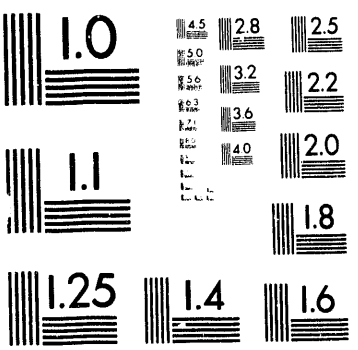
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NWPO-TR-019-92

REVIEW AND CRITIQUE OF THE U.S. DEPARTMENT OF ENERGY ENVIRONMENTAL PROGRAM PLAN FOR SITE CHARACTERIZATION FOR A HIGH-LEVEL WASTE REPOSITORY AT YUCCA MOUNTAIN, NEVADA

State of Nevada
Agency for Nuclear Projects/
Nuclear Waste Project Office
Carson City, Nevada

1992

DISCLAIMER

The Nevada Agency for Nuclear Projects/Nuclear Waste Project Office (NWPO) was created by the Nevada Legislature to oversee federal high-level nuclear waste activities in the State. Since 1985, it has dealt largely with the U.S. Department of Energy's (DOE) siting of a high-level nuclear waste repository at Yucca Mountain in southern Nevada. As part of its oversight role, NWPO has contracted for studies of various technical questions at Yucca Mountain.

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SUMMARY AND CONCLUSIONS

The U.S. Department of Energy (DOE) environmental program plan for site characterization activities at Yucca Mountain principally addresses compliance with federal and state environmental regulation and to a lesser extent monitoring and mitigation of significant adverse impacts and reclamation of disturbed areas. There are 15 documents which comprise the plan and focus on complying with the environmental requirements of the Nuclear Waste Policy Act, as amended, (NWPA) and with single-media environmental statutes and their regulations. All elements of the plan follow from the 1986 statutory environmental assessment (EA) required by NWPA which concluded that no significant adverse impacts would result from characterization of the Yucca Mountain site.

The statutory EA mandated by NWPA was intended as a means of evaluating candidate repository sites and not as a traditional environmental document in the sense of the National Environmental Policy Act (NEPA). Site characterization activities at Yucca Mountain were exempted by NWPA from NEPA documentation procedures and the statutory EA was limited to the use of existing regional environmental rather than being based on comprehensive site specific baseline information on environmental conditions at Yucca Mountain itself. This was a departure from traditional environmental review for siting nuclear facilities. The statutory EA also was based on preliminary, incomplete information on site characterization activities that remained unavailable through 1991, the timeframe for this review of DOE's environmental program plans.

While the site characterization program was exempted from the procedural requirements for NEPA documentation, it was not exempted from the substantive requirements that systematic, interdisciplinary environmental assessment be the basis for decisions about how federal programs are to be carried out. However, neither the 1986 statutory EA nor the present

environmental program plans are responsive to NEPA. In the absence of full scientific and technical information environmental impact review for the program relied on the strength of traditional environmental statutes that address individual components of the environment rather than on an integrated systems approach as intended by NEPA. Thus, DOE's setting aside of NEPA's procedural foundation in favor of equating environmental protection to compliance with routine administrative criteria has resulted in flawed practices that fail to assure adequate protection of the Yucca Mountain environment. The credibility of the DOE environmental program was further undermined by DOE's having expressed the intent to comply with non-NEPA environmental requirements but apparently never having conducted full regulatory reviews either in 1986 or subsequent to the statutory EA.

No new studies of the Yucca Mountain environment were conducted prior to initiation of site characterization. However, despite DOE's often repeated declaration that no impacts would result from disturbance of the site a limited monitoring program was conceived on the basis of complying with environmental regulatory requirements principally intended to protect sensitive species and cultural resources. The monitoring plans are not comprehensive and thus fail to address all components of the environment, especially those related to ecosystem dynamics.

Some of the program plans are incomplete and meant to be amended or supplemented by new plans as the program evolves. This approach precludes DOE ever achieving the comprehensive planning and integration that is essential to sound and effective environmental management. There is no document among the DOE environmental program plans that provides a substantive, as opposed to a procedural overview and illustrates that the program reflects a comprehensive approach to planning for environmental protection. As a result it is not possible to obtain a perspective on the substance of the overall studies that are to comprise DOE's

environmental program. The limited insight to implementation of the program coincident with the initiation of site characterization in mid-1991 indicates that the program plans already are outdated and in need of revision.

The absence of complete environmental baseline information precludes accomplishing a sound analysis of impacts that could result from site characterization and renders all planning based on the NWPA statutory EA subject to uncertainty. The lack of complete information on conditions at the site will not be remedied because the true baseline will be altered by site characterization and never documented. The decision to monitor impacts only in certain components of the environment will mean that unmonitored components of the environment could be impacted and never detected. This is one of the consequences of basing the monitoring program on the 1986 statutory EA and applicable regulatory requirements rather than on a holistic environmental concept as intended by NEPA.

There is no description in the DOE planning documents of an actual planning process that indicates how all the information developed under the EFAPs or in other parts of the program will come together in application to preparing plans and making decisions either about specific site characterization activities, environmental resource management, or even for specifying mitigation requirements. With the exception of the review and approval process for each site characterization activity (Administrative Procedure 8.1), it is not clear from any of the documents how decisions will be made, what information will be required for the decisions, who will make the decisions, and when.

Environmental considerations on the whole need to be integrated into planning and decision-making processes in a manner different than is proposed by DOE. The DOE environmental program plan is constrained by its subordination to the site characterization plan. A fundamental reorganization is needed by

which the environmental program would be separated from the site characterization program so the environmental objectives would be regarded as equal in significance to repository development goals. This is the only way to ensure that independent judgment of site characterization impacts and decisions on avoidance, minimization and mitigation approaches can be made without deference to an inflexible site characterization plan.

The Yucca Mountain Project is not a routine construction project, but rather a singular program receiving national and international notoriety and therefore warranting superior environmental planning, above-average commitment to minimizing environmental impacts, and a model reclamation program. State-of-the-art environmental protection programs are based on concepts of cumulative impacts, biological diversity, environmental integrity, and natural resources management. This is not the case with the Yucca Mountain environmental program plan which should be viewed by DOE as an opportunity to conduct a credible and noteworthy environmental resources protection program based on extensive, long-term investigations.

It is not evident that a survey has been made by DOE of the gaps in the environmental data base for Yucca Mountain. If such an effort were to be conducted with ecosystem processes and analysis in mind it would greatly assist the current program as well as benefit the upcoming scoping effort for the repository environmental impact statement. A survey of how historical, current, and future environmental data bases can be made compatible and complementary and where additional data are needed could lead to a large and meaningful data base for environmental analysis that would help overcome the limitations characteristic of fragmentary short-term environmental studies.

If all the environmental studies currently proposed by DOE for the Yucca Mountain Project are conducted as planned they will

produce a large volume of data. Although the information will not have been systematically and comprehensively planned and collected, it may be possible for it to be pieced together into a reasonably composite qualitative description of the Yucca Mountain ecosystem. Because of the disjointed and inconsistent manner in which the data will have been gathered, however, any quantitative analyses will not be sound and detecting impacts at the ecosystem level from site characterization will not be possible. On the other hand, if care is taken with some of the studies of particular importance, such as those for the desert tortoise and reclamation, good contributions can be made to the scientific understand of complex issues.

Given the circumstances with respect to the current DOE environmental program plan for the Yucca Mountain site, it is difficult to be optimistic with regard to the likelihood of sound information resulting from the program because of the fragmentary nature of the study plans and the resulting inconsistencies, errors, and omissions. There are exceptions to this general characterization of the DOE environmental program plans. These are the field activity plans for water resources, soils, and archaeological resources which appear fundamentally sound despite being incomplete, lacking adequate details in some respects, and not being coordinated with other important components of the overall DOE plan. The water resources, soils, and archaeological activity plans are at least not divided and subdivided into incomprehension as are most other components of the DOE plan.

The failure of DOE to present a comprehensive, integrated plan for protecting the environment gives rise to concerns that the DOE program is deficient. Thus, given the inadequacies of the environmental planning effort, it is unlikely that the DOE can accomplish a credible and effective program of impact analysis and environmental protection during site characterization at Yucca Mountain. The principal points in this respect are the following.

- Compliance with administrative criteria like environmental regulations and requirements assumes major importance in the DOE environmental program plans for site characterization because DOE views compliance as being equivalent with environmental protection.

- Comprehensive site specific studies at Yucca Mountain have not been performed and there is no basis for anticipating the nature of potential environmental impacts that may result from site characterization and for planning monitoring, mitigation, and environmental compliance activities.

- A purpose of the environmental program seems to be to provide environmental information on the Yucca Mountain site, as it is being disturbed by site characterization, that can be used later as a partial baseline for the repository environmental impact statement (EIS). This could be unfortunate in the absence of an EIS implementation plan derived from the scoping process because such preliminary environmental data ultimately could prove to be deficient or could pose a future constraint on gathering proper information for the EIS.

- The DOE environmental program plan lacks defined resource management objectives. Components of the program have been planned in a manner that precludes coordinated and integrated review and implementation. As a consequence the program risks being redundant and suffering critical omissions.

- The program does not identify impact avoidance criteria to guide monitoring all components of the environment while site evaluation is being carried out.

- Assessment of cumulative impacts throughout all phases of the Yucca Mountain Projects are not addressed by the DOE environmental program plans.

- In the absence of sound environmental auditing procedures based on proper baseline information and coordinated planning for regulatory compliance, and professional standards of ethics there is no assurance that the DOE program will meet environmental requirements for protecting the environment, including the goals of NEPA.

The lack of appropriate environmental planning and review for site characterization at Yucca Mountain points to the need for an oversight function by the State of Nevada. It cannot be assumed that on its own DOE will properly comply with environmental requirements, especially the substantive requirements that comprise the intent of NEPA. Thus, procedures must be established to assure that the environmental interests of the State are addressed in the course of the Yucca Mountain Project. Accordingly, steps will be taken by the State of Nevada to review the soundness and efficacy of the DOE field surveys, monitoring and mitigation activities, reclamation actions, and ecological impact studies that follow from the DOE environmental program plans addressed by this review.

1.0 INTRODUCTION AND REPORT OBJECTIVES

1.1 SCOPE OF THE REVIEW

This report presents a critical review of the environmental program plan prepared by the U.S. Department of Energy (DOE) for the site characterization phase of a proposed high-level nuclear waste repository at Yucca Mountain in southern Nevada. The report was adapted from an unissued draft report prepared in September 1991 for the State of Nevada by Environmental Science Associates, Inc. of San Francisco, California.

This review of the DOE environmental program plan for site characterization activities at Yucca Mountain is directed at the program level and does not provide a detailed critique of each individual DOE planning document. The objective was to provide a comprehensive view of the DOE environmental program that focuses on how the various parts reflect a systematic, interdisciplinary approach to environmental management and decision making as required by the National Environmental Policy Act, as amended (NEPA). To achieve this goal the DOE environmental program plan was reviewed for:

1. completeness and adequacy in identifying and assessing the potentially significant environmental issues;

2. adequacy for describing a process that accomplishes integrated and comprehensive environmental planning and resource management; and

3. ability to present sound interdisciplinary analyses of environmental resources, impacts, and mitigation measures.

There are two standards to which the DOE environmental program plan for the Yucca Mountain site characterization project can be

compared. The first consists of the environmental requirements that apply to the project. These requirements served DOE as the principal framework for environmental program planning and include NEPA, the Nuclear Waste Policy Act, as amended (NWPA), federal and state laws related to specific environmental considerations, and DOE orders. These environmental requirements already have been critiqued in detail (Lemons et al., 1989; Lemons and Malone, 1989; Malone, 1989; Malone, 1990; Ulland and Winsor, 1989; Winsor and Malone, 1990).

The second standard is that of current practice of environmental planning and resource management aimed at enhancing environmental quality. Current practice has developed from concepts expressed since the late 1960s. Publications in this regard that provided the basis for this review are those by Cairns and Crawford (1991), McAllister (1973), McHarg (1969), Office of Technology Assessment (1987), Throw et al. (1975), Savory (1990), Westman (1985), and Wilkinson and Anderson (1990).

Neither of these standards is precise and quantifiable because aspects of both involve subjective interpretation. In reviewing the DOE environmental program plan for the Yucca Mountain site it is clear that DOE has pursued narrow interpretations of both standards and is treating the site characterization project as it would a routine construction activity. The critique presented here follows from considerably broader interpretations based on the assumption that a high-level nuclear waste repository program, because of its singular character and international notoriety, should be sensitive to and adhere to high standards of environmental ethics.

1.2 DOCUMENTS REVIEWED

This review of DOE environmental program planning for site characterization activities at Yucca Mountain included the

following documents received by the State of Nevada from DOE through 1991.

