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ENVIRONMENTAL MANAGEMENT OBJECTIVES, IMPACT POTENTIAL AND RECLAMATION PLANNING FOR DOE SITE CHARACTERIZATION AT YUCCA MOUNTAIN, NEVADA

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1. INTRODUCTION

This report presents a proposed strategy for the State of Nevada to identify and mitigate impacts related to the proposed Site Characterization activities of the U.S. Department of Energy (DOE) at Yucca Mt. and its vicinity. The report was prepared in response to the directive of the Nevada Nuclear Waste Project Office (NWPO) of 2/14/89 to prepare environmental guidance for use in evaluating the suitability of areas chosen by DOE for surface disturbing activities and the acceptability of reclamation measures. As such, this report responds to issues raised by NWPO regarding impact identification, reclamation and monitoring activities proposed by DOE in Section 8.7 of the Draft Site Characterization Plan of December 1988 (DOE, 1988a) and the Environmental Monitoring and Mitigation Plan (EMMP) of December 1988 (DOE, 1988b).

1.1 BACKGROUND TO THIS REPORT

The need for a State originated strategy on potential impact identification and reclamation related to Site Characterization is grounded in the inherent deficiencies of DOE's program for dealing with environmental issues. The deficiencies result from the lack of an integrated planning program directed to the fundamental concept of resource management. Key deficiencies relevant to impact identification and reclamation planning in DOE's Environmental Program are summarized as follows:

1) Key Issue 3 in the DOE Draft Mission Plan (DOE, 1985) remains undefined and unresolved. Resolution of Key Issue 3 has been delayed by DOE until after scoping of the EIS on repository development; scoping at present is unscheduled. Thus, the DOE environmental program lacks specific objectives and direction. Site Characterization activities that will result in environmental impact are scheduled to proceed in advance of the identification of environmental objectives or defined approaches to resolution of the potential impacts.

2) The Statutory Environmental Assessment (EA) prepared by DOE in 1986 for siting the repository at Yucca Mt. determined that no significant environmental impacts were anticipated from Site Characterization activities. That determination cannot be justified on grounds already identified by the State. In adopting the position that the determination of the EA is the basis for focused program of environmental monitoring, mitigation and reclamation, DOE has created a program that is deficient for the following reasons.

DOE's failure to conduct comprehensive baseline studies makes it impossible to determine environmental sensitivities that are needed for establishing conditions in which impacts would occur.

DOE failed to address impacts and environmental conditions of Site Characterization activities in their totality. Activities and related disturbances and their impacts that extend beyond Yucca Mt., as well as potential cumulative and indirect impacts are not addressed. This restriction to the analysis means that DOE's monitoring of environmental changes will be too narrowly conceived and mitigation and reclamation will be too limited to provide effective management of the affected resources.

DOE's EA failed to integrate information in a way that provides meaningful interrelation of impacts. The environmental monitoring and mitigation program, which was tiered on the EA, is likely to proceed as an uncoordinated attempt to deal with issues singly, separately, and in an ad hoc manner, lacking balance and unity of direction. Specific reclamation efforts may operate at odds with each other or other mitigation efforts.

The EA failed to clearly identify criteria for determining impact significance. This will result in monitoring, mitigation and reclamation efforts that 1) lack specific direction and 2) provide no means by which to measure success or failure of efforts in eliminating or reducing environmental impacts.

3) DOE's Environmental Monitoring and Mitigation Plan (EMMP) (DOE, 1988b) proposes identification and monitoring of impacts in only a few issue areas and assumes a priori that significant impacts will not occur. This assumption creates a highly restricted view of monitoring requirements and a minimal approach to mitigation. Suggested mitigation measures outlined in the EMMP are narrow in scope, possibly unworkable or ineffective, and possibly environmentally damaging in some cases. Protocols are lacking for enforcement and the ad hoc approach to dealing with impacts ensures an uncoordinated, piecemeal program of mitigation.

4) The fundamental shortcoming in DOE's program is the lack of identified resource management objectives. At present, there is no environmental management plan that identifies both objectives for managing resources and policies for fulfilling these objectives. Impacts are anticipated to occur over a wide variety of environmental conditions and in numerous jurisdictional areas. DOE has not addressed environmental conditions beyond the immediate Yucca Mt. site and has not related the program to resources management objectives and policies of other jurisdictional agencies.

5) DOE's SCP and EMMP do not recognize other mitigation approaches. Notably impact avoidance is equally valid and generally preferable to reclamation of disturbances. DOE's approach fails to acknowledge the well documented fact that reclamation in desert ecosystems throughout the world generally and in the West, specifically, has met with very limited success (USGS, 1983).

6) Section 8.7 of the SCP (DOE, 1988a) contains the assumption that reclamation will begin after site closure or when project abandonment at Yucca Mt. occurs. This is a narrow interpretation of the intent of the NWPA with regard to reclamation requirements. Furthermore, that interpretation may be in conflict with existing laws, environmental management objectives and policies of the United States, Nevada and California. Although NWPA and NWPAA alleviated DOE of the need for an EIS on Site Characterization, it does not alleviate DOE of the need for compliance with the intent of NEPA. DOE should consider maintenance of environmental quality in carrying out the repository program and should carry out a meaningful, responsible and comprehensive, environmental management program.

Given the above inadequacies of DOE's environmental program, it is doubtful that DOE can carry out a credible program of objective impact assessment and environmental resource management. As guaranteed by Section 116 of NWPA, the State must assume its rightful role in ensuring that environmental resources are properly protected and managed in relation to Site Characterization activities carried out by DOE.

At present, the State appears to have no clearly identified objectives or plan for resource management in relation to the DOE's repository project. Lacking such a management plan, the State's position is likely to remain reactive to DOE's program. It appears that the State could take a more assertive role by creating a solid plan for resource management and establishing an implementation strategy to which DOE must respond. At the very least, such a plan and strategy would provide an alternative approach to what DOE has proposed to date. DOE would have to respond to the State's plan and justify why its plan offers superior management of the resources. At best, if DOE were to adopt the State's plan, it would ensure greater protection of the resources whether or not the repository were developed.

1.2 GENERAL GOALS OF THE STATE FOR THE ENVIRONMENTAL PROGRAM IN RELATION TO DOE CHARACTERIZATION ACTIVITIES

In carrying out the role of environmental resource manager, the State must provide independent assessments of environmental impacts and planning of mitigation which are free of the limitations imposed by DOE on its own program. The State program should be oriented to identifying and fulfilling environmental management objectives as the primary goal. In contrast to the DOE's current environmental program, should be driven by the repository development goal, the State's program is driven by the environmental management objective. The overall strategy of the State's program should be directed at three goals (in order of priority).

1) Avoidance of impact should be the primary goal; impacts that are unnecessary or which would seriously compromise attainment of environmental objectives, should be prevented.

2) Mitigation prior to and during disturbance to eliminate and reduce impact should be the second goal. If impacts cannot be avoided, mitigation should be clearly identified in advance of the impact. Mitigation should be viewed broadly so as to include application of specific techniques to a given site, preparation for reclamation techniques, off-site considerations and compensation. The State should assertively pursue mitigation planning that is enforced as conditions committed to by DOE in any aspect of Characterization.

3) Reclamation should be regarded as the a follow-up to disturbance and impact. It would be applied when avoidance and coordinated mitigation measures to minimize impact cannot be achieved. Reclamation should be regarded as an integrated program directed to attainment of resource management objectives. It must also be regarded as an ongoing program: initiated prior to disturbance - at which time specific reclamation needs and plans are defined, implemented immediately after impact occurs, applied continuously and monitored for success, and adapted to changes in information on potentially successful techniques.

This report provides the basic framework for a coordinated and integrated program of identifying objectives for resource management, assessing impact potential, and identifying mitigation approaches and reclamation strategies. It is necessarily generic in nature.

1.3 STRATEGY FOR ASSESSING IMPACT POTENTIAL AND IDENTIFYING RECLAMATION REQUIREMENTS

The environmental management strategy for the State is defined to address issues specific to DOE activities. That strategy contains the following primary elements (Figure 1):

1) Development of objectives and policies for management of environmental resources. These will be embodied in an environmental management plan for the DOE's program which will provide the basis for guidance of monitoring, impact assessment, regulatory compliance, mitigation planning and reclamation.

2) Identification of environmental sensitivities and constraints to siting of proposed Site Characterization activities before such disturbances occur.

3) Identification of potential impacts and their significance using a broader spectrum of criteria for significance determination than simple exceedence of a standard (which is the only criterion identified by DOE). These include:

    - past and existing distribution and condition of the resources
    - trends in the state of the resources
    - established standards
    - identified thresholds of significance
    - cumulative impacts on resources
    - maintenance of ecological integrity
    - indicators of mitigability and reclaimability.

4) Identification and monitoring of specific impact indicators impacts that can be measured in the field to indicate, singly or in combination, level of impact, including incremental impact.

5) A program for reclamation that encompasses varying levels of reclamation effort based on reclamation needs, practical limitations of reclamation techniques, and environmental restoration goals.

Each of these elements is described in summary fashion in Section 1 of this report (beginning with Section 1.4). Section 2 presents generic resource management objectives, potential impacts and indicators. These will be defined more specifically as the program progresses. Sections 3, 4, and 5 describe the general process of implementation of the approach including reclamation objectives and criteria.

ELEMENTS/PROCESS	COMPONENTS	ORGANIZING CONCEPT
IDENTIFY RESOURCES & SENSITIVITIES	Distribution & Condition Trends in Status Standards Thresholds of Significance Cumulative Effects Reclaimability Ecological Integrity	"Ecological Models" Reclamation Tests
↓		
IDENTIFY RESOURCE MANAGEMENT OBJECTIVES	Resource-specific Objectives Sub-area Objectives Jurisdictional Concordance Regulatory Requirements Public Interests & Concerns	Prioritization: 1. Avoidance of Impact 2. Mitigation 3. Reclamation
↓		
DEVELOP ENVIRONMENTAL MANAGEMENT POLICIES	Resource Maintenance Control of Impacts Regulatory Compliance Reclamation Planning	Impact Models Regulatory Compliance Model
↓		
IMPLEMENT POLICIES	Sensitivity Screening Impact Assessment Mitigation Requirements Reclamation Plans Monitoring	Decision Tree (Figure 2)

FIGURE 1: PRIMARY ELEMENTS AND SEQUENCE OF THE ENVIRONMENTAL MANAGEMENT PLAN DEVELOPMENT PROGRAM

1.4 IDENTIFICATION OF RESOURCE MANAGEMENT OBJECTIVES AND POLICIES

The foundation of an environmental management program is the identification of resource management objectives. The objectives embody the overall approach that the State envisions for protection, conservation and use of resources that may be potentially affected by DOE's program for repository development. The objectives are defined by specific legal requirements, where they already apply, as well as existing or expected values placed on the resources by the citizens of Nevada. The objectives can be stated in hierarchical fashion so as to distinguish between objectives of paramount importance, e.g., protection of highly threatened species and their habitat or rare resources like some archaeological sites, and objectives for management of resources in a lesser state of urgency.

Resource management objectives should be presented as long-term goals for use and protection of the resources. Short-term objectives, e.g., goals specific to the Site Characterization period, may also be stated, but these must act in concert with long-term objectives. The objectives should address the conflicts between the natural environment of the area that is both sensitive and complex, and the demands that will be made on the environment by the DOE's program for repository development.

The area for which resource reso. mgmt. obj.)e developed includes the areas
directly affected by DOE dis)otential indirect impact. Thus,
the resource management obj e Nevada Test Site to lands
managed by the BLM, Nation ɔther federal or state agency,
and private lands. The State r 'special resource management
area" coincident with the pote ıvolvement in the identification
of objectives will be required s y already have well defined
objectives and policies for reso ılly affected area.
Additionally, it is recommende ·ment of the State of
California and the BLM Califor establishing the objectives
since some DOE activities are p :e some impacts are
anticipated to extend into Califo

The State probably also should involve special interest groups in identifying resource management values and objectives. These may run the entire spectrum of interests from conservation groups, such as Nevada Natural Heritage, the Desert Tortoise Council and the Sierra Club, to use-oriented and concerned citizen groups such as off-road vehicle recreation interests, gun and hunting clubs, mining and agricultural associations, Native Americans, etc.

