U.S. DEPARTMENT OF ENERGY

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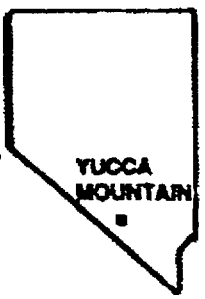
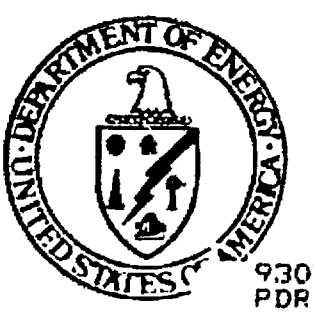


YUCCA MOUNTAIN
SITE CHARACTERIZATION
PROJECT

RESPONSE TO COMMENTS FROM THE U.S. DEPARTMENT OF INTERIOR, STATE OF NEVADA, AND AFFECTED COUNTIES ON THE REPORT OF EARLY SITE SUITABILITY EVALUATION OF THE POTENTIAL REPOSITORY SITE AT YUCCA MOUNTAIN, NEVADA



JUNE 1993

ENCLOSURE

RESPONSE TO COMMENTS FROM THE U.S. DEPARTMENT OF THE INTERIOR, STATE OF NEVADA, AND AFFECTED COUNTIES ON THE REPORT OF EARLY SITE SUITABILITY EVALUATION OF THE POTENTIAL REPOSITORY SITE AT YUCCA MOUNTAIN, NEVADA

INTRODUCTION

Comments contained in this document were received by the U.S. Department of Energy (DOE) on the Report of Early Site Suitability Evaluation (ESSE) of the Potential Repository Site at Yucca Mountain, Nevada, (Younker et al., 1992, SAIC - 91/8000). Comments were received from the U.S. Department of Interior, the U.S. Nuclear Regulatory Commission, the State of Nevada, and several local affected governments in Nevada No comments were received from members of the public This document provides responses to all comments that were received as part of the formal, written review process.

The ESSE report was prepared by a team of scientists who provide technical support to DOE on the Yucca Mountain Site Characterization Project. The team was managed by Science Applications International Corporation, a DOE contractor. An independent Peer Review Panel was also convened to review and evaluate the validity of the technical conclusions reached by the ESSE scientific team. The ESSE report provides recommendations to DOE regarding the adequacy and sufficiency of available site characterization data to support suitability findings in the technical areas specified in 10 CFR Part 960; Parts 4 and 5 of DOE's General Siting Guidelines

The ESSE was an interim evaluation (the first was conducted in 1986) to determine the current status of compliance with 10 CFR Part 960 It had two primary goals: (1) evaluate whether data obtained since 1986 either weaken or strengthen the technical basis for the 1986 findings; and, (2) develop and recommend a process for future evaluations

With respect to the technical basis of the ESSE, DOE accepts the opinions of the Peer Review Panel that technical conclusions drawn from available data were adequate and sufficient, and that recommended findings were objectively developed. Based upon the recommendations of the ESSE Report, DOE will continue to characterize the Yucca Mountain site to establish its potential suitability for development as a repository. DOE regards the ESSE recommendations as useful input for prioritizing site studies, modifying the scope and direction of these activities, and as an aid in deciding when adequate site characterization data have been gathered.

For future site suitability evaluations, DOE may choose to use contractor-prepared reports without formal DOE acceptance of the suitability findings, or DOE may choose to formally accept selected suitability findings. As required by the Nuclear Waste Policy Act, DOE will make formal findings on all guidelines before deciding whether to recommend the site for repository development

With respect to process, DOE intends to establish a mechanism for involving oversight groups, independent scientists, and other interested parties in future site suitability evaluations. Specific evaluation plans will be developed and milestones for future interim site suitability evaluations will be included in the baseline program schedule An analysis of the appropriate interfaces between evaluation of site suitability and the process of complying with the National Environmental Policy Act is currently under way

With respect to the selection of Peer Review Panel members, DOE is considering a process whereby panel members would be nominated by oversight groups and local affected governments, as well as by DOE Selection of panel members would then be made by an independent third-party group of scientific experts.

Involvement of oversight groups and the public in the site suitability evaluation process will evolve. DOE Public Update Meetings in Nevada will continue to be a forum for discussing the status of any future site suitability evaluation The new Director of OCRWM may also establish additional outreach mechanisms for communicating this information to the interested public.

RESPONSE TO CLARK COUNTY COMMENTS

Clark County Comment 1

General Guidelines for the Recommendation of Sites

The Early Site Suitability Evaluation (ESSE) is an assessment of the suitability of the proposed Yucca Mountain Site using the Department of Energy's (DOE) General Siting Guidelines (10 CFR Part 960). These Guidelines were adopted by DOE on December 6, 1984, as required by Section 112(a) of the Nuclear Waste Policy Act (NWPA).

When conducting an evaluation such as this, the first step in the evaluation process should be an assessment of the applicability of the criteria being used in the assessment. The Siting Guidelines were adopted by DOE in 1984, under an entirely different set of circumstances than those that currently exist. When th Guidelines were adopted, the NWPA required DOE to nominate at least five sites for consideration. Three of the nominated sites were to be recommended for site characterization. After the extensive evaluation conducted during site characterization, one site was to be selected. The Siting Guidelines were clearly developed to provide for a comparison between sites, leading the selection of the best site for the repository. For example, 960.3 provides detailed explanations of how the Guidelines will be used to make "comparisons between and among sites."

Since these Guidelines were adopted, the Nuclear Waste Policy Act was amended to eliminate all potential sites but Yucca Mountain. With only one site to consider, many of the Guidelines do not provide for a meaningful evaluation, since they were designed for a comparative analysis. Several examples of criteria which do not provide meaningful assessment of a single site are listed below:

> **960.5-1(3)** . . . ***and the associated costs shall be demonstrated to be reasonable relative to other available and comparable siting options.***
>
> **960.5-2-7(b)(i)** . . . ***Such routes are relatively short and economical to construct as compared to access routes for other comparable siting options.***

Section 112(a) of the NWPA provides that the *Secretary may revise such guidelines from time to time, consistent with the provisions of this subsection.* Before any additional site suitability evaluation is conducted by DOE, the Siting Guidelines should be evaluated against current conditions and revised as required. Any conclusions on site suitability made using inappropriate guidelines should not be considered valid. The Guidelines contain no Post-

Closure criteria for socioeconomics. "Many of these potential social and economic effects could be long term and may extend beyond the life of a repository" (page 3-48). Any revision to the Guidelines should consider the need to address socioeconomics in the Post-Closure criteria.

Use of the Siting Guidelines in the ESSE

In addition to *Qualifying Conditions* and *Disqualifying Conditions*, the Siting Guidelines also include *Favorable Conditions* and *Potentially Adverse Conditions*. The ESSE contains no evaluation of *Favorable* or *Potentially Adverse Conditions* in several sections of the evaluation. For Socioeconomics, there is no consideration of the *Potentially Adverse Condition* of potential for major disruptions of primary sectors of the economy of the affected area. The tourism and gaming industry is the primary sector of the economy of southern Nevada. This industry could potentially be adversely affected by perceptions of risk associated with nuclear materials. Potentially Adverse Conditions for transportation include . . . Railroads that are expensive to construct . . . and terrain between the site and existing . . . railroads such that steep grades, sharp switchbacks . . . will be encountered. If the current Guidelines are going to be used, then they should be used in their entirety. Assessment of the Favorable and Potentially Adverse Conditions should be included in the ESSE.

Response:

While the comment accurately notes that the siting guidelines were developed when it was anticipated that multiple sites would be simultaneously considered, it does not necessarily follow that they no longer "provide for a meaningful evaluation" or that the conclusions "should not be considered valid." The majority of the guidelines require a determination of specific characteristics at individual sites to establish the existence of qualifying conditions and the absence of disqualifying conditions as specifically stated in Part 960.31-1-5. Nonetheless, the comment is well taken and if the siting guidelines are revised, any modifications will reflect the current structure of the nuclear waste program.

The ESSE document does not explicitly address the "favorable conditions" and the "potentially adverse conditions" for socioeconomic impacts or transportation because, as is consistent with the definitions for those terms in 10 CFR Part 960.2, they are preliminary indicators used to evaluate the more definitive qualifying and disqualifying conditions, which were explicitly addressed in the ESSE. The background information on the former terms suggests they were provided for use early in the site selection process, before data were available to evaluate the qualifying conditions.

Clark County Comment 2

Application of the Siting Guidelines

Appendix III of the Siting Guidelines describes how the Guidelines are to be used at three points in the siting process. These are when a site is found to be "potentially acceptable", "nomination and recommendation", and "repository selection." "Lower-level" findings are required before a site can be nominated, whereas "higher-level" findings are required for repository site selection. Presumably, since the Yucca Mountain Site was nominated for site characterization, DOE has already made "lower-level" findings. Although a "higher-level" finding is not required until the repository site selection phase, the ESSE considered whether or not a "higher-level" finding was appropriate at the time, and in some cases, recommended "higher-level" findings. The focus of an early site suitability evaluation at this stage of the process should be on whether or not new information has been obtained which would negate a previously made lower-level finding, and on describing the type of information which should be obtained through site characterization to support a higher-level finding at the repository site selection phase. Higher-level findings are inappropriate at this stage of the process, since site characterization is supposed to provide the information necessary to make these findings at the repository site selection phase.

Even though the Yucca Mountain site supposedly passed the lower-level finding criteria to be eligible for nomination for site characterization, some of the lower-level findings contained in the ESSE are questionable.

For example, the core team made a lower-level finding for both the qualifying and the disqualifying conditions for geohydrology.

The discussion, however, states:

> ***Some finite probability of failing to meet the 1,000-year criterion will always exist.* (page 2-8)**
>
> ***There is considerable uncertainty in the data used to support these conclusions;* (page 2-10)**
>
> **Note, however, that the results presented below are highly contingent on the assumptions used in defining and subsequently performing the analysis. (page 2-22)**

The recommendations state:

> **The results of this evaluation have identified specific activities that should be emphasized to provide information needed to assess site suitability.**
>
> **(page 2-24) Site-specific data are required to understand and quantify . . . . (page 2-25)**

The core team also found that the lower-level finding for future climatic conditions has been strengthened, but concluded virtually no detailed analyses of the possible affect of future climate changes have been performed to date (page 2-68). The lower-level finding is maintained even though the effects of climatic changes on the subsurface geohydrologic systems may lead directly to consequences that could adversely affect waste containment and isolation in the unsaturated zone at the Yucca Mountain site (page 2-70).

The core team supported a higher-level finding for the population density and distribution evaluation guideline. The third disqualifying condition for this guideline requires development of an emergency preparedness program which meets the requirements of 10 CFR Part 60, Subpart I. Even though these criteria have not even been issued yet by NRC, the core team is essentially concluding that no additional information is required!

These statements are difficult to reconcile with a suitability finding. The use of inadequate data to support a suitability finding has resulted in errors in the past. For example, evaluations of the site rail access in the EA were based upon the Dike Siding route, which was subsequently found to be unfeasible.

Inconsistencies between the data and the suitability findings such as these indicate that the core team felt compelled to sustain all previous lower level findings, and to elevate as many lower level findings to higher level findings as possible. Nowhere in the document does one find any serious discussion questioning whether a lower-level suitability finding was, or still is, appropriate. Continuing to make forced suitability findings that are not supported by available information will seriously erode trust and confidence in DOE.

Response.

The reviewer correctly noted that DOE has previously evaluated the Yucca Mountain site against 10 CFR Part 960, these findings are documented in the final Environmental Assessment (DOE, 1986). DOE requested that a contractor, Science Applications International Corporation, perform another site suitability evaluation that would be undertaken early in site characterization to determine if there is new evidence of features or conditions that could render the site unsuitable This second

evaluation is documented in the ESSE report (Younker et al., 1992). Both the Environmental Assessment (EA) and the ESSE provide the basis for higher level findings where there was sufficient evidence to support such a finding The EA did make final findings. The ESSE report did not reach the level of findings, but rather, provided recommendations to DOE as to whether findings could be supported.

The intent of Appendix III of 10 CFR Part 960 is to require lower level findings for all conditions at the "nomination and recommendation for site characterization" decision and higher level findings to support site selection for repository development This Appendix does not state that a higher level of confidence is undesirable before the selection of a site. In fact, paragraph 5 of Appendix III states that for "both the disqualifying and qualifying conditions of any guideline, a higher level finding . . shall be made if there is sufficient evidence to support such a finding."

The reviewer questions the validity of some of the recommendations for maintaining the lower level findings contained in the ESSE, such as those for the geohydrology and the climate change guidelines DOE believes these recommendations to be sound and these findings to be appropriate at this point in site characterization. Furthermore, the available data are insufficient to support a higher level suitability finding, but clearly do not support a finding that the site is disqualified

With respect to the higher level finding for the population density and distribution guideline, the core team limited their evaluation of the third disqualifying condition to an evaluation of the requirements of DOE Order 5500.3A The disqualifying condition states that the site is disqualified if "DOE could not develop an emergency preparedness program which meets the requirements specified in DOE Order 5500.3 . . and related guides or, when issued by the NRC, in 10 CFR Part 60, Subpart I, Emergency Planning Criteria " The core team concluded that there is little reason to believe that DOE could not approve emergency preparedness plans for the repository and little likelihood that additional information would indicate otherwise. The core team did, however, recommend that DOE monitor the status of 10 CFR Part 60, Subpart I, and, where appropriate, participate in the development of those criteria

Finally, the ESSE core team was not forced into making any findings and, in fact, could only make recommendations to DOE for consideration Section 960.3-1-5 of the siting guidelines establishes the need for at least lower level suitability findings prior to nominating a site for characterization On that basis, the core team proceeded to determine if those findings presented in the EA remain valid. The core team was given great latitude in how the evaluation was to be conducted, was encouraged to use all available information, and presented an overview of the information in the ESSE text

It is true that, subsequent to the EA, Dike Siding was found unfeasible as a rail access route. However, the evaluation of the Caliente Route is much more detailed and considered factors like land use that were not considered in the EA. Even with this additional information, feasibility of this route cannot be certain without additional technical and public reviews. This is the basis for the lower level finding (and not a higher level finding) in both the EA and the ESSE documents.

All findings of the core group were made by a consensus process that allowed every core group member to raise and discuss any issue before a group decision to go forward was made

Clark County Comment 3

Information Used for the ESSE

In performing the evaluation, the intent was to review all current, relevant information
. . . (page 1-20). The references listed do not include many of the final reports prepared by the State of Nevada or affected local governments. Certainly these reports contain current, relevant information which should not be ignored. It is also disconcerting to note the absence of controversial reports (e.g. the Szymanski Report) from the list of references.

The information reviewed also included published and draft reports, abstracts prepared for professional meetings, oral presentations, internal memoranda, . . . (page 1-20). Site suitability evaluations should be conducted based upon information that is technically sound (not in draft form) and available to the public (not internal memoranda or oral presentations).

Response.

The ESSE evaluation was based on available evidence, including that presented in technical papers and reports by people who have been openly critical of the Yucca Mountain site and/or who have provided support to the State of Nevada in evaluating DOE's plans for site characterization The report by Szymanski (1989) was considered by the ESSE core team (see Section 5, References, page 5-48) along with many reports prepared for the State of Nevada (see, for example, Quade and Cerling, 1990, and Mountain West Research, 1989, Nobel et al , 1991, Weiss et al., 1990, Chamberlain, 1991, etc)

The majority of the information considered by the ESSE core team and referenced in the ESSE report is contained in papers published in technical journals and in technical reports published by the national laboratories and the U S Geological Survey (USGS) A small fraction of the information is contained in memoranda and other

communications that were made available to the peer reviewers and was also available to others for review, upon request, through the Yucca Mountain Project Office.

Clark County Comment 4

Guidelines for Environmental Quality, Socioeconomic Impacts, and Transportation

To evaluate these guidelines, the core team considered "the range of potential impacts and the extent to which significant impacts can be mitigated." It is noted in the ESSE that the types of impacts in these areas have not yet been defined. Likely impacts were identified based upon "experience on other federal programs."

This approach is seriously flawed. First, if an evaluation and subsequent findings are based upon a range of impacts rather than an analytical assessment, the range should be broad enough to include the worst credible impact. The discussion of impacts in the ESSE clearly is based upon what the core team felt are the most likely impacts. For example, the section on socioeconomic impacts addressed perception of risk type of impacts only after requested to do so by the Peer Review Panel, and does so only in a very cursory manner. The transportation section includes projections of transportation accidents based upon the best case scenario of rail being the predominant mode of transportation.

An even more critical flaw is that this project is unique. "This project is quite unlike anything that has ever been done before. The uniqueness of the project--its focus, size, time frame, and national scope--really demands an assessment process that may be quite unlike the kinds of things that normally are done in social assessment efforts" (Albrecht, Comment 8). The same conclusion can, and should be made for environmental quality and transportation impact assessments. To define the expected impacts based upon experience on other federal projects ignores the unique character of a high-level, nuclear waste repository.

Finally, the core team concludes that if the available information indicates that the impacts can be mitigated, then a lower-level finding can be supported. It is further noted, however, that the specific levels of measures necessary to mitigate significant adverse impacts are not yet established. The Siting Guideline clearly state that a suitability finding must be based upon reasonable mitigation measures. The core team assumes that all impacts will be mitigable. This is not a valid assumption given that the nature of the impacts has not been defined.

Response:

The qualitative arguments that the impacts are bounded by the EA results are for a range of scenarios. Scenarios that were considered include options for no MRS, and an all-truck transportation option. The table in the ESSE report is not based solely on the "best case scenario" as the reviewer suggests.

The reviewer is correct in noting that the approach taken by the ESSE core team to evaluate the Environmental Quality, Socioeconomic, and Transportation guidelines was to develop an understanding of the range of potentially adverse impacts and an understanding of the extent to which significant impacts can be mitigated. This approach was taken because the types of impacts that must be considered for these guidelines have not yet been defined. Potentially adverse impacts will be defined during development of an Environmental Impact Statement (EIS) in consultation with the State of Nevada, affected parties, and the public. Information developed during the National Environmental Policy Act (NEPA) process will be used to determine if higher level findings can be supported with respect to the Environmental Quality, Socioeconomics, and Transportation guidelines.

For the ESSE evaluation, if the available information supports a finding that the impacts considered by the ESSE core team will not be significant, or can be acceptably mitigated, then at least a lower level suitability finding can be supported.

Clark County Comment 5

ENVIRONMENTAL QUALITY TECHNICAL GUIDELINE

The environmental guideline requires that the quality of the environment for both this and future generations will be adequately protected. Any assessment of the quality of the environment must include the human environment, which includes social and economic considerations. The guideline specifically includes these items in the factors to be considered. In defining the "environmental disciplines" that should be included in the assessment for this guideline, the core team inexplicably does not include social and economic sciences. Apparently the core team decided to include the assessment of social and economic factors only in the socioeconomic guideline, even though they are listed in the environmental quality guideline. There are significant differences in the criteria for qualifying conditions, favorable conditions, potentially adverse conditions, and disqualifying conditions between these two sections. The criteria contained in the environmental guideline should be applied to social and economic factors.

Response:

Socioeconomic factors are specified in the environmental quality technical guideline. The same factors are included, explicitly or implicitly, in the qualifying condition for the socioeconomic impacts technical guideline and it was considered redundant to repeat the same discussion and findings in both sections of the ESSE document. If the questions concerning the qualifying condition in the socioeconomic impacts technical guideline can be satisfactorily resolved, the same issues raised in the environmental quality technical guideline also will be addressed.

Clark County Comment 6

SOCIOECONOMIC IMPACTS TECHNICAL GUIDELINE

The entire approach for this evaluation is based upon the assumption that all socioeconomic impacts can be mitigated through reasonable mitigation. This assumption is not valid. Many social and political impacts are not mitigable. The political and social consequences of attempting to site a controversial project are not impacts that can be mitigated. They cause an indelible impact on the social fabric of a community.

The evaluation in the ESSE contains no discussion of the favorable or potential adverse conditions described in the Siting Guidelines. Critical potentially adverse conditions include the *potential for significant repository related impacts on . . . the finances of State and local government agencies in the affected area* and the *potential for major disruption of primary sectors of the economy of the affected area.* The finances of local government and the economy of southern Nevada depends upon a healthy tourist and gaming economy.

One potential impact of the repository is a reduction in this economy due to risk perception impacts. "An 'accident' at the site or along a transportation route would have very substantial implications" (Albrecht, Comment 9). The core team acknowledges that "many of these potential social and economic effects could be long term and may extend beyond the life of a repository" (page 3-43). Until these impacts are evaluated, it is unreasonable to assume that they can be mitigated through reasonable mitigation measures. Yucca Mountain Site Characterization Project Socioeconomic Plan is relied upon for the process "to ensure that socioeconomic issues and concerns are identified, potential socioeconomic effects are evaluated, and appropriate impact mitigation strategies are developed and implemented" (page 3-43). As implied by the title, however, this plan address only the site characterization phase of the project. DOE has not developed a plan to mitigate potential socioeconomic impacts due to construction, operation or closure. It is incorrect to assume that impacts

during these phases will be adequately mitigated through a process developed solely for site characterization impacts.