- Environmental Regulatory Compliance Plan for Site Characterization of the Yucca Mountain Site (U.S. DOE, 1988a)
- Environmental Program Overview (U.S. DOE, 1988b)
- Environmental Monitoring and Mitigation Plan for Site Characterization (U.S. DOE, 1988c)
- Environmental Field Activity Plan for Terrestrial Ecosystems (U.S. DOE, 1988d)
- Environmental Field Activity Plan for Air Quality (U.S. DOE, 1988e)
- Environmental Field Activity Plan for Cultural Resources: Native American Component (U.S. DOE, 1988f)
- Environmental Field Activity Plan for Cultural Resources: Archaeological Component (U.S. DOE, 1988g)
- Draft Reclamation Program Plan for Site Characterization (U.S. DOE, 1989a)
- Yucca Mountain Project Reclamation Guidelines (U.S. DOE, 1989b)
- Draft Reclamation Feasibility Plan (U.S. DOE, 1990a)
- Environmental Field Activity Plan for Soils (U.S. DOE, 1990b)
- Environmental Field Activity Plan for Water Resources (U.S. DOE, 1990c)
- Environmental Protection Implementation Plan for the Yucca Mountain Project (U.S. DOE, 1990d)
- Environmental Management Plan (U.S. DOE, 1990e)
- Reclamation Implementation Plan (U.S. DOE, 1991a)

A list of the acronyms used in this report, including those for the DOE documents listed above, is in the Appendix.

Noted herein but not addressed in detail are the few documents and publications available to date that address how the DOE environmental program plan currently is being implemented (e.g., EG&G, 1991; U.S. DOE 1991b; Green et al., 1991). These and similar materials will be the subject of later reviews by the State of Nevada and are mentioned here to indicate discrepancies between the environmental program plan and its implantation to illustrate that some components of the plans need to be amended or revised.

1.3 REPORT ORGANIZATION

This report is organized into the following three parts.

- General Review and Comments on the DOE Environmental Program
- Critique of the DOE Approach to Environmental Topical Areas
- Critique of the DOE Approach to Integration of Environmental Topics

2.0 GENERAL COMMENTS ON THE DOE ENVIRONMENTAL PROGRAM

As noted in earlier reviews by the State of Nevada (1897 and 1988) of DOE's preliminary environmental plans for the Yucca Mountain Project, there is no DOE document that provides comprehensive plans for addressing environmental issues for the entire Yucca Mountain repository development program. The present DOE environmental program focuses on site characterization and does not provide details on (a) related activities carried out prior to the conceptual formulation of the site characterization program or (b) repository construction, operation, and closure that is meant by DOE to follow the site characterization phase. This approach prevents comprehensive environmental assessment of all the program's repository siting and development phases and activities. Additionally, the approach increases the difficulty of assessing incremental and cumulative impacts and makes it impossible to determine how the DOE will address long-term environmental resources issues at Yucca Mountain in a comprehensive manner.

Another problem is that contrary to NEPA the DOE Site Characterization Plan (SCP) (DOE, 1988h) and the environmental program plans were formulated without regard to a documented search for reasonable alternatives to activities that could avoid or minimize damage to the environment. This omission results in weak integration of the environmental program into other parts of the site characterization project at Yucca Mountain. The root of the problem is that DOE is frozen in the traditional paradigm of design first, environmental review later. This general approach results in a tendency to address issues in a fragmentary manner and to inadequately develop comprehensive environmental strategies (Marsh and Lallas, 1990).

2.1 ENVIRONMENTAL MANAGEMENT OBJECTIVES AND POLICIES

In current practice, environmental management is based on the identification of objectives for the sound use of the natural resources involved. After conducting an inventory of the resources and assessing their sensitivities and susceptibilities to alteration, options for sound use of the resources are identified. Next, goals are drawn from the available options. The goals commonly are established as long-term goals that are oriented to maintaining or enhancing the quality of specific resources and for the comprehensive environment that sustains them. Often short-term or interim goals for the environment are also identified. An environmental management plan then is prepared as a set of principles, policies, regulatory requirements, and guidelines that are implemented to bring about resource management in a way that will achieve the established objectives. The plan also serves as a way of integrating resource information and land use practices into a unified program of elements that work in concert to achieve balance and coherence in managing the resources. The plan is used as the basis for making decisions about land use planning and resource management. Typically, the process for decision making is included in the plan.

The Environmental Management Plan (EMP) (U.S. DOE, 1990e) and the Environmental Program Overview (EPO) (U.S. DOE, 1988b) are intended to provide a general summary of how DOE's environmental program for the Yucca Mountain Project is procedurally constructed. The EMP and EPO are documents in which one would expect to find the philosophical and ethical basis of the environmental program discussed and objectives and policies identified.

The EMP summarizes the program for addressing environmental requirements for site characterization, discusses program management and structure, addresses specific environmental statutes, regulations and DOE orders, identifies the individual

planning documents comprising the program plan, and discusses how the proposed activities will be used to produce programmatic documents. The EPO presents a similar treatment but with more discussion of how the various components of the overall environmental plan relate procedurally to programmatic requirements. Given the redundancy of text and lack of clear distinction between the purpose of the two documents, the EMP and EPO could have been integrated into a single document.

It is not clear what the combined function of the EMP and EPO is intended to be. This is because the documents lack the most critical element of all - a clear statement of the DOE's objectives for environmental management for the high-level nuclear waste program. The EMP and EPO state that DOE is committed to performing its activities in an environmentally safe and sound manner that will comply with applicable environmental requirements. What one would expect to follow from such a broad commitment are definitive statements and supporting discussions that explain how the overall goals of systematic and comprehensive environmental protection, enhancement, and compliance consistent with NEPA will be achieved. That is, specific environmental objectives should be described as well as the policies that DOE intends to enforce to see that the objectives are realized. Such objectives and policies are the framework on which the development of an environmental plan should be based and they are missing from DOE's program.

Following the broad commitment to compliance the EPO progresses into a general discussion of environmental requirements. The EPO provides a summary of regulatory requirements for repository siting and development, but there is no attempt to translate these into an environmental mission statement with a body of environmental planning objectives and policies. There are no clear objectives stated which demonstrate an intent on DOE's part to improve environmental resources such as air and water quality, ecological habitat, and wildlife.

Like the EPO and EMP, the DOE Environmental Regulatory Compliance Plan for Site Characterization (ERCP) (U.S. DOE, 1988a) equates conducting Yucca Mountain operations in an environmentally safe and sound manner with complying with environmental requirements. The ERCP thus describes the federal and state environmental statutes and regulations that may apply to site characterization at Yucca Mountain. Regulatory compliance as set forth in the EMP, EPO, and ERCP therefore stands as the only identified objective of DOE's environmental program plan. This point was noted earlier by the State of Nevada (1987) in a review of DOE's preliminary environmental planning strategy. While compliance is one way to address environmental planning, it is a narrow approach in comparison to the current practice of adopting more comprehensive planning based on standard environmental resource management and practice as intended by NEPA. The ERCP does in fact include the NEPA requirements that apply to characterization of the Yucca Mountain site including the use of a systematic, interdisciplinary approach to addressing environmental issues. However, nowhere else in DOE's environmental program plan is compliance with NEPA requirements addressed.

Thus, a key step in routine environmental planning - identification of adequate objectives and the policies needed for fulfilling them - has been missed by DOE resulting in the absence of a holistic and integrated environmental component to the Yucca Mountain Project. This is a significant gap because, lacking clearly defined, comprehensive environmental objectives, it is not possible to determine what, other than compliance with applicable administrative criteria, DOE hopes to accomplish through the program outlined in the EMP and the EPO. Instead of the vague commitments stated in those two documents, the preparation of an "Environmental Objectives and Policies" document would be useful. There is no such document among those that comprise the DOE environment program plan for the Yucca Mountain Project.

2.2 ENVIRONMENTAL REGULATORY COMPLIANCE

Given that DOE's sole objective for the environmental program at Yucca Mountain is environmental compliance, the ERCP (U.S. DOE, 1988a) should be a cornerstone among the various environmental program planning documents. The ERCP basically consists of two fundamental components: (1) a brief summary of site characterization activities, and (2) a discussion of potentially applicable federal and state statutes and regulations and the associated generic procedural processes for complying with them. The ERCP does not analyze either individual site characterization activities or categories thereof, e.g., drilling, excavation, and construction of access roads, to determine which regulatory and administrative criteria apply to specific types of actions. Instead, the ERCP relies on information concerning environmental regulatory compliance that has resulted from past federal and commercial projects. The result is that discussion of regulations in the ERCP is reduced to a generic treatment that is not correlated directly to the activities presented in the SCP. The absence of a connection between the discussion of site characterization activities and the summary of regulations that follows makes it impossible to understand how DOE intends to apply specific regulatory criteria to its program.

This lack of connection results in the failure of DOE to present a true plan that specifies substantively how environmental compliance will be achieved. Instead, the impression that emerges is that the generic requirements listed in the ERCP are those that DOE has dealt with in the past but that DOE does not know which ones apply to the Yucca Mountain Project. Thus, the ERCP fails to describe the course to be followed in complying with regulations but rather describes a procedural process that DOE intends to follow in evaluating whether particular requirements, with the exception of NEPA, apply to individual site characterization actions one at a time. If DOE intends to be conducting activities

that could be expected to involve compliance requirements it should have a plan that clearly lays out an approach that will ensure compliance in an orderly and comprehensive manner. An ongoing activity-by-activity evaluation as the basis for compliance planning risks both omissions and inconsistent evaluations and does not achieve coordination and balance in meeting the requirements identified in the EMMP and those of NEPA.

The DOE thus lacks a definitive plan for integrating site characterization activities and environmental requirements into an orderly program to achieve compliance. Such a systems approach is necessary if DOE is to avoid conflicting compliance actions, to track compliance status, and to document compliance. Chapter 4 of the ERCP hints at a procedure for achieving this, but as with other parts of the document it only identifies an organization chart and presents a statement of intent rather than discussing the substance of environmental compliance planning. That a systems approach will not be taken is confirmed in Chapter 4 of the Reclamation Implementation Plan (RIP) (U.S. DOE, 1991a) where a procedure (Administrative Procedure 8.1) is described that implements an activity-by-activity approach for review and approval of site characterization activities. The review is meant by DOE to assure that the environmental requirements and administrative requirements addressed in the ERCP and the EMMP are met prior to a site characterization activity being initiated.

A systematic, integrated, and comprehensive approach to compliance for all site characterization activities is especially needed with respect to NEPA. The ERCP provides a good start on part of that task as the descriptions of the statutes and regulations likely to apply to site characterization is sufficient for a beginning point. An approach based on the substantive strength of NEPA would result in an environmental program that meets DOE's goal of complying with administrative criteria as well as providing a foundation for the program based on the current

practice of NEPA-based environmental resources management. Unfortunately, the approach represented by Administrative Procedure 8.1 is counter to this goal and reflects DOE's lack of a comprehensive and integrated approach to environmental planning.

Environmental compliance auditing is an important topic that receives little attention in the ERCP. The single paragraph devoted to the subject states that an auditing program will be conceived and implemented later. With one exception the brief discussion mentions the essential components of a successful auditing program. The exception is the omission of ethical standards that are the cornerstone of such programs in current environmental practice. Ethical guidance lends creditability to auditing programs because it assures that high standards of technical competence, integrity, and professional conduct are maintained (Duffy and Potter, 1992). The State of Nevada (1987) earlier called upon DOE to implement an environmental auditing program. Now that site characterization is underway at Yucca Mountain DOE must have its auditing activities in place. If this is the case the ERCP, issued in 1988, should be revised to provide details on the program.

2.3 ENVIRONMENTAL IMPACT ASSESSMENT

The NWPA directs DOE to conduct site characterization in a manner that minimizes significant adverse environmental impacts and to reclaim the site and mitigate impacts if Yucca Mountain is found unsuitable for a repository. The intent of NWPA is that DOE give proper attention to environmental issues so that unnecessary impacts will be avoided. Thus, the act recognizes the potential for site characterization to cause significant impacts and directs DOE to mitigate those that do occur. These goals are consistent with the intent of NEPA.

In accordance with another NWPA requirement DOE issued a statutory environmental assessment (EA) (U.S. DOE, 1986) for the Yucca Mountain site that was intended for the purpose of screening candidate repository sites. The 1986 statutory EA concluded that no significant adverse impacts would occur at Yucca Mountain as a result of site characterization. It was not intended that the statutory EA serve as an environmental document in the sense that EAs and environmental impact statements performed under NEPA serve. Despite this, the DOE environmental program plan, having the purpose of describing the approach being taken to satisfy the environmental requirements applicable to siting a repository at Yucca Mountain, has been structured to be consistent with the conclusions of the statutory EA that no significant adverse impacts would occur. Thus, DOE has largely pursued a course of environmental compliance planning on the strength that the statutory EA required by NWPA concluded there would be no impacts to minimize or mitigate.