Management objectives will be developed for each element of the environment including:

Terrestrial Ecology
Rare and Endangered Species
Air Quality
Water Resources
Soils
Cultural Resources
Noise
Visual Resources

The State may also wish to include environmental radiation as an element of the Environmental Management Plan.

The development of objectives is followed by the identification of specific policies which, if implemented, will fulfill the objectives. These are "shall" and "shall not" statements which present the State's position on activities of the DOE that may affect the attainment of environmental objectives. The identification of policies is critical as the basis for identification of impacts and their significance. The policies will identify priority needs for immediate and future protection and administration of the affected resources. The policies may include thresholds of significance.

It is important to note, that while the Environmental Management Plan may be written to specifically address DOE's program, the State (other agencies) would likely have to apply the policies equally to other development activities and uses in the area.

1.5 ENVIRONMENTAL SENSITIVITIES AND CONSTRAINTS TO SITING OF PROPOSED SITE CHARACTERIZATION ACTIVITIES

Environmental sensitivities are the considerations specific to each environmental resource defined by 1) the condition of the resource, 2) the socioeconomic values placed on that resource by the State, and 3) the general "reclaimability" of the resource if it is affected by disturbances. The sensitivities present constraints to Site Characterization activities because of the potential impacts that may affect the condition of a given resource or compromise the values placed on it. Thus, sensitivities may be identified for each resource by:

- the past and existing distribution and condition of the resource in the study area;
- trends in the state of the resource, including broader regional considerations; and
- relative ease or difficulty of recovery of the resource (if renewable) either through natural processes or through direct environmental manipulation (reclamation).

The identification of environmental sensitivities also must proceed on an ecological basis, that is, in the context of interrelationships and interdependencies. For example, it is important to define the sensitivity of a given [illegible] (sensitivities + constraints) [illegible]ideration" not only by its population characteristics, but alsc [illegible] dependencies on other species. The failure to recognize i[illegible]ey shortcomings in DOE's approach in the EMMP to manage[illegible]ved presence of a given species is only one criterion defini[illegible] site. Equally important to defining sensitivity of a site may b[illegible]s times of the year for critical life-cycle activities like ma[illegible]resent important habitat for foraging; or the site may be an i[illegible]ation of another animal species lower in the food chain upo[illegible]n species is dependent for sustenance.

The purpose of the sensitivities analysis is identification of conditions (constraints) at a specific site for which proposed disturbance is anticipated by Site Characterization that may lead to significant impact directly, indirectly or cumulatively. It is additionally oriented to identifying conditions which provide opportunity or constraint to reclamation techniques. The information would be recorded in a mapped database, preferably a computerized Geographic Information System, that would be available for predisturbance assessments, reclamation planning and recordation of follow-up information (e.g., mitigation and reclamation techniques applied to a given site and their relative effectiveness).

1.6 IDENTIFICATION OF IMPACT POTENTIAL RELATED TO SITE CHARACTERIZATION

The past disturbances identified by ESA in the Interim Impact Assistance Report (ESA, 1989) indicate that substantial disturbances have occurred. Conflicts may already have arisen between DOE activities and environmental resource management objectives (identified in Section 2 of this report). Those disturbances, totalling about one square mile in area, have been permitted without regard to environmental management objectives. Estimates of future disturbance indicate approximately a doubling of total disturbed area. Thus, approximately two square miles of disturbance from siting and Site Characterization are anticipated. It appears that a significant proportion of the disturbance could be avoided by better planning for DOE's field effort. Moreover, the above disturbance figures do not indicate the relationship of disturbance to environmental sensitivities or direct and indirect impacts.

Impact identification proceeds from the environmental sensitivity analysis. The goal is to define the potential significance of each site-specific impact of an individual disturbance activity and its relation to cumulative impact. The impacts may be direct, that is, immediate alteration of the environment by physical alteration of the landscape (e.g., loss of archaeological sites, soil compaction, vegetation removal, killing or removal of animals, dust plumes, etc.), addition of new elements to the environment (e.g., water, soil additives, toxic chemicals, nutrients), and creation of features and conditions which directly alter existing interrelationships and interdependencies (e.g., roads create barriers to some wildlife movement, noise creates stress in animals, etc.). The impact may be permanent ephemeral, e.g., noise and dust creates temporary stress conditions on animals and plants.

The impacts may also be indirect, that is, occurring later in time or at locations distant from the disturbance site. For example, alterations in surface and groundwater flow created by a road may alter water supplies to vegetation and wildlife on the downstream side of the road. Use of groundwater for characterization may reduce water supply to pools in which the desert pupfish is located at Devil's Hole.

The impacts may be incremental and cumulative. For example, the loss of a rare species at Yucca Mt. should be identified in relation to the wider distribution and trend in the status of that species, as in the case of the desert tortoise which is experiencing significant decline in populations throughout its range. The cumulative impacts are identified both in relation to combined impacts of repository development (e.g., combined effects in time and space of disturbance related to past and future Site Characterization) and to other development that "compete" with the repository for use of the resource (e.g., changing air quality because of multiple activities related to Site Characterization and because of out-of-area inputs of pollutants from Las Vegas).

Generic direct and indirect impacts are identified in Section 2 of this report.

A key element of impact analysis will be the identification of thresholds of significance. These may be established standards, e.g., for air and water quality, or based on other considerations related to sensitivities specific to given resources. Thresholds of significance are especially important to identification of impact indicators.

1.7 IMPACT MODELS AND IMPACT INDICATORS

Because of wide variety of direct, indirect and cumulative impacts that may result from Site Characterization disturbances, it is not possible to measure every impact that is likely to occur. Budget and time limitations constrain the scope of such an effort. Additionally, such detailed studies probably are unnecessary. Instead, ESA proposes to direct the effort to the construction of impact models which can used to predict direct and indirect impact of disturbance types and relate them to the primary environmental sensitivities. The models will be generic in nature, and adaptable to specific conditions and environmental sensitivities. The models are designed to predict potential impact but will require verification through direct measurement in the field. The Impact Indicators provide the means by which actual impacts can be verified through field investigations.

Impact Indicators identify the most important aspects of environmental effects that can tell the investigator whether an impact is occurring and if it is significant. The Impact Indicator is focused on aspects of resource change that may result in significant adverse effect on the resource. The Impact Indicator is must be something that is measureable (e.g., amount of soil loss, reduction in species diversity) or at least identifiable by a qualified scientist or a trained technician (e.g., archaeological artifacts, observable stress symptoms in animals and plants).

We propose to focus on those Impact Indicators that are of a negative character, i.e., those which indicate that an adverse impact could significantly impair achievement of the resource management objective. In sum, Impact Indicators generally will be identified in reference to thresholds of significant impact. Established exceedence standards may constitute a threshold significance; the Impact Indicator will identify where and when the threshold is being approached or exceeded. Significance criteria which are commonly accepted among professionals may also be used to identify Impact Indicators. A statistical indicator may also be appropriate as a threshold of significance - in that case the Impact Indicator is created by measurement of specific environmental parameters that are needed to develop the statistic. Some Impact Indicators may be interpretive, i.e., the information provides the basis for a judgment of significance mad[illegible] mitigation & reclam.

1.8 IDENTIFICATION OF [illegible] ATION OF DISTURBANCES

The identification of potential [illegible] ctive action. Corrective action can take three forms: avoidan[illegible] e or eliminate the consequences of the impact or reclamation. [illegible] n if the impact is potentially significant. Mitigation refers [illegible] ken prior to and during the disturbance to eliminate the impact, to reduce it to lesser significance, or to compensate for unavoidable effects. Reclamation refers to specific mitigation that would be applied following a disturbance to restore conditions approximately to their previous state.

In each case, mitigation and reclamation should be directed to achievement of environmental resource management objectives. Specific measures should be conceived within a larger coordinated program of corrective actions so that specific measures are not counter-productive or and do not result in significant residual impacts. In general, mitigation and reclamation techniques should attempt to minimize or reverse impacts at the site of disturbance. Mitigation and reclamation that depends on trade-offs of site impact for off-site improvements should be viewed as undesirable and only as a last resort when other on-site mitigation or reclamation is not possible. Similarly, monetary compensation for unavoidable losses is not a desirable approach.

1.9 IMPLEMENTATION APPROACH

A structured program is envisioned to evaluate how Site Characterization activities may conflict with the State's environmental objectives and policies and how mitigation and reclamation may be achieved (Figure 2). The program begins with identification of environmental sensitivities and proceeds through impact identification, determination of corrective action including identification of mitigation and reclamation requirements, monitoring of impact and mitigation, and implementation and monitoring of reclamation. These are briefly described below.

SENSITIVITIES/CONSTRAINTS IDENTIFICATION

The program begins with general pre-disturbance assessments of resources and their relative sensitivities to disturbance and their relative reclaimabilities.

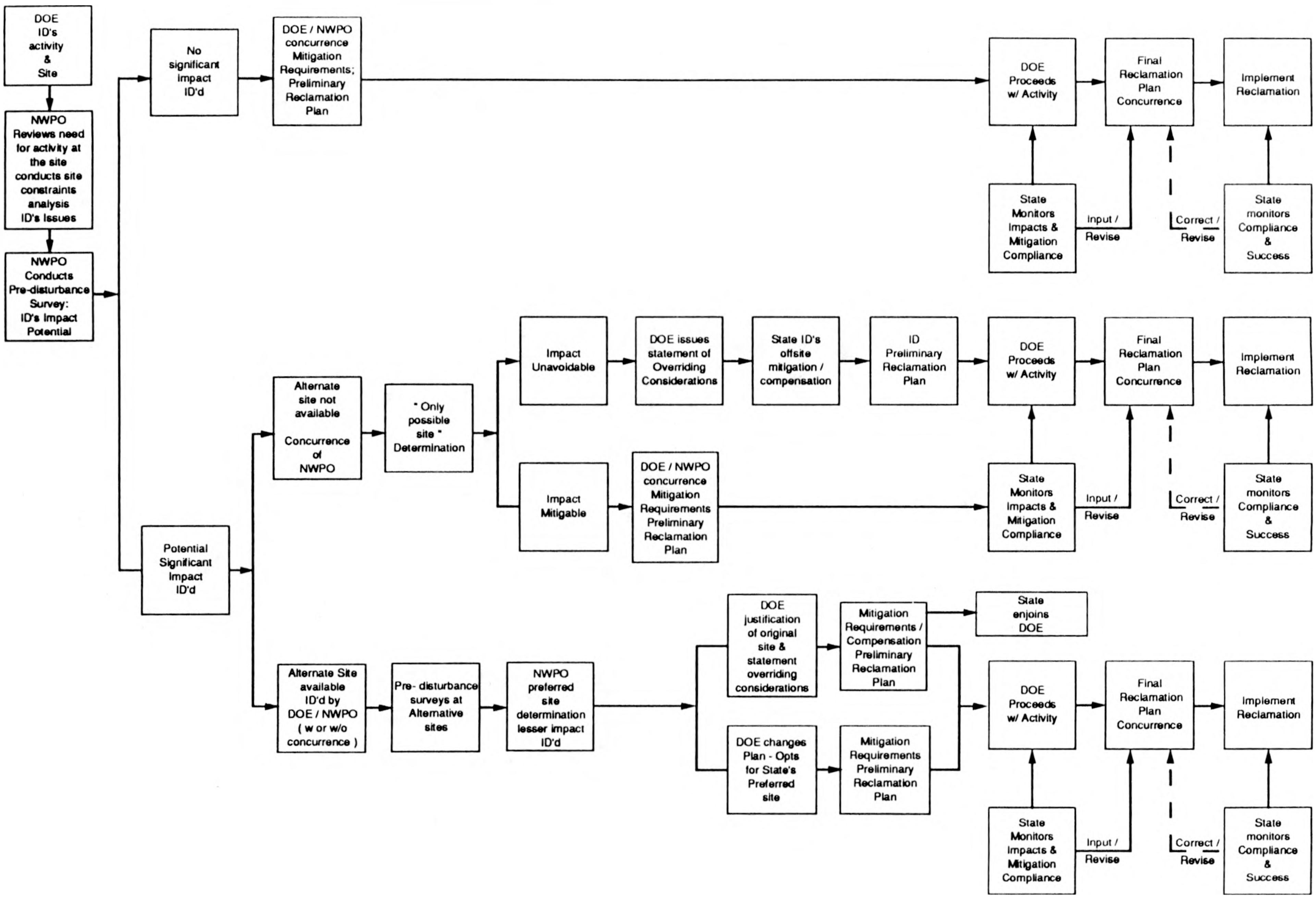

FIGURE 2
HYPOTHETICAL PROCESS CHART FOR DECISIONS ON IMPACT IDENTIFICATION, MITIGATION REQUIREMENTS AND RECLAMATION PLAN

The identification of a proposed Site Characterization disturbance activity at a specific site will lead to two actions. First, the generic disturbances associated with the activity will be identified. Next, generic impacts associated with the proposed disturbance will be identified from the impact models. Site specific pre-disturbance evaluations will be conducted relating generic impacts to site specific environmental sensitivities. The environmental sensitivities of the site will be identified by querying the mapped database. Specific sensitivities of individual resources with respect to impact and reclamation potential will identified. This information will allow evaluation of impact potential.