The ESSE acknowledged that "methods for addressing potential social impacts and perception-based impacts are less clearly understood" (page 3-44). Even though these types of impacts have never before been addressed, the core team assumes simply that DOE will need to work with affected parties to determine "how they can most efficiently be addressed with reasonable mitigation and compensation" (page 3-44).

Even though the impacts are not defined, and are not similar to the impacts from any other project, the core team assumes that the only issue is "how" they can be addressed. The fundamental question which should be addressed in a suitability finding is can these impacts be addressed. The core team also assumes that these impacts can be addressed with reasonable mitigation.

Until the impacts are defined and quantified, it cannot be assumed that the impacts can be mitigated, or that mitigation measures that address these impacts will be reasonable.

The qualifying condition for socioeconomic impacts is incorrectly evaluated in the ESSE. The discussion begins "the qualifying condition requires only that significant adverse impacts be mitigable" (page 3-44). This restatement of the qualifying condition ignores the requirement that mitigation and compensation be considered reasonable. It is unclear at this time who will actually determine what is meant by reasonable mitigation and compensation. Until these values are defined and the level of impacts are quantified, suitability findings cannot be made.

The evaluation relies, in part, on the findings of the Section 175 Report. Clark County submitted significant comments on this report that DOE has never addressed. Until Clark County's concerns with this report are addressed, relying on the conclusions of this report results in invalid conclusions.

The statement "The State of Nevada and Nye, Clark, and Lincoln counties are currently conducting their own assessment of potential impacts with the goal of requesting financial and technical assistance from DOE to mitigate those impacts" (page 3-45) is incorrect. Section 116(c) of the NWPA provides that grants to affected local governments are provided also for the purposes of determining impacts; to engage in monitoring, testing, or evaluation activities; to provide information to its residents; and to request information from, and make comments and recommendations to the Secretary. These are the current goals of the Clark County program, not the development of requests for mitigation.

The core team concludes that "unmitigable social and/or economic impacts are not expected to occur" (page 3-46). This conclusion is not supported by the analysis. No evaluation of social impacts or risk perception impacts was conducted. The conclusion ignores the requirement that mitigation must be reasonable. Until these issues are addressed, a suitability finding cannot be made.

Response:

The comment does not accurately characterize the approach used for the evaluation of the socioeconomic impacts technical guideline

The assumption that *"all socioeconomic impacts can be mitigated through reasonable mitigation"* was not made, nor is it required. The qualifying condition specifies that *"any significant adverse social and/or economic impacts . . . can be offset by reasonable mitigation or compensation, as determined by a process of analysis, planning, and consultation . . ."* (emphasis added). The lower level finding for the qualifying condition, and the discussion in the ESSE document that continues to support that finding, is consistent with those requirements by suggesting that additional information concerning the nature and extent of potential socioeconomic effects, the determination of which effects may be "significant adverse impacts," how those impacts can be offset, and how "reasonable" mitigation measures are defined must be developed in consultation with the State of Nevada and affected units of local government. In the absence of that additional information, a higher level finding regarding the qualifying condition was considered inappropriate.

Potential long-term impacts and potential impacts that may be associated with construction or operation of a repository were evaluated in the EA and will be assessed in the EIS.

Clark County Comment 7

TRANSPORTATION TECHNICAL GUIDELINE

The evaluation contained in the ESSE does not consider critical factors listed in the favorable and the potentially adverse conditions. Favorable conditions not addressed include routes are relatively short and economical to construct; cuts, fills, tunnels or bridges are not required; routes are free of sharp curves or steep grades; and routes bypass local cities and towns. Potentially adverse conditions include routes that are expensive to construct; steep grades, sharp switchbacks, rivers . . . encountered along access routes to the site. The current rail spur under consideration is very long; has high construction costs; and encounters steep grades; and crosses streams with high flood potential. It does not meet the favorable conditions, and has many of the potentially adverse

conditions. The length of the required spur is longer than any railroad construction in the modern history of this Country. The current allowable highway routes pass through Las Vegas. Any reasonable alternatives to this route that might be designated by the State of Nevada are two-lane highways that pass directly through the center of local cities and towns.

The transportation evaluation is based upon the assumption that new, high-capacity casks will be used. DOE has suspended design work on these casks pending resolution of several critical issues. Not one new generation cask has been licensed by the NRC. This is still uncertainty surrounding the testing of casks through the use of scale models and the public acceptance on this issue.

The core team concludes that potentially feasible routes have been identified for both highway and rail access. This conclusion is tenuous at best, given the potential problems identified for the rail spur and the issue of shipping nuclear waste through communities in southern Nevada.

Any evaluation of potentially feasible routes must consider the cost of constructing the rail spur and the cost of constructing by-passes around communities. Based upon the current cost estimates for rail spur construction, one could easily conclude that rail access to the site is not economically feasible. No evaluations have been conducted of by-passes necessary to avoid cities and towns. The current information simply does not support a suitability finding.

Response

Favorable and potentially adverse conditions identified in the regulations were fully evaluated in the EA. They were addressed individually in the ESSE if they represented site-specific issues related to a given guideline. It was decided they would not be individually evaluated because they were intended to be applied during the site selection process before adequate information is available to evaluate the qualifying conditions. Regarding the highway routes passing through Las Vegas, it is the responsibility of the State of Nevada to define preferred alternatives to the highway route developed using the Department of Transportation guidelines.

The transportation evaluation is based on licensed casks currently available to ship spent nuclear fuel, both by rail and highway. Eventually, there will be a new generation of casks available to ship spent fuel to a repository. All shipping casks that will be used will be certified by the NRC.

The conclusion that there are potentially feasible routes is only that. There are potentially feasible rail and highway routes that can be constructed using current technology and that are consistent with current railroads and highways. These are not

necessarily easy or inexpensive routes Spent nuclear fuel has been shipped successfully throughout the country for more than 25 years.

The evaluation of potentially feasible routes will eventually consider the cost of construction. DOE's present responsibility is to determine potentially feasible routes and develop cost estimates as part of that comparison. DOE has the present cost estimate for the Caliente rail alignment (probably the most expensive), yet there is no indication in any of the system cost analysis that rail transport will be abandoned. To the contrary, the rail spur costs are being incorporated into the next revision of theTotal System Life Cycle Cost analysis.

The reviewer is correct in stating that no evaluations have been conducted for the cost of constructing by-passes to avoid cities and towns That item is one which would need to be proposed by the State in establishing the preferred alternative routes and then be a subject of negotiations.

DOE agrees that the current information does not support a higher level suitability finding but continues to maintain the lower level suitability finding specified in the EA.

Clark County Comment 8

GUIDELINES FOR EASE AND COST OF SITING, CONSTRUCTION, OPERATION, AND CLOSURE

This guideline requires that the associated costs shall be demonstrated to be reasonable relative to other available and comparable siting options. Any assessment of this guideline is inherently flawed since DOE is not currently considering other available and comparable siting options. Either the criteria should be modified, as recommended above, to provide evaluation criteria to determine how costs will be determined to be reasonable; or the ESSE should include an evaluation of the available and comparable siting options.

Detailed considerations of costs were not made in the evaluation. Design requirements and plans for activities are not completely developed. Given the lack of information on cost, and the lack of specified criteria for determining the reasonableness of costs, it is difficult to understand how any suitability finding can be supported.

Response:

Costs for technologies needed in siting, construction, operation, or closure relative to those for other siting options were not explicitly considered by the ESSE core team because the core team did not identify any site conditions that could lead to the use of mitigation techniques that would be unusually expensive In addition, the NWPA

Amendment of 1987 effectively removed the requirements to consider comparisons with other candidate sites when determining whether the Yucca Mountain site should be recommended for repository development

RESPONSE TO ESMERALDA COUNTY COMMENTS

Esmeralda County Comment 1

Esmeralda County's major concerns are with socioeconomic and transportation impacts to our communities. The 24 comments of Dr. Stan L. Albrecht were summed up in basically two paragraph changes. There is still much uncertainty in these areas and the ESSE does not adequately answer how or when these issues will be addressed. The ESSE states: "As circumstances require, socioeconomic studies will be needed to examine other potentially affected areas, such as counties or communities that may experience socioeconomic effects related to potential rail and highway access routes to the Yucca Mountain site." I believe that circumstances require the need now for more detailed studies of expected impacts. Social and perception-based impacts are very strong in Nevada communities and there is a need to look specifically at these impacts. Likewise, more information on water quality and availability needs to be gathered and assessed. This section of the ESSE leaves more questions unanswered than it addresses. There is doubt as to methods to be used and specific items to be addressed. Some clarification here would be appreciated.

Response:

The comment raises an issue regarding the scheduling of additional studies of socioeconomic effects "related to potential rail and highway access routes to the Yucca Mountain site." The issue concerning the need for additional information regarding water quality and availability is also raised. The discussion of the qualifying condition for the socioeconomic impacts technical guideline indicates that additional information is necessary and must be developed prior to reaching a conclusion. However, the schedule for completing additional studies and for the development of methods to be used in those studies was not the responsibility of those developing the ESSE document. Recommendations for conducting additional studies regarding expected impacts are appreciated and will be taken into consideration in all appropriate technical disciplines on the Project.

Esmeralda County Comment 2

Transportation to the proposed repository also leaves many questions unanswered. There are still unresolved issues from the EA regarding military overflights and shipment of waste. Other issues not resolved include:

- **Difficult terrain conditions and geologic hazards on the proposed rail route.**
- **Endangered species.**
- **Characteristics of fuel. The cask design program is currently in limbo.**

- **Questions of highway access. Truck shipments increase if no rail route is used.**

More information regarding transportation related impacts needs to be gathered and assessed. It is likely that the eventual highway route in Nevada will travel through the center of Goldfield. This has created a real fear in the minds of some residents as regards safeguards, emergency response, number of shipments and cask design. I urge that open planning issues identified in the ESSE be given priority. Avoidance of adverse impacts or acceptable mitigation strategies need to be developed. Our communities need to know that the public and the environment will be protected from the hazards involved in the transportation of high-level radioactive waste.

The concern of the Esmeralda Board of County Commissioners is for the health and safety of county residents and for the residents of all affected communities in Nevada and elsewhere on the potential transportation routes. By prioritizing studies on socioeconomic and transportation impacts, some of these concerns would be greatly alleviated.

Response.

Preliminary evaluations regarding the potential impact of military overflights and aircraft mishaps indicate that a crash event is unlikely and would be less severe than reported in the EA. Rerouting of planes and strong building designs would be used to mitigate this hazard. A final agreement for the overflight issue needs to be reached between the appropriate federal and state agencies

In regard to the other issues mentioned in the comment, the Caliente Rail Route Conceptual Design Report discusses in detail the question of the terrain and geological features, and environmental and biological restrictions for that alignment and future conceptual design studies will address those issues for other alignments.

The characteristics of the spent fuel are known. There are currently existing spent fuel shipping casks that have NRC certificates of compliance and could be used for transporting spent nuclear fuel. Additionally, there will be NRC certified casks available for this program. Highway access to Yucca Mountain from Route U.S. 95 is discussed in detail in the Caliente Route Conceptual Design Report. The remaining highway access routes in Nevada are defined by the requirements of DOT Regulation HM-164. This regulation allows the state to identify alternative routing other than those defined by HM-164. There will be a significant increase in truck shipments if no rail shipments are used; however, it is very premature to assume there will not be rail shipments to Yucca Mountain if that site is found to be suitable for a high-level waste repository.

Once the State of Nevada identifies the preferred alternatives for the highway routes to Yucca Mountain, the State and DOE under Section 180(c) of the NWPA Amendment, working with the local affected communities, should determine what the mitigation strategies need to be, and prepare that as a part of the State's negotiations With regard to protection of the public and the environment, both the NRC and the Office of Technology Assessment state in published reports that NRC-certified spent fuel shipping casks provide a high level of public protection.

The ESSE report has no bearing on the priority of transportation studies. These studies have been temporarily slowed to allow the program to mature to the point where it is appropriate to evaluate specific routes. Transportation of spent nuclear fuel to Yucca Mountain, should the site be found suitable as a high level nuclear waste repository, will not occur for another 18-20 years. This is an adequate amount of time for DOE, working with the State and local communities, to resolve socioeconomic and transportation issues.

Esmeralda County Comment 3

Rather than releasing this document as a finished product, the public, affected parties and others should have had the chance to participate.

Response.

The ESSE report was prepared and published as a DOE-contractor report. As stated on page E-3 of this report, the conclusions contained in this report do not constitute DOE siting decisions, but do represent technical recommendations to DOE with respect to the suitability of the Yucca Mountain site for continued site characterization The ESSE and the Peer Review Report will be used as part of the basis for future plans relating to the evaluation of the site DOE has requested comments from the State of Nevada, other affected parties, and the public as input to be factored into future decisions on evaluating site suitability The Federal Register Notice announcing the availability of the ESSE report and the Peer Review Report for review and comment was published on March 20, 1992. Additionally, the ESSE core team made an effort to include published documents and consideration of the many comments received on the Site Characterization Plan (SCP) from the State of Nevada, the NRC, and other parties as input to their decisions Following issuance of the ESSE report and the Peer Review Report, efforts were made to discuss this evaluation in open forums.

In November 1990, DOE hosted a workshop open to the public in Albuquerque, New Mexico to provide an opportunity for open discussion of various approaches to the evaluation of site suitability Based on the results of this meeting, DOE initiated the early assessment of the suitability of the Yucca Mountain site in accordance with 10 CFR Part 960. During 1991, the status of the ESSE was provided in monthly

meetings held by the Yucca Mountain Project Office that were open to the public, and in other public briefings to the Nuclear Waste Technical Review Board, the NRC, and the Advisory Committee on Nuclear Waste. In May 1992, DOE held a Director's Forum in Chicago, Illinois where OCRWM Director, John Bartlett, discussed the results of the ESSE, comments received on the ESSE, and questions solicited from the forum participants.

Esmeralda County Comment 4

Although not issued as a policy document, DOE has used the ESSE to draw a conclusion on erosion as stated in the Topical Report on "Erosion Rates at Yucca Mountain Geologic Setting: Methodology and Results" submitted to the NRC on April 27, 1992.

There should be regular intervals of technical suitability evaluations.

By making formal findings on certain issues, that precludes the application of new test results to these same findings. There is uncertainty that DOE would re-evaluate formal findings since they would be considered "closed," although later testing or design revisions could change the status of a formal finding.

Response:

For future site suitability evaluations, DOE may choose to use contractor-prepared reports without formal DOE acceptance of the suitability findings, or DOE may choose to formally accept selected suitability findings. DOE intends to periodically evaluate the site for technical suitability. As required by the NWPA, DOE will make formal findings on all guidelines before deciding whether to recommend the site for repository development. To ensure new test results are reflected in site investigations, plans are periodically and formally reviewed and modified as required to reflect new data obtained in the project. Additionally, DOE believes that the several independent technical oversight groups, such as the Nuclear Waste Technical Review Board, ensure technical issues are not closed prematurely and that potentially closed issues are reopened if new information justifies further examination of an issue.

DOE did not submit a topical report on erosion to the NRC in April 1992. An outline for a proposed topical report was sent to the NRC, State of Nevada, and counties as part of premeeting materials. The outline formed the basis for discussion of erosion at a technical exchange in May 1992.

Preliminary conclusions regarding the erosion rate at Yucca Mountain are contained in the SCP. Similar conclusions are presented in the ESSE based on more recent data. DOE believes sufficient erosion data have been collected to support the absence of the potentially adverse condition for extreme erosion pursuant to 10 CFR Part 60.122

DOE has submitted a topical report on extreme erosion to the NRC for their evaluation as a reference in a potential license application, should the Yucca Mountain site be found suitable for a high-level radioactive waste repository Such results are expected products of site characterization activities that are carried out to gather data to evaluate compliance with two primary regulations, NRC's 10 CFR Part 60 and DOE's 10 CFR Part 960. No aspect of compliance with 10 CFR Part 60 is addressed in the ESSE. The ESSE is solely a product to identify the status of compliance with 10 CFR Part 960. Site characterization will yield a large data set for Yucca Mountain that will be drawn upon to evaluate compliance with both 10 CFR Part 60 and 10 CFR Part 960. The technical basis used to comply with each regulation is the same, but separate documentation will be used to demonstrate compliance.

Esmeralda County Comment 5

The independence of the Peer Reviewers remains in doubt. Several of the Peer Reviewers are currently involved in the program.

Management of the Peer Reviewers should have been by a group independent of the team performing the evaluation.

Response:

Members of the ESSE Peer Review Panel were selected on the basis of their recognized technical expertise in their respective fields and on their independence from the Yucca Mountain Project. In a few cases, members of the Peer Review Panel had marginal involvement in the program as reviewers, but their recognized technical expertise was thought to outweigh their limited involvement in the program.

DOE does not agree that the Peer Review Panel should have been managed by a group of people independent of the team performing the evaluation. The Peer Review Panel was managed in compliance with a quality assurance procedure meeting NRC's guidance regarding peer reviews. As an administrative function, this management had no influence on the findings of the Peer Review Panel

Also refer to the Introduction Section for additional clarification.

Esmeralda County Comment 6

By having only one expert on a certain issue, that Core member could influence other core team members since they would not have the same expert knowledge. This could result in a biased outcome.

Response:

The development of a consensus position by the core team was a lengthy process supported by many technical experts It is unlikely that a single expert could bias the results Each guideline was assigned a lead core team member who then selected a group of technically qualified experts from organizations throughout the program to assist in data compilation and analysis.

When technical positions were developed by the expert groups on each guideline, the core team lead for that guideline presented the developed position to the entire core team for discussion. After thorough debate, the core team was balloted. Not all core team members had expert knowledge of each guideline In such cases, the individuals had the option of questioning the guideline technical lead for more information or abstaining from the vote After balloting, a draft document was developed that outlined the core team position and results of the balloting.

This document was subjected to internal technical review as prescribed by contractor procedures that require the internal reviewer be independent of the work being reviewed, in this case the ESSE report. Internal reviewers provided numerous comments on the data, analysis, regulatory interpretations, and conclusions in the draft ESSE report The core team met with the internal reviewers and all comments were resolved

Subsequent to revision of the document resulting from internal review comments, the ESSE report was technically reviewed by external reviewers who were, for the most part, independent of the OCRWM Program and the Yucca Mountain Project. All comments by extended peer reviewers were resolved and the document was again revised

Given the large number of technical experts who developed the positions, internal technical reviewers and external peer reviewers, it is unlikely that a single core team member had the latitude to significantly bias the results in a manner that would result in technically indefensible conclusions.

RESPONSE TO LINCOLN COUNTY COMMENTS

Lincoln County Comment 1

Disclaimer **". . . no warranty, legal liability, or responsibility for information accuracy, completeness." Why is such a disclaimer necessary? Several billion dollars of future expenditures may in part rest on the report's findings.**

Exec. Summary, Page E-1, 3rd paragraph

Did not the State of Nevada request that ESSE be done to avoid costly and potentially needless further characterization?

Response:

The disclaimer found in front of the Table of Contents is a standard disclaimer that is placed in front of DOE contractor reports. The conclusions in the report are recommendations to DOE on the suitability of the Yucca Mountain site for continued site characterization, and will be considered by DOE in future planning efforts.

In the 1989 Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program, the Secretary of Energy responded to suggestions made by the State of Nevada and others and committed to ". . . a new focus on the early evaluation of the suitability of the Yucca Mountain site . . ." The Secretary stated that ". . . in its near term scientific investigations of the Yucca Mountain candidate site, DOE has decided to focus on surface-based testing aimed specifically at evaluating whether the site has any features that would indicate it is not suitable as a potential repository site."

In addition, when DOE was planning the process and scope for the ESSE, the State of Nevada was invited tc participate, however, the State declined the invitation.

Lincoln County Comment 2

Page E-1, 5th paragraph

The team was directed to consider available site data and information.
- published and draft reports
- internal memorandums
- oral presentations
- written communications

Apparently very little of the millions of dollars worth of work done by state and local governments in Nevada was considered. Why not? To a large extent, peer reviewers appear to have only had benefit of considering DOE sponsored data.

Page 1-1 2nd paragraph

This paragraph appears to imply that only DOE sponsored or obtained information was considered. Why was not extensive work produced by NWPO considered in the ESSE?

Page 1-24 Peer reviewers were to consider completeness of information presented. Did they consider whether all available information had been considered (RE: NWPO information)?

Page 3-50-51, bottom paragraph

It is inappropriate for the ESSE report to include data and studies being conducted independently by the State, universities, and counties as information planned for eventual use in an EIS. DOE cannot depend upon either the characteristics or quality of such data sources.

Response:

The final EA (DOE, 1986) and the SCP (DOE, 1988) summarized existing information about the Yucca Mountain site from DOE studies and open literature. The ESSE core team was charged with the task of evaluating existing literature, including published reports from the State of Nevada's Nuclear Waste Project Office. The peer reviewers were not limited to the consideration of DOE sponsored data. Copies of all references cited in the draft ESSE report were made available to the peer reviewers upon request.

Additionally, peer reviewers were encouraged to contact anyone necessary, and to request any additional information that would aid their review. Reports of external researchers were considered in the ESSE. (See also the response to Clark County comment 3).