Despite DOE's position that significant impacts from site characterization are unlikely to occur at Yucca Mountain, DOE has recognized that the NWPA directive to minimize and mitigate impacts resulting from site characterization places an important environmental requirement on the repository siting program. Accordingly, DOE has left open the possibility that significant impacts can occur even though they have not been predicted as likely to happen. This is the rationale behind the Environmental Monitoring and Mitigation Plan (EMMP) (U.S. DOE, 1988c) described by DOE as the document which guides compliance with the NWPA impact minimization and mitigation requirement. The extent to which DOE has failed to address NEPA in the environmental program plan is especially evident in the EMMP because NEPA and its requirements, listed in the ERCP, are never mentioned despite the importance of environmental monitoring, impact assessment, and impact mitigation to NEPA with respect to federal actions.

2.3.1 Identifying the Impact Assessment Methods Used by DOE

There is no DOE environmental program document that specifically addresses the methodology of environmental impact assessment for the Yucca Mountain Project. Instead, impact assessment is touched on in several that repeatedly refer to the conclusions of DOE's 1986 statutory EA. The scattered discussions of impact assessment make it difficult to identify what DOE's approach is to impact assessment and one must attempt to piece together the approach in an effort to understand and review it.

The EPO states that impact assessment will be carried out, but the conceptual environmental planning process illustrated in the document does not identify environmental impact assessment as part of the process. The EPO does note that environmental monitoring and mitigation as presented in the EMMP will be performed for site characterization activities having the potential for causing significant adverse environmental impacts. However, the EPO does not address how impacts will be identified.

The EMP also does not directly address how environmental impact assessment will be conducted, and impact assessment is not indicated in the environmental program integration process illustrated in the EMP. The document points out that impact assessment will be a part of the site activity review and approval process, i.e., Administrative Procedure 8.1 which is to be followed by DOE to assure compliance with environmental requirements and to give permission to initiate a site characterization activity at Yucca Mountain. There are no specifics given in the EMP or even in the EMMP or the ERCP about what the site activity review and approval process entails. However, as noted in the previous section, the RIP briefly describes the process and implies that its principal purpose is compliance with environmental requirements. Administrative Procedure 8.1 ignores the intent of NEPA that includes assessment of potential environmental impacts, and once

again no insight is given regarding how environmental impact assessment is to be performed. The Environmental Protection Implementation Plan (EPIP) (U.S. DOE, 1990d) reiterates information presented in other documents. While some environmental issues, including monitoring for impacts, are summarized in the EPIP, impact assessment appears to be an incidental component of DOE's environmental program plan.

It should be noted that the EPO, EMP, and EPIP call attention to the EMMP as the document in which questions of impact assessment are addressed. The EMMP states that it addresses the potential for site characterization activities to cause significant adverse environmental impact. However, the concept of impact assessment is not developed in the EMMP nor does the document address how systematic and integrated impact assessment as envisioned by NEPA will be conducted. What stands out in the EMMP are statements that refer to the 1986 statutory EA and how it formed the basic foundation for the EMMP. From the fundamental finding of no significant adverse impacts presented in the statutory EA, the EMMP imposed a degree of uncertainty stemming from the SCP and reexamined the potential for previously unanticipated impacts to occur. The reexamination process is not documented and there is no description of methods used to assess potential impacts.

One must assume, because of the explicit link between the 1986 statutory EA and the current DOE environmental program plan, that the same environmental impact assessment process used for the statutory EA was carried over to the EMMP. The 1986 document did not identify an environmental impact assessment methodology and as a result in no part of the entire DOE environmental review process have impact assessment concepts and methods been developed. Thus, with regard to environmental impact assessment the EMMP merely cross-references the 1986 statutory EA and constitutes a reaffirmation of that document. Consequently, it must be assumed that DOE's continued approach to impact assessment is based on

judgement, as was the case for the statutory EA, and is not bound by quantitative measures or conceptual models of impacts. Impact assessment as visualized by DOE for the Yucca Mountain Project thus consists of a narrowly conceived monitoring and mitigation program for some components of the environment. The program provides information for site activity review and approval based principally on cursory environmental surveys for resources protected by law plus verification that the requirements (with the exception of those of NEPA) addressed in the ERCP and the EMMP have been met.

In sum, the monitoring and mitigation program lacks a conceptual focus on impact assessment. The site activity review and approval procedure that drives the program consists of a paper-trail exercise that is not connected to impacts aside from those defined by the non-NEPA regulatory compliance requirements and the NWPA. Thus, environmental impact assessment for the Yucca Mountain Project follows from the sole objective of the DOE environmental program, i.e., environmental compliance excluding NEPA. There is no foundation to the program that stems from comprehensive and integrated environmental management, protection, and enhancement as set forth by NEPA. Despite the ERCP's identifying the substantive requirements of NEPA that apply to the Yucca Mountain Project none of these are addressed and implemented in other components DOE's environmental program plan.

2.3.2 Identification of Impact Criteria

Another consequence of the DOE having based its environmental program exclusively on the concept of compliance with non-NEPA environmental requirements occurs with respect to how the EMMP designates adverse impacts. The sole focus of the EMMP is the NWPA's program-specific requirement concerning impact minimization and mitigation. On the basis of the statutory EA and an evaluation of the SCP DOE acknowledges that impacts could occur in only four traditional environmental area; threatened or endangered species,

air quality, water resources, and archaeological resources. A fifth area, radioactivity, is included by DOE in order to justify obtaining baseline radiological monitoring information that can be used later for repository licensing. The radiological environment is of interest to human health considerations principally with respect to a repository (Shenk et al., 1992) but is of no concern to potential environmental impacts that may arise from site characterization and is not addressed further in this review.

The principal purpose of the EMMP is to address how individual environmental impacts in four regulatory areas are to be identified and recognized at Yucca Mountain. The document notes that designing impact criteria is a step in this process but thereafter avoids the term "impact criteria" by using the words "initiating conditions" instead. The concepts of impact criteria or criterion of significant impact are those commonly used in current environmental practice, and DOE's usage of initiation conditions to identify individually occurring impacts seems to be based on legal requirements as well as being an effort to avoid using terminology involving the words "significant" and "impact."

When presenting the initiating conditions for sensitive species, air quality, water resources, and archaeological resources there is little discussion of how the conditions were developed or why DOE believes the initiating conditions will help minimize environmental impacts. It is clear that the conditions stem solely from environmental compliance requirements and are meant to reflect when environmental conditions are out of compliance with legal administrative criteria and therefore in need of corrective action. The initiating conditions thus have no basis in environmental protection and management consistent with NEPA.

The EMMP trivializes the compliance concept by saying that attaining or exceeding an initiating condition only means with certainty that DOE will continue observing the situation and will

only consider mitigation measures as opposed to taking definite corrective actions. Thus, the initiating condition is not strictly an exceedance criterion but rather a recognition that site characterization activities are contributing to an undesirable environmental situation. An initiating condition only triggers a situation on paper that must await a decision to act or not to act. The EMMP restricts mitigation actions to changing the schedule for the offending site characterization action or altering its design. If a "Decision Not To Act" is made by DOE the adverse environmental impact is accepted and goes unabated. Viewed in this light, the initiating condition is not an impact criterion in the sense of recognizing significant impacts but instead records a fact that can be weighed or disregarded in DOE's decision-making process. The EMMP implies that the decision rests on the consequences to the site characterization program rather than on impact avoidance.

The concept of initiating condition also does not incorporate the concept of cumulative impacts. As activities are planned over a broad area, there is a high potential for cumulative impacts and consequent environmental stress to result from decisions not to act when individual initiating conditions occur.

Initiating conditions as envisioned by DOE in the EMMP will be useful only if they reflect impact criteria that are meaningful in terms of environmental resource management issues and objectives in the sense of NEPA. The DOE's environmental plan for the Yucca Mountain site as reflected by the EMMP does not consider the interrelatedness of environmental components to be important and instead focuses only on compliance with a narrow range of individual environmental requirements. For example, it shows no consideration for protecting areas critical to the reproductive success and survival of important species. For terrestrial ecosystems, the initiating conditions should take into account questions of populations, communities, limiting factors, feedback loops, thresholds of impact, and irreversible changes that are both

incremental and cumulative in nature. More consideration is needed in DOE's environmental program plan concerning the goal of NEPA in maintaining ecosystem integrity. Such considerations should be the basis for defining impact criteria, and the search for answers to such questions should direct DOE's environmental monitoring and mitigation program, not simplistic regulatory compliance.

2.3.3 Program Implementation

It is difficult to understand how the basic concepts of monitoring and mitigation for environmental impacts can be accomplished by DOE when there are no clearly defined program goals for environmental management. The EMMP appears to be an ad hoc or post hoc application of stop-gap measures applied only when things seem to be going awry. This is exacerbated by the fact that little attention is given to early recognition of when things are going awry or what the cause may be. Thus, a primary concern is that the initiating conditions adopted in the EMMP will not be recognizable until impacts already have occurred or until a disturbance has started a process leading to unravelling of the environment.

The above shortcoming stems partly from the failure of DOE to identify impact criteria and to view environmental conditions in a comprehensive, integrated, and systematic manner as intended by NEPA. Environmental components are treated as individual elements rather than as integral parts of a complex natural system. The DOE's failure to adopt a systematic approach to environmental management and impact assessment will provide little or no insight to potential impacts on terrestrial ecosystems, especially cumulative, long term impacts. Monitoring should be a continuous program before, during, and following disturbance activities. Mitigation also must be well planned and aimed at successful results for individual plants and animals, for populations, and for biotic communities and habitats as a whole.

Early insight to how the DOE environmental program plan is being implemented at Yucca Mountain confirm the above fears. Moreover, discrepancies exist between some of the plans addressing environmental impact assessment (e.g., U.S. DOE, 1988c and 1988d) and the field studies implementing them (EG&G, 1991; U.S. DOE 1991b; Green et al., 1991). This suggests either that agendas exist that are unknown to those outside the DOE program or that revisions to update the planning documents are lagging behind the environmental field activities at Yucca Mountain.

2.4 IMPACT AVOIDANCE, MINIMIZATION, AND MITIGATION

The DOE environmental program plan fails to fully recognize the importance of the concept of impact avoidance. There is no substantive approach to avoiding impacts and the subject is largely disregarded by DOE. The fact that impact avoidance is the most effective approach to preventing environmental impacts was acknowledged in the NWPA where discussion was called for in the statutory EA of alternatives to site characterization activities that would achieve avoidance of significant impacts.

The DOE has never presented alternatives for site characterization activities at Yucca Mountain with the intent of avoiding impacts to the environment. This shortcoming appears to stem from the DOE's reliance on the findings in the statutory EA for the Yucca Mountain site which reported that no significant impacts would result from site characterization. Thus, the unstated but obvious conclusion that follows is that DOE has ignored the concept of impact avoidance because it does not recognize that significant adverse impact can occur. This approach, however, is inconsistent with DOE's program presented in the EMMP for monitoring selected potential impacts from an ever changing site characterization program. The EMMP holds open the possibility that some significant impacts may occur but does not emphasize alternative activities that could avoid them.

What is needed to correct this omission is first a recognition that the potential for significant impacts to occur must be separated in concept from the 1986 statutory EA. The statutory EA was only a preliminary assessment of impacts that met an early requirement of the NWPA regarding evaluating the suitability of alternative candidate sites for characterization. Yet, DOE has used the document to set the course for its environmental program. The EMMP recognizes this shortcoming to a point but fails to establish a clear and realistic approach to remedying impacts.

Instead, dealing with impacts is relegated by DOE to mitigation and minimization, two concepts which are used interchangeably in the EMMP. Impact mitigation, or minimization, is to occur after impacts have been observed by monitoring. The EMMP indicates that changes in individual site characterization activities after an initiating condition has been observed are the only mitigation measures to be considered. While the DOE may intend to carry out a program of impact minimization through modification of ongoing activities, little is presented in the EMMP or elsewhere that indicates a commitment or the means to do so. Despite the limitations placed on mitigation by the EMMP other documents are inconsistent with the EMMP and discuss mitigation measures directed toward specific components of the environment.

A key concern in undertaking mitigation is that the effectiveness in achieving a reduction of impacts is never known at the outset. The effectiveness of mitigation is especially speculative when it entails making changes in natural ecosystems. In the case of Yucca Mountain, little is understood about the ecosystem which lies in a region that is a complex mosaic of soils, habitats, and biota at the interface of two major biomes. Such transition zones display complex ecological relationships and features. This makes it difficult to predict what the consequences of environmental disturbance will be and how effective remediation of impacts will be. An underlying assumption implicit in the DOE

environmental program is that mitigation is going to be easy and effective. Such optimism is unrealistic because it ignores facts to the contrary regarding arid regions.

