billion for a two-repository system. The underlying detailed calculations and assumptions which reflect the most current Program strategy, plans, and policies do not appear to have been incorporated. Had the DOE performed the more comprehensive analyses each year, as required by law, it would be easier to anticipate and understand significant increases or decreases to the Program/Project. Furthermore, the DOE could potentially utilize the

TSLCC analysis in conjunction with other analyses (i.e., cost-driver study, independent cost estimates, etc.) as a management tool for annual budgeting and long-term financing.

The cost and time to perform a comprehensive total life cycle system cost analysis, similar to the analysis of 1989, is extensive and expensive. The concept of estimating a multitude of cost accounts and work breakdown structure (WBS) elements for necessary planned activities over the useful life of this Program is challenging and formidable. Further, modeling, extrapolating, and interpolating costs to incorporate Program milestones, the most current plans and strategies, work scopes, integral Program details, the time value of money, etc., is no simple task. In fact, the process as generically described above, can take up to a year to complete and cost in excess of \$1 million as indicated by the fees paid to Roy F. Weston, Inc., which is under contract to prepare the annual total system life cycle cost estimates under DOE's direction and guidance.

Given the aforementioned, the DOE's desire to perform an update of prior analyses for current year dollars rather than performing the more comprehensive analysis is understandable. The Review Team submits, however, that because of the critical importance of the total cost figure and subsequently, the fee adequacy analysis, a comprehensive analysis should be performed and published every year. Further, not to do so would appear to be in violation of the NWPA. Significant changes in the Program over the last several years, may in fact be the impetus behind DOE's commitment to perform the 1995 total system life cycle cost analysis. The results of this analysis should be interesting not only to the DOE but to Stakeholders, contractors, managers, and all other interested parties. The analyses will provide insight into potential impacts on the Program as a whole and more specifically, its financial viability.

Approach. Despite the difficulties and challenges alluded to above (i.e., Program uncertainties, numerous variables, useful life span unpredictabilities and other complexities), the Review Team has provided an updated total system life cycle cost analysis based on current available and useful information. Due to time and budget constraints associated with our review, the Review Team did not independently validate the information relied upon. For the same reasons, the Review Team, also, did not attempt to perform a total system life cycle cost analysis in the comprehensive manner described previously. As alluded to above, to do such a comprehensive analysis would require a budget in excess of the one provided to perform the entire Independent Management and

Financial Review and the associated work scope requested by NARUC. The TSLCC analysis, however, is just one of the many work scope items requested to be reviewed. Further, since the DOE is in the process of and is in a better position to provide a comprehensive 1995 total system life cycle cost analysis, the Review Team's work product was somewhat abbreviated.

Nevertheless, the analysis performed should provide some degree of reasonableness as well as a basis for the recommendations which follow. The basic approach utilized includes a recapitulation of actual Program expenses from 1983 to 1994, and the Review Team's estimate of costs to the year 2000 based on the new Program Approach. Furthermore, a projection of costs through the end of the Program were projected by the Review Team based on a combination of sources including the updated 1990 TSLCC analysis, the draft 1995 TSLCC assumptions package, the 1995 Preliminary Draft TSLCC Analysis, and the Program Approach were included in the analysis.

Methodology. Utilizing both the 1990 and 1995 TSLCC Analyses as sources, the Review Team estimated total life cycle costs in 1995 dollars for two scenarios based on the number of repositories. The number of repositories can be represented as one or two repositories. The Review Team includes the second repository as it is still possible that a single repository will be insufficient to store all wastes. The quantity of spent fuel requiring disposal was assumed to be based on the discharge projection of currently operating nuclear plants (i.e., the "no new orders" case regarding the construction and operation of nuclear power plants). Variations on scenarios one and two, "one-repository, no new orders" and "two repositories, no new orders," respectively, were also reviewed in order to examine the impact of three- and five-year time delays on the life cycle costs of the Program.