DOE does not agree that it is inappropriate for the ESSE report to include data and studies being conducted independently by the State, universities, and counties as information for use in an EIS. This comment appears to conflict with the concern expressed earlier that only DOE sponsored information was considered The ESSE core team was responsible for evaluating all available information, and part of that evaluation included a consideration of the quality of the data sources.

Lincoln County Comment 3

Page E-2, 1st full paragraph

According to the text, "Major conclusions of the ESSE are supported by every member of core team. Consensus opinion was required on each major suitability finding or conclusion." Did each member of core team have sufficient expertise in all technical areas to be able to fully understand issues and concur with full knowledge?

Response:

Refer to the response to Esmeralda County Comment 6.

Lincoln County Comment 4

Page E-2, Figure E-1

From Page E-1 - "Purpose of ESSE was to determine if there is evidence of features or conditions that would render Yucca Mountain Site unsuitable for repository development."

Figure E-1 should recognize that ESSE finding of unsuitability early in process would result in site abandonment. Figure might recognize differing levels of site characterization. (i.e., . surface based testing vs. ESF).

Response:

Figure E-1 recognizes that a formal DOE finding of unsuitability early in the process would render the site unsuitable for repository development whether that information was gathered from site characterization surface-based testing or Exploratory Studies Facility testing. A formal siting decision of unsuitability would cause DOE to abandon the Yucca Mountain site, while a siting decision of potential suitability leads to continued site characterization. The figure was used to illustrate the decision process and, therefore, does not need to consider the details of the site characterization process (i e , Exploratory Studies Facility testing or surface-based testing programs).

Lincoln County Comment 5

General Comment

Has DOE formally concluded as a result of the ESSE to proceed with site characterization at Yucca Mountain? Is a systematic approach for prioritizing future studies being devised by DOE (as is recommended on pg. E-20)

Response.

Based on its 1986 EA of the Yucca Mountain site, DOE formally concluded to proceed with site characterization. Based upon the recommendations of the ESSE report, DOE will continue to characterize the Yucca Mountain site to establish its potential suitability for development as a repository.

The ESSE is one of several integrating tools designed to help focus the emphasis of the site characterization program on the most important technical issues at Yucca Mountain. Other important efforts have been the Test Prioritization Task (Mattson et al., 1991) that sought to establish a gross prioritization of site characterization technical issues, and our recent Total System Performance Assessment (TSPA) exercise (Barnard et al., 1992). The TSPA contained DOE's first attempt to combine various physical system models into a total system performance simulation. The latest and most comprehensive approach for prioritizing individual Site Characterization Plan studies has been the Integrated Test Evaluation (see discussion in Site Characterization Progress Report 7; DOE, 1992). In a generic sense, all of these efforts have focused on establishing methodologies for aiding DOE management in determining when enough characterization data has been gathered to demonstrate compliance with applicable regulations.

Lincoln County Comment 6

Page E-15, Table E-4

How can a HLF for population density and distribution qualifying conditions 1 and 2 be made when only a LLF for tectonics is possible. If additional information may indicate that future tectonic events could violate release limits is it not then also possible that doses to southern Nevada residents could exceed limits?

Response

The preclosure tectonics guideline does not address release limits or doses to individuals Whereas the guideline for population density and distribution is contained in the subdivision "Preclosure Radiological Safety," for preclosure tectonics, it is contained in the subdivision entitled "Ease and Cost of Siting, Construction, Operation, and Closure."

The (preclosure) tectonics guideline implicitly considers avoidable releases exceeding those allowable under the applicable safety requirements Rather, the guideline asks whether the technology to avoid such releases is demonstrably available and affordable Continuing the lower level finding does not, therefore, imply uncertainty that the public can be protected during repository operation It does imply, as stated in the ESSE report (page 3-104), that "additional site-specific seismic data are needed to reach an adequate level of confidence that the surface facilities can be designed to accommodate seismic hazards on the basis of reasonably available technology "

The legitimate concern expressed in this comment is a part of the composite requirements of the Preclosure System Qualifying Condition (1), "Preclosure Radiological Safety." A higher level finding on this condition requires analyses beyond the technical guidelines to demonstrate that releases will not exceed those allowable under the applicable safety requirements Thus, the analysis for the system guideline is to ensure that all pertinent processes, such as this reviewer's concern, are evaluated whether or not they are addressed by the subsidiary technical guidelines

Lincoln County Comment 7

Page E-15 Given that DOE has been unable to guarantee safety through emergency procedures for certain downwind areas associated with on-going nuclear weapons testing programs, how can a HLF for preclosure disqualifying condition 3 under population density and distribution be made? A LLF would seem more appropriate given uncertainties associated with DOE's ability to effectively design and implement emergency preparedness programs in rural areas.

Response

The disqualifying condition states that the site would be disqualified if DOE could not develop an emergency preparedness program that meets the requirements of either DOE Order 5500 3 or 10 CFR Part 60 The condition does not require that DOE guarantee safety through emergency procedures since such a guarantee cannot be made Safety will be achieved through the total Mined Geologic Disposal System (MGDS) evaluation, design, and siting process consistent with regulatory compliance and licensing processes Because the emergency preparedness requirements for 10

CFR Part 60 have not been established, suitability evaluations are based solely on meeting the requirements of DOE Order 5500.3.

Currently, DOE/Nevada Operations office (DOE/NV) is in compliance with DOE Order 5500.3 for Nuclear Test Site (NTS) activities. By policy, the MGDS and support facilities also will have to comply with the requirements of DOE Order 5500.3. Under Appendix F of the draft Memorandum of Understanding (MOU) between the Yucca Mountain Site Characterization Project Office (YMPO) and DOE/NV, YMPO will develop an emergency preparedness program that meets the requirements set by DOE/NV and DOE Order 5500.3. DOE/NV would not approve a program that did not meet the same requirements that its own program had to meet. It is the consensus of the core team that a higher level finding is appropriately justified for this condition

Lincoln County Comment 8

Page E-3, 2nd paragraph

> **Here the text states, "DOE may factor in many other considerations in decisions to continue characterization, recommended site as suitable, or abandon site." What is the statutory basis for considerations other than technical suitability.**

Response:

The comment is correct. The statutory/regulatory basis is technical. The "other considerations" factor indirectly into the process by which DOE reaches a technical finding, and whether or not a regulatory or oversight group accepts or dissents with a technical finding Primary factors influencing technical findings are: (1) the complexity of the technical issue; (2) the degree of uncertainty that is acceptable in technical findings; (3) the costs to obtain data at a required level of certainty, if it can be reached; and, (4) costs to inform the public of technical arguments and subtleties.

Lincoln County Comment 9

Page E-20 3rd paragraph, Document Resolution of Issues

> **Would a negotiated rule making be an appropriate vehicle for selecting a preferred method for documenting and closing resolved issues?**

Response:

A negotiated rule making is an option for selecting a preferred method for documenting and closing resolved site suitability evaluation issues. Such issues are the technical issues identified throughout the ESSE that need to be resolved before final conclusions can be made regarding suitability of the site for repository development. Those final conclusions are to be contained in a recommendation to the President as required under the NWPA Amendment. Resolution of the technical issues would be accomplished by appropriate scientific analysis of sufficient data to confidently answer the questions posed. Closing resolved issues would indicate further information or testing would be unlikely to change a preliminary conclusion about suitability of the site. "Closing" in this sense means the preparation of written material to document the resolution of an issue. Final closure, however, would not occur until consideration of the Site Suitability Recommendation by elected officials and regulatory bodies.

With respect to the NRC and issue resolution, refer to the response to Lincoln County Comment No. 38 for additional clarification.

Lincoln County Comment 10

Page 1-2 2nd paragraph

How will low level findings (LLF) and high level findings (HLF) designation be used in allocating Nuclear Waste Fund (NWF) resources for further technical work?

Response:

DOE uses the status of lower level and higher level findings as recommendations to help allocate resources for additional site characterization activities. A lower level finding indicates that additional data are required to make a higher level finding with respect to the suitability or unsuitability of the site. Additional resources may be required to collect the data necessary before a higher level finding can be made.

Lincoln County Comment 11

Page 2-8 Section 2.3.1.2.1

Is there a consensus within the scientific community regarding transport by ground water as being the "most likely mechanism for radionuclide release to the accessible environment after repository closure"? What about volcanism and human intrusion?

Response:

Indeed, there is a long-standing national and international scientific consensus that was documented in the mid-1950s when the National Academy of Sciences recommended the geologic disposal of nuclear wastes within rocks that minimize the possibility of waste dissolution and transport by ground water. It was recognized that the rock depths required to safely isolate radioactive waste from the biosphere would be beneath the water table at almost any place on earth. Therefore, moving ground water generally would be present in any geologic host medium, and the potential for ground water transport is inevitable.

The early siting criteria relied on rocks of low permeability to limit ground water flow, but broader criteria that considered redundant safeguards were developed in the 1970s. Among the favorable factors were a dry climate, which would limit the amount of ground water flow, and the presence of sorptive minerals that would delay the movement of radioactive elements dissolved in ground water.

These factors were paramount in a 1976 recommendation by the Director of the USGS that DOE's predecessor should examine the area in and around the NTS for possible waste-repository locations. For five years, exploration of the NTS was directed at rocks beneath the water table, until the unique advantages of waste emplacement in the thick unsaturated zone of Yucca Mountain governed the decision in 1982 to concentrate effort in that hydrogeologic environment.

Ground-water transport of radionuclides from a geologic repository to the accessible environment still is considered, by American and international scientists, to be the most likely release mechanism. Volcanism and human intrusion are considered to be disruptive events that are distinct from the set of presently active or likely processes. Within the regulatory process, however, the predicted risks and consequences from all credible processes must be considered in evaluating the suitability of a site.

Lincoln County Comment 12

Page 2-15 1st paragraph

3rd Sentence - What were the standard error and variance estimates for these values?

Response:

The values cited in the ESSE report were taken from Sinnock [(1986, ed.), "Preliminary Estimates of Ground-water Travel Time and Radionuclide Transport at the

Yucca Mountain Repository Site," Sandia National Laboratories Report SAND85-2701, Albuquerque, NM, 1986]. The report provides the range, mean, and standard deviation of the stochastically simulated ground-water travel time values. For an assumed percolation flux of 0.5 mm/yr, the calculated travel times through the unsaturated zone from the potential repository disturbed zone to the underlying water table ranged from 9,345 to 80,095 years, with a mean of 43,265 years, and a standard deviation of 12,765 years.

Standard-deviation values are not presented for the other assumed percolation-flux values (0.1 and 1.0 mm/yr). The ground-water travel time through the saturated zone was a deterministic estimation from a simple analytical model; hence, no standard deviation information was generated.

Lincoln County Comment 13

Page 2-121 Section 2.3.8.1.1 2nd paragraph

> **Interpretation of the phrase "foreseeable future" seems unnecessary as it does not show up within either the qualifying or disqualifying condition for this guideline. At a minimum the term future should be interpreted to extend through closure of the repository.**

Page 2-124 Resolution of Issue 3

> **It does not make much sense to only consider a "foreseeable future" of 30 years to address radionuclide releases greater than allowed in the Postclosure System Guideline. Postclosure will occur after 30 years. "Foreseeable Future" should be redefined to include a lengthy postclosure period during which site monitoring should occur to establish the apparent long-term integrity of the site.**

Response:

The use and interpretation of the term "foreseeable future" in the ESSE is well founded in the regulatory guidelines and in the field of economic geology. For instance, it is common in economic geology to provide economic mineral projections for 10 to 30 years (e.g., Brooks and Andrews, 1974; Harris and Agterberg, 1981; Zwartendyk, 1981), but projections over longer time frames into the future are not typically practiced or recommended

In 10 CFR Part 960, the term "foreseeable future" is used in the Favorable Conditions (960.4-2-8-16) and Potentially Adverse Conditions (960 4-2-8-1c), and implied in the Qualifying Condition (960.4-2-8) for the Human Interference guideline

Lincoln County Comment 14

Page 3-5 Section 3.3.1.1.1 Qualifying Condition

> **Did the Core Team consider population densities along possible nuclear transportation routes in evaluating this guideline?**

Response

The qualifying and disqualifying conditions associated with the population density and distribution technical guideline focus on the "site" location. Therefore, population densities along possible transportation routes were not included in the evaluation of these conditions. Population densities along the potential highway routes are evaluated by the state to identify preferred alternative routes. These state studies, using Federal Emergency Management Administration guidelines, determine the population densities along the highway in a one-mile band, a five-mile band and a ten-mile band to evaluate potential economic impacts. Population densities along any potential rail routes will be considered in the rail spur EIS process.

Lincoln County Comment 15

Page 3-6 & 7, 4th paragraph

> **This paragraph implies that because DOE/Nevada Operations has established an MOU with the State of Nevada and an emergency management plan, that development of such a plan which meets the requirement of DOE Order 5500.3A will not be a problem. It is not clear however that the existing plan is adequate. The ability to prepare future plans which provide adequate protection is then in question.**

Response.

The issues raised in this comment are addressed in the response to Lincoln County Comment 7.

Lincoln County Comment 16

Page 3-23, Aircraft Mishaps

> **The conclusions reached in this section appear inconsistent with earlier statements by DOE and USAF correspondence regarding conflicts between repository and DOD missions.**

The findings in this section would indicate justification by DOE for reevaluation of the merits of a rail spur access through Lincoln County and into the north-end of Nellis/NTS.

The administrative procedures cited in this section could presumably be used to minimize DOD conflicts with the scheduled and relatively infrequent rail-shipments of HLW and spent-fuel to Yucca Mountain.

Response.

The conclusion stated on page 3-23, aircraft mishaps, is based on mishaps over the potential Yucca Mountain surface facilities The same conclusion does not apply to a transportation route across the Nellis Bombing Range and NTS, as this route is along the main air traffic lane between the Nellis Air Force Base and the Bombing Range. However, as a result of recent changes in world politics, it would be appropriate to reevaluate the possibility of developing a transportation route across a section of the Range. The Project plans to initiate an inquiry into this possibility in the near future

Lincoln County Comment 17

Page 3-33 Disqualifying Condition 1

How does the present inability of DOE/Nevada Operations to be able to guarantee protection of off-site uncontrollable areas in Lincoln County bode for DOE/YMPO to be able to adequately protect county residents from repository risks. What is the definition of the "affected area"?

Response:

DOE/NV is presently able to adequately protect the general population within the regulatory standards that apply to their activities Comparisons between weapons testing activities and a highly engineered underground repository are not appropriate Nevertheless, adequate protection from the hazards posed from high-level nuclear waste disposal will be achieved through the total mined geologic disposal system evaluation, design, and siting process consistent with regulatory compliance and licensing processes. The "affected area" cited within the guidelines "means either the area of socioeconomic impact or the area of environmental impact . ."

Lincoln County Comment 18

Disqualifying Condition 3

Do "repository support facilities" include transportation corridors? Is it possible that rail corridors could conflict irreconcilably with Nevada State Parks located within Lincoln County?

Response:

In the context of 10 CFR 960, "repository support facilities" means all permanent facilities constructed in support of site characterization activities and repository construction, operation, and closure activities, including surface structures, utility lines, roads, railroads, and similar facilities, but excluding the underground facility.

The conceptual design study of the Caliente rail access route considered all of the areas identified in Disqualifying Condition 3, including state and county lands, as severe or significant restrictions. These areas were avoided for the rail alignment shown in the report (Ref. Caliente Route, Conceptual Design Report, June 1, 1992).

Lincoln County Comment 19

Page 3-33 Discussion

The last sentence of this paragraph should include state-protected areas as well.

Response

The second disqualifying condition for the environmental quality technical guideline addresses federally protected lands only (i.e., National Park Systems, National Wildlife Refuge Systems, National Wilderness Preservation Systems, and National Wild and Scenic Rivers Systems.) However, the third disqualifying condition in the guideline does include "... any comparably significant State-protected resource..." for purposes of suitability evaluations. While the statement in question in the text does mention only federally protected lands, at least a portion of the overall evaluation for the guideline would indeed include applicable state-protected lands as well.

Lincoln County Comment 20

Page 3-40, Section 3.3.1.3.2

What about avoiding impacts to state protected lands?

Response:

As mentioned in response to Lincoln County Comment 19, Disqualifying Condition 2 for this technical guideline addresses only federally protected lands. Avoiding impacts to state-protected lands would be a subject of Disqualifying Condition 3 with regard to potential "irreconcilable conflicts" with siting a mined geologic disposal system (including support facilities). Transportation corridors have been and will continue to be studied to avoid impacts to federal- and state-protected lands. At this time, it does not appear that irreconcilable conflicts would occur; however, additional data is necessary. Therefore, only the lower level suitability finding was recommended in the evaluation.

Lincoln County Comment 21

Page 3-42, 3rd paragraph

The third sentence notes the conditions which relate to common socioeconomic factors. What about special or unique efforts?

Response:

The history of the development of the socioeconomic impacts technical guideline does not appear to include a discussion of "special or unique" socioeconomic factors. However, subsequent discussions in the socioeconomic impacts technical guideline section of the ESSE document (see Sections 3.3.2.2.2 and 3.3.2.2.3) recognize the concerns regarding perception-based impacts.

Lincoln County Comment 22

Page 3-42, 3rd paragraph, 4th sentence- those statements

What statements are being referred to here? Is it possible that without coordination, State impacts may not be mitigable? The assumption of state and local government cooperation may be invalid.

Response:

Those statements are taken from the "Overview of the Guidelines" (see pages 47746 and 47747 of Vol. 49, No. 236 of the Federal Register). While a lack of coordination in identifying and addressing socioeconomic impacts would be unfortunate and would undoubtedly render the task more difficult, it is unlikely that impacts would be unmitigable as a result.

Lincoln County Comment 23

Page 3-43, 3rd paragraph

> **Although DOE and affected parties have coordinated, DOE has to date not developed a socioeconomic impact assessment plan acceptable to said parties.**
>
> **At issue is whether DOE assessment will be pro-forma or ex-post (monitoring).**
>
> **DOE has proposed a monitoring based ex-post assessment method. Such a method will necessarily imply a lag between the time when impacts are identified and when they are mitigated. DOE plan does not allow for early anticipation of potential effects.**

Response:

The YMPO Socioeconomic Plan describes a process of communication and coordination that is intended to provide for timely identification of potential impacts, avoidance of those impacts to the extent possible, and development and implementation of effective mitigation measures. The socioeconomic monitoring program is being modified, in consultation with affected parties, to provide the information necessary to effectively anticipate potential effects.

Lincoln County Comment 24

Page 3-44, top paragraph, last sentence

> **Because it is possible, if not likely, that the State of Nevada will be unwilling to cooperate with DOE, it cannot be assumed that mitigation or compensation will be timely.**

Response:

As was indicated in the response to Lincoln County Comment 22, a lack of cooperation would make the development and implementation of effective mitigation measures much more difficult. It remains to be seen if the State of Nevada will cooperate in that endeavor and, if not, whether that will negatively affect the timeliness of mitigation programs.

Lincoln County Comment 25

Page 3-45, first full paragraph

The third sentence needs to include other "affected" units of local government.

Response:

This comment from Lincoln County is well taken. While most of the socioeconomic studies conducted by DOE in the past have focused on the initial three affected counties, it is recognized that an additional seven counties have applied for and received that designation.

Lincoln County Comment 26

Page 3-46, 3rd paragraph

If the Core Team is willing to state that unmitigable social and/or economic impacts are not expected, then why is it not willing to support a higher-level suitability finding? In fact, not enough information exists to know whether or not unmitigable impacts will occur. The final sentence of this paragraph needs to be withdrawn from the text.

Response:

The statement by the core team is intended to summarize the information available to date and not to conclude that a higher level finding is appropriate. The previous sentence in that discussion accurately reflects the proposed process to develop sufficient information to address the requirements of the socioeconomic impacts technical guideline.

Lincoln County Comment 27

Page 3-48, 1st paragraph (iv)

How will the term unacceptable risk or environmental impact be defined?

Response:

Because of the lack of definition of what is unacceptable other than taking into account the factors identified in the Qualifying Condition there will, more than likely, be affected parties that will always find this kind of activity unacceptable. Based on other spent nuclear fuel shipping campaigns, those that found the activity unacceptable had

public acceptance in evaluating routing options is one of the factors in the overall routing decision process.

Lincoln County Comment 29

Page 3-52, 1st paragraph

This section needs to include "Location of Transportation System Support Facilities."

Response:

The listing shown on page 3-52 under Transportation Planning is not intended to be all inclusive, but to identify some of the planning issues related to operations. The reviewer is correct in stating that another issue is the location of transportation system support facilities, but there are also the issues of driver qualifications, driver training, emergency response training, the truck/rail split, etc.

Lincoln County Comment 30

Page 3-52, 3rd paragraph

What would be the goal of public involvement? How would it help in meeting the transportation qualifying condition? Is there an assumption that public involvement is related to public acceptance of risks and/or environmental effects?

Response:

Public involvement in the transportation guideline evaluation would serve several purposes: interested members of the public would be provided: (1) information about the project, (2) opportunities for public review, questions, and comment on the proposed activity; and (3) an opportunity to identify local information and issues that could be factored into and considered in the program design. There is no assumption that public involvement is related to public acceptance of risks and/or environmental effects other than to support members of the public in making informed choices about the acceptability of risks and environmental impacts · Consultations with the public are desired by DOE, and required by the NWPA Amendment of 1987 and the NEPA process.