Additionally, from what is presented in the EMMP, mitigation measures will be developed on an ad hoc or post hoc basis related to a specific site characterization activity at a given location, and apparently only after an initiating condition has occurred. Such fragmentary mitigation will be uncoordinated and have the potential for implementing mitigation measures which could operate against one another or induce incremental and cumulative adverse impacts that may equal the impact being mitigated.

2.5 RECLAMATION

The NWPA places specific requirements on DOE to reclaim disturbances caused by site characterization if Yucca Mountain is found unsuitable for a repository. In response to this environmental requirement DOE prepared four plans that address reclamation. The resulting documents are the Draft Reclamation Program Plan for Site Characterization (RPP) (U.S. DOE, 1989a), the Draft Reclamation Feasibility Plan (RFP) (U.S. DOE, 1990a), the Yucca Mountain Project Reclamation Guidelines (U.S. DOE, 1989b), and the Reclamation Implementation Plan (RIP) (U.S. DOE, 1991a). These have been succinctly summarized elsewhere (Ostler et al., 1991). The reclamation plans stand apart from the EMMP and as a consequence reclamation is not integrated with the concept of impact mitigation in the DOE environmental program.

2.5.1 Reclamation Objectives

In response to the requirement for reclamation established by NWPA, the RPP states that the DOE's objective for reclamation at Yucca Mountain is to return land disturbed by site characterization to a stable ecological state with a form and productivity similar

to the predisturbed state. The concept of "disturbed land" is not defined by DOE in terms of the size of a disturbed area, whether the disturbance is direct or indirect, and whether both immediate and delayed disturbances are included. It is not known if DOE has established or will identify some limits on what it considers sufficient disturbance to merit reclamation. By providing no specifics regarding what constitutes a disturbance DOE has left itself broad options for determining how encompassing its reclamation objective will be.

An important undefined concept is what DOE considers the pre-disturbance baseline condition to be and whether reclamation will be based on structural and functional characteristics or on a lesser standard not based on ecological integrity. There is no interpretation of what is considered to be a stable ecological state, what is meant by a form and productivity similar to the pre-disturbance state, nor how these conditions will be established. These are important considerations because they determine what the DOE's reclamation program should expect to accomplish (Malone, 1991). Establishing sound reclamation goals is contingent upon determining pre-disturbance baseline conditions, which DOE has stated it will not do for the Yucca Mountain site characterization project (U.S. DOE, 1988b; Parker et al., 1990). The RFP describes studies of natural succession on previously disturbed land and implies that the studies ultimately may be used to establish reclamation goals. Should this become the case, the DOE's reclamation objectives will be satisfied essentially with achieving a low degree of site stabilization as opposed to habitat restoration to a stable and productive ecological condition.

2.5.2 Reclamation Techniques and Program Activities

With respect to reclamation activities, the various documents comprising DOE's reclamation plans represent an intent to develop specific reclamation instructions for each individual area

disturbed by site characterization. The instructions are to be developed through a phased program of study incorporating reclamation feasibility studies, preactivity surveys, pre-reclamation surveys, and post-reclamation monitoring. This is a standard sequence of steps that works well in application to projects with well-defined objectives. In the Yucca Mountain Project, however, the lack of (1) a holistic concept of the environment and (2) an understanding of the full scope and schedule of disturbances involved in site characterization prevents a cohesive reclamation plan being structured. The reasons for this are as follows.

First, there are questions about the degree to which the DOE understands the environment at Yucca Mountain because an environmental baseline was unavailable for the 1986 statutory EA and has yet to be established. The DOE has not addressed questions about the existing components, forms, processes, spatial aspects, chronological relationships, and linkages within the ecosystem (Lemons and Malone, 1991). If reclamation is to be successful in restoring a stable ecological state with a form and productivity similar to the predisturbed state, a program to develop such baseline information for the Yucca Mountain ecosystem is critical.

Second, the DOE prevents itself from relating baseline information to reclamation requirements because of *a priori* limitations on its understanding of how site characterization may alter the environment. Because DOE believes that significant adverse impacts are unlikely to occur at Yucca Mountain it has made no effort to comprehend how site characterization may alter the ecosystem which in turn determines the need for reclamation to return the site to baseline conditions of stability, form, and productivity. The DOE belief that no unusual reclamation needs will be necessary at Yucca Mountain (Parker *et al.*, 1990) illustrates that DOE fails to understand the complex nature of the transitional environment at the site. The ecosystem is highly

susceptible to environmental alteration and presents hostile conditions for reclamation (Malone, 1991). With no clear concept of assessing environmental impacts one wonders how DOE hopes to design reclamation measures to correct ecological impacts never anticipated or identified in the first place. Because of the harsh environment careful and thorough investigation of the transitional desert ecosystem at Yucca Mountain needs to be undertaken. Only after this is accomplished can informed decisions be made about the locations of site characterization activities and appropriate impact mitigation measures, including reclamation.

Third, the reclamation program fails to regard reclamation as a process that needs integration into planning for site characterization. What the DOE has proposed is the paradigm discussed earlier in which a program of activities is proposed and then a reclamation effort is designed to respond to its effects. This superimposition of one plan over another can result in fragmentary reclamation planning and implementation. Instead, reclamation considerations should be incorporated into decisions about the location of site characterization activities. This would allow the activities to be located and designed in ways that minimize disturbance and maximize the potential for successful reclamation.

Similarly, the DOE's approach to site-by-site reclamation planning cannot provide sufficient information for achieving a comprehensive and coordinated reclamation product. By conducting pre-activity surveys at each location immediately prior to their disturbance, no sense of scale with regard to the scope of the whole site characterization program and the Yucca Mountain ecosystem can be achieved. The fragmentary nature of this approach integrates none of the elements (baseline information, operations plan, impact assessment and monitoring plans, reclamation plan) of the total project. Site-by-site planning and evaluation is useful only if it occurs within the context of a broader reclamation

objective based on the ecosystem concept. That is the only way to ensure that cumulative impacts and critical considerations of environmental relationships are incorporated effectively into a project like that proposed by DOE for the Yucca Mountain site.

2.5.3 Reclamation Feasibility

Reviews of investigations and techniques for reclaiming desert ecosystems (e.g., ESA 1988 and 1989; RCI, 1989; Malone, 1991) make it clear that reclamation at Yucca Mountain is problematic. Basically, any reclamation plan for arid ecosystems must be considered an experimental undertaking requiring a long-term commitment, ample funding, and a willingness to readily undertake changes in course and approach to achieve success. It is because of these pitfalls, unrecognized by DOE (Parker et al., 1990; Ostler et al., 1991), that emphasis on impact avoidance should be preferred to relying on impact mitigation and reclamation of disturbed areas at Yucca Mountain.

Despite the well known difficulties of arid land reclamation, the scope of reclamation feasibility studies planned by DOE at Yucca Mountain is limited. The activities outlined in the RFP are of two general types. First, studies of existing disturbed areas are planned that consist of inventorying the areas and characterizing the natural succession that has occurred over the years. Second, reclamation studies are planned that consist of a literature review on desert reclamation, studies to develop a strategy for establishing vegetation on and stabilizing topsoil stockpiles and mined spoil, and trials to test revegetation techniques on existing disturbed areas.

The scope of DOE's reclamation feasibility activities should be expanded to address topics such as topsoil replacement depth, significance of microbial association, testing of local genotypic plant races for significant adaptation to local conditions,

transplanting of mature plants, creation of fertile islands, and the significance of disturbing duripan and fragipan soils. A more realistic approach needs to be taken by DOE that focuses on what is feasible at Yucca Mountain with the present understanding and technology for reclaiming harsh desert environments. It is likely that what will be required for reestablishing conditions at Yucca Mountain to the predisturbance state is to develop a new reclamation technology or at least to substantially improve the existing technology. The RFP is too limited to achieve such an objective. This gives rise to the concern that reclamation efforts will fail at Yucca Mountain and that in response DOE will alter its objectives to something less demanding than that stated in the RPP. An early indication that this may already be anticipated is the emphasis in the RFP on previously disturbed areas and their colonization by invading species. Armed with this information there is fear that DOE will conclude that the only reasonable course for reclamation at Yucca Mountain essentially is abandonment of disturbed areas to natural revegetation.

3.0 ENVIRONMENTAL TOPICAL AREAS

This section of the report discusses the adequacy of DOE plans that address the environmental topics of air quality, water resources, soils, terrestrial ecosystems, and cultural resources. The review addresses key issues and DOE's response to them as evident from the appropriate Environmental Field Activity Plans (EFAPs) (U.S. DOE, 1988d, 1988e, 1988f, 1988g, 1990b, and 1990c) for the environmental topics covered by DOE's environmental program. An EFAP for Radiological Studies is available (U.S. DOE, 1988i) but is not reviewed here because the issues addressed principally concern repository licensing and not site characterization (Shenk et al., 1992).

3.1 AIR QUALITY

The 1986 statutory EA for the Yucca Mountain site concluded that no significant adverse impacts on air quality would result from site characterization. However, DOE has left open the possibility that such impacts might occur and the EMMP established initiating conditions for total suspended particulates (TSP) and respirable particulates (PM-10). While DOE has correctly identified the pollutants of concern, it has not addressed aspects of the air quality issues that result in a potential for creating significant adverse impacts. Neither has DOE identified a program for establishing baseline conditions and for monitoring air quality that can be used to effectively resolve the issues.

Particulate emissions are of concern because respirable particulates can pose human health risks. The DOE environmental plan that addresses air quality issues is the EFAP for Air Quality (U.S. DOE, 1988e). The air quality EFAP and the ERCP identify the applicable environmental regulatory requirements, including state permits, that pertain to particulate emissions at Yucca Mountain. The program set forth in the air quality EFAP consists of data

collection at two monitoring stations on the Yucca Mountain site. DOE cites the rational for the study as being to collect data representative of air quality conditions throughout the region. The purpose of the program is to establish ambient particulate concentrations that can be used in determining impacts as required for regulatory compliance.

The program falls short of what is needed to establish the ambient air quality of the Yucca Mountain area. Sufficient meteorological information is needed to describe airflow from the particulate emission sources at the site to surrounding sensitive receptors and site boundaries. Ambient air pollutant concentrations monitored at receptor locations, not just at the sources of emissions, would be needed in order to establish baseline conditions and to determine air quality impacts. Such data collection efforts are not included in the air quality EFAP. There are few sensitive receptors such as population centers, highways, and public parks of concern in the Yucca Mountain area. Because of this the DOE air quality program could be significantly improved by the addition of only a few stationary and mobile monitoring stations to better characterize ambient conditions and to identify impacts at the few existing receptor locations and at site boundaries under given meteorological conditions.

To be used as valid input to an appropriate dispersion model, meteorological data would be required in sufficient detail to account for the effects of local topography, and the data should be collected for a sufficient time (1-5 years). The model could then be used to estimate concentrations likely to occur at sensitive receptors under given emission volumes of particulates from site characterization activities. Because off-site air quality monitoring is not included in the air quality EFAP DOE must rely on modeling to predict impacts using data from too few points. Models would have to be fairly sophisticated to account for the complex effects of dispersion in the varied topography of the region as

well as being capable of taking into account particulates from other sources. Modeling of this nature does not appear to be in any of DOE's environmental program plans thus giving rise to questions about how air quality will be assessed.

Thus far there has been no detailed assessment of air quality issues at Yucca Mountain. Treatment of the issue in the 1986 statutory EA was cursory as the document was intended as a preliminary analysis to be compared with other potential repository sites. The air quality EFAP and the EMMP are based largely on the statutory EA and need to be re-evaluated using revised assumptions about emissions now that more is known about the plans for site characterization. The completeness of the analysis also should be reconsidered so that a stronger basis will be available for identifying potential impacts, initiating conditions, and impact reduction measures that can be taken if necessary.

What remains needed with respect to the issue of potential health impacts from particulate emissions associated with site characterization are:

- A definitive impact threshold with supporting basis for it and a set of measures that automatically would be enacted if the threshold were encountered during monitoring;

- A model for assessing impacts and determining methods for data collection and reduction;

- A description of how impact modeling and field monitoring efforts will be used to guide decisions and trigger specific corrective actions.

A potential air quality issue that should be addressed by DOE is regional visibility. In the case at hand visibility is important to environmental and recreational opportunities at Death

Valley National Park, to operations at Nellis Air Force Base, and to quality of life and tourism in the Las Vegas Valley, an area that already does not meet air quality standards for particulates. In each of these instances, the underlying basis of concern regarding site characterization is additive or cumulative contributions to restricted visibility deterioration over a broad area. Neither the 1986 statutory EA nor the DOE environmental program plan for the Yucca Mountain Project addresses the issue of diminished visibility.