If a proposed activity occurs in an area of high environmental sensitivity, DOE would be asked to identify an alternate location for the activity or disturbance. By so doing, the State could conduct comparative potential impact and reclaimability evaluations to identify the site with lesser impact or better opportunity for reclamation.

IMPACT EVALUATION

Section 2 of this report identifies the generic impacts that may be expected to result from the disturbances. The generic direct and indirect impacts will form the basis for an impact checklist which can be employed as each activity is proposed for initiation by DOE. Each disturbance will have specific impacts relative to the types of resources and their sensitivities at a particular site (see preceding discussion). The generic checklist provides a means to identify which areas are susceptible to significant impacts.

Impact significance determination will be based on single and combined criteria. For example, the disturbance of an archaeologic site suitable for the National Register alone may constitute a potentially significant impact. Such a determination would mean that avoidance of the site for that activity would be the preferred action. In such cases, an alternate site for the activity would be identified by DOE or in conjunction with NWPD and its subcontractors (e.g., Mifflin and Associates could recommend another site which might be equally suitable for the purposes of geological characterization). Alternate sites would be selected to achieve less environmentally damaging effects.

In the event that a proposed Site Characterization activity site has no single resource that would constitute an avoidance determination by the State, an evaluation would be made to determine if impacts in combination may constitute significant impact. Such impacts could be the combined alteration of different resources at the specified site or the cumulative effects on a given resource. A rating system incorporating those considerations would determine the level of impact. If a rating suggesting an exceedence of significant impact is achieved, avoidance of the site would be determined as the preferred action.

CORRECTIVE ACTION DECISION

Impact identification will form the basis for a decision on corrective action. Impact avoidance is the preferred corrective action. Where avoidance of impact to a single sensitive resource or significant impact on combined resources is not possible, or if DOE refuses to relocate the disturbance activity, the State will require justification for the action and commitment to mitigation and reclamation in advance of the disturbance. Mitigation would be oriented to minimizing impacts; reclamation would be oriented to repairing damages caused by impacts. At this phase, we may prescribe pre-disturbance mitigation measures that will assist in achieving eventual reclamation objectives after the disturbance occurs. Commitments by DOE, or by the State if DOE refuses compliance, would include specific measures of mitigation and reclamation that will assist in attaining resource management objectives.

IMPACT MONITORING

During the disturbance activity, monitoring of impacts will be carried out by the State using Impact Indicators. Monitoring would be oriented to identifying conditions approaching a threshold of significance. If a threshold is approached, corrective action would be identified, possibly leading to another corrective action decision.

The success of mitigation measures in reducing impact will also be monitored in this phase.

IMPLEMENTATION AND MONITORING OF RECLAMATION

Monitoring of environmental changes during the period of disturbance will be the basis for scoping the final reclamation efforts. Prior to the termination of the disturbance activity, appropriate efforts for restoration of the disturbed site will be identified. The level of reclamation effort will be determined by the environmental management objectives, original environmental conditions at the site, and potential success of specific restoration measures (as determined by state of the art practices and expected success based on reclamation test plots).

2. POTENTIAL IMPACTS AND IMPACT INDICATORS

INTRODUCTION

Section 1 of this report presented the overall concept of an integrated environmental management plan and discussed the approach to impact assessment and reclamation. Subsequent sections of the report focus on each of these elements. Section 2 presents a discussion of resource management objectives, potential impacts that relate to attainment of the objectives and impact indicators which address measures of impact. These are presented according to general discipline areas.

GENERAL RESOURCE MANAGEMENT OBJECTIVES

The resource management objectives are general in nature. They are based on common concepts currently used in resource management. Although the objectives are generic in nature, they address resources and environmental conditions likely to obtain in the Yucca Mt. study area. The objectives are grounded in the fundamental concept of limiting degradation of the environment and maintenance of ecological integrity. A brief discussion is presented under each objective which identifies primary issues or concerns that justify the establishment of a generic objective. The general resource management objectives form the foundation for identifying specific objectives that would be incorporated into the proposed environmental management plan. The specific objectives would address specific resources and sub-areas within the area of potential impact.

The resource management objectives provide general direction and guidance to the environmental program.

1) The objectives provide a means by which to organize the program elements. Objectives drive the data collection effort, the approach to impact assessment, the approach to mitigation and the overall orientation and approach to reclamation.

2) Objectives form the conceptual framework for identifying environmental impacts related to Site Characterization activities. Impacts can be defined by the manner and degree to which environmental disturbances conflict with the management objectives, singly or in combination. Objectives drive the concept of avoiding unnecessary or significant impacts.

3) Objectives provide the basis for identifying mitigation requirements when potential adverse impacts are anticipated.

4) Objectives provide direction to the reclamation efforts. Reclamation planning must be directed to reestablishment of environmental conditions that support and promote maintenance of environmental quality. When objectives are defined, it will be possible to determine the scope of the reclamation requirements. Additionally, the objectives provide the basis for determination if reclamation has been successful.

As noted in Section 1, resource management objectives require specific policies to be established by the State which, if implemented, will allow attainment of the objectives. Policies cannot be presented in this report because specific objectives remain undefined as yet.

IMPACT POTENTIAL

For each resource management objective, there is a presentation of generic potential impacts. The discussion presents likely impacts that could adversely affect attainment of the general objective. The generic impacts form the equivalent of a standard checklist of potential impacts that might be applied to any given disturbance activity proposed for Site Characterization. In a checklist, the potential impacts would be identified by questions posed to the impact reviewer, similar in concept to the initial study prepared by planning departments for proposed developments. The potential impacts also form the theoretical framework for developing impact models. The impact potential is broken out by direct impacts and indirect impacts. The discussion of each potential impact is necessarily brief.

IMPACT INDICATORS

An immense variety of impacts may occur because of Site Characterization. It is not possible to measure every impact. Instead, the focus is on identification of potentially important impacts which require identification of their actual or likely occurrence and which need a measure of their potential significance. These are provided by the impact indicators.

The impact indicators are also generic. At the time when the State identifies specific resource management objectives and policies, it will be possible to focus on impacts of special significance or likelihood of occurrence in given resource management areas. At that time, specific impact indicators can be identified in relation to a specified Site Characterization activity and its related disturbance, the site environmental conditions.

The impact indicator concept encompasses measures needed for determining reclamation requirements. These may include specific elements of the environment which provide information that will assist in identifying whether reclamation is feasible, the relative form which reclamation may have to take at a given site (data needed for reclamation planning), and the amount of effort that may be required for attainment of resource management objectives.

2.1 TOPOGRAPHY AND SOILS

OBJECTIVE 1

Protect distinctive topographic features important to soil and hydrologic characteristics and to habitat value.

Discussion

The hydrologic regime and habitats controlled by topographic features have evolved over a long period. Topographic changes may readjust hydrologic regimes, vegetative communities, and wildlife populations. Such readjustment may be immediate or may require many years to identify.

DIRECT IMPACTS

1) The contours of natural features can be altered by borrowing material, such as aggregate or cinders, to use for concrete pouring or paving. Such alteration can change drainage and infiltration patterns.

2) New topographic features will be created by drill pads, large spoils piles from tunneling activities road cuts and other features. These features would change drainage locally.

INDIRECT IMPACTS

1) Grading or excavation on or near a slope may lead to excessive erosion and subsequent impacts to vegetation (Section 2.2), wildlife (Section 2.3), water quality (Section 2.6), and air quality (Section 2.8). This can happen when the toe of a slope is disturbed, promoting headward erosion or undercutting the slope so that a massive land failure can occur.

2) Topography can be changed by deposition of eroded material downslope of the disturbance. This is most likely to affect vegetation and wildlife by such mechanisms as direct burial of plants, seeds, nests, or burrows.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Slope and length of slope combine to be an important factor in predicting soil losses due to sheet and rill erosion. The effects of slope and length of slope are discussed below under Objective 2 of this section where the Universal Soil Loss Equation (USLE) is described.

Other characteristics which may be affected by alterations to topography, such as sheltered north-facing slopes which could have special plant communities or cliffs which may provide nesting areas for special status birds, are discussed in the sections on vegetation (Section 2.2) and wildlife (Section 2.3).

OBJECTIVE 2

Preserve soil resources from human induced or accelerated erosion by wind and water.

Discussion

Undisturbed soil allows anchorage for plants and a medium for moisture and nutrient cycling critical to the growth of vegetation which provides food and shelter for wildlife. It provides a medium for burrows which are vital to many forms of wildlife. In addition, undisturbed soil with healthy vegetation promotes good air and water quality. Natural erosion can be accommodated in the environment. Man-induced forms of erosion or accelerated natural erosion often cannot be compensated for through natural recovery processes.

DIRECT IMPACTS

1) Disturbance of soil or removal of vegetation may result in soil loss from the disturbed area. Intense rainstorms characteristic of desert regions are particularly likely to result in excessive erosion of disturbed areas. Factors used to estimate erosion rates, commonly calculated with the USLE, are rainfall, soil texture, slope, and management practices.

2) Strong winds in desert areas contribute to erosion of soil resources and burial of vegetation, seeds, and other features. Dust and sand can also coat vegetation and animals or cause pitting and etching of protruding features. Susceptibility to wind erosion is mainly determined by grain size of soil particles and soil aggregates.

INDIRECT IMPACTS

1) Grading or excavation may lead to excessive erosion and subsequent impacts to vegetation (Section 2.2), wildlife (Section 2.3), water quality (Section 2.6), and air quality (Section 2.8).

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

The SCS (1983) has established soil loss tolerances as a function of soil depth and effectiveness of management practices. In general, the soils at Yucca Mountain are shallow; extensive application of fertilizer and soil amendments is not feasible; thus, the annual soil loss tolerance is likely to be no more than 1-2 tons per acre.

Soil loss from rainfall erosion can be estimated using the USLE and its specific factors, as follows:

$$A = R \times K \times LS \times C \times P$$

where: A = soil loss in tons per acre per year

R = rainfall erosion index, a measure of the intensity and erosive force of typical annual rainstorms in the region measured in 100 feet (tons/acre)(inches/hour). This is calculated from the 2-year, 6-hour rainfall (Goldman, Jackson, and Bursztynsky (1896). Historic weather records for the area are used to establish the intensity of the 2-year, 6-hour storm.

K = soil erodibility factor, determined by the texture of the soil expressed in tons/acre per unit of R. K is a function of the grain size distribution, organic matter content, structure, and permeability of the soil (SCS, 1983). These characteristics will be determined during the soil survey.

LS = slope length and steepness factor, dimensionless. The slope/length factor is a calculated from a formula given by Goldman, Jackson and Bursztynsky (1986) using slope and slope length.

C = vegetative cover factor, dimensionless. Bare soil has a C-value of 1.0. Undisturbed native vegetation is usually assigned a C-value of 0.01 (Goldman, Jackson and Bursztynsky, 1986).