Lincoln County Comment 31

Page 3-52, 4th paragraph

> **The issue is not one of impact significance but rather impact acceptance. It remains to be seen whether or not an overwhelming majority of residents in Nevada will be accepting of HLW transportation risks.**

Response:

The comment is well taken. We agree the issue is acceptance of impacts by the public.

Lincoln County Comment 32

Page 3-55, 2nd paragraph

> **What options is DOE considering against which comparisons for Yucca Mountain costs are being made?**

Response.

DOE completed comparisons of the cost among the five sites nominated for site characterization (DOE, 1986). This analysis concluded that of the five sites, Yucca Mountain was most favorable with respect to the combined costs for repository development and transportation. Congress, in the NWPA Amendment of 1987, directed DOE to conduct site characterization studies only at the Yucca Mountain site. Thus, costs of technologies needed for siting, construction, operation, or closure relative to those for other siting options were not explicitly considered by the ESSE core team.

The ESSE core team did consider costs that could result from use of unavoidable technologies or changes that could result in design. However, the core team did not identify any site conditions at Yucca Mountain that would lead to the use of mitigation techniques that are unusually expensive.

Lincoln County Comment 33

Page 3-56, 2nd paragraph 3rd sentence

> **Does this suggest that the Core Team views the potential cost of the Caliente Rail Spur option to be a reasonable cost or not unusually expensive? The spur is a mitigation measure largely intended to avoid shipping through the Las Vegas metropolitan area.**

Response:

The ESSE evaluation considered the rail access study for the Caliente route (DeLeuw, Cather & Co., 1991) and when the cost of constructing the rail spur is compared to the extra cost for just truck shipments, the Caliente rail spur cost is about 20% higher than using just truck shipments and, therefore, is not considered unusually expensive. In addition, the cost to construct the Caliente alignment is considered the most expensive of the three routes identified in the Preliminary Rail Access Study (1990). The Caliente route study indicates that for "the conceptual design of the alignment, including several options, the railroad can be constructed within the limitations of present railroad engineering practices and normal operating standards" (Younker et al., 1992). Additional studies were recommended to identify alignments that have similar characteristics. The possible use or construction of this rail spur and its cost will be considered by DOE when it makes recommendations to Congress. (Also refer to the response to Lincoln County Comment 34 for additional clarification.)

Lincoln County Comment 34

Page 3-56, 2nd paragraph

> **The conclusion that NWPA Amendment negated a requirement for DOE to consider the costs of developing Yucca Mountain against other options is unfounded. DOE still has the responsibility to notify Congress if Yucca Mountain appears at any time to be unsuitable. Unsuitable in terms of costs as compared to other options remains clearly important. Obviously, Congress has not told DOE to study and develop Yucca Mountain at any cost.**

Response:

DOE agrees with the reviewer that we have the responsibility to notify Congress if the Yucca Mountain site appears at any time to be unsuitable. The DOE is still required to evaluate the cost of siting a repository, a determination that the cost of developing a repository at Yucca Mountain would be unreasonably large would be sufficient for an

unsuitability notification. In evaluating the guidelines for ease and cost of siting, construction, operation, and closure, the ESSE did not identify any characteristics of the site that would lead to the use of mitigation techniques that are unusually expensive. The core team concluded the information obtained since the EA (DOE, 1986) continues to support a lower level finding for the qualifying condition for the system guideline for ease and cost of siting, construction, operation, and closure. The core team also concluded that additional information is needed in some technical areas, such as preclosure rock characteristics and preclosure tectonics, before a higher level suitability finding can be supported. Additional data could also lead to disqualification of the site, if a higher level suitability finding cannot be supported for any qualifying or disqualifying condition.

Lincoln County Comment 35

Page 3-105, section 3.3.3.5

This section does not appear to consider all aspects of repository construction such as rail spur access costs. The focus is very narrow. In addition, no attention is given to other options for siting against which Yucca Mountain might be compared.

Response:

See responses to Lincoln County comments numbers 32 and 34.

Lincoln County Comment 36

Page 3-66 and 67

The noted levels of uncertainty regarding the biological activity and spatial extent of mordenite in the Calico Hills Unit suggests the need for additional information. This uncertainty is also reason enough to support a lower-level suitability finding for the Preclosure Rock Characteristics disqualifying condition. The justification given in the ESSE for a higher-level suitability finding is very tentative and highly qualified. It is recommended that a lower-level finding be made and additional information concerning Preclosure Rock Characteristics.

Response:

It is agreed that levels of uncertainty regarding the biological activity and spatial extent of mordenite in the Calico Hills unit suggest the need for additional information. This unit directly underlies the potential repository host rock and characterization of this natural barrier may involve extensive drifting. The evaluation of the Preclosure Rock Characteristics Guideline specifically notes that "the potential for an inhalation hazard to workers and an environmental impact from mining this formation must be evaluated. Uncertainty remains concerning the occupational health risk and environmental impact represented by mordenite. However, reasonably available ventilation and health protection technology is likely to be adequate to mitigate the hazard."

Studies of the biological effects on humans due to exposure to environments with mordenite present, and an analysis of mitigation and protection technologies will provide enhanced confidence. An alternative approach to characterizing the Calico Hills that obviates this hazard and the potential impact could also provide improved confidence

The ESSE conclusion to support a higher level (Level 2) finding for the preclosure rock characteristics disqualifying condition (10 CFR Part 960.5-2-9(d)) is based on the core team consensus that this disqualifying condition, taking into account mitigating measures that use reasonably available technology, is not present at the Yucca Mountain site. Further, on the basis of the expectation that rock characteristics will not pose significant risks to the health and safety of workers, new information is considered unlikely to change this conclusion.

Lincoln County Comment 37

Page 3-68, 3rd paragraph

> **While it is agreed that there are no other candidate sites at this time, there are other available and comparable siting options. As a consequence, comparative evaluation of costs between Yucca Mountain and other available and comparable siting options is possible.**

Response:

This guideline is contained within 10 CFR Part 960, "Nuclear Waste Policy Act of 1982; General Guidelines for the Recommendation of Sites for the Nuclear Waste Repositories." Under Section I, Background Information, the guidelines explicitly address sites for mined geologic repositories. Within this context, the ESSE core

team judged there were no "other available and comparable siting options" because consideration of other candidate sites has been suspended by the NWPA Amendment of 1987.

The NWPA Amendment of 1987 designates Yucca Mountain, Nevada to be the single potential repository site for characterization. Consequently, as stated in the third paragraph on page 3-68 of the ESSE report, "...comparative evaluation of costs among candidate sites is not possible." Presumably, a comparative evaluation among Yucca Mountain and other available and comparable siting options would be possible if Congress were to again mandate the study of multiple sites.

Lincoln County Comment 38

Page 4-8 and 9

> **It is not at all clear why DOE would seek to reach formal closure of some issues prior to licensing by NRC.**
>
> **Of what benefit is early issue closure to DOE, the NRC, and other affected or interest parties? Rather than a formal process of issue closure, it seems as though DOE could choose to simply focus its characterization activities in areas where further data is needed. All issues could then be considered together during licensing. In this manner all new data generated could be considered for application in resolving all relevant issues.**

Response:

DOE plans to seek resolution of some issues during the pre-licensing consultation phase of site characterization. DOE benefits from this process by gaining a greater level of confidence that, if the site is found suitable, its recommendation of the site to the President will be sustained in a licensing proceeding with the NRC. Pre-licensing consultation and issue resolution will ensure that any potential repository license application will be acceptable for review by the NRC. This level of confidence can only be attained by conducting pre-licensing interactions with NRC staff along with their review, comment, and acceptance of DOE's program. The benefit to the NRC is that the agency can complete its license application review within the required time allotted.

Issue resolution during the pre-licensing consultation phase consists of an agreement on a particular issue that enough information has been gathered to satisfy DOE and the NRC that a technical or regulatory aspect of site characterization has been sufficiently understood so that other technical aspects of the site can be focused upon.

This allows limited resources to be focused on the most significant unresolved issues. Although a mutual understanding of this type is reached between DOE and NRC staff during site characterization, it does not preclude an issue from being raised or challenged during the licensing hearing process

A major benefit of issue resolution to other affected or interested parties is that the process enables those parties to understand in detail the data and evaluations made to resolve a particular issue. Periodically site investigations are formally reviewed and modified as required to reflect new data obtained in the project. For any given issue, new data may be found to cause DOE or NRC staff to reopen an issue for additional study or consideration.

Lincoln County Comment 39

Page 4-9, 3rd paragraph

Does DOE intend to evaluate the cost and value of additional information? Will the results of such an evaluation be documented and made available for review by affected parties prior to DOE decisions to proceed with site characterization?

Response:

In the evaluation of several guidelines, the ESSE core team concluded that the site is likely to be suitable, but some important uncertainties exist. In these areas, the core team recommended additional data collection to address these uncertainties. DOE will consider the ESSE recommendations in prioritizing site characterization activities. In the course of prioritization, DOE management will consider the cost and value of the additional information, but a formal evaluation is not planned.

Lincoln County Comment 40

Page 4-10, 4th paragraph

Will DOE conduct a comprehensive prioritization effort to identify and prioritize future site characterization activities? Will the results of such an effort be documented and made available for review by affected parties prior to initiation of further characterization work by the Department?

Response

The ESSE report, along with input received from public comments and many other factors, will be used by DOE to establish testing priorities for assessing site suitability. In addition, DOE and its contractors have conducted several studies to aid in prioritizing the site characterization tests. This has included the Test Prioritization Task (Mattson et al , 1991) and the Calico-Hills Risk/Benefit Analysis (DOE, 1991). These tasks produced prioritization of tests, conducted sensitivity efforts, and documented insights and conclusions. All of these reports provided recommendations to DOE management. The main integrating and prioritization tools used as the bases for DOE management to make decisions regarding the course and direction of site characterization are available to the State, affected counties, and the public.

RESPONSE TO STATE OF NEVADA COMMENTS

NV Comment 1

The ESSE does not explicitly consider the extensive and rigorous evaluations of the suitability of the Yucca Mountain site which this office already has provided to DOE in the form of comments on the 1986 Environmental Assessment for Yucca Mountain, and the 1988 statutory Site Characterization Plan for Yucca Mountain. And, the ESSE ignores the detailed basis for our conclusion that the site is unsuitable contained in Governor Bob Miller's November 14, 1989, letter to Energy Secretary Watkins. Despite your letter of April 10, 1992, in which you suggest that our conclusions were explicitly considered in the ESSE, we find no reference to such consideration by the authors.

Response:

The evaluations of the suitability of the Yucca Mountain site that the State provided in the form of comments on the 1986 EA and the 1988 SCP were addressed by DOE in the form of written responses issued in September 1991. The geotechnical issues identified by the State in their comments on the SCP included the following suitability issues: potential impacts on repository performance from recurrent faulting and volcanism and of human intrusion due to the possible presence of natural resources at the site. The same concerns, plus an additional concern related to fast flowpaths for ground-water travel time, were expressed by the State in an attachment to the November 14, 1989, letter from Governor Miller to the Secretary of the Department of Energy.

The ESSE report explicitly considers the potential unsuitability of the Yucca Mountain site with respect to postclosure tectonics (faulting and volcanism), human intrusion with respect to natural resources, and the postclosure geohydrology disqualifying condition for ground-water travel time. These guideline discussions cover the geotechnical issues on site suitability that have been raised by the State of Nevada.

The April 10, 1992 letter from John Bartlett to Robert Loux was not intended to suggest that the State's conclusions were explicitly considered in the ESSE report. The attachment to that letter states that all the suitability issues raised by the State were considered in the evaluations conducted by the core team and their conclusions were subject to review by independent technical peers.

NV Comment 2

The ESSE is much more an exercise in analysis and interpretation of the Department's site recommendation guidelines (10 CFR Part 960) than it is an evaluation of suitability based upon available information and data regarding Yucca Mountain site conditions. As such, the ESSE finding that the site remains suitable simply illustrates that those who frame the questions control the answers. This observation regarding the ESSE is one of the many conclusions of the attached analysis of the ESSE performed for this Office by Kristin Shrader-Frechette titled Expert Judgement and the Frame Problem: Analysis of the "Early Site Suitability Evaluation, Yucca Mountain." It is intended that this attachment be considered a part of the State of Nevada's comments on the subject report.

Response:

DOE does not agree with this comment because DOE's guidelines (10 CFR Part 960), the NRC's guidelines (10 CFR Part 60), and guidelines referred to in those two primary guidelines are the basis for formulating educated and intelligent decisions concerning the suitability or nonsuitability of the Yucca Mountain site. Without the regulatory criteria, there would be no technical basis for either accepting or rejecting the Yucca Mountain site. DOE does not accept the applicability of the analysis provided by Kristin Shrader-Frechette (see attachment), as it is not based on factual information, the ESSE report, the methods employed in developing the ESSE report, or the regulatory guidelines. Also see the responses to State of Nevada comments 3, 4, 5, 6, 7, and 8 for further clarification

NV Comment 3

Among the conceptual flaws identified is the imposition of an evaluation logic that only permits one of two conclusions, i.e. the site is unsuitable or it is suitable. It is pointed out that "the most basic problem with the ESSE logic is that it is not typically used in scientific discovery and confirmation. In science we use a three-valued logic, according to which claims are falsified (e.g., site is unsuitable), confirmed (e.g., site is suitable), or uncertain, (e.g., we cannot determine suitability one way or the other)." An important consequence of allowing only a conclusion of suitability or unsuitability is that, if researchers find no disqualifying condition, then their failure to do so is sufficient to produce a suitability finding for that condition. This result is specifically prohibited in DOE's siting guidelines (10 CFR Part 960). According to DOE's rule, it must demonstrate that the qualifying condition is present in order to make a suitability finding.

It is noteworthy that in one case the ESSE intentionally violates its own ground rule regarding conclusion that the site is either suitable or unsuitable. In considering whether potential gaseous releases of Carbon-14 from a Yucca Mountain repository may exceed the U.S. Environmental Protection Agency's quantitative limit for radionuclide releases from a repository (40 CFR Part 191), the ESSE, instead of making a suitability determination, concludes that the limit is inappropriate and should be revised. Clearly there was considerable concern in this case about whether the suitability of the site could be defended. Resorting, instead, to an attack on the standard of safety evaluation undermines any shred of credibility that the ESSE may have.

Response:

DOE does not agree with the reviewer that a conceptual flaw in the ESSE evaluation is the imposition of an evaluation logic that only permits two conclusions. DOE siting guidelines provide for three levels of decisions (i.e., a three-valued logic). One is that the site is disqualified or "falsified." Another decision is that the site is qualified or "confirmed." The third conclusion is "uncertain, i.e., there are insufficient data to make a decision with respect to suitability or unsuitability for site recommendation for repository development. " This "uncertain" decision corresponds to two of the lower level findings listed below:

- The evidence does not support a finding that the site is not likely to meet the qualifying condition [10 CFR Part 960, Appendix III, 3 (a) for a qualifying condition]; and,

- The evidence does not support a finding that the site is disqualified [10 CFR Part 960, Appendix III, 2 "1" (a) for a disqualifying condition].

These lower level findings provide for suitability decisions that are uncertain. Insufficient data exist to qualify or disqualify the site for the site recommendation decision Once a lack of data sufficiency was identified, the core team sought to identify the areas in which collection of more data would allow DOE to make a finding in the future.

With respect to the analysis of the postclosure total system guideline, DOE recognizes some inconsistency in the logic regarding site suitability with respect to the release of carbon-14. The ESSE summarizes various studies that note the gaseous release of carbon-14 through the unsaturated zone and recognizes a significant probability that the remanded Environmental Protection Agency (EPA) standard may be violated. However, the report also notes that the effect on public health would not be significant in comparison to natural sources of carbon-14 in the atmosphere. In addition, the major uncertainties in the release of carbon-14 are not site characteristics, but rather

uncertainties related to the amount and rate of release of carbon-14 in the gaseous phase from the waste package Given the recent action taken by the U.S Congress to request the National Academy of Sciences to reevaluate the basis for the EPA standard, DOE believes it would be premature to take actions based on potential carbon-14 noncompliance at this time

NV Comment 4

Another serious conceptual flaw in many of the arguments in the ESSE is the "appeal to ignorance" in which a conclusion is considered correct simply because it has not been disproved. This is a case in which a positive conclusion is drawn from something negative, ignorance. An example is the ESSE conclusion that site characteristics are such that unusually expensive mitigation techniques will not be required. However, the report also indicates that detailed cost evaluations were not made and the costs of mitigation are not known.

As a result of the conceptual flaws summarized above, the ESSE arrives at favorable conclusions about site suitability that are subjective and lack rationale in its consideration of specific site characteristics.

Response

In no case did the ESSE assume that something is true simply because it has not been disproved The basic scientific process is to gather available information and make an informed judgment of the meaning and implications of the data for the problem at hand The scientific method does not prove a data set, a conclusion, or an hypothesis is correct. The scientific method eliminates possibilities and concludes that a data set, a conclusion, or an hypothesis is highly likely or not

In the example used in the comment, the question posed is: "Would unusually expensive mitigation techniques be required?" An expert judgment was used to assess the likelihood of an unforeseen event causing an unusually expensive mitigation technique In the judgment of the core team, no information presently available about the site nor information and results likely to be attained in the future are likely to result in an unusually expensive mitigation technique.

It is reiterated that the ESSE is a set of recommendations to DOE on the suitability of the Yucca Mountain site It is not a suitability finding, but rather a technical view of the status of site suitability at the time the questions were asked

NV Comment 5

In concluding that natural resources are unlikely to encourage interference activities leading to radionuclide releases, the ESSE ignores its own observation that there have been recent discoveries of gold, silver and tungsten in the Yucca Mountain area. Instead, the ESSE states that information gathered since evaluating this condition in the 1986 environmental assessment "strengthens" the favorable suitability conclusion regarding this condition. This is simply a case of treating an earlier suitability conclusion as being immune to revision, even when new unfavorable information becomes available. Also, the ESSE "appeals to ignorance" in stating its evaluation of the natural resources condition "uncovered no information that indicates that the Yucca Mountain site is . . . likely to be disqualified."

Response.

The ESSE report does not ignore the observation that there have been recent discoveries of gold and silver in the region of Yucca Mountain. In addition, occurrences of tungsten were not reported in the SCP, but were reported in the ESSE. The SCP (DOE, 1988) reviewed new types of deposits discovered and mined in the last two decades in the Yucca Mountain region. The ESSE report provides additional information on these deposits, occurrences, and their geology so that a careful comparison can be made with the geology of the Yucca Mountain site. The ESSE concludes that recent information and the information contained in the SCP point to the need for careful evaluation of the Yucca Mountain site before a final conclusion on resource potential can be made. Recent discoveries of mineral deposits were not at the Yucca Mountain site and do not constitute "unfavorable information." Rather, available geologic information suggests that the occurrence of an economic ore body of gold, silver, or tungsten is extremely unlikely at Yucca Mountain.

The ESSE report also summarizes new site information, such as recently published geologic maps and site-specific geochemical data, which lends further support to findings that were documented in the final EA.

NV Comment 6

The ESSE concludes that the site is suitable in regard to the standard for groundwater travel time from the repository to the accessible environment. This appears to be a case of begging the question by assuming that the models to evaluate this groundwater question will be devised, and that they will provide information favorable to site suitability. As we have pointed out in previous comments, use of available data and empirical methods provides a basis for our conclusion that the site should be disqualified because of the groundwater conditions.

Response:

The ESSE report does not conclude that the site is suitable for repository development with respect to the 1,000-year ground-water travel time disqualifying condition. The report states that for the assumption of matrix flow and expected conditions at the site, ground-water travel times are likely to exceed 1,000 years along paths of likely and significant radionuclide travel. The text also states that this conclusion is based on limited data using models that may not approximate the dominant conditions that operate at the site On this basis, the ESSE core team chose to give it a lower level finding. Site-specific studies to characterize potential flow paths, to define the spatial and temporal distribution and magnitude of infiltration, and to develop a representative data set for modeling the geohydrologic system will provide information to support an evaluation of whether higher level suitability can be supported.

NV Comment 7

Finally, as a result of the ESSE emphasis on interpretation in order to apply each guideline in an independent manner, the complexity of the Yucca Mountain site and the potential effects of coupled natural processes are ignored. For example, hydrothermal activity is mentioned in association with tectonics, yet not reviewed in the context of hydrology and geochemistry. Thus the ESSE view that the site is suitable from a perspective of total system performance is overly simplistic and seriously underestimates the complexity of geologic processes and events at the site and in the Yucca Mountain area.

Response

DOE does not agree that the ESSE perspective of total system performance is overly simplistic and, therefore seriously underestimates the complexity of geologic processes and events at the site The siting guidelines evaluate each guideline independently, while considering impacts in other technical areas For example,

hydrothermal activity is considered under the postclosure tectonics guideline, but in the context of the effect of igneous activity on the hydrologic system.

NV Comment 8

We find that the Early Site Suitability Evaluation falls both conceptually and in its implementation to meet acceptable standards of objective scientific evaluation. DOE's reliance on this document for its continued belief in the suitability of the Yucca Mountain site for a high-level nuclear waste repository is unjustified, and dangerously misleading regarding the ability of the site to safely contain these highly radioactive wastes.