Another issue regarding particulate emissions that is not addressed in DOE's environmental program plan is the potential for dust fall to adversely affect the Yucca Mountain ecosystem. Larger dust particles fall out relatively near the source of disturbance and can coat vegetation to the extent that reduced productivity and weaken plants result. An environmental program that does not clearly address the intent of NEPA that ecosystems be protected and instead focuses exclusively on compliance with environmental requirements and administrative criteria would miss this issue because no legal standards exist to protect biota from dust fall. Long term effects of exposure to dust are not well researched in natural ecosystems and neither is it known what effects dust fall might have on the success of reclamation efforts. These are among the unresolved scientific and environmental issues that should be addressed by DOE in the course of the Yucca Mountain Project (Lemons and Malone, 1991).

Although ecological impacts of dust fall are not addressed in the EMMP, the air quality EFAP, or elsewhere in DOE's environmental program plans, the issue has been acknowledged aside from the planning documents reviewed here. A DOE conference paper on biological impacts at Yucca Mountain (Green et al., 1991) acknowledged that dust fall associated with site characterization activities constitutes a primary indirect disturbance to vegetation. The paper states that the extent of such impacts is

being investigated. This indicates that the DOE environmental plan is not consistent with the field studies that are underway and that at least some of the component plans (e.g., U.S. DOE, 1988c, 1988d, and 1988e) need to be updated.

3.2 WATER RESOURCES

As with air quality, the 1986 statutory EA concluded that no significant adverse impacts to water resources would result from site characterization activities at Yucca Mountain. However, in planning its environmental program DOE wisely acknowledged that impacts to water resources could occur. Thus, the EMMP specified initiating conditions for water resources including water quality.

The EMMP and the EFAP for Water Resources (U.S. DOE, 1990c) focus attention on the potential for ground-water impacts on proposed withdrawals from Well J-13 during site characterization. Drawdown of the water table is assumed and a program for testing and monitoring to detect the extent of drawdown is presented. The water quality issue is not focused on anything specific. Rather, it is cast as a general issue regarding the potential for some activities to be sources of varied types of contamination of both surface and ground water.

3.2.1 Key Water Resources Issues

There are two key issues with respect to water resources and water quality concerns associated with site characterization activities at Yucca Mountain. They are as follows.

(A) Impacts to ground-water supplies is a priority concern. The potential impacts are not well understood because the baseline data are too incomplete to identify hydrogeological relationships in the Yucca Mountain area. For example, the degree of interconnection in ground-water basins of the region

is not clear. Impacts may be either narrowly defined, e.g., localized drawdown that may little affect the regional aquifers, or broadly defined, e.g., effects on regional aquifers such as the ground-water supplies to the Ash Meadows area, including Devil's Hole.

(B) The introduction of hazardous and toxic materials into water resources poses both human health risks and hazards to natural ecosystems. Adverse effects on water quality could be both localized and more widely dispersed as well as being cumulative. Thus, site characterization has the potential to generate sewage, ground-water tracers, and drilling effluents that could both pose health risks to humans and threaten the natural ecosystems in the Ash Meadows area.

3.2.2 DOE Response to Water Resources Issues

Addressed in this subsection is how the DOE environmental program plans respond to the above issues surrounding water resources and water quality.

Impacts to Ground-Water Resources

The program presented in the water resources EFAP for monitoring and evaluating impacts on ground water appears comprehensive. Although the program seems to have a sound conceptual base, it lacks specifics. An effective working plan should have more details on how the monitoring program would operate, which models would be applied, the type of output expected from the models and how the output would be used to identify specific initiating conditions and thresholds of significant impact. Modeling efforts are briefly discussed in the water resources EFAP but decisions on the structure of the models and criteria are put off until some undefined future date. Aquifer testing and modeling would be useful if directed to identifying

specific impact criteria and assessing whether thresholds of significance would be met. There is insufficient substantive information in the DOE environmental program plan to determine how DOE intends to recognize significant adverse impacts and relate them to an appropriate mitigation action.

Alteration of Sensitive Habitats

Springs are important to some of the biota in desert environments, especially to threatened and endangered species that depend on such sensitive habitats. The water resources EFAP presents some good information and inventories on springs in the Yucca Mountain area and recognizes the potential for ground-water withdrawal to adversely impact them. What remains needed is a better understanding of geohydrological and spatial relations of the springs in the Yucca Mountain area. An effort is needed to determine the importance of each spring and its sensitivities to disturbance. The effort would include developing information on recharge areas and topographic or geologic exposure that would make a spring susceptible to impact from site characterization activities. This approach is needed to establish realistic impact avoidance and minimization planning.

The water resources EFAP lacks a clear connection between the initiating conditions for ground water and springs and how these trigger decisions to act. As written in the plan, no measures are to be taken to protect springs until impacts are found to be approaching a significant adverse condition. However, no such initiating condition is presented in the EFAP or the EMMP and no insight is given to what constitutes a significant adverse condition. Neither are there criteria for relating monitoring observations to a predetermined set of actions that would be implemented to prevent an impact.

While the EFAP contends that the springs at Ash Meadows and Devil's Hole will not be affected, it nonetheless holds open the possibility that impacts to the habitats could occur. However, no special consideration is given to them in either the water resources EFAP or the EFAP on Terrestrial Ecosystems (U.S. DOE, 1988d) which addresses the aquatic ecosystems in the Ash Meadows area. For example, questions remain about the local ground-water connection between Yucca Mountain and the Ash Meadow's area. DOE's lack of significant attention to the resources is based on the assumption that there is no direct hydrological connection that could lead to impacts on water levels due to withdrawals or impacts to water quality as a result of contamination at Yucca Mountain. This position is weak from the viewpoint of technical adequacy of the data on which the assumption is based. Moreover, DOE has a legal requirement and ethical commitment to prevent significant impacts to resources like those at Ash Meadows and Devil's Hole that are protected by law. It is contingent on DOE to demonstrate that its activities will not result in significant impacts in the area either because of a lack of natural pathways that could lead to impacts or because of safeguards built into the program that would prevent impacts from occurring. Neither has been accomplished to date.

The DOE environmental program plan does not provide specifics about how this issue will be resolved. A program of monitoring is presented, but there is no discussion of how the data will be used to identify impacts. Nor does DOE present what is considered to be an initiating condition at Ash Meadows and Devil's Hole. While water level and water quality monitoring at those sites is discussed, it is not made clear what impact or initiating condition would trigger some type of action by DOE to halt or prevent further worsening of the condition. One would expect that, given the extreme sensitivity of Devil's Hole to significant impact from minor changes in water level, a precise and strictly adhered to initiating condition would be specified. Instead, DOE puts off

this critical step to a later unspecified date when data are developed from the monitoring program about normal fluctuations on pool water levels and spring flow. Data from which to establish a baseline and develop thresholds for impacts should be developed before any site characterization activity is undertaken that could affect ground-water supply to Ash Meadows and Devil's Hole.

Control of Hazardous and Toxic Effluents

The DOE states in its environmental program plan that it intends to comply with requirements to control effluents and that it will monitor wastes. However, DOE puts off the development of details on such a program to an unspecified future date when facility design if further developed. This illustrates that planning on this issue has not been finished and that the water resources EFAP must be regarded as an incomplete document. Some conceptual design for dealing with waste storage and sewage disposal should be provided and criteria relevant to effluents should be identified that can be used for facility siting and design to ensure that pollutants will be properly managed.

The water resources EFAP states that the proposed muck storage pile for the exploratory studies facility will be lined, but details are not provided. Effluent from the pile would be treated and any releases would comply with standards for discharges established under permits granted by the state. When the EFAP was issued DOE apparently did not know what pollutants may be of concern or what the permit requirements might entail. Thus, a concern remains about how muck pile effluent containment and discharge should be taken into consideration in making decisions about the location and design of the pile. The DOE addresses alternative siting only in reference to important species. No attention is given to such matters as siting criteria that recognize sensitivities to impacts from muck pile effluents.

3.3 SOILS

Soil resources at Yucca Mountain have never been characterized. Despite this, the 1986 statutory EA and the EMMP conclude, without the benefit of empirical data and analysis, that no significant adverse impacts to soils are expected from site characterization. Thus, there are no initiating conditions and no monitoring plans for soils. The EFAP for Soils (U.S. DOE, 1990b) is a reasonable first step toward remedying some of these deficiencies as it presents a comprehensive program of studies to characterize the soil at Yucca Mountain. The soils EFAP is one of the better programs presented among the DOE environmental planning documents because it attempts to be complete in describing the data collection efforts. However, the EFAP is more a study plan for developing baseline data than a plan to manage soils in relation to site characterization. Below are discussed three important environmental issues regarding protection of soil resources that need further attention by DOE.

3.3.1 Soil Loss

Site characterization activities have considerable potential to induce erosion of soil by water and wind. Estimates of soil disruption volumes should be provided by DOE. It would be important to provide estimates of soil loss and to identify measures that would be applied to minimize soil losses and mitigate impacts. Thus, the soil information that will be collected should be put to useful purpose in developing a soil management plan. Specific measures to control soil erosion should be identified in relation to the erodibility characteristics for each major soil type. Categories of site characterization activities should be related to the kinds of soil disturbances expected and measures to minimize and mitigate impacts should be specified.

Information also is needed on how DOE intends to reduce losses of removed topsoil through management of storage piles. This is important because topsoil is a limited, critical resource, and because topsoil that is stockpiled and improperly managed rapidly could become infertile and have little effectiveness when used for reclamation.

3.3.2 Alteration of Soil Characteristics

Site characterization activities have the potential to alter a variety of soil characteristics through soil removal, compaction, alteration of drainage, removal of vegetation, and other causes. The DOE environmental plans do not address how these issues will be dealt with. The baseline studies proposed in the soils EFAP will provide useful information in this regard but there is no discussion of how these data could be applied to ensure that soil characteristics will be preserved or restored.

The field moisture of soil is one of the most critical elements in desert ecosystems but is not among the parameters addressed by the soils EFAP. Site characterization will alter field soil moisture levels and result in soil dehydration. The significance of this impact is based principally on cumulative alterations of soils with attendant cumulative impacts on biota and air quality. Additionally, any attempt at site reclamation must include provisions for reestablishing field soil moisture to levels that will sustain the plant community at a given location. The environmental baseline should incorporate information on field soil moisture characteristics to capture annual variation and identify seasonal variability in moisture amount and depths. The information would be especially useful for reclamation planning.

3.3.3 Reclamation

A significant portion of reclamation is directed to reestablishment of soil conditions that will support plants and animals. The success of reclamation efforts will depend considerably on how well the soil characteristics and their interrelationships are understood as well as the ability of DOE to reestablish soils and their characteristics in a manner that will achieve reclamation objectives.

In the soils EFAP the data proposed to be collected for purposes of reclamation are extensive. However, the effort lacks direction with respect to reclamation goals because there is no clear understanding of DOE's reclamation objectives. Thus, it is difficult to see how all the data that will be collected will come together to create a definitive reclamation plan. It may be that DOE's purpose is to use the baseline data to assess reclamation feasibility and to develop specific reclamation objectives that are alternatives to the generic objective of restoring the ecosystem to its former condition as stated in the RPP.

3.4 ECOSYSTEMS

As with other environmental issues, DOE does not recognize that site characterization could cause significant ecological impacts (U.S. DOE, 1986), but it nonetheless leaves open the possibility that changes in the program might have such results (U.S. DOE, 1988c). The EFAP on Terrestrial Ecosystems (U.S. DOE, 1988d) emphasizes legally protected species at Yucca Mountain and in the Ash meadows area, including Devil's Hole. Also emphasized are pathways studies for radiological analysis. Other aspects of ecosystem evaluation receive less attention. The effort devoted to pathways analysis is directed principally to repository licensing, is not relevant to site characterization, and therefore is not reviewed here. Because a radiological baseline is fundamental to

repository licensing rather than to managing environmental impacts from site characterization the radiological studies in both the terrestrial ecosystems EFAP and the radiological studies EFAP should be included among the site characterization plans.

There is a significant inconsistency between the ecosystems EFAP and the RFP that needs to be resolved in a revised EFAP. The RFP says that field studies of plant community structure are addressed in the ecosystems EFAP while the EFAP says the opposite is to be the case. As a consequence of this lack of coordination between two documents published two years apart, neither contains plans for studies of plant communities. In actuality, however, the studies are being carried out as part of the activities associated with a series of ecological study plots that are discussed in the ecosystems EFAP for investigating the fauna at Yucca Mountain (EG&G, 1991; Green et al., 1991). This is as it should be, but the ecosystems EFAP should be revised to reflect the reality of DOE's field studies program.

3.4.1 Key Issues Related to Ecosystems

The DOE ecology program for the Yucca Mountain Project is too narrowly drawn as a result of its limited objective of meeting environmental requirements exclusive of NEPA. The focus on the desert tortoise, the kit fox, protected species in the Ash Meadows complex, and to a lesser extent on other species associated with environmental compliance requirements, fails to address ecological and distributional issues that are vital to all species, especially those in the transitional desert ecosystem at Yucca Mountain. The key issues related to this concern are as follows.