Assumptions. Under the one repository scenario, the repository was assumed to begin operations (i.e., accepting waste) in 2010, with final closure in 2075. Under the two repository scenario, the first repository would begin accepting waste in 2010, with final closure in 2073. The second repository would begin accepting waste in 2039, with final closure in 2094. All scenarios include a repository in tuff (first repository), a generic geologic medium repository (second repository), intact disposal of spent fuel, and interim storage, transportation and disposal of multipurpose canisters containing waste. More detailed assumptions are generally in accordance with

the DOE's assumptions in its 1995 analysis and would entail the non-existence of an MRS facility, a 50-year retrievability period, civilian versus defense percentages ranging from 70 percent to 100 percent depending on the cost category, etc.

Calculations. Similar to the structure provided in previous TSLCC analyses, the Review Team estimated total costs per the following cost categories:

- Development and Evaluation,
- Transportation,
- First Repository,
- Second Repository,
- Waste Acceptance and Multipurpose Canisters, and
- Benefit and Payments-Equal-to-Taxes (PETT).

As defined by the DOE, "the development and cost category covers all the siting, preliminary design development, testing, regulatory, and institutional activities associated with the repositories, waste acceptance, storage, and the transportation system." As such, the Review Team calculated actual Program costs incurred for each year from the beginning of the Program through December 1994, and considered all such costs as 100 percent development and evaluation. For purposes of this analysis, all costs are represented in 1995 dollars. For the period 1995 to 2000, Program estimates, again assumed to represent development and evaluation costs, were obtained from the Program Approach. Development and evaluation costs from the year 2001 forward were projected based on the 1990 and 1995 TSLCC analyses and converted to 1995 dollars.

Per the DOE, "the transportation category covers the capital costs of purchasing the transportation casks and the operating costs of accepting the waste and providing all the transportation services needed to support the DOE's waste management system." For purposes of this analysis, transportation costs identified prior to the year 2001 were assumed to be development costs and therefore, are reflected in the development and evaluation costs. For the years following and including 2001, transportation costs are represented in 1995 dollars based on projections included in the 1990 and 1995 TSLCC analyses.

"The repository cost component covers the engineering, construction, operation, and closure and decommissioning costs for the repositories" as defined by the DOE. Further, repository engineering costs cover various design costs including preparation of the license application design, final procurement and construction design, and the Title III design. All other design-related work was concluded to be preliminary and therefore, included in the development and evaluation costs. The repository construction costs include site preparation, the construction of surface facilities, and excavation activities, as well as general outfitting, installation and functional testing. Per the DOE, "construction costs are incurred until all repository facilities are in operation. Operating costs include all staffing, maintenance, supplies (including waste packages), and utilities during the emplacement and caretaker phases." Finally, repository closure and decommissioning costs may include the backfilling and permanent sealing of the underground repository and decommissioning of the surface facilities. To the extent incurred, first and second repository costs are assumed to be included in development and evaluation costs for the years 1983 to 2000. First and second repository cost projections for the year 2001 forward were obtained from the 1990 and 1995 TSLCC cost estimates and updated for 1995 dollars.

According to the DOE, "the operational phase of the Waste Acceptance element provides the interface between the Civilian Radioactive Waste Management System and the Purchasers and Producers to take title and physical possession of the waste." It includes both civilian and defense-related activities and encompasses the necessary support facilities and operations. "MPC operations cost elements include the acquisition of MPCs, delivery of MPCs to utility sites, welding equipment used to seal MPCs and on-site transfer equipment. . . ." Waste acceptance and MPC development costs are reflected in the development and evaluation cost category. The Review Team assumed that operational costs related to Waste Acceptance and MPCs would begin in 1998 and end in 2042. These costs were projected based on estimates provided in the 1990 and 1995 TSLCC analyses.