Response:

The conclusions contained in the ESSE report do not constitute DOE siting decisions or suitability findings, but do represent technical recommendations to DOE that the Yucca Mountain site should continue to be characterized. Although the ESSE and the Peer Review Report will be used as part of the basis for future plans, DOE has not made decisions regarding such plans based solely on the recommendations of ESSE. DOE does not agree that the ESSE fails to meet standards of objective scientific evaluation. DOE required its contractor to perform an independent peer review of the ESSE report to evaluate the validity of conclusions and recommendations. After the resolution of all peer reviewer comments, the ESSE was revised to reflect these resolutions. Peer review members agreed that their comments were resolved and that peer review criteria objectives had been met.

RESPONSE TO U.S. DEPARTMENT OF INTERIOR COMMENTS

Department of Interior (DOI) Comment 1

Ground water

We continue to have concerns about possible impacts to DOI water rights downgradient from the area of proposed Department of Energy (DOE) activities. We are also concerned with potential impacts to both the quantity and quality of ground water at Devil's Hole, as well as to Death Valley springs as a result of the proposed activities.

It is generally accepted by ground water hydrologists that many of Nevada's ground water basins are interconnected into large flow systems. Additionally, there is a regional carbonate ground water flow system at greater depth that operates independently of surface topography. The mechanisms of interbasin and regional ground-water flow are poorly understood, as pointed out in the report, and must be more carefully studied before reasonable assurances can be provided regarding the protection of National Park Service (NPS) water resources. We are encouraged that the current program of site characterization and ground-water monitoring is designed to provide an understanding of such ground-water flow. We remain hopeful that the understanding which is gained will adequately address potential impacts to the nationally important water resources at Death Valley National Monument.

DOE studies indicate that there is little local recharge of the aquifers. The area is heavily dependent on ground water flowing to it from distant locations. Most of the ground water basins surrounding Death Valley are either fully or overly appropriated. The Nevada State Engineer has estimated that the Amargosa Desert, Nevada ground water Basin 230, which contains Devil's Hole is currently more than 200% over appropriated.

To support site characterization activities, DOE proposes to bring Basin 227A, which may provide outflow or recharge to Basin 230, to full appropriation. A monitoring plan, titled Monitoring Program for the Ground water Levels and Spring Flows in the Yucca Mountain Region of Southern Nevada and California, February 1991, U.S. Department of Energy, Yucca Mountain Project Office was agreed to by the NPS and DOE to address DOE's current and recently proposed appropriations for water to support site characterization activities. The plan provides an "early warning system" to detect potential impacts so that timely measures can be implemented to protect NPS water rights and water resources, should the need arise.

The NPS and DOE have not discussed a monitoring plan to address any appropriations associated with the construction and maintenance of a repository. This would be premature since it is not yet clear if the repository

will be located at Yucca Mountain. NPS remains concerned about the potential impacts to Death Valley from any such future appropriations.

With regard to the separation of the Fortymile Canyon-Jackass Flat (Basin 227A) system and the Amargosa Desert (Basin 230) system, the current view of most hydrologists knowledgeable about the area is that the two are separate. A ground-water divide appears to be present between the central part of the Amargosa Valley and the Ash Meadows springs (Winograd and Thordarson, 1975). Additional data are needed to confirm whether or not this is the case. Similarly, additional data are needed to determine the quantity of regional ground-water which discharges at Franklin Lake Playa and at Death Valley springs. For obvious reasons, these determinations are of great importance to the National Park Service.

We concur with the comment by Steven W. Carothers (page 199 of the Report of the Peer Review Panel) that DOE should further investigate the potential effects of site operation on the aquatic and biological resources in Ash Meadows National Wildlife Refuge, including Devil's Hole and Death Valley National Monument.

DOE has not demonstrated that water required for site construction and operation will not affect those resources, which include three species of fishes and seven species of plants currently listed by the Federal Government as endangered or threatened.

Response:

Comments under the heading "Ground water" appear to be directed at the DOI's general impressions and understanding of the Yucca Mountain Project rather than at the content of the ESSE report, which is focused on an evaluation of the potential repository site in the context of DOE Siting Guidelines of 10 CFR 960. DOE, with assistance from the DOI's Geological Survey (USGS), has responded to very similar DOI comments on the Yucca Mountain Site Characterization Plan, as well as in several meetings with National Park Service (NPS) personnel regarding the effects of water use for site characterization. The hydrogeologic understandings and modeling analyses that support DOE's expectation of minimal hydrologic impacts on the Amargosa Desert and Death Valley National Monument were reviewed, challenged, and supported in the Nevada State Engineer's hearing in September 1991 on DOE's initial application for water from Well J-13 near Yucca Mountain. The NPS retracted its earlier protest of that application after reaching agreement with DOE on the plan for monitoring ground-water levels and spring flows, as cited in the present DOI letter.

Because it has not yet been determined that the Yucca Mountain site is suitable for a repository, DOE has not completed estimates of water requirements for repository

construction and operation, nor has it filed an application for such water use with the State Engineer's office. It can reasonably be expected that currently permitted locations and rates of withdrawal would be adequate and that the continued operation of the well and spring monitoring program implemented for site characterization would provide timely documentation of hydrologic effects.

DOI Comment 2

Environmental Quality Technical Guidelines

We generally agree that additional information is needed to adequately evaluate the site for suitability as a repository for radioactive waste. Section 3.3.2.1.2 notes that the types of impacts to be considered for the Environmental Quality Guideline have not yet been defined.

Response.

Comment noted.

DOI Comment 3

Socioeconomics

Water quality and quantity are significant issues for fish and wildlife resources, but they are addressed under section 3.3.2.2, Socioeconomic Impacts Technical Guideline even though they are considered part of the environmental evaluation program. The document provides conclusions and recommendations for future activities associated with various siting guidelines. Because various studies are in progress or are being formulated, we are providing preliminary recommendations for issues that should be addressed in order to fully evaluate the suitability of the site as a radioactive waste repository. Additional recommendations may be provided later in the process, particularly during scoping pursuant to the National Environmental Policy Act.

Response:

Comments noted.

DOI Comment 4

Endangered and Threatened Species

We recommend that DOE periodically request an updated list of endangered, threatened, proposed, and candidate species from the U.S. Fish and Wildlife Service (FWS) Reno Field Office (4600 Kietzke Lane, Building C-125, Reno, Nevada 89502, 702-784-5227). The accuracy of the list can be informally verified with that office in lieu of requesting an update of a formal list. Since species are periodically added to the Federal list of endangered, threatened and candidate species, and others are proposed for listing, and changes to the Animal and Plant Notices of Review occur approximately every 2 years, requesting updates would allow DOE to remain current on this issue. Because perceived areas of impacts may change during the evaluation process, we recommend that a map showing areas of potential indirect, as well as direct impacts, of the project be submitted when a list is requested.

We are particularly concerned with possible impacts to endangered, threatened, and candidate species through ground water depletions associated with site development and operation.

Ground water flow in the area is extremely complex. The Report mentions ongoing studies to evaluate the potential for impacts at Ash Meadows National Wildlife Refuge and sensitive fish habitats associated with Death Valley National Monument. Long-term pumping of ground-water may be an issue affecting listed species. Additional studies may be necessary in the area of the Amargosa River. Springs in the vicinity of the river may contain populations of the Category 2 candidate species, the Amargosa toad (Bufo nelsoni). The DOI's FWS is currently investigating these springs for the presence of this amphibian which appears to be declining in numbers.

Response:

DOE, through its subcontractor EG&G/EM, does track the latest updated list of federal threatened and endangered (T/E) species as they are published in the Federal Register. They also track the state protected species, and rare and sensitive species as listed by the Nature Conservancy and the Natural Heritage Program that may occur near the site. Currently, there is only one federally listed species (desert tortoise) that occurs in the Yucca Mountain Project area. DOE has entered into consultation with the FWS and has obtained a non-jeopardy opinion for site characterization activities on the desert tortoise. DOE will continue to be aggressive in protection of endangered and threatened species, and will periodically request updated lists from the FWS for the area of concern. DOE does not believe that current water usage at the site will impact T/E species in the Ash Meadows/Devils Hole area. This issue was addressed

during the hearing for obtaining the water permit. However, YMP is evaluating ground-water movement and is monitoring approximately 40 wells and springs to assess whether depletions occur. These studies will be used to determine if potential threats are possible to T/E species in the Ash Meadows area.

DOI Comment 5

Wildlife Populations and Habitat

Direct and indirect impacts to terrestrial and aquatic wildlife and habitats should be assessed for the project site, for access and utility corridors, and for ancillary facilities as well as other potentially affected areas. Negative impacts that should be assessed include, but are not limited to, destruction or alteration of breeding, nesting, cover, and foraging habitat for wildlife. Qualitative and quantitative assessments of habitat should be developed. Areas with sensitive resources should be identified. These include unique plant communities; wetland and riparian communities; raptor nesting sites; habitat for endangered, threatened, candidate, and rare species; and, wildlife corridors. The potential for reducing biological diversity in impacted areas should be examined.

The Report evaluates the System Guideline for Radiological Safety. The document states that characteristics of the site favor its ability to limit worker and public exposure to radiation during the preclosure timeframe. Accessibility of wildlife to radionuclides that may escape from the facility over time or during an accident, whether from natural or man-made causes during both the preclosure and postclosure time frames, also should be assessed.

Response:

DOE does have a monitoring program (Terrestrial Ecosystems Environmental Field Activity Plan) to characterize and evaluate wildlife populations and habitat in the project area. Through the pre-activity survey process, areas of critical or important habitat such as riparian areas, nesting sites, burrows, etc., are identified and avoided when possible. DOE also has an active reclamation program to mitigate the direct impacts of activities on the wildlife.

DOE has a radiological monitoring program that monitors wildlife and assesses uptake of radionuclides by wildlife and uptake by forage consumed by wildlife. This program will continue through site characterization and construction/operation if the site is selected. This monitoring is required by NRC regulations.

BOB MILLER
Governor

STATE OF NEVADA

ROBERT R
Executive Di

Jul 15 9 15 AM '92

AGENCY FOR NUCLEAR PROJECTS
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July 14, 1992

John W. Bartlett, Director
Office of Civilian Radioactive Waste Management
United States Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

RECEIVED
7/15/

RE: STATE OF NEVADA REVIEW OF REPORT OF EARLY SITE SUITABILITY EVALUATION OF THE POTENTIAL REPOSITORY SITE AT YUCCA MOUNTAIN, NEVADA. SAIC-91/8000, JANUARY 1992.

Dear Dr. Bartlett:

We have conducted a limited review of the subject report and the companion REPORT OF THE PEER REVIEW PANEL ON THE EARLY SITE SUITABILITY EVALUATION OF THE POTENTIAL REPOSITORY SITE AT YUCCA MOUNTAIN, NEVADA (SAIC-91/8001, January 1992).

As you are aware, on March 11, 1992, I wrote to you questioning some procedural aspects associated with the Early Site Suitability Evaluation (ESSE). The questions posed were as follows:

1. Why has the DOE issued the ESSE for public comment in the form of a final contractor report, rather than as a draft DOE program document subject to revision after review and comment by affected parties and the public?

2. Why were affected parties and the public excluded from the process of development of this final report?

3. Does the DOE intend to consider the comments of affected parties and the public and adopt a revised report as a DOE program document on the results of its early Yucca Mountain site suitability evaluation?

Certified Mail

4. What was the basis of the DOE review of the report prior to its issuance for public comment? Does the DOE endorse the report's results and recommendations, despite the published disclaimer?

5. What is the significance of your reference to this report as a baseline site evaluation? DOE has adopted other "baseline" documents which are considered controlling documents of the DOE program.

6. To what extent are the results of the ESSE based on draft reports, internal memoranda, oral presentations and written communications that are not readily available to affected parties and the general public during the announced review period?

7. Why were the previous substantive comments of the State of Nevada, other affected parties and the public regarding the unsuitability of the Yucca Mountain site not considered in the ESSE?

From your April 10, 1992 response to these questions, we determined that the programmatic status of the ESSE was unclear, at best, its intended use was likely for little more than internal justification to continue the Yucca Mountain project, and the DOE neither reviewed the technical evaluations nor endorsed the ESSE conclusion of site suitability.

Therefore, our current review of the ESSE was limited in the sense that we did not specifically focus on the technical basis of each evaluation. In our judgement such an endeavor would have been redundant and would not have been a prudent expenditure of resources. The ESSE does not explicitly consider the extensive and rigorous evaluations of the suitability of the Yucca Mountain site which this Office already has provided to the DOE in the form of comments on the 1986 Environmental Assessment for Yucca Mountain, and the 1988 statutory Site Characterization Plan for Yucca Mountain. And, the ESSE ignores the detailed basis for our conclusion that the site is unsuitable contained in Governor Bob Miller's November 14, 1989, letter to Energy Secretary Watkins. Despite your letter of April 10, 1992, in which you suggest that our conclusions were explicitly considered in the ESSE, we find no reference to such consideration by the authors.

Furthermore, the ESSE is much more an exercise in analysis and interpretation of the Department's site recommendation guidelines (10 CFR Part 960) than it is an evaluation of suitability based upon available information and data regarding Yucca Mountain site conditions. As such, the ESSE finding that the site remains suitable simply illustrates that those who frame the questions control the answers.

This observation regarding the ESSE is one of the many conclusions of the attached analysis of the ESSE performed for this Office by Kristin Shrader-Frechette titled Expert Judgement and the Frame Problem: Analysis of the "Early Site Suitability Evaluation, Yucca Mountain." It is intended that this attachment be considered a part of the State of Nevada's comments on the subject report.

The Shrader-Frechette analysis identifies significant and compelling conceptual flaws in the development of the ESSE as well as some specific cases in which the report presents favorable conclusions about site suitability but provides no rationale for these conclusions.

Among the conceptual flaws identified is the imposition of an evaluation logic that only permits one of two conclusions, i.e. the site is unsuitable or it is suitable. It is pointed out that "the most basic problem with the ESSE logic is that it is not typically used in scientific discovery and confirmation. In science we use a three-valued logic, according to which claims are falsified (e.g., site is unsuitable), confirmed (e.g., site is suitable), or uncertain, (e.g., we cannot determine suitability one way or the other)." An important consequence of allowing only a conclusion of suitability or unsuitability "is that, if researchers find no disqualifying condition, then their failure to do so is sufficient to produce a suitability finding for that condition." This result is specifically prohibited in the DOE's siting guidelines (10 CFR Part 960). According to DOE's rule, it must demonstrate that the qualifying condition is present in order to make a suitability finding.

It is noteworthy that in one case the ESSE intentionally violates its own ground rule regarding conclusion that the site is either suitable or unsuitable. In considering whether potential gaseous releases of Carbon-14 from a Yucca Mountain repository may exceed the U.S. Environmental Protection Agency's quantitative limit for radionuclide releases from a repository (40 CFR Part 191), the ESSE, instead of making a suitability determination, concludes that the limit is inappropriate and should be revised. Clearly there was considerable concern in this case about whether the suitability of the site could be defended. Resorting, instead, to an attack on the standard of safety evaluation undermines any shred of credibility that the ESSE may have.

Another serious conceptual flaw in many of the arguments in the ESSE is the "appeal to ignorance" in which a conclusion is considered correct simply because it has not been disproved. This is a case in which a positive conclusion is drawn from something negative, ignorance. An example is the ESSE conclusion that site characteristics are such that unusually expensive mitigation techniques will not be required. However, the report also indicates that detailed cost evaluations were not made and the costs of mitigation are not known.

As a result of the conceptual flaws summarized above, the ESSE arrives at favorable conclusions about site suitability that are subjective and lack rationale in its consideration of specific site characteristics.

In concluding that natural resources are unlikely to encourage interference activities leading to radionuclide releases, the ESSE ignores its own observation that there have been recent discoveries of gold, silver and tungsten in the Yucca Mountain area. Instead, the ESSE states that information gathered since evaluating this condition in the 1986 environmental assessment "strengthens" the favorable suitability conclusion regarding this condition. This is simply a case of treating an earlier suitability conclusion as being immune to revision, even when new unfavorable information becomes available. Also, the ESSE "appeals to ignorance" in stating its evaluation of the natural resources condition "uncovered no information that indicates that the Yucca Mountain site is...likely to be disqualified."

The ESSE concludes that the site is suitable in regard to the standard for groundwater travel time from the repository to the accessible environment. This appears to be a case of begging the question by assuming that the models to evaluate this groundwater question will be devised, and that they will provide information favorable to site suitability. As we have pointed out in previous comments, use of available data and empirical methods provides a basis for our conclusion that the site should be disqualified because of the groundwater conditions.

Finally, as a result of the ESSE emphasis on interpretation in order to apply each guideline in an independent manner, the complexity of the Yucca Mountain site and the potential effects of coupled natural processes are ignored. For example, hydrothermal activity is mentioned in association with tectonics, yet not reviewed in the context of hydrology and geochemistry. Thus the ESSE view that the site is suitable from a perspective of total system performance is overly simplistic and seriously underestimates the complexity of geologic processes and events at the site and in the Yucca Mountain area.

Based upon the above discussion and the attached analysis, we find that the Early Site Suitability Evaluation fails both conceptually and in its implementation to meet acceptable standards of objective scientific evaluation. DOE's reliance on this document for its continued belief in the suitability of the Yucca Mountain site for a high-level nuclear waste repository is unjustified, and dangerously misleading regarding the ability of the site to safely contain these highly radioactive wastes.

If you have questions about the comments contain in this letter and the incorporated attachment, please contact me. We look

forward to your responses to our views on the Early Site Suitability Evaluation.

Sincerely,

Robert R. Loux
Executive Director

RRL:cs

Attachment (1)

cc: Bob Miller, Governor
Nevada Congressional Delegation
Nevada Commission on Nuclear Projects
Senator Tom Hickey, Chairman
Nevada Legislature, Committee on
High-Level Waste

EXECUTIVE SUMMARY

Expert Judgment and the Frame Problem: Analysis of the Early Site Suitability Evaluation, Yucca Mountain

Kristin Shrader-Frechette
Distinguished Research Professor
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Tampa, Florida 33620-5550

The ESSE reported at least lower-level site-suitability findings for every condition specified for the proposed Yucca Mountain repository (Younker, Andrews, et al., 1992). Although the 14 ESSE peer reviewers affirmed the revised ESSE, nevertheless they warned that much of it contains "substantial uncertainties" (Younker, Albrecht, et al., 1992, p. B-2) Why did the peer reviewers both affirm the report yet warn of its "substantial uncertainties"? One answer is that the ESSE authors, alone, framed the site-suitability questions, whereas the peer reviewers had little control over how to frame the ESSE questions. They "were given" limited choices, as one reviewer (D. K. Kreamer) put it, regarding how to discuss site suitability (Younker, Albrecht, et al., 1992, p. 460). They answered the questions only in the frames provided by the ESSE and the DOE, frames that predispose one to support at least lower-level suitability findings. The ESSE shows that those who frame the questions control the answers.

This report examines some of the methodological frameworks used by the DOE in the ESSE. These "frames" prescribe the context for evaluating Yucca Mountain site suitability. The most serious frame problem of the ESSE includes use of a two-valued logic that is not typically employed in science. The two-valued logic forced both ESSE authors and reviewers to choose either that the site was suitable or unsuitable; they were not allowed to choose a third option, that the current data and methods are inadequate to make a determination about site suitability. A second frame problem of the ESSE is use of appeals to ignorance, a deductive fallacy in reasoning that consists of the presumption that, if the site has not been shown unsuitable, therefore it is suitable. The obvious problem, however, is that one may not be able, at present, to show suitability or unsuitability. Other frame problems that undercut the validity of ESSE conclusions are begging the question, another deductive fallacy in reasoning; use of many subjective judgments; reliance on a number of apriori, rather than empirical, conclusions; and the assumption that, despite their uncertainty, the methods of probabilistic risk assessment are adequate for repository regulation.

In addition to framing problems, we also argue that the ESSE inappropriately handles some of the specific, empirical questions related to groundwater transport times, repository flooding, postclosure human interference, and mitigating or compensating all socioeconomic impacts.

Expert Judgment and the Frame Problem: Analysis of the Early Site Suitability Evaluation, Yucca Mountain

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Distinguished Research Professor
Philosophy Department/Center for Urban Ecology
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One of the most problematic methodological issues raised by the Early Site Suitability Evaluation (ESSE) for the proposed Yucca Mountain repository is the apparent conflict between the ESSE authors and the ESSE peer reviewers. The ESSE reported at least lower-level site-suitability findings for every condition specified for the proposed repository (Younker, Andrews, et al., 1992). Yet, the 14 ESSE peer reviewers expressed serious reservations about the ESSE methods used in the assessment. They concluded that

> many aspects of site suitability are not well suited for quantitative risk assessment .... Any projections of the rates of tectonic activity and volcanism, as well as natural resource occurrence and value, will be fraught with substantial uncertainties that cannot be quantified (Younker, Albrecht, et al., 1992, p. B-2).

How is one to reconcile the optimistic site-suitability conclusions of the ESSE with the reservations expressed by the peer reviewers who nevertheless accepted the ESSE document?