(A) Site characterization has the potential to significantly affect the desert tortoise at Yucca Mountain. Too little is known about this unit of animals for DOE to establish a management plan for it, much less to undertake relocation of

individuals as proposed in the ecosystems EFAP. It is possible that the small number of tortoises at Yucca Mountain could enhance the significance of an impact because the animals may be a viable subpopulation with unknown characteristics. If this is the case, site characterization could decrease the size of the unit and further isolate it from areas of larger tortoise populations. The DOE's proposed relocation of tortoises is a measure that may not mitigate impacts but instead may cause losses of both the relocated animals and the animals already in the relocation area.

(B) Site characterization has the potential to significantly alter the habitat of both the desert tortoise and the kit fox. This issue is based on the sensitivity of these species to disturbance by virtue of their being located at the extremity of their natural range. Thus, it may be assumed that these species are near the limits of their environmental tolerances and are especially sensitive to small changes in their habitat.

(C) The Yucca Mountain area offers habitat conditions which have escaped much of the alteration of the environment that has led to the decline of the desert tortoise and the kit fox elsewhere. Public access to the area is highly restricted thus eliminating many activities that result in kills and injuries of the animals. Moreover, the site has been protected from grazing, mining, and roadway construction with the result that vegetation, soil, and watershed conditions have sustained minimal alteration in comparison to other areas which the species occupy. This argues for a program to avoid disturbance of the environment in the Yucca Mountain area to the maximum extent possible.

(D) Site characterization has the potential to adversely affect the unique ecosystems and legally protected species at Ash

Meadows and Devil's Hole. This has been partly discussed in Section 3.2 on water resources.

(E) Site characterization has the potential to result in cumulative and incremental damage to the transition desert ecosystem at a location which, as noted above, has remained largely undisturbed. The concern expressed above in reference to the desert tortoise and kit fox apply equally to other species in the study area. Little is known about the nature of this ecosystem and how it relates to surrounding ecosystems. That there are important ecological connections between the transition desert and adjacent ecosystems like those at Ash Meadows and Devil's Hole must be assumed. The issue here is two fold. The first concern is the extent to which site characterization may disrupt the transition desert at Yucca Mountain. Second is the extent to which diminished environmental quality could induce environmental degradation in adjacent and nearby ecosystems. A related issue is that a more comprehensive understanding of the ecosystem is required if realistic reclamation objectives are to be achieved.

3.4.2 DOE Response to Ecosystem Issues

Desert Tortoise

The EMMP identifies only two initiating conditions for terrestrial ecosystems: finding a desert tortoise and finding an active kit fox den. Both conditions follow from legal requirements protecting these two species and have the purpose of dealing with them at Yucca Mountain so that site characterization can proceed as planned. The discussion of the conditions in the EMMP reflects the degree of seriousness with which DOE addresses environmental concerns. For instance, the statement is made that neither initiating condition is expected to occur. While this may prove true for the kit fox it is unlikely to be so for the desert

tortoise for which a modest population in the Yucca Mountain study area has been documented (U.S. DOE, 1989c; Malone, 1991). Thus, a failure by DOE to encounter tortoises at Yucca Mountain in the course of site characterization must be viewed with skepticism.

The DOE rationale that proceeding with site characterization is more important than protecting environmental resources like the endangered desert tortoise and its habitat is guided by a distortion of the environmental issues surrounding protected species. The DOE claims that its environmental program is defined by compliance with legal requirements, and it is likely that in the cases of the desert tortoise and the kit fox the program will comply with the letter of the applicable laws. The opposed argument is that DOE's ecosystem program does not adequately protect these or any other species and that compliance with requirements like those stemming from the Endangered Species Act and NEPA should be targeted at a higher level to better serve the spirit and intent of the law and to demonstrate a commitment to a higher environmental ethic. The DOE should conceptually alter its program toward the objective of determining how site characterization can be planned and implemented so that significant impacts to the ecosystem can be avoided or held to a minimum.

The 1988 terrestrial ecosystems EFAP devotes considerable effort to describing methods of desert tortoise censusing and studies related to tortoise movement. The censusing methods presented by DOE are standard, but their application may not be adequate for correctly characterizing the population in the defined study area. For example, DOE (U.S. DOE, 1989c) appears to have underestimated the tortoise population in Midway Valley, which is the location of numerous site characterization activities (Malone, 1991). These and related shortcomings in DOE's 1988 study plans for the desert tortoise seem to have been partially corrected in the more recently implemented desert tortoise field studies program (Rautenstrauch et al., 1991).

Another important issue regarding the desert tortoise is that in the terrestrial ecosystems EFAP DOE is considering sites for tortoise relocation despite the fact that the EMMP states that finding desert tortoises is not expected. However, there is no provision in the EFAP for detailed censusing of tortoise populations or assessment of the carrying capacity in prospective relocation sites to determine if relocated individuals can survive. This should be included in the environmental studies program if relocation efforts are to be undertaken. As already noted, there are concerns that efforts to relocate tortoises could have adverse impacts on the animals already occupying the relocation sites.

Alteration of Desert Tortoise Habitat

Little is known about desert tortoise populations in marginal habitats like Yucca Mountain. Much can be learned by research on how this species survives in low densities under limited habitat conditions. Populations surviving at the extremity of a species' distribution often have special or unique adaptive characteristics and biological value. If research is to be conducted on how tortoises have adapted to their natural environment, Yucca Mountain must rate high as a potential location for such studies. If site characterization causes disruption of the Yucca Mountain population and degradation of its habitat, the result could be the irreversible and significant loss of a unique resource. This is one of the important issues that should be addressed by long-term ecological studies at Yucca Mountain (Lemons and Malone, 1991).

The DOE environmental program can be criticized for its lack of a holistic approach. Nowhere is this more evident than in the degree of attention DOE proposes devoting to desert tortoise habitat. Without conducting comprehensive baseline studies that included tortoise habitat, DOE has drawn significant conclusions regarding the types of studies and mitigation measures to be used during site characterization. These actions include partial

baseline surveys while site characterization is ongoing, ad hoc and spatially constrained pre-activity and post-activity surveys, and impact minimization or mitigation as discussed below.

Baseline Studies: In the terrestrial ecosystems EFAP two studies are proposed to monitor and evaluate impacts to the desert tortoise; transect surveys to evaluate populations and conditions of cover sites, and radiotelemetry studies to determine movements of relocated and undisturbed tortoises, tortoise home range, critical habitat, and mortality. These are not true baseline studies because they are to be carried out while site characterization is underway. This is consistent with DOE's view that environmental activities at Yucca Mountain are to reflect the disturbed condition following site characterization and that the resulting information on altered environmental quality will constitute the baseline for addressing the impacts to be anticipated from repository development. Because DOE did not conduct baseline studies prior to the initiation of site characterization it has no choice other than to continue ignoring pre-disturbance conditions at Yucca Mountain and to attempt to persuade others to accept conditions of the disturbed site as the baseline for NEPA compliance in the repository phase of the program. The absence of baseline information was a serious shortcoming of the 1986 statutory EA mandated by NWPA in concert with granting the site characterization program an exemption from the environmental documentation requirements under NEPA. The issue will arise again when the NEPA documentation that is required by NWPA for the repository is initiated by DOE.

The tortoise studies outlined by the terrestrial ecosystems EFAP places minimal emphasis on habitat assessment. This is one of the most important gaps in the study plan because habitat will be lost as a result of site characterization without an understanding of the tortoise's relation to its habitat requirements and tolerances at Yucca Mountain. In the absence of this information

it will be impossible for DOE to develop a desert tortoise management plan that can be hoped to succeed. Thus, the tortoise will be another victim of DOE's lack of ecosystem level studies at Yucca Mountain. Everything presented about the tortoise in DOE's study plans is based or unsupported assumptions in the 1986 statutory EA and the EMMP that impacts will not be significant and that there is no need to understand how the tortoise is sustained in and functions in its environment.

To help remedy this situation as best possible at this late date, DOE's tortoise studies should be expanded to address the questions of habitat with a detailed research design to investigate all vital aspects of the tortoise population and its relationships to the physical environment as well as to other species. Such an ecosystems approach to understanding the susceptibilities of the desert tortoise to alterations in the environment resulting from site characterization should include factors such as availability and variability in food resources, interaction with other herbivores and with predators, characteristics and availability of suitable substrate for burrows, and effects of human-made barriers on tortoise movement. At this point it is important that the needs of the species be determined and that potential impacts from site characterization activities be identified and either avoided, minimized, or mitigated as circumstances dictate.

Pre-Activity Surveys: The pre-activity survey that is to be conducted before each site characterization activity is initiated is meant to determine the presence of sensitive species like the desert tortoise. These surveys will be conducted individually for the location of each activity and without the benefit of an understanding of the whole site characterization program plan. Further, as no comprehensive baseline studies have been conducted, the relevance of each individual pre-activity survey to the larger issue of desert tortoise habitat and requirements is unknown. The fractious nature of the surveys will do little to minimize site

characterization disturbances or prevent disruption of the tortoise population. Without knowledge of the requirements of the desert tortoise, critical habitat for the species may be destroyed.

Impact Minimization and Mitigation: Strategies to minimize or mitigate impacts to tortoises are to be developed from the pre-activity surveys. The minimization measures to be considered include flagging the area to avoid animals or their observed habitat and changing the design of, relocating, or canceling the offending site characterization activity. The sole mitigation measure is relocation of animals.

This single mitigation measure is too limited, given that the desert tortoise is an endangered species, because there are significant concerns about the survival of relocated animals. The terrestrial ecosystems EFAP acknowledges that relocation places stress on the relocated individual but does not note that the existing scant evidence indicates that tortoise relocation has not been successful elsewhere. The DOE's mitigation measure must be viewed as an experiment with an unknown outcome that is likely to be the death of relocated animals.

Post-Activity Surveys: Surveys will be conducted after each site characterization activity is completed and the location is no longer needed for the program. The purpose of post-activity surveys is to monitor the actual impacts from site characterization activities and to determine whether the mitigation strategies were successful. As noted, monitoring is a necessary component of any measure as drastic as a tortoise relocation effort. But in this case monitoring is necessary because of the extent to which relocation of tortoises is an experimental measure with uncertain outcome as opposed to being proved effective as a mitigation measure. If relocation is not successful the number of tortoises will decrease and DOE will be without a method of successful

mitigation. Under this scenario at some point mitigation becomes unnecessary as the species is extirpated from the area.

Post-activity surveys should be careful evaluations of the status of the environment and the progress being made in achieving the objectives set for the effort. Contingency plans for dealing with circumstances of failing mitigation measures like relocating tortoises should be included in the environmental program plans. Thus, post-activity surveys that show the tortoise relocation program is not succeeding should be followed by halting the program and replacing it with another measure such as avoidance of impacts.

Ash Meadows and Devil's Hole

The Ash Meadows area, including Devil's Hole, is identified by DOE in the ecosystems EFAP as containing twelve species which are listed as threatened or endangered. DOE acknowledges that water levels are critical to survival of the species but states that water usage at Yucca Mountain is not expected to affect Ash Meadows. Because the hydrologic investigations at Yucca Mountain are preliminary, DOE proposed in the terrestrial ecosystems EFAP to monitor populations of the legally protected species in Ash Meadows for possible impacts from site characterization.

The program goal is oriented toward identifying relationships between fluctuating water levels and fluctuation in the populations of protected species. However, no specifics are provided on how this will be accomplished. The ecosystems EFAP presents no details for study of and impact management for the ecosystems and biological resources at Ash Meadows. Discussion of the study and management program is delayed until an unspecified future date, and there are no indications that DOE has or actually will implement any ecological activities in the Ash Meadows area (U.S. DOE, 1991b; EG&G, 1991; Green et al., 1991).

Impacts resulting from ground-water withdrawal and contamination have the greatest potential to do the most damage. The challenge to DOE is to identify the biological impacts that would occur at Ash Meadows under various scenarios of alterations of water supply and water quality. This cannot be accomplished until there is a good understanding of the ecology at Ash Meadows. Thus, ecological relationships must be addressed and an inventory must be conducted of the unique biological resources involved at a level suitable for purposes of impact assessment and development of measures to avoid, minimize, and mitigate adverse impacts.

The DOE program for the Ash Meadows area is not directed at obtaining a comprehensive understanding of the issues and the significant environmental variables involved. Instead, it is focused only on legally protected species and their relationship to water levels. The protected species are part of a complex web of biological and physical environmental components. An approach is needed that will provide an understanding of how the ecosystems at Ash Meadows are structured and how they function in relation to water resources. Additionally, the seasonal, annual, and long-term variabilities in both the biological systems and the physical environment undoubtedly exert significant controls over the resources in question. As almost none of this information is available, it is difficult to understand how DOE will be able to establish cause-effect relationships between water levels and protected species, much less strategies to prevent or minimize potential adverse environmental impact.