Based on agreements that can potentially be made between the Secretary of Energy and the State of Nevada, another state or an Indian Tribe, benefits could be paid to said parties for consideration of a repository or an MRS facility to be located within their territory. Regarding repositories, annual benefit payments would be \$10 million upon execution of a benefits agreement, and remain at that level until the start of waste acceptance at the repository. The annual payment would increase to \$20 million at the start of acceptance, and remain at that level until closure and

decommissioning are complete. A similar payment, known as PETT, has also been established by the NWPA of 1987. These payments are intended to reflect an amount equivalent to the amount a state or affected unit of government would receive if authorized to tax site characterization activities. Based on the above stipulations, and the 1990 and 1995 TSLCC analyses, the Review Team estimated Benefit and PETT payments, as appropriate, in 1995 dollars.

Results. The results of the above analysis for the two scenarios described previously are as follows:

Review Team's
Summary of Total System Life Cycle Cost Estimates
(Millions of 1995 Dollars)

Cost Category:	Scenario 1: Single Repository No New Orders	Scenario 2: Two Repositories No New Orders
Development & Evaluation	\$ 13,243	\$ 17,087
Transportation	2,430	2,414
First Repository	12,286	9,814
Second Repository	NA	9,336
Waste Acceptance & MPCs	6,854	6,854
Benefit & PETT Payments	710	1,401
Total System Costs	\$ 35,523	\$ 46,906

(See Appendix for Summary Calculations.)

The following considerations should be noted with respect to the cost estimates provided above. These considerations were generally noted by the DOE in their 1990 analysis, but excluded from the draft 1995 analysis, as a second repository is not considered. The difference between the single repository and two repository systems is approximately \$11 billion. The majority of this difference is associated with an increase in total repository cost, and development and evaluation cost. Total repository cost for the single repository system is \$12.3 billion while total repository cost for the two repository system is \$19.1 billion. One might expect, however, that total repository cost

with a two repository system would at least double the \$12.3 billion repository cost under the single repository system. This may not be the case for several reasons: (1) The cost of the first repository in a two-repository system is reduced due to the fact that its capacity requirements and operating period are lessened when a second repository is introduced; and (2) The second repository is of a much smaller capacity than the first repository. Under Scenario 2, the cost of the second repository, although smaller in size, is nearly identical in cost. The DOE would anticipate more expensive construction costs in handling a more difficult geologic formation (as compared to tuff) for the second repository.

One might also expect development and evaluation costs to double. However, lessons learned in the development of the first repository are assumed to be applied in the development of a similar, yet smaller, second repository. Irrespective of this process learning curve, there is a risk that the geologic conditions at the second location may require more extensive development and evaluation than represented. The time value of money is another factor that must be considered when evaluating these cost estimates. For example, the fact that the second repository is evaluated, developed, sited, and constructed in later years, has a decreasing effect on its costs as compared to the more contemporaneous costs of the first repository.

It is important to note that the "upper reference" case, which appeared in prior DOE TSLCC analyses, was not reviewed by the DOE in its 1995 draft TSLCC analysis, nor by the Review Team in its final analysis. The upper reference case which traditionally reflects the construction and operation of new nuclear power plants, and hence, generation of additional waste, was not deemed to be a likely scenario by the Review Team.

Variations. The cost estimates provided in the preceding table reflect a Program that is on-time and on-budget. As has been the history with this Program, however, schedule slippages and year-to-year funding shortfalls have been common events. The Review Team recognizes that the scenarios presented are most likely to be considered as best case scenarios, since they do not reflect any schedule or budgetary limitations. To reflect the impact on costs of time delay (caused by schedule slippages and/or budget constraints), the Review Team examined the impact on total system costs of a three-year and a five-year delay to the repository start date (originally estimated to occur in the year 2010). This examination was performed only for the "no new orders" cases, as they

appear more reasonable at this time in terms of their discharge projections. The results indicate that a three-year slip to the repository start date creates a \$1.9 billion increase in total costs to \$37.4 billion for the one repository case, and a \$1.9 billion increase in total costs to \$48.8 billion for the two repository case. Likewise, a five-year slip results in a total cost of \$38.6 billion, or an increase of \$3.1 billion from the original estimate for the one repository case, and a total cost of \$50.1 billion, or an increase of \$3.2 billion from the original estimate for the two repository case. (See Appendix)