1. Overview: Those Who Frame the Questions Control the Answers

One possibility -- for explaining why the ESSE peer reviewers both criticized and affirmed the ESSE -- could be that the ESSE authors and the ESSE peer reviewers each had different "frames." That is, they might have had different "paradigms" (see Kuhn, 1970) or sets of theoretical assumptions and expert judgments in terms of which they viewed the issues of site suitability. (We use the term "frame" as Minsky (1981, p. 96) did, as a way of structuring data so as to represent a situation (see Fetzer, 1992; 1990, p. 216); we use the term "assumption" to mean a proposition that is a supposition, something taken for granted, rather than one that is confirmed or known to be true. Often assumptions are taken for granted because it is impossible or impractical to confirm them.)

Another possibility -- for explaining why the peer reviewers both affirmed the revised ESSE (see, for example, Younker, Albrecht, et al., 1992, p. 13), yet warned that it contains "substantial uncertainties" (Younker, Albrecht, et al., 1992, p. B-2) -- is that the ESSE authors, alone, framed the site-suitability questions. The peer reviewers, however, may have had little choice as to how to frame the ESSE questions. They "were given"

limited choices, as one reviewer (D. K. Kreamer) put it, regarding how to discuss site suitability (Younker, Albrecht, et al., 1992, p. 460). They answered the questions in the frame provided by the ESSE, thus confirming the dictum that those who frame the questions control the answers.

If one examines the ESSE carefully, one discovers a number of methodological problems both with (A) the general, theoretical frames in terms of which claims about Yucca Mountain site suitability have been evaluated, and (B) the specific, empirical claims themselves. We shall assess (A), the frame problems, before (B), the empirical claims, and for two reasons. For one thing, how we frame the site-suitability question has consequences for every empirical claim about the site. Also, it is more efficient and less redundant to analyze a given frame problem, at the beginning, rather than repeat our discussion of it in each instance where it affects the truth of an empirical claim. For example, one framing assumption that we shall address is the reliability of subjective judgments in the ESSE. It is reasonable to treat this framing issue first, rather than to repeat the problems associated with subjective judgments each time they occur in specific claims, for example, about rates of volcanism, seismicity, tectonics, fracturing, or the presence of valuable natural resources.

The general frame questions (A) that we shall address include problems with (1) the two-valued logic of the ESSE, (2) appeals to ignorance, (3) begging the question, (4) subjective judgments, (5) apriori conclusions, and (6) the assumed compatibility of regulatory and scientific goals in repository risk assessment. Some of the specific, empirical questions (B) that we shall investigate include problems with (1) groundwater transport times, (2) repository flooding, (3) postclosure human interference, and (4) mitigating or compensating all socioeconomic impacts. We shall consider the frame questions first.

2. The Two-Valued Logic of the ESSE

One of the most important and problematic ways in which the ESSE answers are controlled is by the "frame" of a two-valued logic. The evaluators assumed that all decisions regarding site suitability could be formulated in terms of only two options, that the site is suitable, or that the site is unsuitable. In so doing, they assumed that they did not need a three-valued logic, or a third option -- such as "the data, at present, are inadequate to assess site suitability" or "the suitability decision, at present, is uncertain." As the ESSE report (Younker, Andrews, et al., 1992, p. E-5) formulated this two-valued logic:

> conclusions about the site can be either that current information supports an unsuitability finding or that current information supports a suitability finding.

One important consequence of using a two-valued logic in the ESSE

is that, if researchers find no disqualifying condition, then their failure to do so is sufficient to produce a suitability finding for that condition. As the ESSE Core Team (Younker, Albrecht, et al., 1992, p. 57) put it: "A suitability finding means that (1) a disqualifying condition is not present, or (2) a qualifying condition is present." There are at least six reasons that this two-valued ESSE logic and its associated consequence are questionable.

First, the most basic problem with the ESSE logic is that it is not typically used in scientific discovery and confirmation. In science we use a three-valued logic, according to which claims are either falsified (e.g., site is unsuitable), confirmed (e.g., site is suitable), or uncertain (e.g., we cannot determine suitability one way or the other). Because often we do not know whether a scientific claim is true or false, we say that it is uncertain (see Baylis, 1936; Ducasse, 1941; Helmer and Oppenheim, 1945; Hempel 1936-1937; Rescher, 1969).

Moreover, in science, we do not typically accept the consequence of the ESSE two-valued logic, that the absence of a falsification (or a disqualifying condition), is sufficient grounds for accepting an hypothesis (or claim about site suitability). In science we typically test an hypothesis, by means of hypothesis-deduction, to see if it can be falsified. If, after testing, we have not falsified a hypothesis, we do not affirm its truth, but its uncertainty. It remains uncertain because, although we were unable to falsify it, it is possible that the hypothesis could be falsified by further testing (see, for example, Popper, 1959, 1963; Hempel, 1966). Hence, in science, repeated failure to falsify an hypothesis is not alone sufficient grounds for confirming it, even though one falsification is alone sufficient grounds for rejecting it. In science, confirmation and falsification of an hypothesis are not symmetrical; a third option is often needed.

We are able to confirm an hypothesis (1) only after we have performed every relevant test on every relevant case, that is, only after we have completed all representative tests, (2) only after completing all risky tests, that is attempting to falsify precise, predictive hypotheses, and (3) only after knowing that we have exhausted the set of representative and risky tests (see Popper, 1959, 1963; Hempel, 1966) Yet, in the Yucca Mountain case, obviously condition (1) cannot be met for long-term predictions (ca 1000 years or longer). At Yucca Mountain, the most crucial hypotheses -- about rates of volcanism, tectonics, and natural resource occurrence, for example -- are, in practice, not susceptible to representative testing because of the long time frame (Younker, Albrecht, et al., 1992, p. B-2; Johnson and Tillson, 1992). Consider, for example, the hypothesis that fault diplacement near Yucca Mountain, over the next 10,000 years, will not be adequate to interfere with total system performance of the repository. This hypothesis is obviously not in practice testable. Moreover, since Yucca Mountain provides little deterministic data, and even inadequate probabilistic and

statistical data (Younker, Albrecht, et al., 1992, p. B-2), condition (2) cannot be met by current site studies. But if (1) and (2) cannot be satisfied, then neither can (3), since it is a function of them. To claim that our inability to falsify an hypothesis (e.g., that the site is suitable) is sufficient grounds for confirming it -- in the absence of meeting conditions (1), (2), and (3) -- is to commit the fallacy of affirming the consequent. Affirming the consequent is a classic form of invalid inference in scientific method (see, for example, Popper, 1959, 1963; Hempel, 1966; Fetzer 1991). This inference is invalid, because it might still be possible to falsify the hypothesis in the future; hence, our inability to falsify an hypothesis is never alone grounds for confirming it. (We use the term "inference" to mean a rule used in deriving conclusions from premises, especially in science. Inferences may be valid or invalid. For example, if we are given the premise, "A entails B," we use an invalid inference if we draw the conclusion, "B entails A," because the premise provides no grounds, in every case, for affirming the conclusion. Or, for instance, if we are given the premises, "A entails B," and "B entails C," then we use a valid inference -- transitivity -- if we draw the conclusion, "A entails C.")

Of course, failure to find a problem with an hypothesis may be sufficient grounds -- in some nonscientific or pragmatic sense -- for accepting it. Presumably, however, the ESSE is supposed to be accepted on scientific, rather than nonscientific or pragmatic grounds. And if so, then it is arguable that the ESSE ought to follow a three-valued, rather than a two-valued logic, just as scientific evaluation does.

Second, the ESSE use of two-valued logic is also questionable because classical methods of Bayesian decisionmaking typically employ three-valued logic, in the sense of including a category for events that are "uncertain" or about which we have inadequate information to make a decision. Bayesian decision theory (see Resnick, 1986; Luce and Raiffa, 1957, pp. 275-326) recognizes that decisions are made under conditions of certainty (the outcome is known with probability 1), risk (the outcome is known with some probability less than 1), or uncertainty (the outcome is known so little that we are unable to assign any exact probabilities to it). Because Bayesian decision theory is the premier theory used in probabilistic risk assessments (such as those being performed at Yucca Mountain), and because Bayesian decision theory includes a third category for "uncertain" decisions, it is arguable that the ESSE evaluators ought not have used the two-valued logic (see Shrader-Frechette 1991, pp. 100-130).

Third, apart from the fact that classical scientific and Bayesian methods employ a three-valued logic, it is reasonable to use such a logic in many situations (see Rescher, 1969). Few events and decisions can be assessed in terms of two alternatives -- either suitable or unsuitable -- because often we do not have complete knowledge. Whenever we have less than perfect knowledge, or

whenever there is not complete logical and factual closure on a problem, a particular resolution of it can never be either/or: either suitable or unsuitable. Later events could show that a judgment of suitability, for instance, was unsuitable (see Fetzer 1991, pp. 223, 227). Hence, many situations, because they are open-ended and imperfectly known, require a three-valued logic that reflects the category of uncertainty. For example, in earlier days, scientists might have claimed that vitrifying (incorporating within glass) highly radioactive liquids was suitable to prevent them from escaping into the environment (see Younker, Andrews, et al., 1992, p. 1-31). In 1992, however, scientists at Argonne National Laboratory learned that, contary to previous scientific opinion, radioactive wastes may escape from glass via a new route (Bates et al., 1992). They discovered a "previously unknown mechanism for directly generating colloids" from glass, particles too tiny to settle out of water (Raloff, 1992, p. 141). By releasing only one drop of water per week over an inch-long, half-inch diameter, glassy cylinder -- containing neptunium, americium and plutonium -- scientists showed that exposure to slow dripping of water can change the largely nonreactive borosilicate glass into a form that facilitates the flaking of mineralized shards containing radionuclides. Hence, any claims about the suitability or unsuitability of vitrification for controlling radwastes depend on whether we have gained closure on the problems associated with vitrification. Likewise, in the absence of complete knowledge of, and closure on, numerous problems at Yucca Mountain, one can argue that scientists and policymakers ought to employ a three-valued, rather than a two-valued, logic for site evaluation (Ducasse, 1941; Rescher, 1969).

Fourth, a three-valued logic (that includes an alternative such as "uncertain at present") is also more reasonable than the ESSE two-valued logic, because it is more consistent with the ESSE peer reviewers' expert judgments about the level of scientific knowledge at Yucca Mountain. In their "Consensus Position," the reviewers warned that the site was very poorly known. They said:

> many aspects of site suitability....predictions involving future geologic activity, future value of mineral deposits and mineral occurrence models....rates of tectonic activity and volcanism, as well as natural resource occurrence and value, will be fraught with substantial uncertainties that cannot be quantified using standard statistical methods (Younker, Albrecht, et al., 1992, p. B-2).

If many aspects of Yucca Mountain site suitability cannot be quantified and are uncertain, then the peer reviewers' own words appear to argue for a three-valued logic and against the two-valued logic that they were asked to use. Indeed, many of the ESSE peer reviewers -- such as D. K. Kreamer, M. T. Einaudi, and W. J. Arabasz -- complained that they "were given" only the choices of site suitability or site unsuitability, despite the fact that "there is ... currently not enough defensible, site-specific information available to warrant acceptance or rejection

of this site" (Younker, Albrecht, et al., 1992, pp. 460, 257, 40-51). Hence, rejection of the two-valued logic appears consistent with the "Consensus Position" of the peer reviewers and with the comments of many individual reviewers of the ESSE.

Fifth, use of the two-valued logic in the ESSE also appears questionable because so many of the conclusions on which the ESSE rests are qualitative, rather than quantitative and precise (see Rescher, 1969, pp. 328 ff.; Helmer and Oppenheim, 1945). On the admission of the ESSE authors, many of their conclusions are not amenable even to probabilistic formulation and are based on subjective judgments (see Younker, Andrews, et al., 1992, p. 1-18). For example, the qualifying and disqualifying conditions for the site repeatedly use qualitative language to speak of conditions that are "likely" or "unlikely," rather than conditions having a certain probability (see Younker, Andrews, et al., 1992, p. 1-13). Such imprecise and qualitative language itself argues that a third decision option, such as "data inadequate at present to support a conclusion," be used.

Sixth, the two-valued ESSE logic -- for decisions that the proposed repository site is suitable or unsuitable -- is also questionable because it ignores the category (uncertainty) applicable to most controversial siting decisions. Many experts, including the US National Academy of Sciences (NAS), have indicated that virtually all questions involving technological controversy are Bayesian cases of uncertainty, not cases of risk or certainty; the fact that they involve significant factual or probabilistic uncertainties is one of the reasons that they generate controversy (Otway and Peltu, 1985, p. 4). Hence, to ignore the third decision option ("uncertainty") is to ignore the one category which, according to experts, is most likely to be applicable to Yucca Mountain.

Of course, the obvious objection to the claim -- that the ESSE evaluation, predicated on a two-valued logic, is inadequate in ignoring the decision finding of "uncertain" -- is that the peer reviewers approved the ESSE. Most of the peer reviewers signed a statement (see for example, Younker, Albrecht, et al., 1992, p. 13) acknowledging that (1) "the conclusions about the status of lower and higher-level findings on the siting guidelines are balanced and defensible," and (2) "the revised ESSE Integrated Evaluation Package adequately addresses my comments." If there were problems with the two-valued logic -- including the absence of the "uncertain" option regarding site suitability -- then why did most of the peer reviewers agree to statements (1) and (2)? The answer appears to be that, in the words of the ESSE Core Team (Younker, Albrecht, et al., 1992, p. 460):

> The DOE General Siting Guidelines (10 CFR Part 960) do not allow a "no decision" finding .... Thus the ESSE Core Team followed the intent of the guidelines.

In other words, the ESSE team and peer evaluators appear to have answered the questions in the two-value "frame" that was provided

to them, despite the fact that their own words (see reason four above) indicate that use of the two-value frame itself is questionable in the Yucca Mountain situation.

3. Appeals to Ignorance

Another recurrent flaw in the ESSE is that many of its arguments are framed in terms of (what logicians criticize as) "appeals to ignorance." One makes an appeal to ignorance when one concludes that something is the case, purely on the grounds that it has not been disproved, or when one concludes that something is not the case, purely on the grounds that it has not been proved. In both instances, one attempts to draw a positive conclusion from something negative, ignorance. Hence, this form of argument has been termed "the appeal to ignorance." Such invalid forms of inference, like the fallacy of affirming the consequent (see discussion in the previous section) occur repeatedly throughout the ESSE and the supporting Yucca Mountain literature (see Shrader-Frechette, 1992), as exemplified in the following argument:

> The Core team did not identify any characteristics of this particular site that would lead to use of mitigation techniques that are unusually expensive. However, detailed considerations of costs were not made in this evaluation (Younker, Albrecht, et al., 1992, p. 142).

Obviously, the team's failure to identify expensive techniques is not itself a valid argument for the claim that mitigation will require no expensive techniques. If no detailed considerations of costs were made, then it is impossible, without committing the appeal to ignorance, to conclude that mitigation techniques would not be expensive.

Framing the arguments of the ESSE, as appeals to ignorance, occurs not only in the discussion of mitigation techniques, but also in virtually every section of the evaluation. Typically the ESSE team notes a variety of substantial uncertainties regarding a particular site condition, but then concludes that a lower-level site suitability finding is justified. Indeed, the appeal to ignorance is one of the main inferences of the ESSE method, and the ESSE team admitted as much. The team claimed that

> If .... current information does not indicate that the site is unsuitable, then the consensus position was that at least a lower-level suitability finding could be supported" (Younker, Andrews, et al., 1992, p. E-11).

Accepting the ESSE argument frame -- the appeal to ignorance -- virtually guarantees that, despite serious uncertainties regarding the site, the evaluators will judge the site suitable. Indeed, only an invalid inference, like the appeal to ignorance, could allow one to conclude that a site is suitable, despite massive and widespread uncertainties about the site. The ESSE peer reviewers warned that there was substantial, non-

quantifiable, uncertainty regarding "future geologic activity, future value of mineral deposits and mineral occurrence models....rates of tectonic activity and volcanism...natural resource occurrence and value (Younker, Albrecht, et al., 1992, p. B-2; see also Johnson and Tillson, 1992; Turrin et al., 1991)." Nevertheless, if there is uncertainty regarding crucial site factors (see above quotation), if this uncertainty precludes proving a disqualifying condition, and if the ESSE defines the absence of a disqualifying condition as site suitability (Younker, Andrews, et al., 1992, p. E-5), then the site will be found suitable, simply as a result of ignorance.

By assuming that the failure to prove unsuitability is sufficient to support a finding of lower-level suitability, the ESSE Team (Younker, Andrews, et al., 1992, p. E-11) not only committed the appeal to ignorance, but also placed the burden of proof on those arguing for site unsuitability. Placing the burden of proof on one side of a controversy is ethically questionable because it treats the two sides inequitably. On the contrary, it is arguable that Yucca Mountain decisionmaking, like that in civil cases, tort cases, ought to follow the decision rule of supporting the side having the greater weight of evidence on its side (Shrader-Frechette, 1991, pp. 133-145). Hence, the burden of proof in the two-valued logic of the ESSE is not only ethically inconsistent with standard civil-case procedures, but also it is inequitable in not placing the same evidentiary burdens on both sides of the siting controversy. Hence, to the degree that ESSE conclusions about site suitability are based on appeals to ignorance, then it is arguable that they are problematic.

Of course, the difficulty with the ESSE is not merely that it falls victim to deductively invalid reasoning, such as appeals to ignorance. Much of science relies on induction and is not purely deductive. The real difficulty is that, in the presence of deductively invalid arguments, scientists need to provide good inductive reasons for their conclusions. Instead of doing so, the ESSE authors merely assumed that the absence of adequate evidence against site suitability provided sufficient grounds for concluding that the site was suitable. Hence their conclusions are questionable.

4. Begging the Question

Another way of framing the ESSE arguments also casts doubt on the ESSE conclusions. This problem is that many ESSE conclusions are based on (what logicians have criticized as) classical cases of the invalid inference known as "begging the question" (see the discussion of inference in section 2). One begs the question when one assumes what one intends to provide. For example, the ESSE concludes that "estimates of expected releases from the NTS can be predicted" (Younker, Albrecht, et al., 1992, p. 128). Nevertheless, the authors of the document admit that "no specific evaluation has been done for a repository at Yucca Mountain for expected releases, since design details are not yet available" (Younker, Albrecht, et al., 1992, p. 128). But if there is

neither a design nc an evaluation regarding expected releases, then it begs the question to claim that releases can be predicted.

Similar cases of begging the question occur throughout the ESSE, the ESSE response to peer reviewers, and the Yucca Mountain literature (see, for example, Shrader-Frechette, 1992). For instance, the authors of the ESSE conclude that no "significant amount of radionuclides will be released from the proposed Yucca Mountain repository" (Younker, Albrecht, et al., 1992, p. 120). Yet, when peer reviewer J. H. Bell inquired, "What method of analysis [was used] to determine 'significant amount'?" the ESSE team responded (Younker, Albrecht, et al., 1992, pp. 120-121):

> The potential release of radionuclides, design factors, release of radionuclides to unrestricted areas, weather, that amount less than allowable under the regulations, and many more parameters are all related through a comprehensive dose-assesment model and calculations for the site, yet to be completed. Such an effort will be accomplished and discussed as part of the system guideline for radiological safety (Younker, Albrecht, et al., 1992, pp. 120-121).

If the dose-assessment model and site calculations have not been completed, however, then one begs the question to claim that the studies show no significant amounts of radioactivity will be released. Likewise, when the ESSE team concludes that "Radionuclides released from the proposed facility are expected to be minimal," yet admits that "a site dispersion model has not been developed" (Younker, Albrecht, et al., 1992, p. 122), they also beg the question. When conclusions are assumed rather than proved, as they are when we beg the question, their truth value remains uncertain. Hence, the presence of numerous cases of begging the question, in the ESSE and the supporting documents, casts doubt on the truth of the ESSE conclusions about site suitability. The problem is not merely that begging the question is an invalid form of deductive reasoning, since much of science relies on inductive, rather than deductive, reasoning. Rather the problem is that, instead of supplying adequate inductive evidence for their conclusions, the ESSE authors merely resorted to begging the question.

5. Subjective Judgments in the ESSE

Another inference that assessors have used to frame many of the specific, empirical claims in the ESSE is an assumption about subjective judgments. This assumption is that nonquantifiable and subjective judgments about risk are adequate for determining site suitability. The ESSE report admits repeatedly that subjective judgments have played a "significant" and a "critical" role in site determinations, given the inadequacy of the data and the inability of assessors to quantify many site risks (see, for example, Younker, Andrews, et al., 1992, pp. 1-18, 2-6). There are a number of reasons, however, for believing that this reliance on subjective judgments in the ESSE is highly

problematic.

For one thing, for the ESSE to assume the adequacy of nonquantifiable, subjective judgments is inconsistent with the repeated ESSE claim (Younker, Albrecht, et al., 1992, pp. 13, 47, 107, 149, and so on) that "The content of the ESSE Integrated Evalution Package provides an unbiased and objective presentation of information relevant to the suitability issues covered by each guideline." How can the ESSE core team admit its repeated reliance on nonquantified, "subjective" judgments, and yet claim that its presentation is "objective"? How can the ESSE core team itself admit that its judgments are subjective (Younker, Albrecht, et al., 1992, pp. 13, 47, 107, 149, and so on), and yet claim that the purpose of the peer review was "to determine whether the ESSE report presents an objective and technically defensible view" (Younker, Albrecht, et al., 1992, p. 7) of the site suitability issue? If the team admitted its reliance on subjective decisions, then it already knows the answer to its own question. Hence, ESSE acceptance of the "subjectivity frame" appears, at minimum, inconsistent with its claim of objectivity.