Important Species and Cumulative Ecological Impacts

With respect to the biota, the EMMP and the terrestrial ecosystems EFAP emphasize legally protected species like the desert tortoise and the threatened and endangered biota at Ash Meadows. Other species are scarcely addressed because of the conclusions of the 1986 statutory EA that there would be no significant ecological

impacts from site characterization at Yucca Mountain. This assumption was based on rudimentary qualitative information on the biotic environment. The lack of quantitative data on the biota in the Yucca Mountain Project area means that no conclusions regarding the presence and distributions of species or the status of their populations can be scientifically inferred. Thus, there was and remains insufficient information to empirically support assertions of no significant impacts in the 1986 statutory EA.

The weakly researched and poorly supported conclusions of the 1986 statutory EA have been used by DOE to address legally protected species as the principal focus of the EMMP and the terrestrial ecosystems EFAP. There is some discussion of "important species" in reference to nuclear regulatory requirements associated with repository licensing. Although the basis for DOE's interest in the concept of important species is not discussed, it appears to be grounded in a concern for establishing pathways for radionuclide movement in the environment. Such information is not relevant to assessing impacts that may result from site characterization activities at Yucca Mountain.

In the repository licensing requirements of the Nuclear Regulatory Commission (10 CFR 60) the concept of important species is tied in part to ecological concepts. In addition to including commercially or recreationally important species and threatened or endangered species, the regulations include species that affect the well-being of important species as well as species that are critical to the integrity of an ecosystem. DOE's list of important species at Yucca Mountain does not include either species that affect important species or species critical to ecosystem structure and function. This oversight is a matter of DOE not having sufficient understanding of the ecosystem to identify such species.

The 1986 statutory EA does not contain adequate information to allow identification of all the species important to the Yucca

Mountain ecosystem. The terrestrial ecosystems EFAP indicates that studies will be conducted to identify important species but fails to discuss how this will be accomplished. It is not possible to identify species important to the structure and function of an ecosystem without having a good fundamental understanding of the ecosystem. Research and studies presented by DOE in the environmental program plans do not address the basic question of ecosystem structure and function. The program of ranging studies addresses the populations of selected individual species with little effort to relate the information to the environment or to interrelationships with other species.

The issues that DOE needs to address with regard to important species include how to recognize such species at Yucca Mountain, how to assess the importance of a species to maintaining the integrity of the ecosystem, and how to determine how site characterization can affect important species. Answers to these questions will come only from comprehensive investigations of the complete ecosystem, an approach that the DOE environmental program excludes in preference of studies only on selected species and selected aspects of the environment. Comprehensive surveys and ecological analysis are sacrificed in preference of pre-activity surveys and limited investigations to be conducted in study plots. These investigations will not produce sufficient information for constructing models of ecosystem structure and function. Thus, the DOE environmental program will produce only small bits of information in scattered pieces that will make the traditional practice of ecosystems analysis impossible.

The significance of this issue for site characterization and for NEPA compliance later in the overall program is grounded in the concept of cumulative impacts which is framed in the ecosystem concept. Important species other than those that are legally protected or addressed by regulations are so identified because impacts to them affect not just that species but also induces

broader changes in the environment and among other species. Because of the significant relationships which important species have in an ecosystem, it is necessary that research be directed to identifying thresholds of impacts on them. This must then be accompanied by monitoring of populations and distributions of the species and the related condition of its environment to ensure that conditions can be recognized when the species is approaching its threshold of significant impact. Monitoring must also be conducted of the cumulative alterations in the environment caused by human disturbance or fluctuations in the natural environment. The DOE environmental program includes none of this.

If thresholds for important species can be identified it is possible to establish resource management objectives and specific implementing measures directed to ensuring that the species and its environment do not deteriorate to the impact threshold. Such thresholds also have utility in setting reclamation goals where impacts to the important species have occurred or are anticipated. Again, DOE's plan provides no basis for making informed management decisions for important species.

Ecosystem studies embodying cumulative impact assessment should be carried out by DOE at Yucca Mountain because the environment there is unusual and there is potential for site characterization to fragment and diminish environmental quality. This results from a combination of conditions at Yucca Mountain associated with the transition desert, the volcanic substrate, the lack of significant human alteration of the environment, and the potential for significant connections with the Ash Meadows complex. The Yucca Mountain site poses opportunities for long-term environmental studies seldom presented elsewhere (Lemons and Malone, 1991). Such considerations fit into the context of a previously proposed alternative to DOE's environmental program plan that is based on ecosystem level studies and management of environmental resources (Winsor and Malone, 1990).

3.5 CULTURAL RESOURCES

The DOE has sponsored investigations of cultural resources at Yucca Mountain for several years. That research has produced the recognition that Yucca Mountain possesses rich archaeological remains related to a long history of human use and occupation. As noted by DOE, Yucca Mountain has been nominated to the National Register of Historical Places.

The ERCP and the two EFAPs for cultural resources (U.S. DOE, 1988f and 1988g) discuss the applicable laws for Native Americans and archaeology. Key issues for cultural resources protection are derived directly from legal requirements and are adequately addressed in DOE's environmental program plans. The cultural resources surveys designed to implement and comply with the requirements are consistent with current practice.

The program presented in the cultural resources EFAPs is the best of all the environmental disciplinary plans presented by DOE for the Yucca Mountain Project. Both EFAPs indicate a carefully structured plan formulated in response to an understanding of the significance of the resources in question. Unlike other elements of the DOE's environmental program plan these have the advantage of baseline studies on which to build a meaningful program. The EFAP for archaeological resources (U.S. DOE, 1988g) is unique among all other EFAPs in that it proposes a specific plan for dealing with the issue of impact avoidance by establishing an avoidance index. The index is important in deciding if a cultural resource is to be preserved by moving or stopping a specific site characterization activity or, alternatively, if it will be subjected to a resource recovery effort. This is a useful approach that should be applied to other environmental resource issues at Yucca Mountain as well.

4.0 INTEGRATION OF ENVIRONMENTAL TOPICS

As noted earlier in this review, the DOE's environmental program plan for the Yucca Mountain Project should be responsive not just to an objective of meeting legally based environmental requirements, including NEPA, but also to goals of resource management. Modern approaches to resource management are grounded in principles of comprehensive impact assessment, interdisciplinary studies, and integrated planning processes. These principles of good environmental stewardship are the base upon which the nation's environmental policy was set forth by NEPA.

While the NWPA exempted site characterization at Yucca Mountain from the procedural requirement of preparing an environmental impact statement under NEPA, DOE must still comply with the substantive provisions and intent of NEPA. Notable in this regard are provisions in NEPA for evaluating the environmental impact of a proposed action utilizing an interdisciplinary approach to environmental analyses in planning and decision making concerning how a project is to be conducted. The approach should be systematic and in accord with a plan or method in which the impact assessment demonstrates the interrelationships among the technical disciplines and the effects actions will have on the environment in the broadest sense. A systematic interdisciplinary approach calls for more than a multidisciplinary analysis, i.e., separate analysis for each environmental topic or discipline. It requires a comprehensive, coordinated assessment and evaluation of impacts among and between environmental technical disciplines and the environmental and social sciences.

Environmental assessment and planning in the spirit of NEPA has never been carried out for the Yucca Mountain Project, a shortcoming that stems from DOE having ignored NEPA as a consequence of being exempted from formal procedures for environmental reporting. Neither the 1986 statutory EA nor the

environmental program plans for site characterization that is reviewed here responds to the principles and substantive requirements of NEPA. The DOE's program has been divided into separate parts that lack integration and are characteristic of a multidisciplinary rather than an interdisciplinary program. While some reasonably detailed and sound studies are being proposed within some discipline, there is little evidence in any of the plans to suggest that individual program components were developed with consideration given to the effort proposed in other components.

The DOE environmental program's lack of well-conceived integration of its components stems from four primary deficiencies: incomplete plans relative to each issue area; lack of coordination between issue areas; poorly defined decision-making process; and poorly defined reporting. Each is discussed below.

4.1 INCOMPLETE PLANS

Most of the critique in this report has been directed to deficiencies in the scopes and approaches of the components of the DOE environmental program plan for site characterization at Yucca Mountain. The various documents that comprise the plans are uneven in their completeness; some are thorough, others are detailed in some aspects but lacking sufficient treatment in others. Some of the individual component contain references to portions of the plan that will be completed later at unspecified times. Some plans have been developed under narrow interpretation of the pertinent legal requirements and the methodological bases of environmental impact assessment and resource management. As a result, significant gaps in information will result in reference to specific issues.

The basic problem with incompleteness in individual components of the DOE plan is that it prevents integration of all the necessary information into the planning and decision-making

processes. For example, it would seem that habitat requirements for the desert tortoise would comprise an important consideration in reclamation planning. But the terrestrial ecosystems EFAP hardly addresses habitat questions and, therefore, will generate little useful information that can be applied to designing a tortoise habitat restoration effort. The soils EFAP incorporates a standard soil survey approach that probably will not produce information useful for understanding the substrate habitat requirements of the tortoise or that could be applied in reclamation specifications for the tortoise.

Additionally, there is no attention given in the various reclamation plans (U.S. DOE, 1989b, 1990a, and 1990b) to efforts directed to individual species, including the desert tortoise. In the case of the tortoise, this means that decisions affecting the species and its habitat will be made without all the information needed to select among choices that should be included in a comprehensive management plan. Thus, many decisions affecting environmental resources will be made on the basis of assumptions that may or may not be true.

Another important problem affecting integration of the DOE plan is the narrow focus on identifying the actual problem. For example, the DOE environmental program focuses almost exclusively on direct impacts. Indirect impacts are only casually addressed and cumulative impact are ignored altogether. The failure to address indirect and cumulative impacts results in research and monitoring plans that are too narrowly drawn. This prevents establishment of a coordinated program directed to overall resources management goals. In short, the DOE program plan will produce information suitable only for dealing with environmental issues on a location-by-location basis within a limited timeframe. The plan will not produce information needed to provide a comprehensive understanding of environmental problems and to identify possible solutions that incorporate an understanding of

their broader implications for the resources in question. The existing DOE environmental program plan loses sight of the bigger picture of environmental management while focusing on fragmentary analyses and planning within the confines of a narrow application and interpretation of environmental compliance requirements that fail to address NEPA.

4.2 COORDINATION BETWEEN COMPONENTS OF THE DOE PLAN

The lack of coordination between the various elements of the DOE environmental plan becomes obvious in attempts to determine how a given issue might be handled. For example, the air quality EFAP and the EMMP make an open-ended commitment to water down disturbed sites, while the water resources EFAP (U.S. DOE, 1990c) provides no estimates of how much water this might take. The question then arises if the water resources EFAP adequately addresses the issues required to meet the needs of the air quality EFAP. Some issues are more complex and will require input from many disciplines both to define the scope of the problem, identify options, and determine information needs to resolve the problem.

The DOE program plan is constructed on significant assumptions about the environment, of which little is known, as well as significant assumptions about the amount of impact that site characterization will have on the environment. The plan does not recognize the implications with respect to component EFAPs if these assumptions prove incorrect. In short, DOE has not given sufficient credence to the options that are possible. As a result, each component of the program has been focused on a different set of issues and solutions, essentially via the narrow direction of the EMMP. This means that DOE will be producing information capable of dealing only with preconceived assumed impacts and narrowly drawn mitigation solutions. If the assumptions prove wrong or the solutions do not work as planned, a redirection will

be necessary. In such a case, the changes needed in one study component may precipitate changes throughout the program plan.

A significant concern remains that if such a redirection were determined to be necessary, DOE will already have reduced its choice of options because of the impacts induced by site characterization disturbances or because insufficient time will be allowed to gather the necessary information to choose among alternatives. An alternatives analysis apparently has never been conducted and the concept is absent from the environmental program plan. It appears that the DOE is so convinced that the environmental program plan will work as presented that there it sees no need to consider options or even to develop a fall-back plan. Neither is there an identified process for reevaluation and mid-course redirection of the plan.

4.3 DECISION-MAKING PROCESS

The EMMP, ERCP, and most of the EFAPs present descriptions or diagrams of procedures for evaluating certain resources or for monitoring conditions in the environment and using the information for establishing a course of action. Such decision-making processes for all environmental issues are not identified for the program as a whole in any single component of the DOE environmental program plan. Each procedure appears to have been developed independently in response to a specific issue and not all issues are covered throughout the various components of the plan.

Thus, it is not clear how individual decision-making processes will be integrated to reach a decision on how to act with respect to a site characterization activity. In only one case does DOE's environmental program plan clearly indicate how a given procedure will be applied to a specific issue. Chapter 4 of the RIP briefly describes the preactivity and postactivity surveys conducted under Administrative Procedure 8.1, Land Access and Environmental

Compliance, and how the resulting information is used for making reclamation decisions. Nowhere else among DOE's plan is it made clear how Administrative Procedure 8.1 will be used for determining that (a) an initiating condition exists, (b) a priority condition exists, (c) a site characterization activity should be altered or halted, and (d) a detected impact should be resolved. Such descriptions should be included in Section 6 of the EMMP and the discussions in both the RIP and EMMP should be coordinated and crossreferenced instead of appearing to be unrelated.