P = erosion control factor, dimensionless. This is a measure of the surface condition of disturbed soil. In construction site application, P is determined by how rough the soil surface is after grading, compacting, raking, disking, or any other operation.

TABLE 2.1-1P Factors for Construction Sites

Surface Condition	P Value
Compacted and smooth	1.3
Trackwalked along contour /a/	1.2
Trackwalked across contour /b/	0.9
Rough, irregular cut	0.9
Loose to 12 inches (30 cm)	0.8

/a/ Tread marks oriented up and down the slope.
/b/ Tread marks oriented along the contours.

SOURCE: Goldman, Steven J., Katherine Jackson, and Taras A. Bursztynsky, 1986, Erosion and Sediment Control Handbook: New York, McGraw-Hill.

The SCS (1983) places soils in Wind Erodibility Groups (WEG) based on properties of the soil surface layer (grain size, organic matter, and carbonate content) and the weight percent of dry soil aggregates more than 0.84 mm. These soil characteristics will be determined during the soil survey of the area. Air quality impacts of blowing particulate matter are discussed in Air Quality, Section 2.5.

OBJECTIVE 3

Protect productivity and usefulness of the soil from damage due to compaction of soil or disturbance or removal of soil structure.

Discussion

Severe compaction of the soil can result from operating heavy equipment and soil productivity can be diminished by disturbance of soil horizons. Study the impacts off-highway vehicle use (Webb et al. 1978) and the effects of military manuevers on soil desert (Prose, 1985 and 1986).

DIRECT IMPACTS

1) Remove or compaction of soil reduces the ability of seeds to generate and root to develop.

2) Burrowing wildlife cannot dig in severely compacted soil or bedrock to find food or shelter.

INDIRECT IMPACTS

1) Vegetation and habitat value is diminished.

2) Wildlife population may suffer if the area affected is an uncommon habitat.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Bulk density

Penetrometer

2.2 VEGETATION AND WILDLIFE

OBJECTIVE 1

Protect and restore "fertile island" structures, desert pavements and soil surface characteristics.

Discussion

Activities that alter the soil surface characteristics are likely to have severe impacts on desert revegetation in areas other than washes (Wallace and Romney, 1980). In the Mojave Desert soils generally lack zonal soil structure (topsoil layers) except in patches below the shrub-clumps where centuries of biological activities (e.g. litterfall, microbial and animal decomposition and burial activities) have occurred (Wallace et al., 1980, Wallace and Romney, 1972). Most of the ecosystem nutrient processing activities occur in these widely spaced "fertile islands", which are surrounded by infertile, bare areas that serve as part of the water-capturing system of the shrubs (Wallace et al., 1980, Wallace and Romney, 1980, Vasek et al. 1975). The fertile islands have higher soil organic matter, increased water holding capacity, and seedling establishment. On bare areas, seedling establishment and plant growth are generally depressed, and when vegetation is removed without destroying the local soil conditions, natural re-vegetation will occur almost exclusively on the fertile islands, by relatively short-lived pioneer species. In addition, some vegetation communities occur on soils that are characterized by a layer of "desert pavement", which develops slowly over centuries, and is not reclaimable.

Long-term reclamation goals should include protection of fertile islands and desert pavement by avoiding surface disturbances, particularly soil scraping and hydraulic soil removal techniques. Where vegetation removal is unavoidable, care should be taken to keep the soils and crown roots of plants in place. Reclamation practices that include removing and storing of the topsoil layer for later replacement are not adequate for reclamation of Mojave Desert plant communities, because they alter the natural pattern of heterogeneous topsoil deposition. Any disturbance that affects the topsoil and fertile island structures will severely limit restoration of vegetation on that land. Since the re-establishment success of creosote communities is best on sites having relatively high soil moisture levels (within a limit), short-term reclamation goals should include practices that increase soil moisture availability. Thus, where surface soil disturbance is unavoidable, the undulating topographic relief should be re-instated to allow certain areas to collect more water naturally, which should improve the growth and recovery rates of vegetation.

DIRECT IMPACTS

Reduction or loss of fertile island structures, desert pavements and soil surface characteristics would be directly affected by characterization activities such as drilling, seismic testing, coring, hydraulic excavation, road and building construction, scraping, topsoil removal, stockpiling, slope alterations, etc.

INDIRECT IMPACTS

Soil disturbances, particularly on fertile island areas could lead to: lowered soil fertility, altered drainage patterns, effects on infiltration and water availability for plants and animals, accelerated erosion and blowing dust, sedimentation in temporary watercourses. All of these could affect vegetation and wildlife by causing reduced vegetation cover and biomass, loss of structural complexity of habitat, decreased seed germination rates, increased invasions by alien (non-native) species, reduced wildlife habitat quality, and soil texture changes that could affect burrowing animals.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Changes in soil surface characteristics could be measured by comparing disturbed and undisturbed sites below creosote shrubs, and noting the difference in soil compaction, soil organic matter and fertility, and changes in seed germination and productivity.

OBJECTIVE 2

Protect and restore floristic and faunistic species diversity.

Discussion

The importance of maintaining plant and animal species diversity has long been recognized by ecologists, because changes in species composition and abundance often signal a decline in habitat or environmental quality. Maintenance of diversity is especially important on sites with unique features that contribute significantly to the number or diversity of species present (e.g., sites with water basins, Joshua trees, or unusual species assemblages) and on sites where disturbances cover extensive areas, either individually or cumulatively. Sites with greater floristic diversity can produce and sustain a more diverse herbivore community, which in turn can support more avian and terrestrial predators.

Long-term management plans should protect or restore site quality so that it is capable of supporting a diversity of organisms, as close as possible to the pre-disturbance condition. An important short-term goal of environmental management should be to minimize potential disturbance impacts before and during characterization activities, rather than focusing on uncertain reclamation after the fact.

DIRECT IMPACTS

Diversity could be significantly reduced by activities that reduce or remove vegetative cover or structural complexity, alter soil surface characteristics, or affect wildlife habitat or behavior over large areas, or in unique or sensitive areas.

INDIRECT IMPACTS

Loss of vegetation diversity could lead to lower wildlife diversity and abundance, loss of special status or unique species, and loss of top food chain species. Species that would most likely be impacted include those with restricted geographic ranges, limited abundance, narrow requirements or specific requirements. In addition, predator-prey relationships could be disrupted, and food webs impacted.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Changes in species diversity of plants and animals can be measured by monitoring the number and abundance of species on the site, both before, during and after disturbance. The degree of impact would be determined relative to the pre-disturbance condition, i.e. as a percent of original.

OBJECTIVE 3

Restore and protect vegetation cover and structural complexity.

Discussion

The degree of structural complexity of vegetation is a function of both the vertical layering created by the presence of plants of different heights (e.g. grasses, shrubs, and trees), and the horizontal variation in cover and density across the ground. Habitats with greater structural complexity have been shown to support greater faunal abundance and diversity (Hill, 1980). Usually, sites with greater vegetation diversity offer more types of food, cover and nesting sites, etc. For example, Joshua Trees add significantly to the structural complexity of a habitat: by virtue of their height and unusual morphology, they provide vital places for birds to display, roost or nest for which there is no substitute.

Long tenn management goals should include preservation of important elements that are impossible to replace within a reasonable period of time, such as Joshua Trees. Short-term reclamation goals should include a pre-disturbance assessment of the site to avoid impacts on unique features, and revegetation with a mix of species that will resemble the original structural composition at maturity.

DIRECT IMPACTS

Activities that remove, injure or destroy vegetation directly affect cover and structural complexity.

INDIRECT IMPACTS

Reduced vegetation cover and structural complexity could lead to a loss of wildlife habitat, loss of plant and animal diversity and abundance due to altered habitat, increased risk of predation associated with loss of cover, loss or extinction of special status and protected species, loss of top carnivores with changes in trophic level structure, increased soil temperature, disruption of soil microbial activity, and lowered soil fertility, decreased germination rates, and lowered water availability for plants and animals.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Changes in vegetation cover and structural complexity can be measured using one of several canopy coverage techniques (e.g. line transect or plot methods), and comparing data before, during and after disturbance. The degree of impact would be relative to the original condition, and could be assessed by community, species, height-class or life-form categories.

OBJECTIVE 4

Restore and protect extant native floral and faunal assemblages and composition, and discourage encroachment by exotic (non-native) species.

Discussion

Changes in the composition or abundance of plant species in a community are likely to cause alterations in the faunal community. In areas that have been relatively undisturbed for long periods of time such as Yucca Mountain, there is a higher probability that specific relationships or dependencies may have developed between native species. Because of these inter-dependencies, significant impacts on a given species might cause the loss of a number of associated or specialist species. The loss of native species may result in the invasion of generalists, such as the European starling and house mouse. Often in response to disturbance, there is an increase in the number or coverage of non-native (alien) colonizing weeds such as Russian thistle and cheatgrass. These species may persist on disturbed sites for a few years, eventually giving way to native species, or may hold the site permanently, excluding natives. Cryptogams are species associations (often lichens and algae) that form a crust over the soil and play an important role in nitrogen fixation, and "capping" the soil surface to prevent water loss and discourage weedy growth.

Long term management goals should include exclusion of non-native species. Short term reclamation goals should include immediate re-planting with native species to prohibit encroachment by alien weeds which normally establish and grow much faster than natives.

Native species used for re-seeding or transplanting should be taken from the local area, to ensure that adapted ecotypes are used, planting should be done at the time appropriate for each species, and irrigation may help reestablishment. Revegetation of Mojave Desert sites is improved by fencing to keep rodents out. Where native species cannot be used, then species with equivalent ecological roles should be chosen, for example, if symbiotic nitrogen fixing species are lost, they should be replaced by species that also fix nitrogen, with their specific soil innoculum.

DIRECT IMPACTS

Losses of native species could occur wherever disturbance is extensive, and in unique or sensitive areas.

INDIRECT IMPACTS

Most disturbances that affect vegetation and soils result in colonization by pioneer species, many of which are alien species. Where excess water and nitrogen sources (such as in drilling fluids) are spilled, aliens will be able to out-compete natives and they could take over disturbed sites. Alien weeds may have detrimental effects on the ecosystem, for example, the presence of cheatgrass promotes a greater frequency and spread of fire, and forage and habitat quality of alien plants may not meet the needs of native animals, particularly specialists. Spilling of toxic chemicals and spoils materials could lead to poisoning of animals.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Changes in numbers or cover of both native and alien plants and animals can be measured using one of a variety of survey techniques, both before, during and after disturbance. The degree of impact could be measured in absolute terms (presence/absence, by species) or by changes in the ratio of aliens vs. residents. The loss of cryptogams from the soil surface (per cent of ground covered) can be a measure of disturbance impact to the system, since they are extremely slow growing and easily destroyed even by foot traffic, and therefore difficult to reclaim.

OBJECTIVE 5

Restore and protect nutrient cycling processes and participatory organisms.

Discussion

After water, nitrogen availability is probably the most important limitation to growth of plants in deserts. Most of this nitrogen is available in the "fertile islands" described in objective one. Plants with high nitrogen contents provide the best quality forage (high protein) for herbivores and subsequently to other members of the food chain. Nutritional quality is strongly tied to the survival and reproductive success of animals. In desert ecosystems where resource levels (water, nutrients and biomass) are very low, nutrient cycling processes may be very dependent on the abundance of certain "linkage organisms". These include symbiotic nitrogen fixers, cryptogams and mycorrhizal organisms that facilitate nutrient aquisition from abiotic sources, and microbes and animals (such as termites, ants and beetles) that fragment and decompose organic materials, thus facilitating re-mineralization and nutrient recycling through the biota. The roles of desert animals, particularly small mammals, are also important in nutrient processing. For example, they mix organic material and urine into the soil while digging their burrows, and their seed caching activities are often vital to the germination success of plants, since some buried seeds may survive to germinate once "planted" in the soil.