A second problem with accepting the adequacy of the "subjectivity frame" for site suitability is that, as one reviewer (J. H. Bell) put it, if some data are "subjectively" determined, "why couldn't it [the decision that the site is "suitable"] just as well be an unsuitable [site decision]?" (Younker, Albrecht, et al., 1992, p. 112). More precisely, if the ESSE decision is based in part on subjectivity, as both the ESSE team and the peer evaluators admit, then presumably there is no clear, purely objective procedure for deciding whether the site is suitable or not. But if there is no purely objective procedure for deciding whether the site is suitable or not, then it cannot be a purely objective decision to say that the site is suitable rather than unsuitable.

A third problem with the assumption -- that nonquantifiable and subjective judgments about risk are adequate for determining site suitability -- is that at least one of the peer reviewers appears to disagree with this judgment. W. J. Arabasz signed a statement denying that the ESSE, in final form, was "unbiased" and "objective." He also denied that the site suitability conclusions were balanced and objective (Younker, Albrecht, et al., 1992, p. 47). Another peer reviewer (T. Webb) simply did not sign the statement affirming that the ESSE was unbiased and objective (Younker, Albrecht, et al., 1992, p. 511). Moreover, three other reviewers (M. T. Einaudi, D. K. Kreamer, and W. G. Pariseau) noted on their statements that, provided that the original ESSE document was revised along the lines they suggested, it would be unbiased and objective (Younker, Albrecht, et al., 1992, pp. 247, 411, 467). This means that more than one third of the peer reviewers apparently believed that at least the original ESSE was not unbiased and objective. Also, one, possibly two, of the 14 reviewers maintained that even the final version of the ESSE was not unbiased and objective.

Of course, someone might object that, at worst, nearly two-thirds

of the peer evaluators signed statements affirming that the ESSE was unbiased and objective. Hence, someone might argue that there are grounds for believing that it is unbiased and objective. However, an alternative interpretation is that, because so many of the site data, assumptions, and conclusions are subjective, they are impossible to classify as either "biased" or "unbiased," "subjective" or "objective." If one cannot easily determine whether they are biased, because of the "substantial uncertainties" involved (Younker, Albrecht, et al., 1992, p. B-2), and if one follows the presumption that the ESSE team ought to be judged innocent until proved guilty of bias, then a reasonable person could believe that the ESSE was unbiased and objective. In other words, a reasonable person could presume innocence in the face of uncertainty and thus presume that the ESSE was unbiased. Therefore one could plausibly sign the statement affirming the ESSE lack of bias -- even though there was proof of neither bias nor lack of bias. Hence, it is not clear that the peer reviewers have absolved the ESSE of bias.

Even more importantly, it is not clear that the peer reviewers accept any of the frame assumptions, including the claim that subjective judgments are an adequate basis for site-suitability decisions. As mentioned earlier, J. H. Bell claimed that the subjective data might argue for a decision that the site was unsuitable (Younker, Albrecht, et al., 1992, p. 112). And K. V. Hodges, for example, claimed that Yucca Mountain predictions regarding volcanism over the next 10,000 years were possible only if we "make a number of preliminary assumptions that are next to impossible to evaluate" (Younker, Albrecht, et al., 1992, p. 384).

The ESSE team itself also appears to have exhibited some discomfort with the frame assumption that subjective judgments provide an adequate base for site-suitability studies. Regarding seismic risk and ground motion, for example, the ESSE noted that the data were so incomplete that the team was forced to do parametric studies (Younker, Andrews, et al., 1992, pp. 3-91, 3-92). But the parametric studies were so uncertain that the ESSE team drew a weak, almost trivial, conclusion:

> Unless new information contradicts the assumptions made .... the conclusions ... appear sound.... The analyses presented to resolve this issue, however, are still general and they may need to be validated...." (Younker, Andrews, et al., 1992, p. 3-99).

Given such weak conclusions, it is not clear that all the ESSE team members believe that the subjective judgments in the ESSE provide an adequate basis, even for lower-level site-suitability decisions. Moreover, the analysis (for example, in the seismic case just mentioned) is general, highly dependent upon assumptions that cannot be checked, not site specific, and not validated for Yucca Mountain. If so, then one wonders how the ESSE can move from such problematic analyses to the judgment of lower-level suitability regarding seismicity. The answer could

be, as we mentioned earlier, that the ESSE team justifies site suitability on the basis of problematic appeals to ignorance, two-valued logic, and the failure to prove that the site is unsuitable. As the ESSE team (Younker, Andrews, et al., 1992, p. E-11) claimed, "If .... current information does not indicate that the site is unsuitable, then the consensus position was that at least a lower-level suitability finding could be supported."

6. Apriori Conclusions in the ESSE

A fifth frame problem with the ESSE is the apparent assumption that conclusions about site suitability need not be responsive to changes in scientific data. And if conclusions about site suitability need not be empirical in this way, then it is questionable whether they are scientific or merely based on apriori opinion. (Propositions that are apriori are independent of observation or experience.) Consider the case of the claim made in the Environmental Assessment of the site, that "no rock characteristics that could cause undue hazards to personnel have been identified" (Younker, Albrecht, et al., 1992, p. 143). Later, however, the early site suitability evaluation team discovered a potential hazard arising from one rock, mordenite, and claimed that "Unacceptable uncertainty remains concerning the occupational health risk and environmental impact represented by mordenite" (Younker, Albrecht, et al., 1992, p. 143). Nevertheless the ESSE team concluded that "the lower-level finding (site suitability) has been maintained for this guideline" (Younker, Albrecht, et al., 1992, p. 143). The empirical and scientific status of this lower-level finding is highly questionable, however. How could a genuinely empirical site-suitability claim (regarding hazardous rocks) remain the same, even after the risk from mordenite was discovered, and even after the ESSE team concluded that "unacceptable uncertainty" surrounded the risk (Younker, Albrecht, et al., 1992, p. 143)? The apparent resistance of the site-suitability claim to empirical findings suggests that the claim may be based more on apriori opinion than on empirical findings.

Similarly, the scientific status of numerous other lower-level ESSE findings is also questionable because they appear to have been treated as immune to revision on the basis of new empirical information. Consider, for example, the issue of future natural resources activities at Yucca Mountain. The ESSE began in the context of a lower-level suitability finding, from a 1986 environmental assessment (EA), that natural resources are unlikely to encourage interference activities leading to radionuclide releases. Moreover, the ESSE claimed that "in general, the information obtained since the EA (DOE, 1986a) supports and strengthens the findings made in the EA" (Younker, Andrews, et al., 1992, pp. 2-128 and 129). At the same time, however, the ESSE confirmed that, since the EA, deposits of gold, silver, and tungsten have been discovered in the region of Yucca Mountain (DOE,1988a). The ESSE also noted that these discoveries "influence the perceived resource potential of the region, including the Yucca Mountain area" (Younker, Andrews, et al.,

1992, p. 2-129). The ESSE concluded that more studies were needed, in the light of new discoveries, to assess and evaluate "potential mineral resources of the site" (Younker, Andrews, et al., 1992, p. 2-132). New structural models for Yucca Mountain, it noted,

> will need to be carefully evaluated in light of their significance to possible ore-forming flow conduits and the potential for hidden mineral deposits at the Yucca Mountain site .... The identification, ranking, and comparison of ore-forming systems to site-specific data will be very important in assessing the potential for undiscovered deposits at the site .... a careful evaluation will be needed before final conclusions about the resource potential of the proposed site are made (Younker, Andrews, et al., 1992, p. 2-133).

As the previous statements make clear, it is not clear why the ESSE can claim (1) that recent natural resources information, obtained since the EA, "strengthens" the site suitability claims (Younker, Andrews, et al., 1992, pp. 2-128 and 129), even though (2) new discoveries have influenced the perception that there may be more undiscovered deposits at the site (Younker, Andrews, et al., 1992, pp. 2-129 and 133). Given claim (2) and the ESSE admission that "there will continue to be a diversity of opinion, about the occurrence of and potential for natural resources in the Great Basin" (Younker, Andrews, et al., 1992, pp. 2-144), it would appear that the new empirical information, if anything, counts <u>against</u> claim . However, the ESSE supported claim (1). Hence, it is not clear that the ESSE team based its "strengthened" conclusions on empirical findings. Nor is it clear why, in the light of new resource discoveries, the ESSE team continued to support the lower-level suitability finding.

Of course, the ESSE team conjectured, at one point, that "no likely future mining...will be located close enough to...result in an inadvertent loss in waste isolation" (Younker, Andrews, et al., 1992, pp. 2-140). This conjecture, however, does not address the future potential for resources to be discovered even closer to the repository, as the ESSE earlier admitted. Likewise, the conjecture does not address the fact that reasonable claims cannot be made that discount mining for 10,000 years. It is puzzling that the ESSE team apparently discounted new resource discoveries, even though peer reviewers (for example, M. T. Einaudi) claimed (see Younker, Albrecht, et al., 1992, p. 250) that future resource potential needs to be evaluated. Hence, the ESSE optimistic conclusion regarding human interference and natural resources appears to be based on something other than empirical findings. Indeed, both of these examples from the ESSE (the mordenite and natural resources/human interference cases) suggest that there may be a problem with site-suitability findings. If such findings are not modified, after discovery of potentially damaging information about the site, then the findings themselves may not be empirical or scientific, but based on apriori opinion.

Another example of the way that the ESSE appears to be framed in terms of apriori or nonfalsifiable conclusions appears in the discussion of tectonic models. The ESSE team concluded that there was a lower-level suitability finding regarding postclosure tectonics. Yet, the empirical status of this finding is questionable by virtue of the fact that the ESSE team said that its "discussion does not support uniquely any single tectonic model for the Yucca Mountain area. The evidence is at least permissive" of five different alternative models, each leading to quite different predictions (Younker, Andrews, et al., 1992, pp. 2-107 and 108). Moroever, said the ESSE, three radically different tectonic models (a shallow- detachment model, a segmented strike-slip model, and a normal-fault model) all appear equally consistent with the evidence (Younker, Andrews, et al., 1992, p. 2-109). Because the implications of each of the three models, for "faults, ground motion, volcanism, and deep groundwater flow differ substantially" (Younker, Albrecht, et al., 1992, p. 166), however, even though each of them is consistent with the data, the models are too general and the data are too sparse to distinguish among them. As Gibson (1991) said of all the seismic models for Yucca Mountain, "all of these hazard analyses contain large uncertainties, owing to the limited site-specific data" (see Younker, Albrecht, et al., 1992, p. 95; see also Johnson and Tillson, 1992). In other words, the models are not empirically confirmed in any "risky" sense.

But if the ESSE admits that models with radically different predictions are all equally consistent with the data, then the models are not empirical in a strong sense. And if they are not empirical in a strong sense, then conclusions based on them are likewise not empirical in a strong sense. Given the problems with these tectonic models, one wonders how the ESSE team could justify a lower-level site suitability finding, especially when the team noted that "hidden underlying faults" and "north striking faults probably penetrate deeply" (Younker, Andrews, et al., 1992, p. 2-110).

As the examples of the mordenite risk and the tectonic risk reveal, respectively, even when newer empirical information appears to heighten site risk, or even when equally acceptable models make radically different predictions about the site, neither of these situations is taken by the ESSE team as weakening the site-suitability findings. Hence, the frame assumption about the value of apriori or nonfalsifiable site conclusions appears to lead to conclusions that are scientifically questionable.

7. The Misfit between Site-Related Science and Site Regulation

Yet another framing assumption, one that appears throughout the ESSE, is that vague and qualitative descriptions about the Yucca Mountain risk are adequate to confirm site suitability, even though the regulations for the site are typically precise and quantitative. The ESSE evaluates the Yucca Mountain risk using

vague words such as "likely." Yet the regulations, for example, speak of precise requirements such as "less than a 0.1 percent probability of exceeding 10" or "less than 5 pCi/liter of Ra-226, 228" (Younker, Andrews, et al., 1992, p. 2-4). Contrary to the ESSE, there appear to be several reasons that the often imprecise science available for site characterization is not adequate to the precise regulatory task demanded of it. And if not, then it is questionable whether the site suitability findings are plausible.

At the center of the apparent mismatch between science and regulation is geology. As one peer reviewer (K. V. Hodges) put it, the Congressional mandate for siting a high-level repository is for predictive models, but geology traditionally has been an explanatory, not a predictive, science (Younker, Albrecht, et al., 1992, p. 362). One of the reasons geology is not predictive "with a high degree of accuracy" is that we are unable to make inferences about the future, on the basis of the past. Predictive geology requires a sort of "reverse uniformitarianism" (Younker, Albrecht, et al., 1992, p. 363), but uniformitarianism has been discredited at least since the recent revolution in plate tectonics. Since long-term geological predictions are not reliable, reviewer Hodges claims that it is "patently absurd" that we attempt to predict the probability of volcanic disruption over 10,000 years. Indeed, he says that, in asking for such predictions, Congress and the Department of Energy are asking for the impossible (Younker, Albrecht, et al., 1992, p. 364). Thus both the Hodges review and the nature of geology itself argue for an assymmetry between the scientific activities at Yucca Mountain and the current regulatory demands of repository siting.

Part of the mismatch between science and regulation regarding Yucca Mountain is revealed in the qualitative language used in the ESSE. Many of the peer reviewers, including Arabasz and Einaudi, mention the vague language of the ESSE. The final ESSE document, however, continues to formulate site risks in terms of words such as "likely" and "unlikely," rather than by using numerical probabilities (see, for example, Younker, Andrews, et al., 1992, pp. 2-94, 2-163). Similarly, when M. T. Einaudi complained that the ESSE had vaguely defined the "foreseeable future" as "the next few years to 10 years, and occasionally as long as 30 years" (see Younker, Albrecht, et al., 1992, p. 25), the ESSE team responded by removing from the document all language mentioning the number of years. Next the team noted:

> The evaluation and definition of the terms, such as "reasonable projections" and "likely future activities" will receive considerable attention in the future and is likely to utilize the review of a panel of experts (Younker, Albrecht, et al., 1992, p. 259).

This response, however, does not solve the problem with vague language, both because the ESSE core team uses the language to argue for site suitability, and presumably such usage must have implications. Indeed, if the language did not have certain

implications regarding future time periods, then it would not be part of an effective argument for site suitability. Hence, if the terms are used effectively, they must have some precise implicit meaning. If they do not have a precise, implicit meaning, then it is arguable that they are not effective in supporting the site-suitability conclusions and ought not be used. Indeed, by using indefinable terms to defend conclusions about site suitability, the ESSE renders its conclusions nonfalsifiable and therefore ineffective, because vague claims cannot be falsified. And if the ESSE site suitability claims are not falsifiable, then this suggests that they are apriori rather than empirical and scientific.

Another reviewer, J. I. Drever, also complained about the failure of the ESSE to provide rigorous definitions of words such as "likely" and "significant" (Younker, Albrecht, et al., 1992, p. 214). Again, the final ESSE document did not alleviate the difficulty. Instead the ESSE Core Team responded (Younker, Albrecht, et al., 1992, p. 214) to Drever's criticism:

> The terms 'likely' and 'significant' should be defined in the context of the overall postclosure performance objectives. Because the evaluations of system performance cannot be definitive at this time, the ESSE Core Team believed it inappropriate to define those terms precisely for this evaluation.

This response by the ESSE Core Team, however, creates more questions than it answers. For one thing, to say that terms like "likely" should be defined in terms of overall postclosure performance is not coherent, because the term "likely," for example, is rarely if ever used in the context of "total system performance." Rather, it is used in radically different, but specific contexts, such as probability of human interference at the site, or the probability of a route of radionuclide transport (Younker, Andrews, et al., 1992, pp. 2-121, 1-3). Hence, terms like "likely" not only do not refer to "overall performance," as the Core Team claimed, but, second, they are not univocal. They clearly mean different things in different ESSE contexts. Third, although the ESSE team says that such terms cannot be defined precisely because the system evaluations are incomplete, this response is puzzling because the ESSE team obviously has already used the terms to mean something. Fourth, if the system-performance evaluations are not definitive enough to allow the ESSE team to define the very terms that it uses, then it is unclear why the system-performance evaluations are definitive enough to support a lower-level suitability finding, rather than an unsuitability finding. Fifth, contrary to the response of the ESSE Core Team, the terms used by the team clearly presuppose some precise meanings, because words like "likely" are often used in precise regulatory contexts, such as "not likely to exceed small fraction of [radiation dose] limits" (Younker, Andrews, et al., 1992, p. 1-9). If such terms were not used somewhat precisely, then it would be impossible for the claims in which they are imbedded not to be false. Likewise, the ESSE Core Team

claims, for example, that "although confidence is substantial, it is not yet sufficient to support the higher-level suitability finding for this qualifying condition" (Younker, Andrews, et al., 1992, p. 2-117). Such a claim appears to presuppose some precise level or cut-off of confidence or likelihood. It appears to presuppose that lower-level findings are justified below this level, and that higher level findings are justified above it. For all these reasons, there appears to be a mismatch between the science and the regulations discussed in the ESSE. Because of this mismatch, it is questionable whether the science discussed in the ESSE justifies the claims that the site meets lower-level suitability requirements.

Apart from frame problems, such as two-valued logic and the mismatch between science and regulation regarding the repository, there are a number of methodological problems with specific empirical claims in the ESSE. Next, we shall consider some of these specific difficulties.

8. Groundwater Transport Times

One of the most controversial questions in the ESSE -- and what one reviewer (T. A. Vogel) calls the biggest conceptual issue in the ESSE -- is whether there is likely to be fracture flow at Yucca Mountain (and therefore groundwater travel time from the disturbed zone to the accessible environment in less than 1000 years (Younker, Andrews, et al., 1992, pp. 214, 2-13). In discussion of this issue, as with so many others in the ESSE, the main difficulty is that, although the ESSE team reports a site-suitability finding, it is unclear exactly how and why this finding is justified. Given the admission that the data set regarding groundwater flow is limited, and given that the models are idealized (Younker, Andrews, et al., 1992, p. 2-24), one wonders how and why the core team was able to overcome these uncertainties and to support a lower-level suitability finding. In this case as in others, the ESSE core team provided a conclusion about site suitability, but not a rationale for its conclusion. Given the fact that the assumptions in the groundwater-transport models, especially for the unsaturated zone, cannot (in practice) be verified, the ESSE reliance (for site- suitability findings) on untested models is all the more problematic. Moreover, even the Department of Energy admits that unsaturated flow in fractured media is highly uncertain, and that we don't know the dominant processes and mechanisms influencing the flow (Younker, Albrecht, et al., 1992, p. 188).

Some of the peer reviewers (for example, Carothers, Vogel, Drever, Kreamer, and Pariseau), likewise, criticize the ESSE for lacking a detailed discussion of fracture flow and relying on simplified models for a heterogeneous site (Younker, Albrecht, et al., 1992, pp. 181, 490, 240, 427-430, 472, 506). What all of their criticisms suggest is that, given controversy over fracture flow and groundwater transport times, if the ESSE team is to conclude that the site meets the 1000-year criterion, then the team must provide a detailed rationale. Lacking such

rationale, the ESSE appears to beg the question of groundwater transport time. Arguments based on an invalid inference, however, provide no support for any level of site-suitability claims.

9. Possible Repository Flooding

Similar problems with failure to provide a rationale for the ESSE lower-level, site-suitability finding occur with respect to the issue of possible future repository flooding. With this issue, as with many others, the ESSE team provided a first-order analysis of the relevant arguments, but it failed to offer any second-order arguments. As a first-order analysis, the ESSE surveyed the reasons for (see, for example, Yang, 1989) and against (see, for example, Levy, 1991) climate-induced flooding. In order to resolve the disagreement at this first level, however, we need second-order arguments -- a rationale for deciding which side of the controversy is more correct. There is no such rationale in the ESSE. After admitting controversy and uncertainty in the first-order analysis of the flooding issue, the ESSE authors merely jumped to a conclusion about site suitability.

In the case of the climate issue and possible repository flooding, the ESSE authors agree with the experts who argue against flooding induced by climate change (for example, Levy, 1991). They fail, however, to explain why they find their arguments more compelling than those that predict possible repository flooding (see Yang, 1991). Of course, the ESSE position is consistent with that of a recent panel of the National Academy of Sciences (Raleigh, 1992). Nevertheless, the ESSE authors fail to provide a second-order analysis of arguments that explain how to account for a number of anomalous events, such as the existence of fossils of several different "wet species" near Yucca Mountain (see Raleigh, 1992, pp. 140, C-19 - C-23.).

The failure to provide a second-order analysis of the climate issue in the ESSE is all the more puzzling because the authors claim that the lower-level finding of suitability has been strengthened by evidence obtained since the environmental analysis (Younker, Andrews, et al., 1992, p. 2-69). At a minimum, the authors' second-order analysis would need to explain how and why the evidence is stronger for site suitability, even though they admit (1) that they have ignored certain issues (Younker, Andrews, et al., 1992, p. 2-67), (2) that the quantitative model needed to predict future climate is problematic and incomplete (Younker, Andrews, et al., 1992, p. 2-68; Younker, Albrecht, et al., 1992, p. 520), and (3) that there are large uncertainties in their data (Younker, Andrews, et al., 1992, p. 2-70). In the absence of a second-order analysis, the conclusion about site suitability appears to beg the question.