Another important issue regarding decision-making processes is that in most cases DOE has limited the input of other authorities. The principal responsibility of DOE for integrating the input of other agencies is one of notification and reporting. The environmental program has been established within a framework of permits and programmatic agreements that basically give DOE free reign in decision-making provided DOE remains in compliance with the conditions of the specific agreements. In this respect DOE monitors its own compliance which encourages it to continue a self-directed environmental program without the benefit of input from other parties in day-to-day decision making. Issues of this nature were addressed in an earlier report by the State of Nevada (1988) that concluded that the State should have a strong role in environmental oversight for the Yucca Mountain Project.

4.4 REPORTING

The DOE environmental program plans contain provisions for the production of numerous reports. Some reports are progress reports, others seem to be data files, some are decision documents, some are permits or information needed to fulfill an environmental requirement, and others are notifications. The problem in this respect is understanding how the reports will be used to support the planning and decision-making processes within the environmental program. Specific procedures should be established by DOE that

define the information needed for making a decision, how the information will be reported, how the decision will be documented, and what notification about the decision will be made. An example of the need for such a procedure is identifying an initiating condition and the subsequent actions that should follow.

The issue of reporting is crucial to the State of Nevada in its oversight role. Through its permit requirements the state will get some of the information needed to formulate responses and make determinations of compliance or non-compliance. All other environmental information is managed internally by DOE in obscure manners like that of Administrative Procedure 8.1. There are no statements among the DOE's environmental program plan regarding information that is placed into accessible databases and what is subject to DOE's discretion as to reporting and filing. As a result it is not clear what databases and other information are available to the state and other interested parties. There are some internal DOE processes which do not seem to have a formal reporting requirement, particularly to outside agencies. For example, the ERCP discusses plans to develop a regulatory compliance auditing program but reporting of results are not identified as part of the program.

The DOE environmental program plans should provide detailed information on all aspects of reporting including procedures for preparing reports, the information and data to be contained, reporting responsibilities and notification requirements, and filing location or destiny of reports and associated data files. It is contingent upon DOE to establish credible environmental reporting plans and to comply with them. This is an aspect of performance monitoring that is crucial to the State of Nevada with respect to oversight of the DOE environmental activities for the Yucca Mountain Project.

5.0 REFERENCES

Cairns, J., Jr. and T.V. Crawford. 1991. Integrated Environmental Management. Lewis Publishers, Inc., Chelsea, MI. 214 pp.

Duffy, D.P. and J.E. Potter. 1992. Environmental auditing: A profession comes of age. ENVIRONMENTAL SCIENCE AND TECHNOLOGY 26: 1706-1708.

EG&G. 1991. Yucca Mountain Biological Resources Monitoring Program: Annual Report FY89 & FY90. EGG 10617-2084. EG&G Energy Measurements, Goleta, CA.

ESA (Environmental Science Associates, Inc.). 1988. Nevada Environmental Studies Program at Yucca Mountain: Fiscal Year 1988-89. Project 87092. Environmental Science Associates, Inc., San Francisco, CA.

_____. 1989. Impact Assistance Report: Inventory of Past DOE Land Disturbance, Yucca Mountain, Nevada, and Estimated General Reclamation Costs. Environmental Science Associates, Inc., San Francisco, CA.

Green R.A., M. Cox, T. Doer, T. O'Farrell, W. Ostler K. Rautenstrauch, and C. Wills. 1991. Assessing impacts on biological resources from site characterization activities of the Yucca Mountain Project. Pages 1456-1460, In HIGH LEVEL RADIOACTIVE WASTE MANAGEMENT, Proceedings of the Second International Conference, Las Vegas, NV, April 28-May 3, American Nuclear Society, Inc., La Grange Park, IL.

Lemons, J., C.R. Malone, and B. Piasecki. 1989. America's high-level nuclear waste repository: A case study of environmental science and public policy. INTERNATIONAL JOURNAL OF ENVIRONMENTAL STUDIES 34: 25-42.

Lemons, J. and C.R. Malone. 1989 Siting America's geologic repository for high-level nuclear waste: Implications for environmental policy. ENVIRONMENTAL MANAGEMENT 13: 435-441.

_____. 1991. High-level nuclear waste disposal and long-term ecological studies at Yucca Mountain. BIOSCIENCE 41: 713-718.

Malone, C.R. 1989. Environmental review and regulation for siting a nuclear waste repository at Yucca Mountain, Nevada. ENVIRONMENTAL IMPACT ASSESSMENT REVIEW 9: 77-95.

_____. 1990. Implications of environmental program planning for siting a nuclear waste repository at Yucca Mountain, Nevada, USA. ENVIRONMENTAL MANAGEMENT 14: 25-32.

_____. 1991. The potential for restoring the Yucca Mountain site to a stable ecological condition. THE ENVIRONMENTAL PROFESSIONAL 13: 216-224.

Marsh, L. and P. Lallas. 1990. Focused special area planning: An approach for reconciling development and wildlife habitat and other environmental concerns. COMMENTARIES ON RECENT DEVELOPMENTS IN LAND USE AND ENVIRONMENTAL LAW 3: 1-33. Siemon, Larsen, and Marsh Law Offices, Irvine, CA.

McAllister, D.M. (Ed.). 1973. Environment: A New Focus For Land-Use Planning. National Science Foundation, Washington, D.C. 328 pp.

McHarg, I. 1969. Design With Nature. Falcon Press, Philadelphia, PA. 197 pp.

Office of Technology Assessment. 1987. Technologies to Maintain Biological Diversity. OTA-F-330, General Printing Office, Washington, DC. 334 pp.

Ostler, W.K., T. O'Farrell, V. Winkel, and B. Schultz. 1991. The reclamation program for the Yucca Mountain Project. Pages 1461-1468, in HIGH LEVEL RADIOACTIVE WASTE MANAGEMENT, Proceedings of the Second International Conference, Las Vegas, NV, April 28-May 3, American Nuclear Society, Inc., La Grange Park, IL.

Parker, G.J., J.R. Krummel, K.E. LaGory, G.J. Marmer, and S.P. Goel. 1990. The Environmental protection program for site characterization at Yucca Mountain. THE ENVIRONMENTAL PROFESSIONAL 12: 185-195.

Rautenstrauch, K.R., M.K. Cox, T.B. Doerr, R.A. Green, J.M. Mueller, T.P. O'Farrell, and D.L. Rakestraw. 1991. Management and research of desert tortoises for the Yucca Mountain Project. Pages 1449-1455, In HIGH LEVEL RADIOACTIVE WASTE MANAGEMENT, Proceedings of the Third International Conference, Las Vegas, NV, April 12-16, American Nuclear Society, Inc., La Grange Park, IL.

RCI (Resource Concepts, Inc.). 1989. Review of Revegetation Practices Appropriate for Reclamation of the Proposed Nuclear Waste Repository at Yucca Mountain, Nevada. Resource Concepts, Inc., Carson City, NV.

Savory, A. 1990. Holistic Resource Management. Island Press, Covelo, CA. 545 pp.

Shenk, K.J., J.K. Prince, and C.D. Sorensen. 1992. Radiological environmental monitoring for the Yucca Mountain site. Pages 2313-2317, In HIGH LEVEL RADIOACTIVE WASTE MANAGEMENT,

Proceedings of the Third International Conference, Las Vegas, NV, April 12-16, American Nuclear Society, Inc., La Grange Park, IL.

State of Nevada. 1987. Environmental Program Planning for the Proposed High-Level Nuclear Waste Repository at Yucca Mountain, Nevada. NWPO-TR-001-87, Nuclear Waste Project Office, Carson City, Nevada.

_____. 1988. A Role in Environmental Compliance for the State of Nevada During Site Characterization of the Proposed High-Level Nuclear Waste Repository at Yucca Mountain, Nevada. NWPO-TR-008-88, Nuclear Waste Project Office, Carson City, NV.

Thurow, C., W. Toner, and D. Erley. 1975. Performance Controls for Sensitive Lands, A Practical Guide for Local Administrators. American Society of Planning Officials, Chicago, IL. 156 pp.

Ulland, L. and M. Winsor. 1989. The role of the state and environmental compliance in NWPA implementation. Pages 167-171 in PROCEEDINGS, WASTE MANAGEMENT 1989 CONFERENCE, Vol.I, University of Arizona, Tucson.

U.S. DOE (U.S. Department of Energy). 1986. Environmental Assessment: Yucca Mountain Site, Nevada Research and Development Area, Nevada. DOE/RW-0073, 3 Volumes. U.S. Department of Energy, Washington, D.C.

_____. 1988a. Environmental Regulatory Compliance Plan for Site Characterization of the Yucca Mountain Site. DOE/RW 0209. U.S. Department of Energy, Washington, D.C.

_____. 1988b. Environmental Program Overview. DOE/RW-0207. U.S. Department of Energy, Washington, D.C.

_____. 1988c. Environmental Monitoring and Mitigation Plan for Site Characterization. DOE/RW-0208. U.S. Department of Energy, Washington, D.C.

_____. 1988d. Environmental Field Activity Plan for Terrestrial Ecosystems. DOE/NV-10576-14. U.S. Department of Energy, Las Vegas, NV.

_____. 1988e. Environmental Field Activity Plan for Air Quality. DOE/NV-10576-13. U.S. Department of Energy, Las Vegas, NV.

_____. 1988f. Environmental Field Activity Plan for Cultural Resources: Native American Component. DOE/NV-10576-15. U.S. Department of Energy, Las Vegas, NV.

_____. 1988g. Environmental Field Activity Plan for Cultural Resources: Archaeological Component. DOE/NV-10576-16. U.S. Department of Energy, Las Vegas, NV.

_____. 1988h. Site Characterization Plan. DOE/RW-0199. U.S. Department of Energy, Washington, D.C.

_____. 1988i. Environmental Field Activity Plan for Radiological Studies. DOE/NV-10576-12. U.S. Department of Energy, Las Vegas, NV.

_____. 1989a. Draft Reclamation Program Plan for Site Characterization. DOE/RW-0244. U.S. Department of Energy, Washington, D.C.

_____. 1989b. Yucca Mountain Project Reclamation Guidelines. DE-AC08-87NV10579. U.S. Department of Energy, Las Vegas, NV.

_____. 1989c. Biological Assessment of the Effects of Site Characterization Activities on the Endangered Desert Tortoise. U.S. Department of Energy, Las Vegas, NV.

_____. 1990a. Draft Reclamation Feasibility Plan. DOE/YMP-90-10. U.S. Department of Energy, Las Vegas, NV.

_____. 1990b. Environmental Field Activity Plan for Soils.DOE/YMP-90-11. U.S. Department of Energy, Las Vegas, NV.

_____. 1990c. Environmental Field Activity Plan for Water Resources. YMP/90-50. U.S. Department of Energy, Washington, D.C.

_____. 1990d. Environmental Protection Implementation Plan for the Yucca Mountain Project. YMP/91-12. U.S. Department of Energy, Las Vegas, NV.

_____. 1990e. Environmental Management Plan. YMP/CC-0006. U.S. Department of Energy, Las Vegas, NV.

_____. 1991a. Reclamation Implementation Plan. YMP/91-14. Department of Energy, Las Vegas, NV.

_____. 1991b. Environmental Monitoring and Mitigation Plan Progress Report. (Unnumbered). U.S. Department of Energy, Las Vegas, NV.

Westman, W.E. 1985. Ecology, Impact Assessment, and Environmental Planning. John Wiley and Sons, New York, NY. 532 pp.

Wilkinson, C.F. and H.M. Anderson. 1990. Land and Resource Planning in the National Forests. Island Press, Covelo, CA. 400 pp.

Winsor, M.F. and C.R. Malone. 1990. State of Nevada perspective on environmental program planning for the Yucca Mountain Project. THE ENVIRONMENTAL PROFESSIONAL 12: 196-207.

APPENDIX

List of Acronyms

DOE	-	Department of Energy
EFAP	-	Environmental Field Activity Plan
EMMP	-	Environmental Monitoring and Mitigation Plan
EMP	-	Environmental Management Plan
EPIP	-	Environmental Protection Implementation Plan
EPO	-	Environmental Plan Overview
ERCP	-	Environmental Regulatory Compliance Plan
NEPA	-	National Environmental Policy Act, as amended
NWPA	-	Nuclear Waste Policy Act, as amended
PM-10	-	respirable particulates
SCP	-	Site Characterization Plan
RFP	-	Reclamation Feasibility Plan
RIP	-	Reclamation Implementation Plan
RPP	-	Reclamation Program Plan
TSP	-	total suspended particulates

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