Long-term goals should aim to preserve and restore the efficiency of nutrient transfers through the system (via atmosphere, plants, animals, insects, microbes, and soils). Short-term reclamation goals could include the preservation of fertile islands, which are essentially nutrient cycling systems, organisms with nitrogen fixing or other nutrient cycling roles, and the use of fertilizers to mitigate unavoidable damage (Wallace et. al, 1980).

DIRECT IMPACTS

Activities that alter soil surface characteristics or remove vegetative cover have direct impacts on nutrient cycling, especially on fertile islands.

INDIRECT IMPACTS

Changes in nutrient cycling processes could result from spilling of toxic or non-toxic chemicals such as drilling fluids or spoils that effectively alter soil pH or microbial activities and thus prohibit plant growth or reduce productivity.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

The loss of key organisms that play roles in nutrient cycling processes could be monitored as an indirect indicator of whether nutrient cycling pathways have been impacted. This could involve monitoring changes in cryptogam crust cover, the number and variety of plants that are symbiotic nitrogen fixers or mycorrhizal, and the number and variety of fragmenter or decomposer organisms such as termites, ants and beetles. Direct means of measuring nutrient cycling would involve long-term studies of annual production, standing biomass, decomposition, soil fertility, mineralization rates, etc.

OBJECTIVE 6

Protect and restore biological productivity.

Discussion

For plants, measures of productivity include photosynthesis, annual production and standing biomass. For animals, the amount and distribution of biomass among the trophic levels is important. For wildlife studies, the number and diversity of top carnivores may indicate the structural integrity of the food web, i.e. the higher the production at lower trophic levels, the greater the biomass of top carnivores.

Long-term goals should be to preserve the productivity of sites as close as possible to the original condition, because production is already low, and recovery time is very long. Short-term reclamation goals should include re-vegetating with native species as quickly as possible after disturbance, and during the season appropriate for each species.

DIRECT IMPACTS

Activities that alter vegetation and/or soils could cause significant reductions in plant productivity.

INDIRECT IMPACTS

Reduced vegetation productivity will cause declines in animal biomass and predator-prey relationships.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Changes in productivity could be measured by comparing disturbed and undisturbed sites or before-and-after measurements of standing biomass, annual productivity of plants, and number and abundance of animals.

OBJECTIVE 7

Protect unique features, species and species assemblages.

Discussion

This includes unique species such as Joshua trees, species assemblages unique to the region or transition zone, and any areas with unique features such as Ash Meadows with its unusual hydrology and rare species assemblages.

Long-term management goals should include protection of unique features and organisms, because these are not reclaimable.

DIRECT IMPACTS

Characterization activities should not be carried out in areas with unique features, species and species assemblages.

INDIRECT IMPACTS

Plans must be implemented to avoid alterations in surface and groundwater hydrology that could conceivably affect unique or sensitive areas which receive those waters, such as Ash Meadows.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Changes in the number and abundance of unique species or the components of species assemblages might indicate impacts on the resources. Changes in drainage patterns, springs, stream courses or water bodies might indicate that even off-site activities were affecting the biota of unique areas.

OBJECTIVE 8

Protect water bodies, drainages and catchments.

Discussion

Water is the most important control of biotic processes in this region (Wallace et al., 1980), and alterations, even to small catchment areas such as covered depressions in rocks, could be potentially disastrous to wildlife and plant survival. Larger, permanent water bodies are of the highest importance for preservation, particularly if they support a diversity of species. Seasonal and intermittent bodies of water such as springs etc. should be given intermediate importance. Ephemeral water features are of third order of importance, unless they are essential for the seasonal survival or breeding of key species, in which case they would be given higher priority.

DIRECT IMPACTS

Surface disturbance activities or hydraulic soil removal techniques could directly alter drainage patterns that are important to the biota.

INDIRECT IMPACTS

Erosion, dust deposition and sedimentation asscoaited with activities could negatively affect seed germination success and water relations of plants.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Changes in drainage patterns, springs, stream courses or water bodies might indicate that activities were affecting the hydrology and biota of an area.

OBJECTIVE 9

Reduce probability and incidence of anthropogenic fires during site characterization activities

Discussion

The presence of some human activities and of certain alien or introduced species may increase the potential for the spread of wildfire or anthropogenic fires.

DIRECT IMPACTS

Soil disturbances that remove cryptogam or vegetative cover could favor establishment of alien weeds such as cheatgrass and Russian thistle, particularly if they were associated with higher water and/or nitrogen inputs e.g. related to dust control mitigation measures.

INDIRECT IMPACTS

Cheatgrass is an annual grass that fills in the intershrub spaces during the wet season, then dries up in summer, thereby leaving a continuous layer of highly flammable dry material. The dried grass fuels fire and allows it to spread easily from shrub to shrub.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Changes in presence or abundance of cheatgrass may indicate a greater risk of fire, as will the use of vehicles off-road, especially those with catalytic converters, cigarette smoking, and other human activities.

OBJECTIVE 10

Protect and restore existing native wildlife habitat.

Discussion

Wildlife habitat has three major components: food, water and cover. Habitat quality is assessed relative to the needs of individual species. Changes in any of the components of relatively undisturbed habitats are likely to be detrimental to native species, to cause lowered animal species diversity and productivity, and to favor the invasion of exotic alien species. Any of the changes in vegetation or soil discussed (e.g. vegetation diversity, structure, or productivity, soil surface characteristics, etc.) may reduce the quality and quantity of wildlife habitats.

DIRECT IMPACTS

Activities that affect vegetation diversity, cover, productivity and structural complexity usually result in a degraded habitat for native wildlife.

INDIRECT IMPACTS

Road construction could lead to increased animal mortality due to road kills, formation of barriers to animal movement, and habitat fragmentation (which might be of particular significance for special status species such as desert tortoise). Other potentially detrimental effects on wildlife habitat would be due to human presence at construction sites, with its round the clock noise and lighting that might force behavior responses in animals, e.g. interruptions in breeding activites, or interference with nocturnal foraging activities.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Changes in animal populations due to raod kills, or changes in behavior such as altered migration routes, poor breeding success, or absence from construction areas could indicate impacts.

2.3 PROTECTED AND REGULATED SPECIES

OBJECTIVE 1

Protect special status species and their habitats.

Discussion

Special status species are those that are legally protected by federal law due to their classification as rare, threatened or endangered, species that are critically endangered according to Nevada law (and Nevada Division of Forestry), and species that are candidates for protection, including the desert tortoise, Mojave fishhook cactus, Mojave sweet pea, black wooly pod and others. "Critical Habitat" as defined by the endangered Species Act of 1973, includes land, air or water areas, and any portion of the present habitat of a listed specie which may include additional areas for reasonable population expansion (Rhoads, et al., 1973) food or resources, water and cover needed for survival, as well as additional features or resources that are required seasonally for reproduction e.g. areas for breeding displays or congregating, nesting materials, burrow sites, etc.

DIRECT IMPACTS

The major direct impact on special status species would be mortality due to construction activities, such as destruction by heavy vehicles.

INDIRECT IMPACTS

Indirect impacts would be related to loss of habitat (due to roads, buildings, parking lots, spoils). Both mortality and loss of habitat could decrease the population size of the affected species, or cause local extirpation.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Loss or decline in special status species populations would be the main indicator of impact, as measured by changes in population size, life history characteristics, or resource requirements, relative to baseline (pre-disturbance) conditions. With rare and endangered species, or animals and plants with patchy distributions, these characteristics may be very difficult to measure. In such cases, the loss of critical habitat may provide a rough estimate of changes in species populations. Ecological information would be needed to make such an assessment, i.e. to determine which elements of the habitat are needed for survival and successful reproduction, including seasonal requirements for breeding and producing young.

OBJECTIVE 2

Protect cacti and yuccas.

Discussion

All species of cacti and yucca are protected according to Nevada Law. Numerous species of cacti occur in the study area, including the Mojave fishook cactus. Joshua Trees are present on mesa tops on Yucca Mountain.

DIRECT IMPACTS

Same as objective one.

INDIRECT IMPACTS

Same as objective one.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Same as objective one.

OBJECTIVE 3

Protect wild horses and burros.

Discussion

Wild horses and burros are protected by the Federal Wild Horse and Burro Act. Bands of feral horses and burros may occur in the study area: feral horses occur over parts of the Nevada Test Site, and burros have been seen in Solitario Canyon (which is part of the study area), and west of Yucca Mountain in the vicinity of Beatty, Nevada (O' Farrell and Collins, 1983).

DIRECT IMPACTS

Road kills.

INDIRECT IMPACTS

Open water areas associated with site characterization activities may draw bands of horses or burros to the site (O'Farrell and Collins, 1983).

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Loss or decline in populations.

OBJECTIVE 4

Protect furbearing species.

Discussion

Furbearing species such as kit fox and bobcat are protected by State of Nevada regulations. Both of these are present on the Yucca Mountain site (O'Farrell and Collins, 1983).

DIRECT IMPACTS

Road kills.

INDIRECT IMPACTS

Indirect impacts might include altered predator-prey relationships, and alterations in habitat and food webs. These could result in decreased breeding, foraging or hunting success, resulting in lower population sizes or local extirpation, and altered ecological relationships between species.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Decreased population size.

OBJECTIVE 5

Protect game species.

Discussion

Take of game species is regulated by the state of Nevada. Game species that occur on the study site include: desert cottontail, mule deer, chukar, Gambel's quail and mourning dove (O'Farrell and Collins, 1983).

DIRECT IMPACTS

Road kills.

INDIRECT IMPACTS

Loss of habitat.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Decreased population size.

OBJECTIVE 6

Protect raptors.

Discussion

Raptors are protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. Protected raptors that occur on the study site include: turkey vulture, Cooper's hawk, ferruginous hawk, red-tailed hawk, rough-legged hawk, Swainson's hawk, golden eagle, American kestrel and prairie falcon (O'Farrell and Collins, 1983).

DIRECT IMPACTS

Road kills.

INDIRECT IMPACTS

Same as objective four.

SPECIFIC INDICATORS FOR IMPACT IDENTIFICATION

Decreased population size.

2.4 HYDROLOGY AND WATER QUALITY

OBJECTIVE 1

Protect the ground waters of the Yucca Mountain area from contamination which may result from DOE Site Characterization activities.

Description: Many of the activities that are planned for the Site Characterization activities at Yucca Mountain have the potential to release fluids and soluble contaminants as dust. Two spills of drilling mud have occurred at Yucca Mountain where liquid materials consisting of water, additive agents, and possibly floating contaminants such as oil, hydraulic fluids, and cleaning solvents. Normal drilling practice puts a lot of debris into the mud pits prior to moving off of a site.

Nitrates, which are a by-product of commercial explosives, can have several pathways to the shallow ground water in the area. The waste rock excavated from the Exploration Shaft Facility (ESF) will contain appreciable amounts of nitrate which can blow off of the waste piles in dust, leach out of the waste piles with rainfall, or be released into the atmosphere with dust from the exhaust vents at the ESF. The nutrient cycle in a desert environment is a critical balance, and an excess of a critical nutrient without a corresponding increase in the rest of the cycle will result in changes in the vegetative communities.

Direct Impacts: Vegetation uses shallow ground water within the root zone and any change in the quality of water will result in a change in the affected vegetation. Any uses of the ground water for activities of Site Characterization including the gathering of reliable data may be compromised by changing water quality.

Indirect Impacts: Any change in ground water quality in an arid environment has the potential to create offsite, or subsequent impacts that are not immediately apparent. A study done for DOE in 1984 indicates that ground water flow from the Yucca Mountain and Forty Mile Wash areas could conceivably transport contaminants to impact the Ash Meadows area (Rice, 1984).

Impact Identification: Contaminant levels can be determined by analyzing samples of material from dust traps, and soil samples adjacent to activities that are capable of releasing contaminants. Sampling of leachate water and waste water treatment facility discharge can show what contaminants are going directly into ground water. Monitoring of both the shallow and deep ground water is also possible using the many existing monitoring wells.

OBJECTIVE 2

Protect the quality of surface waters that may be affected by activities at Yucca Mountain.