Based on a review of the 1995 TSLCC Assumptions Package and general knowledge obtained throughout its work, the Review Team also recognizes that other factors may affect the total system life cycle estimate. For example, continued development of the transportation system, including the development of multipurpose casks, has resulted in increases to the capital cost and number of casks required. This development has undoubtedly had an impact on total system costs. There could also be an increase to total system costs if some type of benefit payment to utilities for providing on-site interim storage (in the absence and as an alternative to an interim storage facility) were enacted. In sum, there are a multitude of factors that could have an effect on the total system costs including, but not limited to the following:

- Period of life cycle (Program length)
- Program uncertainties (delays, changes)
- Funding allocations/priorities
- Repository number and capacity
- Nuclear power plant lives
- Fuel storage requirements
- Interim storage alternatives
- Expanded ESF
- MRS facility existence
- MPC development
- Thermal loading

- Transportation issues
- Waste acceptance determination
- Geologic findings
- Infrastructure costs
- Contingency allowances
- Capital asset disposition
- Politics, legislation, and other mandates

The Review Team has performed its analysis with many of these considerations in mind both individually and collectively. The impact of some of these factors remains unknown as only pure speculation at this time would allow one to analyze its individual and collective effect.

Depending on one's posture, however, changes to one or many of these assumptions can have an impact on the results of the TSLCC as well as the fee adequacy assessment. In essence, the TSLCC analysis can be viewed as a political document driven by the positions taken with regard to those assumptions. For example, a proponent of the Nuclear Waste Disposal Program might assume only one repository will be necessary (despite capacity and thermal loading constraints which suggest the potential need of a second repository), interim storage can be achieved at on-site reactors at the utilities' cost (versus some form of interim storage at the DOE's cost), a 50-year retrievability period (versus a 100-year period), and an on-time, on-budget Program (versus a delayed program). An opponent of the Program could assume the opposite of the above assumptions, thereby resulting in a divergent opinion regarding the total cost of the Program. The Review Team has attempted to provide an objective analysis with many of these considerations in mind, while at the same time providing a balance between such divergent opinions.

Revenue Projections. As mentioned previously, one must perform a second analysis before fee adequacy can be fully assessed. This second analysis would involve a projection of expected revenues from relevant sources that can then be matched to the total life cycle cost estimates on a cumulative, year-to-year basis to assess fee adequacy. In the case of the Nuclear Waste Disposal Program, the source of revenue which supports the total system costs is a fee of 1.0 mill per

kilowatt-hour of utilities generated nuclear power to fund the permanent disposal of their spent nuclear fuel. These revenues are maintained in the Nuclear Waste Fund in accordance with the Nuclear Waste Policy Act. Other revenue sources which may support the costs of the Program include one-time fee payments also imposed on and collected from utilities generating nuclear power, and the DOE itself which is responsible for paying its fair share of costs to permanently dispose of high-level radioactive waste generated by weapons production facilities. There are also a host of other possible sources that have been proposed by the DOE in recent years in order to provide additional revenue. For purposes of this analysis, the Review Team focuses on the revenue generated by the 1.0 mill per kilowatt-hour fee. One-time fee payments made by utilities through 1985 are included in the Review Team's fee adequacy analysis.

Nuclear power plant capacity and the actual production of electricity generated are the driving forces behind the revenue projected from the 1.0 mill per kilowatt-hour fee. Total capacity and actual production can be dependent on a number of factors including the number of operating and/or planned nuclear power plants, scheduled plant startup dates, scheduled plant decommissioning dates, plant efficiency, plant productivity, and unforeseen events, such as explosions, radioactive leaks, unscheduled maintenance repairs, outages, delayed startup dates, and premature decommissioning dates. While some of these factors can reasonably be reflected in an analysis of fee generation (revenue projection), others are much more difficult to reflect with any degree of certainty. As such, the Review Team focused on the more tangible factors to calculate its projection of revenues.