Description: Flood flows in this area are rare, but have the capability to transport a lot of sediment and debris to the area of Franklin Lake Playa. Ground water flow from the area may feed the springs and pools at Ash Meadows. Many materials, contaminants and activities can increase the probability of contamination of surface water bodies. Accidents such as overturned fuel trucks and spills from drilling mud pits during flood season can release a lot of material for surface transport. Erosion through areas of buried mud pits is also capable of releasing undesireable materials for transport in the surface channels.

Direct Impacts: Surface waters in the desert support an extensive ecological system. Any degradation of those water bodies by the introduction of contaminants will be reflected in the wildlife and vegetation that depend on the water for habitat.

Indirect Impacts: Changes in surface water quality can affect much of the primary production in the desert food chain and can result in changes in the populations of predators.

Impact Identification: A lot of information exists on the vegetation and wildlife found in Ash Meadows around the surface waters. The plant and animal populations can be indicators of changes in water quality. When coupled with laboratory analysis of periodic water samples the exact causes of quality degredation can be identified.

OBJECTIVE 3

Prevent the alteration of the the shallow groundwater regime due to water transfer carried out as part of the Site Characterization activities.

Description: Large volumes of water from the well J-12 will be piped up to the ESF and adjacent facilities. This water will be used and recycled, but will eventually be discharged to a treatment plant or evaporated into the atmosphere. The discharge of treated wastewater will have the capability to raise the groundwater table within the unconsolidated alluvial fills of Midway Valley. These fills are bounded by bedrock formations on all sides except for the narrow gaps on the east. Additional ground water in these fills may cause a marked rise in the water table and the possibility of seeps of springs in some low lying areas.

Direct Impacts: Increased water tables could interfere with many of the studies being carried out by the DOE in the shallow drill holes in Midway Valley. Plants with deep root systems could reach shallow ground water that is not currently available. A change in plant communities could result in areas where the water table would come near the surface.

Indirect Impacts: An altered ground water regime may increase infiltration to the deeper aquifer under Yucca Mountain and may increase the infiltration to the fractured tuff above and in the vicinity of the proposed repository formation.

Impact Identification: The shallow ground water in Midway Valley can be monitored by the use of piezometers installed adjacent to the leach fields of the wastewater treatment facility.

2.5 AIR QUALITY

GENERAL OBJECTIVES

OBJECTIVE 1

Characterize criteria air pollutant levels on the site.

Discussion

The air quality at the site is currently only poorly known because ambient concentrations of criteria air pollutants have not been measured. This is an important objective, since the resource cannot be managed until it has been characterized. Short-term measurements (even one year of monitoring) is generally insufficient to sufficiently characterize the air quality at the site because of the paucity of regional data to which the on-site measurements can be tied, but it will permit development of air quality management objectives and strategies. The criteria air pollutants that should be monitored include carbon monoxide, nitrogen oxides, ozone, respirable particulate (PM_{10}), and sulfur dioxide. At least two stations should be established within the project area. This is both a short-term and a long-term objective.

OBJECTIVE 2

Develop specific factors for wind erosion of disturbed soil areas on the site.

Discussion

One of the primary potential impacts of the proposed activities is the creation of large areas of disturbed soils that would be subject to wind and mechanical (i.e., induced by vehicle travel on unpaved roads) erosion. Such erosion could lead to violations of the federal and state ambient respirable particulate standard. By determining specific factors for the erodability of the soils on the site (generic factors are not expected to be typical of the site), prior modeling of wind and mechanical erosion (generally referred to as fugitive dust emissions) could determine whether planned activities posed the potential for significant generation of fugitive dust. This is a short-term objective.

OBJECTIVE 3

Determine meteorological conditions in areas to be developed by DOE.

Discussion

The rationale for this objective is similar to the rationale for Objective 2. To be able to evaluate the potential impact of DOE activities, modeling should be done. This modeling requires both emission factors for the surface soils (see Objective 2 above) and site-specific meteorological information. This is a short-term objective.

OBJECTIVE 1

Preserve air quality on the site.

Discussion

Air quality is a primary natural resource that is highly valued in the open spaces of the southwestern United States, where the extremely clear air makes long vistas possible and outdoor recreation especially desirable. Activities proposed for the site are anticipated to generate small to moderate amounts of air pollutants from point sources (mostly combustion sources) and moderate to large amounts of fugitive dust. These emissions could affect regional air quality and clarity. This is both a short-term and a long-term objective.

OBJECTIVE 2

Preserve regional visibility.

Discussion

Regional visibility, as noted under Objective 1, is considered a natural resource that is important to the environment, and to the economy of rural areas of the southwestern U.S. (since recreation is a primary activity in these areas). The U.S. EPA has established minimum standards for visibility in the region surrounding Class I Air Quality Areas, which include national parks and monuments such as Death Valley.

OBJECTIVE 3

Minimize areas of disturbed surface soils within the project area.

Discussion

Fugitive dust from open areas of disturbed soils contributes substantially to ambient concentrations of particulate, especially during windy periods. Because large-sized particulates tend to settle out of the air fairly rapidly, local dustfall on vegetation and facilities could be substantial even if particulate data from monitoring stations on the site indicate that the air quality on the site is generally good insofar as particulates are concerned. By minimizing the areal extent of exposed soils, the potential for dust emissions is reduced proportionately. This is both a short-term and a long-term objective.

OBJECTIVE 4

Minimize combustion emissions from activities on the site.

Discussion

Assemblages of powered equipment on the site could generate combustion emissions, including the criteria pollutants nitrogen oxides, carbon monoxide, and particulate, that could affect local air quality even if data collected at a monitoring station on the site indicated that the air quality on the site is generally good. By identifying opportunities for reducing or eliminating combustion emissions, these local effects could be reduced.

OBJECTIVE 5

Minimize vehicle travel on unpaved roads within the project area.

Discussion

Fugitive dust from vehicle travel on unpaved surfaces contributes substantially to ambient concentrations of particulate, especially when vehicles travel at high speed. Because large-sized particulates tend to settle out of the air fairly rapidly, local dustfall on vegetation and facilities could be substantial even if particulate data from monitoring stations on the site indicate that the air quality on the site is generally good insofar as particulates are concerned. By minimizing vehicle travel on unpaved roads and reducing vehicle speeds for necessary trips on such roads, the potential for dust emissions is reduced proportionately. This is both a short-term and a long-term objective.

DIRECT IMPACTS

The project could affect regional visibility.

Discussion

The project has already resulted in a significant acreage of disturbed soils, which probably exceeds that observable in the form of large open soils (i.e., there may be substantial acreages of disturbed soils that are not visible from aerial photographs). Future activities would approximately double the acreage of identifiable disturbed soils. Emissions of fine particulate from combustion of fuels by powered equipment would contribute to the amount of airborne particulate. Depending upon the particulate size distribution of soils on the project site and other factors, such as average wind speeds in the areas of disturbed soils, these particulate emissions could affect regional visibility.

The project could affect local air quality.

Discussion

The project would generate criteria air pollutants, the ambient concentrations depending upon the timing and amount of pollutants generated, and the way in which local meteorological and topographical conditions combine to disperse or concentrate the pollutants.

INDIRECT IMPACTS

No indirect impacts of significance were identified.

SPECIFIC INDICATORS

Indicator 1: Exceedence of a state/federal ambient air quality standard, such as the National Ambient Air Quality Standards (NAAQS).

Discussion: Both the state and the federal governments have established ambient standards for carbon monoxide, nitrogen oxides, ozone, sulfur dioxide, and respirable particulate (PM_{10}); exceedence of these ambient standards can be assumed to constitute a significant environmental effect. The U.S. EPA has prepared extensive guidelines and methods manuals on the measurement of ambient concentrations of criteria air pollutants; these documents could be used to establish a monitoring program.

2.6 CULTURAL RESOURCES

OBJECTIVE 1

Provide in situ protection, or appropriate mitigation, of physical aspects of cultural resources, i.e., archaeological and historic sites deemed eligible for nomination to the National Register of Historic Places.

Discussion

Archaeological and historical resources are non-renewable resources. They are "containers" of cultural and scientific information. The purpose of the federal laws (e.g., the 1906 Antiquities Act, the 1979 Archaeological Resources Protection Act, etc.) protecting these resources is to ensure the integrity of the sites, and therefore, the validity of the scientific data they contain. If the integrity is disturbed, or destroyed, the data are permanently lost.

DIRECT IMPACTS

Direct impacts on archaeological and historic sites include: a) any disturbance of site areas by land-altering activities caused by vehicles, drill-rigs, bulldozers, blasting, etc.,; b) any unauthorized collecting of artifacts from, excavating in, or otherwise disturbing the sites. Either a) b) disturbs or destroys the integrity, hence the scientific value of the sites.

The goals of cultural resource protection are to insure that scientific information is protected for immediate, or long term use by scientists and the public. in situ protection, or proper mitigation are the means to insure the goals are met. in situ protection has proven impossible in projects with significant amounts of land disturbance. Therefore, mitigation is the appropriate goal for all resources within Direct Impact Areas. Protection and avoidance, properly monitored, are the goals in Indirect Impact Areas.

INDIRECT IMPACTS

The primary indirect impact on cultural resource is loss or damage of the resources by induced erosion. Soil erosion is a natural process that can affect the integrity of cultural resource sites. However, erosion accelerated or exacerbated by human activities, such as result from redirecting drainage courses, uncontrolled surface runoff, alteration of flow conditions in stream courses of and increased sheetwash from removal of plant cover, can constitute a significant threat to resource sites.

IMPACT INDICATORS

DOE (1988a) has proposed an "Avoidance Index" for archaeological and historic sites. The Index may possibly meet the letter of the relevant laws, but it cannot insure the integrity of the resources. Experience at numerous large-scale, land-altering projects has shown that attempts to protect cultural resources in direct-impact areas is futile. Flagging or other marking of sites is ignored: unauthorized collecting of artifacts, or vandalism of site areas is common, and often deliberate and malicious.

The appropriate objective is mitigation. All areas of direct land-altering impacts -- roads, drill pads, parking lots, housing areas, etc., should be surveyed at BLM Class III standards. All surface artifacts should be mapped in place and a 100% collection made. All site should be tested for sub-surface remains; those having such should undergo sufficient excavation to insure that scientifically adequate sample is recovered. Such mitigation meets federal standards for sites subject to destruction.

To mitigate the vandalism problems, a Direct Impact Area one mile side on all sides of an impact work area should be surveyed at the Class III level, and all surface artifacts mapped and collected. Experience at other large-scale projects has shown that the mile-wide areas are in fact direct impact areas, as people and vehicles move around the immediate work areas, or indulge in illegal "arrow-head hunting."

Historic sites with standing structures should be recorded to Historic American Building Survey standards, and a 100% collection of all associated artifacts should be made. The structures should be fenced; and 8 to 10 ft. high chain fence is standard on government lands.

All artifacts from all mitigation activities are required to be deposited in curation facilities meeting federal curation guidelines.

Recorded sites in areas adjacent to Direct Impact Areas should be monitored periodically for evidence of unathorized collecting or vandalism. The Avoidance Index proposed by DOE (1988a) should be applied to sites in Indirect Areas, and criteria for specific treatment and monitoring proposed and implemented.

OBJECTIVE 2

The second objective is to insure that the concerns of appropriate Native American groups for areas of religious significance are met. The American Indian Religious Freedom Act (AIRFA) of 1978, and regulations stemming there from, require such concerns be taken into account.

Discussion

A consultation process is outlined in a draft Programmatic Agreement (DOE 1988b) relating to the Yucca Mountain project. The issue has been closed by a recent Supreme Court decision that seemingly limits the scope of AIRFA. Presumably, the consultation process will take the decision into account. However, once a consultation process is agreed to, State of Nevada representative should be included in the consultation process to insure that the interest of its Native American citizens are properly met.

2.7 NOISE

OBJECTIVE 1

Preserve an ambient environmental from of vibration effects and noise-induced stress effects on wildlife.

Discussion

This objective presumes that the existing ambient environment is free of vibration effects and noise-induced stress effects on wildlife. The fact that little is actually known about the ambient noise environment at Yucca Mountain is the rationale for noise-related work outlined in the Baseline Studies Plan.