Based on several sources of information including Nuclear News, Spent Fuel Storage Requirements Reports, the Energy Information Administration (EIA) Monthly Energy Reviews, and others, the Review Team projected total plant capacity for currently operating nuclear power plants from 1983 to the end of the last plant's anticipated life. This provided a "base case" for revenue projection as total capacity was converted to actual electricity generation and multiplied by the 1.0 mill per kilowatt-hour fee. For the years 1983 to 1994, electricity generation was based on actual output published by the EIA. For the remaining years (1995 forward), electricity generation was based on total plant capacity projections. Annual kilowatt-hour fees were initially calculated in "year-of-fee" dollars and then converted to 1995 dollars. Results for the base case indicate that approximately \$20.1 billion dollars in fees has and/or will be generated by operating nuclear power

plants (without the effects of inflation) for the period 1983 to 2035. Adjusted to 1995 dollars, total fee generation for the same period would be \$16.2 billion.

Variations. Similar to variations on the total system cost analysis, the Review Team also examined variations in revenue projections. These variations were based on less optimistic assumptions regarding plant capacity. Under the less optimistic variations, it was assumed that total plant capacity would be affected by a premature decommissioning of plants. To reflect premature decommissioning, the Review Team arbitrarily determined that electricity generation would be reduced by 5 percent (less optimistic variation) and 10 percent (pessimistic variation), respectively, beginning in the year 2010. Results for the less optimistic variation indicate generated fees in the amount of \$19.7 billion in "year-of-fee" dollars and \$16.0 billion in 1995 dollars. The pessimistic variation results in revenues of \$19.3 billion in "year-of-fee" dollars and \$15.8 billion in 1995 dollars.

Assessment/Analysis. Based on the results of both the total system life cycle cost analysis and the revenue projection analysis (as well as their respective variations), it would appear that the funding levels needed to pay for the Program will not be sufficiently met by the current projections of revenue generation. The following section takes a more in-depth look at this potentially problematic situation.

Fee Adequacy Analysis

The following scope of work item is addressed:

Does the total system life cycle cost analysis provide data precise enough to insure the integrity of the Nuclear Waste Fund and the adequacy of the fees charged through utilities to their customers? [NARUC D.1.2]

History of Fee Adequacy Analysis. The DOE's last published assessment of the Nuclear Waste Fund Fee Adequacy was performed in December 1990 in conjunction with the updated TSLCC analysis of same date. Prior to 1990, five fee adequacy reports had been published. Since 1990, the Review Team identified a document dated May 11, 1994, entitled, "Total System Life Cycle Cost Estimate and Fee Adequacy Analysis" which basically reiterated the results of the 1990 Fee Adequacy analysis. DOE's 1990 Fee Adequacy publication addressed the continuing adequacy

of the \$1.0 mill per kilowatt-hour to support the civilian portion of the Program's costs. The report examined results of the DOE's analysis for "a variety of scenarios involving construction of either one or two repositories; 2, 3, 4, and 5 percent inflation rate projections; and 1, 2, 3, and 4 percent real interest rates." All scenarios were based on the assumption of the EIA "no new orders spent fuel projections." The following results were published by the DOE in 1990:

DOE's 1990 Analysis of
Projected End-of-Program Nuclear Waste Fund Balance, Civilian Portion
with Ongoing Fee Constant at 1.0 mill/Kwh
(Billions of 1988 Dollars)

Single Repository	Annual Rate of Inflation			
Percent Real Interest	2%	3%	4%	5%
1%	-3	-6	-8	-10
2%	4	-2	-7	-11
3%	23	12	3	-5
4%	74	52	34	19
Two-Repository				
Percent Real Interest	2%	3%	4%	5%
1%	-13	-17	-20	-22
2%	-11	-20	-26	-32
3%	13	-7	-23	-36
4%	111	65	28	-4

Based on these results, and specifically the base case (single repository system assuming 4 percent inflation and 3 percent real interest rates) which had a projected end of Program Nuclear Waste Fund balance of \$3 billion, the DOE did not recommend a fee adjustment at that time. The DOE is planning to release a fee adequacy assessment in the near future based on the finalized 1995 TSLCC estimate. It has been noted that they do not anticipate a long-term financing problem. However, a formal statement regarding the adequacy of the fee itself has not been made to date.