DIRECT IMPACTS

Construction equipment may generate average and peak noise and vibration levels that induce stress effects in wildlife. Such stress effects may result in injury or displacement of individuals to other areas. Vibration effects may collapse burrows in the soil.

Blasting may generate enough vibration to cause destruction of animal burrows. Burrow destruction will result in the death of individuals and/or replacement to other areas.

INDIRECT IMPACTS

None identified.

SPECIFIC IMPACT INDICATORS

Impact indicators will be defined in relation observable effects on wildlife. Noise or vibration and directly measurable thresholds will be defined relative to specific sensitive spcies or guilds of species.

2.8 VISUAL RESOURCES

Objective 1

Maintain visual integrity of rural landscapes to the maximum extent practicable.

Discussion

Visual integrity includes the essential chjaracter of the landscape. The predominant visual elements that define visual character are form, texture, color, pattern and contrast. Much of the area is rural wildland.

Direct Impact

Site Characterization activities create direct changes in the visual landscape elements that can permanently alter the landscape character. High levels of contrast create the potential for significant visual alteration of the landscape. Such contrast is created by roads, buildings,

Indirect Impacts

Changes in vegetation following a disturbance or enhanced erosion can alter the visual landscape significantly.

Impact Indicator

BLM Visual Resource Mangement (VRM) methods identify visual contrast ratings that can be directly applied to a proposed disturbance to determine if the impact may be significant.

Objective 2

Provide stringent protection of visual resources in areas fo special scenic value.

Discussion

Areas of special scenic value include National Parks and Monuments, integral vistas near such areas, designated scenic routes of travel, and areas with unusual scenic character or feature rarity. Many such areas already are afforded protection.

Direct Impact

Site Characterization activities create direct changes of the landscape as noted above. The significance of the impact is enhanced when the visual alteration occurs in areas of special scenic value.

Indirect Impact

None identified.

Impact Indicator

Apply BLM VRM methods. Location of visual landscape alteration in any area of special scenic value creates a potential exceedence of a threshold of significance.

3.0 RECLAMATION MANAGEMENT

The following presentation outlines the important components of a comprehensive reclamation management program. The conceptual program is developed from the perspective of reclamation planning as part of the comprehensive environmental management program described in this report.

3.1 GENERAL OBJECTIVES

The overall objectives of reclamation are derived from the resource management objectives, e.g., the generic objectives identified in Section 2. Reclamation planning specifically is focused on correcting environmental disturbances in such a way that a specific management objective or group of objectives can be attained through direct manipulation of the environment. The target for the reclamation effort is fulfillment of resource management objectives, but tempered by consideration of feasibility of reclamation and costs. Thus, within the context of overall resource management objectives, it is necessary to establish narrower reclamation goals that incorporate practical restrictions of the available technology and limitations of the reclamation site.

Specific reclamation management program components include: 1) identification of overall reclamation objectives of the program; 2) initial site evaluation at land disturbance sites; 3) best management practices and standard engineering practices; and, 4) reclamation planning and monitoring. Components is discussed below. The program assumes that prior to any land disturbance, that sufficient information is available from baseline studies upon which to develop site-specific reclamation plans for the Yucca Mountain site.

3.2 APPROACH TO SITE EVALUATION

PRE-DISTURBANCE SITE EVALUATION

The purpose of the evaluation process is to locate land disturbances in areas that are amenable, or otherwise best suited to reclamation. Two methods area available for identifying the sensitivity of a proposed disturbance site for restoration. The extent of resource data available will affect the provision of application of the methods. These methods are sequential and are described below.

The preferred method is based on comprehensive resource inventories with specific information needed to identify reclamation constraints. Each resource inventory, would be presented in tabular and map overlay formats. Each resource inventory map would be overlaid to indicate combined sensitivity for reclamation at a given site. The areas of least environmental constraint and high potential for reclamation success would be recommended as the preferred site for the proposed disturbance. The minimum required inventory data for reclamation sensitivity include:

Order III Soil Survey

Important characteristics to be mapped would include soil erosivity and reclamation capabilities or limitations such as Soils would be mapped primarily at the association level with some soil consociations and complexes. Soil taxonomic units used will be phases of soil series and soil family levels of classification. The appropriate scale for field mapping is 1:24,000 with a minimum size unit delineation of 9.0 acres.

Ecological Site Classification

Major consideration is given to management needs for post=disturbance land uses such as wildlife habitat, watershed protection, recreation, etc. Vegetation will be mapped to make meaningful distinctions between ecological sites. Data on species composition, production and other pertinent factors would be recorded. Plant association tables would be used to group similar plant communities into ecological sites. Ecological sites will be delineated on base map overlays at a scale of 1:24,000.

Wildlife Habitat Type Classification

Restoration of habitat conditions is the focus of reclamation. Wildlife habitat types would be inventoried. A species habitat type can be defined by the ecological sites of which it is comprised. Therefore, habitat types may be cross several ecological sites. Primary consideration in defining habitat types would be given to areas with preferred food, cover and water characteristics. Wildlife habitat types will be presented in tabular and base map overlay formats at a scale of 1:24,000.

Sensitive, Threatened and Endangered Species

Sensitive, threatened and endangered species of fauna and flora would be inventoried. These species distributions will be delineated on a base map overlay at a scale of 1:24,000 as well as presented in tabular form.

In the event that resource data are not available, general reconnaissance level surveys of vegetation and soils would be undertaken.

The general area of the proposed disturbance would be identified and landforms would be stratified on a base map. Each landform would be stratified into three categories of percent slope: greater than 50%; greater than 33% and less than 50%; and less than 33%. On the basis of landform and slope stratification, at least three individual and distinct area within the general area will be recommended for further evaluation.

A reconnaissance vegetation and soil survey will be conducted at each of the recommended areas. A standard soil pit three feet wide by five feet deep will be excavated and the soil pedon described according to SCS standard procedures. The existing vegetation within the confines of the expected disturbance area will be inventoried.

Ranking using an Environmental Checklist

The second method is an on-site ranking of the environmental sensitivity and potential for success of reclamation of specific resources.

A field checklist would be used to evaluate the potential impact from the proposed disturbance and would include ranking of physical constraints to reclamation (Table 1).

TABLE 1: HYPOTHETICAL ENVIRONMENTAL CHECKLIST FOR RANKING CONSTRAINT TO RECLAMATION AT SITES FOR POTENTIAL DOE DISTURBANCE ACTIVITIES

Directions: Circle the appropriate score for each parameter.

Parameters	Score
I. Physical Constraints	
1. Land Form	3
Within Drainage	2
Within Floodplain	1
Upland	
2. Slope	
> 50%	3
33% to 50%	2
< 33%	1
3. Soil Depth	
0 to 20 inches to restrictive layer	3
10 to 40 inches to restrictive layer	2
40 to 60 greater than 60 inches	1
4. Soil Structure	
massive, single grain (structureless)	3
platy, blocky, prismatic	2
granular	1
5. Soil Reaction (pH)	
< 4.5 or > 8.5	3
4.5 to 6.3 or 7.4 to 8.5	2
6.4 to 7.3	1
6. Soil salinity (mmhos/cm)	
> 16	3
8 to 16	2
< 8	1
7. Soil Available Water Capacity (inch/)	
< 0.8	3
0.8 to 0.16	2
> 0.16	1
Total Site Score	___

The ranking scale would range from n to 3n, where n is the number of parameters on the checklist. The scale for Table 1 would then range from 7 to 21. The site rated with the lowest score would represent the site with the least sensitivity to reclamation. The site which is least environmentally sensitive and most conducive to reclamation success would be the preferred site on which to locate the proposed disturbance. The following explains the criteria used to make this determination.

Landform

The primary consideration for reclamation potentially is the relative instability of the ground surface. Areas subject to frequent changes in the land surface or areas subject to occasional major surface alterations pose the greatest difficulty to accruing successful reclamation. Drainage courses generally are most sensitive with respect to lack of soil development and soil instability from stormwater discharge. Floodplains are subject to a lower concentration of storm discharge and generally have limited soil development. Uplands generally are not subject to storm discharge, although channelized and sheetwash erosion potential would be a consideration. Aeolian erosion of soil is an additional consideration. Soil development on the uplands is generally extensive, rendering such areas the least sensitive and most conducive to reclamation success.

Slope Constraint to Equipment and Practices

Slopes steeper than 50% limit the use of most large equipment used in reclamation and significantly increase the problems for erosion control. Slopes greater than 33% but less than 50% deter the use of some equipment for reclamation practices and erosion control is easier and generally more successful.

Soil Depth Constraint to Rooting

Soil depth is an indication of potential plant rooting depth. Soils shallow to a restrictive layer or bedrock (0 to 10 inches) impede the growth of plant roots, and the movement of soil water and air. Moderately deep soils (10 to 40 inches) are conducive to establishment of some native vegetation, but restrictive to the longevity of others. Deep soils (40 to 60 inches) accommodate the establishment of both shallow and deep rooted native vegetation and increase the potential for longevity.

Soil Structure Constraint to Rooting

Soil structure is indicative of ease of root establishment, acquiring soil water and air. Massive or single grain (structureless) soils are limited by low water holding capacity that restricts root establishment. Platy, blocky or prismatic soils are limited by low available water and air and are somewhat restrictive to root growth. Granular or crumb structured soils are highly conducive to available water and air and are generally nonrestrictive to root establishment.

Soil Reaction (ph) Constraint to Nutrient Cycling

Soil reactions less than 4.5 (strongly acid) or greater than 8.5 (strongly alkaline) restrict nutrient availability and inhibit establishment and longevity for most plants. Soil reaction ranging from 4.5 to 6.3 (medium to slightly acid) or 7.4 to 8.5 (mildly to moderately alkaline) restrict nutrient availability and inhibit establishment for some native plants. Soil reaction ranging from 6.4 to 7.3 (slightly acid to mildly alkaline) would be optimum soil reaction for nutrient availability and establishment and longevity of most native vegetation.

Soil Salinity Constraint to Moisture Availability

Soil salinity is an indication of soil water available for plant uptake. As soil salinity increases, osmotic pressure or negative retention of soil water increases, rendering soil water unobtainable for plant use. Soil salinity greater than 16 mhos/cm (moderately saline) largely inhibits water availability for most plants. Soil salinity less than eight mhos/cm (slightly saline) is optimum for water uptake by most native vegetation.

Soil Available Water Capacity

Available water capacity (AWC), expressed as inch of water per inch of soil, is that portion of soil water that can be absorbed by plant roots. An AWC of less than 0.8 inch/inch is poorly suited to root development and longetivity. An AWC of 0.8 to 0.16 inch/inch is moderately suited to providing available water for root development and longetivity. An AWC of greater than 0.16 inch/inch is optimum for providing available water for root development and longevity.

4.0 RECLAMATION GOALS AND BEST MANAGEMENT PRACTICES

The purpose of these guidelines are to establish minimal uniform performance criteria by which to minimize land disturbances, protect against erosion and prepare sites for reclamation. The practices are intentionally general in scope. Selection of the most effective measures for a given site should be based on an evaluation of the soils, climatic conditions, topography, drainage pattern, vegetation, proposed land use, reclamation goals, and other specific conditions unique to the site. As more becomes known about the Yucca Mountain environment, successful reclamation treatments, and site characterization activities, the best management practices (BMPs) can be refined and expanded to provide for a more comprehensive approach.

4.1 RECLAMATION PLANNING AND ESTABLISHMENT OF RECLAMATION GOALS

A successful reclamation program is the result of careful, site specific planning. As with any plan, the process begins with the formulation of goals. There are three general goals of reclamation as a mitigation after disturbance has occurred. The first goal is stabilization of
the disturbance to stop any expa reclamation goals ıal degradation of the
resources that have been disturb is the use of reclamation
techniques to attempt reduce the nce. The third, long term
goal is the restoration of the dis d area to a pre-defined,
functional condition that meets goals are important as
guidance for the reclamation pl titute the umbrella under
which all of the reclamation str ment of resource management
objectives.