Approach/Methodology. The Review Team analyzed fee adequacy based on a cumulative comparison of the civilian portion of total system costs and revenue projections discussed earlier in this section. The fee adequacy analysis was performed from the year ended 1994 to the appropriate end-of-program date depending on assumptions regarding the number of repositories, and is reflected in 1995 dollars. The NWF beginning balance was assumed to be \$4.6 billion which would include fees generated by the one mill per kilowatt-hour rate, one-time fee payments, interest, and expenses through 1994. The analysis from year-end 1994 forward basically projects the cash flow of the Nuclear Waste Fund, including the calculation of interest at real rates, over the remaining life of the Program. Interest payments on funding shortfalls are not included in this analysis. Further deferred one-time fee payments are not included due to the uncertainty of their collectability as reported by the Office of Inspector General.

Assumptions. The Review Team performed fee adequacy analyses for the time delayed cost variations (i.e., 3 to 5 year slippage in the repository start date) and the fee generation variations (less optimistic and pessimistic plant capacity) presented earlier. For these fee adequacy scenarios, inflation was assumed to be 4 percent while real interest was assumed to be 3 percent. Furthermore, for comparative purposes to DOE's 1990 Fee Adequacy analysis, the Review Team examined fee adequacy for the base case cost scenarios (i.e., Scenario 1—Single repository, no new orders and Scenario 2—Two repositories, no new orders) and the base case fee generation (i.e., currently operating plants) with changes in inflation rates (2 percent to 5 percent) and real interest rates (1 percent to 4 percent).

Highlights. The fee adequacy analysis performed by the Review Team indicates that under any combination of reasonable cost and funding scenarios, the current fee of one mill per kilowatt-hour is inadequate to support the civilian portion of the total system life cycle costs of the Program. More specifically, the Review Team notes that the end-of-program fund balance for its "reasonable scenario" is a shortfall of \$4 billion. The reasonable scenario assumes a repository start date of 2013, which is likely given the history of delays in the Program, and a 5 percent nuclear power plant capacity reduction beginning in 2010, which is intended to represent premature decommissioning and the general uncertainty of the nuclear power industry.

The Review Team's optimistic scenario reflects an on-time repository start-up of 2010 and fee generation based on the capacities of currently operating nuclear plants as projected by the industry. This scenario indicates the Nuclear Waste Fund is underfunded by \$3 billion. Lastly, a pessimistic scenario, representing a five-year slip of the repository start date and a 10 percent reduction in nuclear power plant capacity results in an \$5 billion end-of-program balance shortfall. It is important to note that each of the scenarios described above assumes a one-repository system, a four percent inflation rate, and a three percent real interest rate.

Results. The results of the Review Team's fee adequacy analyses are as follows:

For the cost and revenue variations previously described, the following summary table is provided. For purposes of this particular analysis, inflation was assumed at 4 percent and real interest at 3 percent. The results of the fee adequacy analysis were, for the most part, insensitive to revenue variations projected by the Review Team. More specifically, projected end-of-program balances were impacted by approximately \$100 million on either side of the less optimistic variation shown below. Detailed results for each cost and revenue variation are presented in the Appendix.

Review Team's Analysis of
 Projected End-of-Program Nuclear Waste Fund Balance, Civilian Portion
 with Ongoing Fee Constant at 1.0 mill/Kwh
 (Billions of 1995 Dollars)

Single Repository	
Cost variation	Less optimistic case
Base case	-3
3 year slip	-4
5 year slip	-5
Two Repository	
Cost Variation	Less optimistic
Base case	-12
3 year slip	-13
5 year slip	-14

(See Appendix for Summary Calculations.)

For Scenario 1 and Scenario 2 "base cases" with changes to inflation and real interest rates, the following summary table is provided. (Note: These results are provided as a comparison to the DOE's results on page VII-48.)

Review Team's Analysis of
 Projected End-of-Program Nuclear Waste Fund Balance, Civilian Portion
 with Ongoing Fee Constant at 1.0 mill/Kwh
 (Billions of 1995 Dollars)

Single Repository	Annual Rate of Inflation			
Percent Real Interest	2%	3%	4%	5%
1%	-6	-8	-9	-9
2%	-4	-5	-6	-8
3%	6	-5	-3	-4
4%	44	32	21	12
Two Repository				
Percent Real Interest	2%	3%	4%	5%
1%	-15	-16	-17	-18
2%	-12	-14	-15	-16
3%	-9	-11	-12	-13
4%	10	-4	-7	-9

(See Appendix for Summary Calculations.)

Assessment/Analysis. As mentioned earlier, it is apparent from the fee adequacy analysis that the current fee of one mill per kilowatt-hour is, for the most part, inadequate to support the civilian portion of the total Program costs. Given such a concern, the DOE is advised to not only reassess the fee, but also the financial stability and viability of the Program as a whole. In doing so, it must consider its options and the impact that these options or decisions thereof may have on a number of agencies, organizations, Stakeholders, and individuals.

Summary of Total System Life Cycle Cost Analysis

Given the multitude of factors affecting the total system life cycle cost and to a lesser extent, the fee generation, it is very difficult to insure the integrity of the Nuclear Waste Fund and determine the adequacy of fees with absolute certainty. Performing these analyses is not only a "game of metaphysics" but also an exercise in political posturing. The DOE appears to have a system in place for estimating total system life cycle costs with some degree of reasonableness (i.e., incorporates the best available information) but until recently has failed to utilize this resource on a comprehensive basis since 1990. Furthermore, the analysis can only be viewed to be as reasonable as the assumptions which support it. Given the significant changes in plans, events and activities since 1990, it will be most informative to review the results of the soon to be completed 1995 TSLCC analysis and examination of fee adequacy performed by the DOE. As the Review Team and others have shown, there appears to be a problem regarding the financial viability of the Program. This issue must be vigorously addressed, confronted, openly reviewed, and resolved.

Options for Consideration

The Review Team's options for consideration regarding total system life cycle costs and fee adequacy are as follows:

- With Program and Project uncertainties, and the multitude of variables and factors affecting the analysis, the TSLCC is nothing more than a best guess estimate (i.e., "a moving target"). As a "moving target," it is extremely important for the DOE to comprehensively analyze these costs on a regular basis in order to reflect the best available information and most current plans, events, and activities. The TSLCC analysis should be performed, updated and published every year as required (or on some agreed-upon consistent basis) since it provides meaningful information and gives those involved and affected some indication of the change in total cost over time and, most importantly, the potential affects on the NWF. Furthermore, it should be openly reviewed and challenged by proponents and opponents alike. As a result, the DOE will reduce the chance of being surprised by any significant fluctuations in its estimates of total system costs and be forced to reconcile its assumptions. Insuring the integrity of the Nuclear Waste Fund and assessing fee adequacy is difficult enough given the nature and unpredictability of the TSLCC analysis. The DOE should provide more timely and open comprehensive estimates to avoid compounding the problem.
- Should the results of the DOE's 1995 TSLCC analysis (and fee adequacy) indicate a lack of funds (as others have already found), serious consideration should be given to various recommendations provided by many including this Review Team, the General Accounting

Office, Planning Information Corporation and other agencies, organizations and Stakeholders. General options for consideration of the Review Team include:

- Continue to seek additional funding sources and propose alternative funding mechanisms that may ultimately provide additional monies to the Nuclear Waste Fund.
- Consider ways to reduce the total system costs of the Program without jeopardizing its mission and objectives. While this is notably a formidable task for such a Program, cost reduction efforts should be constantly examined and implemented.
- Index the fee for inflation in order to minimize the potential shortfalls created by inflation swings.
- Potentially increase the fee possibly via step adjustments.