Reclamation strategies can be esource issues such as
preservation of the desert tortc of Yucca Ridge, or they may be
more general to broader, area ts on Ash Meadows or the
Franklin Lake Playa. Many o nation

strategies are identified in section 2, IMPACTS, of this report. These objectives that apply to disturbances are much more limited than those discussed in section 2. When the actual impacts occur many of the mitigation techniques, especially those such as avoidance and site preparation, are no longer available.Reclamation strategies can be broken into three time-elements relative to each disturbance location.

4.2 BEST MANAGEMENT PRACTICES IN PRE-DISTURBANCE PHASE

- Conduct surveys for site evaluation and inventory of existing resource conditions; rate sensitivities for reclamation.
- Develop site-specific reclamation goals and specific reclamation plans for the proposed site characterization activity. Plans would include identification of specific measures, phase scheduling and timing, responsibilities for implementation, costs, monitoring efforts and commitments to the plan (including possible performance bonding).
- Install temporary erosion control measure to protect disturbed soils.
- Clearly delineate the extent of the disturbance area and identify specific measures to prevent impacts beyond the area.
- Designate areas suitable for soil stockpiling, pits to receive solid and liquid wastes.
- Clearly designate ingress/egress corridors to disturbance areas.
- Prepare emergency remove plans related to accidental spills of toxic and hazardous materials, to significant damage to cultural resource sites, or to inadvertant damage to important habitat or direct injury to animals.

4.3 DISTURBANCE ACTIVITY PHASE

Typical BMPs implemented during disturbance activities include:

- Identify topsoil units and fertile islands of topsoil.
- Remove, stockpile and stabilize storage of topsoil.
- Regularly maintain all temporary erosion control measures and initiate additional erosion control measures, as needed.
- Revise site-specific reclamation plans (developed in the pre-disturbance phase) in accordance with actual conditions that exist during disturbance and new findings about reclamation practices derived from reclamation test plots.

- Perform immediate clean-up and remediation of any spills of toxic and hazardous materials.

4.4 POST-DISTURBANCE PHASE

- Backfill and seal all shafts, wells, pits and other unsafe excavations.
- Remove all structures, facilities, equipment, improvements and wastes.
- Grade to approximate original contours, reestablish drainageways and redistribute stockpiled topsoil.
- Implement up=dated reclamation plan(s).
- Monitor reclamation for a minimum of three to five years; mitigate or improve unsuccessful reclamation.

5.0 RECLAMATION PLANS

Reclamation plans must be developed on a site specific basis. At Yucca Mountain, reclamation plans will vary on a case-by-case basis depending upon the extent of disturbance, the soil type, the potential for natural plant reestablishment, and the intended post reclamation land uses. Associated resource needs including watershed protection, wildlife habitat, and aesthetics are incorporated into site specific reclamation plans. For example, replanting with species suitable desert tortoise forage would not be included as a reclamation consideration outside of desert tortoise habitat areas.

Reclamation plans must be implementable with current technology. However, as the understanding of reclamation priorities develops, particularly as information from test plots is obtained, reclamation plans should be revised.

5.2 RECLAMATION IMPLEMENTATION SPECIFICATIONS

The reclamation implementation specifications consist of identification of detailed practices and targets for reclamation. The specifications include directions regarding horticultural practices such as grading, seedbed preparation, fertilization, mulching, and plant maintenance. The reclamation implementation specifications also stipulates construction products, seed mixes, seeding rates, and other additional plant materials.

reclam. plans

The plant species list must be (... amation specialist who is
knowledgeable about a site's p ... mation objectives. Plant
species selection maybe based

- adaptation to climatic con
- seedling establishment po

- plant material and seed availability, and
- the requirements for the post reclamation land uses.

The reclamation implementation specifications can be developed only after an on-site reconnaissance of the disturbance area. The complete reclamation implementation specifications report consists of construction plans, details, and written specifications.

5.3 MONITORING RECLAMATION SUCCESS

Reclamation success is defined as meeting the reclamation goals. Acknowledgement of reclamation success, or failure, is determined by quantifying physical characteristics of the reclamation area and comparing these values to established thresholds.

Threshold are actually the quantifiable component of each reclamation goal. Measurements of the vegetation characteristics of the reclamation site are most frequently used as thresholds. Specific methods of measurement must be identified for each threshold. Such methods are generally described in a reclamation monitoring plan. For example, a likely reclamation goal may be to stabilize a site from accelerated erosion. To accomplish this, it maybe determined that vegetation ground cover must be at least 80% (hypothetical) of the ground cover that occurs in an adjacent, undisturbed area. The reclamation monitoring plan would describe the specific methods and materials to be used to measure vegetation ground cover. The vegetation sampling method would be implemented on the adjacent undisturbed area. The reclamation threshold would be established as 80% of the vegetation cover value that resulted from that sample.

When the designated thresholds are met and maintained without human intervention, the reclamation effort can be considered a success. In arid regions such as Yucca Mountain, three years of monitoring of a reclaimed area is a minimal requirement and additional longer monitoring may be required before an assessment of reclamation success can be made. The minimal monitoring time period would also specified in the reclamation monitoring plan.

Establishment of reclamation thresholds must be made by a professional reclamation specialist who is knowledgeable about the potential for realistic achievements of reclamation goals given the state of the art of reclamation practices. The reclaimability of a disturbed site varies greatly with climatic and edaphic conditions. Yucca Mountain may be considered among the most difficult areas in the United States to reclaim. Therefore, reclamation thresholds must be consistent with reclamation potential, and be attainable within a reasonable time frame.

The reclamation monitoring plan must also include contingency plans that direct actions to be taken is reclamation thresholds are not met. Some options for contingency plans include:

- reimplementation of the reclamation plan with attention to the elements that presented success;
- implementation of a revised reclamation plan;
- acceptance of the environmental status as is, or;
- continuation of the monitoring time period if achievement of the goals cannot be ascertained in the designated period in the plan.

Of critical importance to the overall reclamation effort is establishing the incentive to achieve reclamation success. Bonding is the most commonly used procedure to ensure that the reclaimer will carryout a program oriented to achieving reclamation success. Reclamation bonds are posted by the entity responsible for implementing the reclamation plan. The reclamation bond amount is generally set at the cost that would be incurred for the State or permitting agency to assume the responsibility of reclamation plan implementation. Upon determination of reclamation success, as evaluated in terms of meeting the reclamation thresholds, the reclamation bond is released. If reclamation is not successful, the bond can be forfeited to the bonding agency and used to implement a reclamation contingency plan.

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1.10 BACKGROUND

The Nuclear Waste Policy Act, as amended, directs the U.S. Department of Energy (DOE) to prepare plans for the decontamination and decommissioning of the Yucca Mountain site in the event that the site is determined to be unsuitable for development as a repository, and further requires DOE to mitigate any significant aaverse environmental impacts caused by Site Characterization activities (DOE 1988a). As further established in the Mission Plan (DOE 1987), the overall DOE objective for decontamination, decommissioning and mitigation activities is to return areas disturbed by Site Characterization activities "to their original conditiou," to the maximum extent practical. That statement suggests a commitment to restoration of the site.

DOE SITE CHARACTERIZATION PLAN RECLAMATION OBJECTIVES AND SHORTCOMINGS

To meet its objectives, the DOE states in the Site Characterization Plan (SCP) that impacts would be minimized or avoided, by the adoption of standard operating procedures and good engineering practices (DOE 1988a). As a portion of the standard operating procedures, DOE proposed that a plan would be developed for monitoring and minimizing the potentially significant adverse environmental impacts associated with Site Characterization. The SCP further stipulates that a reclamation program plan, reclamation implementation plan and reclamation feasibility plan would be prepared to describe the various aspects of the decommissioning and restoration of the Yucca Mountain site. According to the DOE, the reclamation program plan will detail policy issues, the reclamation implementation plan will provide detailed descriptions of the types of procedures to be used in decommissioning-related activities, and the reclamation feasibility plan will describe site-specific studies needed to evaluate the feasibility of reclamation practices. These latter reclamation plans have not yet been released, but reportedly are being developed.

While the SCP briefly describes general practices that might be utilized in post-=disturbance reclamation and outlines a limited process for mitigation planning, the plan lacks sufficient information on which to determine if DOE's environmental program will meet the objective to return areas to their original condition. For example, both the SCP and the EA (DOE 1986) assume that successful reclamation can be widely implemented on disturbed lands. The assumption is the basis for DOE's conclusion that no significant adverse environmental impacts will result from Site Characterization activities.

Not withstanding the fact that threshold parameters for 'successful' reclamation have yet to be defined, by citing the need for a reclamation feasibility plan in the SCP, the DOE appears to admit that proven methods are not currently available to guarantee 'successful' restoration of disturbed lands at the site. This shortcoming of DOE's environmental program was also noted by Mitchell (1984).

Although general reclamation techniques are well-known, at this time, no studies have been conducted by DOE to test reclamation materials or practices against constraints of the site-specific conditions found at Yucca Mountain. Lacking this information, it is not known that land disturbances can be restored to acceptable standards. Given the economical and technological constraints of restoration in the desert environment, DOE's reclamation program appears to be grounded in a high degree of optimism.

A real need exists to undertake a comprehensive demonstration program to evaluate reclamation strategies for the site-specific conditions at Yucca Mountain (Mitchell 1984). The information from a well-designed demonstration program will be essential in formulating successful and ecologically sound treatment prescriptions. Information obtained from that effort would facilitate DOE's efforts to locate Site Characterization activities in areas of least environmental impact, and/or with the greatest potential for mitigation. DOE's commitment in the SCP to develop site-specific reclamation guidelines before initiating surface disturbance activities require such a demonstration program with results known prior to initiating site characterization activities.

DOE ENVIRONMENTAL MONITORING AND MITIGATION PLAN APPROACH AND SHORTCOMINGS

The DOE recently released the Environmental Monitoring and Mitigation Plan for Site Characterization, herein referred to as the EMMP (DOE 1988b). The EMMP outlines DOE's approach for avoiding and minimizing potentially significant adverse environmental impacts of Site Characterization. The approach involves use of pre-disturbance surveys to identify if an "initiating condition" exists in a predetermined disturbance area. The presence or attainment of an initiating condition is a warning that an unacceptable situation may exist or be developing, and, thus, it may be necessary to consider alternative Site Characterization activities or mitigation requirements. Appropriate authorities would be notified, further studies may be initiated to qualify the situation, and then decisions would be rendered as to whether an unacceptable situation exists (a "priority condition"). Unfortunately, the EMMP fail to define the thresholds of priority conditions.

Designation of a priority condition investigates a review of possible mitigation measures. If mitigation is considered feasible, corrective actions would be recommended. If it is determined that mitigation is infeasible or impractical, the DOE would review all aspects of the situation including the priority condition, the activity involved, and any options. The EMMP states that DOE may find that mitigation measures are impractical because of cost, schedule commitments, level of impacts, etc. Under such circumstances, a determination would be made that Site Characterization may proceed. The decision to proceed with the activity without initiative action would be documented and reported to the appropriate authorities (DOE 1988b).

Specific initiating conditions listed under the broad category of terrestrial ecosystems in the EMP include, "the presence of desert tortoises or active kit fox dens" (DOE 1988b). While not qualifying as an initiating condition, allowances have been made in the EMMP to include Mojave fishhook cactus in the pre-disturbance survey. As a standard operation procedure, DOE has stated that construction activities would be sited to avoid this species whenever possible.

The narrow scope of the EMMP limits opportunities to avoid or minimize adverse impacts on other affected resources, such as vegetation, wildlife habitat, soils, etc. If DOE's goal is to minimize or avoid adverse environmental impacts, then there is no reason for the EMMP to be limited to only those impacts that have been identified through the previous environmental assessment process as possibly being significant. Other resource issues and concerns could be incorporated into DOE's EMMP by identification of site selection criteria and best management practices.

The EMMP needs to be expanded to incorporate consideration of all the resources on the site for purposes of developing a comprehensive environmental management program. Development of such a program must utilize a holistic approach, where all resources are considered. The focus on a few selected resources runs the risk that other resources may be damaged unnecessarily. For example, selection of disturbance areas based primarily on site reclaimability could disproportionately impact desert tortoise habitat.

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