10. Human-Interference Guidelines: Natural Resources, Site Contro

Several other problems with the specific methodology of the ESSE

occur in the discussion of the two human-interference guidelines, for postclosure site control and for possible natural resources near Yucca Mountain. For these guidelines, the ESSE authors admitted that

> the performance analyses did not quantitatively evaluate the potential for adverse effects on repository performance by disruptive processes or events such as faulting or human intrusion (Younker, Andrews, et al., 1992, p. 2-150).

Instead, the authors said that assessments that "address these processes 'uncovered no information that indicates that the Yucca Mountain site is ... likely to be disqualified' " (Younker, Andrews, et al., 1992, p. 2-150). The difficulty with such a response, however, is that the absence of information that the site is likely to be disqualified provides no justifiable inference that the site is suitable, particularly if no precise probabilistic studies have been done. Rather, reliance on the absence of some information, in evaluating the human-interference guidelines for Yucca Mountain, amounts to an invalid appeal to ignorance, as we argued earlier. This appeal to ignorance is all the more questionable because some of the greatest uncertainties regarding a respository have to do with future disruptive events and human interference. Indeed, when Golder Associates (1990) studied respository performance, they found "that disruptive processes that cause direct releases to the accessible environment provide the only conditions under which the EPA standards might not be met" (Younker, Andrews, et al., 1992, p. 2-157). This means that, citing the very authority used by the ESSE team, the one occurrence most likely to present a radiation hazard at Yucca Mountain is precisely the threat that the team did not (and likely could not) evaluate quantitatively.

Moreover, in evaluating the human-interference guideline for postclosure site control, the ESSE authors admitted that they did not take into account "the probability of occurrence of the senarios" when they were "estimating the probability of exceeding the [radiation] release limits" set by the government (Younker, Andrews, et al., 1992, p. 2-155). If the probability of various occurrences was not taken into account, then how could one determine whether radiation-release standards would be met? The answer appears to be that this conclusion relies on begging the question, on assuming what one wishes to prove. Likewise, since the ESSE team admitted that it did not know the precise materials and design for the waste containers (Younker, Andrews, et al., 1992, p. 2-155), it is not reasonable that the team could validly conclude, as it did, that the waste-package containment will meet regulatory criteria for postclosure system performance. Again, the ESSE team must have begged the question. But if so, then the ESSE conclusions regarding human interference are based on invalid inferences, the appeal to ignorance and begging the question.

Another difficulty is that the human-interference guideline for natural resources appears inconsistent regarding qualification

and disqualification of the site. The ESSE interpretation of the requirements makes it more difficult to disqualify a site than to qualify it, because only one time frame, the present, is sufficient for disqualification, whereas either time frame, present or future, is sufficient for qualification. That is, the site may be disqualified only if "present day activities" or the search for "presently economic resources" will jeopardize waste isolation onsite (Younker, Andrews, et al., 1992, pp. 2-123 and 2-124). On this criterion, future events are unable to disqualify the site, although they are sufficient to qualify it. That is, the site may be qualified on the basis of "the natural resource potential for both those resources that are presently valuable and those resources that ... may be valuable in the foreseeable future" (Younker, Andrews, et al., 1992, pp. 2-123 and 2-124).

The ESSE interpretation makes it more difficult to disqualify (than to qualify) a site with respect to the natural-resources guidelines, in part because a shorter time frame (the present) is applicable to disqualification than to qualification. Also, the two-valued logic (see the earlier discussion) places the burden of proof, generally, on the disqualifier side. As we argued earlier, the ESSE assumes that failure to disqualify a site counts as its being qualified. Hence, because of this assumption, if there is a shorter time period applicable to disqualification questions and, as a result, one does not disqualify the site, then the site will be qualified. Such a situation obviously places a heavier evidentiary burden on the disqualifier side of the site controversy. This inequitable burden suggests that there may be problems with the ESSE interpretations and findings.

Placing a heavier burden on the disqualifier side of the controversy also renders the "logic" of qualification and disqualification inconsistent, because the same time frames are not applicable to both sides. The inconsistency is obvious because the ESSE defines suitability as the absence of a disqualifying condition (Younker, Andrews, et al., 1992, p. E-5). Yet, in the case of the natural-resources guidelines, the absence of a disqualifying condition regarding the present, as required by the ESSE (Younker, Andrews, et al., 1992, pp. 2-123 and 2-124), does not argue for suitability for both present and future time periods. Hence, the ESSE interpretations of time periods relevant to natural resources are clearly inconsistent with the ESSE claim that suitability may be defined as the absence of a disqualifying condition. From inconsistency, no valid conclusions can be drawn. Hence the entire natural-resources discussion of the ESSE appears logically problematic.

Another methodological problem with the ESSE discussion of natural resources is that it often argues for irrelevant theses but ignores the more crucial issues. For example, the ESSE (Younker, Andrews, et al., 1992, pp. 2-128) claims that "no known valuable natural resources are present." However, the real issue is whether any valuable natural resources are present, not

whether any "known" natural resources are present. If one doesn't know about them, of course one does not know if they are present. Hence the ESSE claim is trivial and tautological.

Also trivial is the ESSE claim that exploration for "presently valuable resources" is not likely to occur (Younker, Andrews, et al., 1992, pp. 2-128). Of course not. Whether exploration for presently valuable resources is likely to occur is not the most relevant issue. The real question is whether exploration for resources valuable in the future will occur. This is the question that needs to be answered, and yet it is not answered, probably because, as one reviewer (M. T. Einaudi) put it: "It is likely that 'credible' projections made by 'credible' people will extend no further than 5 or 10 years into the future" Younker, Albrecht, et al., 1992, p. 264). Moreover, credible future projections are even more difficult when they deal with possible human interference, rather than with geological or hydrological events. Hence, if the ESSE cannot provide credible statements about the most critical issues for site evaluation -- such as future resources or human intrusions -- then this may explain why the ESSE conclusions sometimes appear to be irrelevant to the most important site-suitability issues.

11. Mitigating/Compensating All Socioeconomic Impacts

In addition to the the evaluation of human intrusion, the discussion of socioeconomic impacts represents a major area where the ESSE methodology appears flawed. The ESSE argues that "unmitigatable social and/or economic impacts are not expected to occur" at Yucca Mountain (Younker, Andrews, et al., 1992, pp. 3-46). Yet, the primary basis for this conclusion appears to be the assumption that "the history of ... this guideline ... indicates that 'adverse socioeonomic impacts ... can generally be mitigated' " (Younker, Andrews, et al., 1992, pp. 3-42). If indeed the site-suitability conclusion (regarding socioeconomic impacts) is based largely on this assumption, then the conclusion begs the very question at issue in the ESSE. Hence, the conclusion appears logically invalid.

Apart from this fundamental logical problem, there are at least eight additional reasons suggesting that it may not be possible to mitigate/compensate all socioeconomic impacts at Yucca Mountain. First, the Nuclear Waste Policy Act (NWPA) provides for mitigation of up to $ 20 million per year, based upon identified impacts, if the state of Nevada gives up its right to oppose the site. Likewise the Price-Anderson Act allows a limited level of nuclear-incident liability, relevant to repository sites. Given that the mitigation benefits are limited to $ 20 million per year, by the NWPA, it is conceivable that full mitigation for repository-related impacts will not be available. If full mitigation is intended to take place, then it is arguable that there ought to be no ceiling on the annual level of mitigation available by virtue of the NWPA. Hence the existence of the ceiling suggests that full mitigation of all socioeconomic impacts may not occur at Yucca Mountain. Moreover, given that

liability levels are set by law, through the Price-Anderson Act, rather than determined, case by case, it is conceivable that full compensation for a nuclear incident will not be available. In fact, although the states (including Nevada) recommended unlimited strict liability for any nuclear-waste program or incident (DOE, 1986b, vol. 3, p. C.2-8; B. Rusche, 1985, pp. 484, 655), the DOE position has been that "these activities should enjoy indemnity protection equivalent to other nuclear programs" (Rusche, 1985, pp. 484-485). By law, however, other US nuclear programs currently have a liability limit that is less than three percent of the government-calculated costs of the Chernobyl accident, and Chernobyl was not a worst-case incident (Koryakin, 1990). If the ESSE concludes that the government will mitigate/compensate all socioeconomic impacts related to Yucca Mountain, then the ESSE needs to explain, at a minimum, why the government has severely limited liability for nuclear- and waste-related accidents and events. In the absence of such an explanation, the ESSE appears not only to beg the question of compensation/mitigation, but indeed to draw a conclusion that is contrary to the legal evidence regarding the likelihood of compensation/mitigation. Hence the site-suitability finding regarding socioeconomic impacts appears problematic.

A second reason for doubting the ESSE site-suitability finding regarding mitigation/compensation at Yucca Mountain is that the DOE has not provided full mitigation/compensation when difficulties have occurred in the past at its other facilities. When the DOE nuclear-materials plant in Fernald, Ohio was discovered to have serious, life-threatening problems of radioactive contamination and to have violated the law -- causing worker deaths and cancers among nearby members of the public -- the DOE retreated behind the doctrine of sovereign immunity in order to obtain protection from direct legal action by citizens (US Congress, 1989, p. 2). Such a retreat seems possible at Yucca Mountain, in part because of the current DOE attitude to health and safety measures at the site. For example, the 1988 Price-Anderson Amendments Act exempts certain DOE contractors -- working on Yucca Mountain -- from the $ 100,000 penalty for each violation of safety rules (Price-Anderson, 1988). Such an exemption, however, arguably exacerbates -- not mitigates -- Yucca Mountain socioeconomic impacts related to health and safety. Moreover, apart from its challenge to due-process rights of citizens, the absence of penalties for safety violations is also problematic. The lack of penalties suggests an attitude to safety that is not consistent with the ESSE finding of site suitability regarding mitigation/compensation of socioeconomic impacts.

Third, the ESSE site-suitability finding is also doubtful in light of the fact that 80 percent of Nevadans oppose the repository (Slovic et al., 1991, p. 1604). Given this opposition, it is unlikely that any form of compensation or mitigation will satisfy them. If not, then full compensation/mitigation is not possible. Also, fourth, if virtually no attention is given in the ESSE to perception-based

issues, as several reviewers charge (see, for example, Younker, Albrecht, et al., 1992, p. C-4), and if mitigation and compensation are functions of perception, then full mitigation and compensation are unlikely. Moreover, fifth, as peer reviewers have also pointed out (see Albrecht, for instance), the Department of Energy has not indicated how it intends to mitigate impacts (see, for example, Younker, Albrecht, et al., 1992, p. 16). Given this silence, it is reasonable to believe that the impacts might not be fully mitigated. Besides, sixth, the DOE has admitted that "the ...types of impacts that will need to be evaluated have not yet been fully defined" (Younker, Albrecht, et al., 1992, p. 21). If they have not been fully defined, then it is unclear how one can be certain that the impacts will be mitigated/compensated, a point also made by peer reviewer Albrecht (Younker, Albrecht, et al., 1992, p. 38). How can one know that x can be compensated, if one does not know the magnitude or characteristics of x? Once again, the conclusions of the ESSE -- on yet another issue -- appear to beg the very questions that are at issue.

A seventh reason for believing that, contrary to the claims in the ESSE, socioeconomic impacts will not be mitigated/compensated, in full, is that the DOE has delayed the Yucca Mountain social-impact analyses, thus suggesting that they are not a high priority, and forcing the state of Nevada to perform the tasks itself (Younker, Albrecht, et al., 1992, pp. 19, 25, 29). Finally, eighth, full mitigation/compensation is also unlikely to occur because, to satisfy persons desiring mitigation/compensation, one needs to negotiate with them regarding their needs and demands. Yet, nowhere has the DOE indicated that it will engage in genuine negotiations, including negotiations that lead to abandoning the Yucca Mountain site. Instead, when asked for negotiation, it always offers, instead, "communication," "cooperation," or "work with" affected parties. All of these offers suggest that the DOE will retain the upper hand, not that it will submit to genuine negotiation. But if the DOE will not negotiate, then it is not clear that socioeconomic impacts at Yucca Mountain can be mitigated/compensated. Hence there is yet another reason for believing that the ESSE claim -- that "unmitigatable social and/or economic impacts are not expected to occur" (Younker, Andrews, et al., 1992, pp. 3-46) -- is implausible and perhaps indefensible.

12. Conclusions

If the preceding analysis of six important frame questions and four significant empirical conclusions in the ESSE are correct, then there are substantial reasons for doubting both the basic methodology of the ESSE and its specific empirical conclusions. Indeed, a number of the conclusions appear to rely on deductively invalid inferences, such as the appeal to ignorance and begging the question. Although science relies on induction and retroduction as well as deduction, these invalid inferences are problematic because the ESSE authors did not use adequate inductive or retroductive data to support their conclusions.

Instead they relied on invalid deductive inferences. Moreover, and perhaps most importantly, the peer reviewers themselves provided a fundamental objection to the ESSE, an objection that does not appear to have been addressed fully in the revised ESSE. In their Consensus Position, the peer reviewers concluded:

> many aspects of site suitability are not well suited for quantitative risk assessment. In particular are predictions involving future geological activity, future value of mineral deposits and mineral occurrence models. Any projections of the rates of tectonic activity and volcanism, as well as natural resource occurrence and value, will be fraught with substantial uncertainties that cannot be quantified using standard statistical methods (Younker, Albrecht, et al., 1992, p. B-2).

But if the site-suitability analyses are fraught with substantial uncertainties that <u>cannot</u> be quantified -- rather than with uncertainties that have not yet been quantified -- then it is questionable whether anyone can justify any kind of site-suitability finding, now or in the future. As the ESSE reveals, even lower-level site-suitability findings appear dependent on questionable inferences and framing assumptions.

13. References

Bates, J., J. Bradley, A. Teetsov, C. Bradley, M. Buchholtz ten Brink, 1992. Colloid Formation During Waste Form Reaction: Implications for Nuclear Waste Disposal, Science, Vol. 256 (1 May), pp. 649-651.

Baylis, C., 1936. Are Some Propositions Neither True Nor False? Philosophy of Science, Vol. 3, pp. 156-166.

Charniak, E., and D. McDermott, 1985. Introduction to Artificial Intelligence, Addison-Wesley, Reading, MA.

Crawford, M., 1988. Weapons Legacy: A $ 110-Billion Mess? Science, Vol. 241, No. 4862 (July 8), p. 155.

Congress of the U.S., 1989a. Safety of DOE Nuclear Facilities. Hearing Before the Subcommittee on Energy and Power of the Committee on Energy and Commerce, House of Representatives, 101st Congress, First Session, February 22, 1989, Serial no. 101-1, U.S. Government Printing Office, Washington, DC.

Congress of the U.S., 1989b. DOE: Pollution at Fernald, Ohio. Hearing Before the Subcommittee on Transportation, Tourism, and Hazardous Materials of the Committee on Energy and Commerce, House of Representatives, 100th Congress, Second Session on H.R. 3787, H. R. 3784, and H.r. 3785, October 14, 1988, Serial No. 100-236, U.S. Government Printing Office, Washington, DC.

Congress of the U.S. 1987a. Nuclear Waste Program. Hearings Before the Committee on Energy and Natural Resources, US Senate, 100th Congress, First Session on the Current Status of the Department of Energy's Civilian Nuclear Waste Activities, January 29, February 4 and 5, 1987, Part I, U.S. Government Printing Office, Washington, DC.

Congress of the U.S. 1987b. DOE Nuclear Facility at Fernald, Ohio. Hearing Before the Subcommittee on Energy Conservation and Power of the Committee on Energy and Commerce, House of Representatives, 99th Congress, Second Session, August 13, 1986, Serial Nol 99-163, U.S. Government Printing Office, Washington, DC.

DOE (U. S. Department of Energy), 1986. Final Environmental Assessment: Yucca Mountain Site, Nevada Research and Development Area, Nevada, 3 volumes, DOE/RW-0073, Office of Civilian Radioactive Waste Management, Washington, DC.

DOE (U. S. Department of Energy), 1986b. Nuclear Waste Policy Act, Environmental Assessment, Yucca Mountain Site, Nevada Research and Development Area, Nevada, DOE/RW-0073, 3 vols., Office of Civilian Radioactive Waste Management, Washington, DC.

DOE (U. S. Department of Energy), 1988a. Site Characterization Plan, Yucca Mountain Site, Nevada Research and Development Area, Nevada DOE/RW-0199, 9 volume, Office of Civilian Radioactive Waste Management, Washington, DC.

Ducasse, C., 1941. Truth, Verifiability, and Propositions about the Future, Philosophy of Science, Vol. 8, pp. 329-337.

Fetzer, J., 1991. The Frame Problem: Artifical Intelligence Meets David Hume, International Journal of Expert Systems, Vol. 3, No. 3, pp. 219-232.

Fetzer, J., 1990. Artificial Intelligence: Its Scope and Limits, Kluwer, Dordrecht.

Golder Associates, Inc., 1990. Methodology for Evaluating Alternative Licensing Strategies Task 1: Development and Demonstration of Methodology, Prelimary Draft/ALSS 893-1197, Redmond, Washington.

Helmer, O., and P. Oppenheim, 1945. A Syntactical Definition of Probability and Degree of Confirmation, The Journal of Symbolic Logic, Vol. 10, pp. 25-60.

Hempel, C., 1966. Philosophy of Natural Science, Prentice-Hall, Englewood Cliffs, N.J.

Hempel, C., 1965. Aspects of Scientific Explanation, Free Press, New York.

Hempel, C., 1936-1937. Eine rein topologische Form nichtaristotelischer Logik, Erkenntnis, Vol. 6, pp. 436-442.

C. Johnson and D. Tillson, 1992. Seismic Vulnerability or "Living on the Fault Line," Presented to Nuclear Waste Technical Review Board, January 22-23, 1992, Irvine California, NWPO, Carson City, NV.

Koryakin, M., 1990. State of the Soviet Nuclear Industry, World Information Service on Energy News Communique, Vol. 332, 18 May, pp. 2-3

Kuhn, T. S., 1970. The Structure of Scientific Revolutions, University of Chicago Press, Chicago.

Levy, S. S., 1991. Mineralogic Alteration History and Paleohydrology at Yucca Mountain, Nevada, in High Level Radioactive Waste Management, Proceedings of the Second Annual International Conference, April 28 - May 3, 1991, Las Vegas, Nevada, Vol. 1, American Nuclear Society, Inc., La Grange Park, Il. pp. 477-485.

Luce, R. D., and H. Raiffa, 1957. Games and Decisions, Wiley, New York.

Marshall, E., 1990. Hanford Releases Released, Science, Vol. 249 (3 August), p. 474.

Minsky, M., 1981. A Framework for Representing Knowledge, in J. Haugeland (ed.), Mind Design, MIT Press, Cambridge, MA, pp. 95-128.

Otway, H., and M. Peltu, 1985. Regulating Industrial Risks, Butterworths, London.

Popper, K., 1959. The Logic of Scientific Discovery, Harper and Row, New York.

Popper, K., 1963. Cagonjectures and Refutations. Routledge and Kegan Paul, London.

Price-Anderson (Price-Anderson Amendments Act of 1988), 1988. P.L. 100-408, Stat. 102, pp. 1066-1085.

Raleigh, C. B., and the Panel on Coupled Hydrologic/Tectonic/Hydrothermal Systems at Yucca Mountain, 1992. Ground Water at Yucca Mountain: How High Can It Rise? National Academy Press, Washington, DC.

Raloff, J. 1992. Radwastes May Escape Glass via New Route, Science News, Vol. 141, No. 18, p. 141.

Resnick, M., 1986. Choices, University of Minnesota, Minneapolis.

Rusche, B., 1986. Statement, in U.S. Congress, Mission Plan for the Civilian Radioactive Waste Management Program, Hearing Before the Subcommittee on Energy Research and Development of the Committee on Energy and Natural Resources, U. S. Senate, 99th Congress, First Session on the Department of Energy's Mission Plan for the Civilian Radioactive Waste Management Program, September 12, 1985, U.S. Government Printing Office, Washington, DC.

Shrader-Frechette, K., 1991. Risk and Rationality, University of California Press, Berkeley.

Shrader-Frechette, K. 1992. Expert Judgment in Assessing Radwaste Risks, Nevada Agency for Nuclear Projects, Yucca Mountain Socioeconomic Project, Carson City.

Slovic, P., J. H. Flynn, and M. Layman. 1991. Perceived Risk, Trust, and the Politics of Nuclear Waste, Science, Vol. 254, pp. 1603-1607.

Turrin, B., D. Champion, and R. Fleck., 1991. Age of the Lathrop Wells Volcanic Center, Yucca Mountain, Nevada, Science, Vol. 253, Nol. 5020 (August 9), pp. 654-657.

Yang, I. C. 1989. Climatic Changes Inferred from Analyses of Lake

Sediment Cores, Walker Lake, USGS-WRI-84-4006, Nevada, Water-Resources INvestigations Report, U.S. Geological Survey.

Younker, J. L., S. L. Albrecht, W. J. Arabasz, J. H. Bell, F. W. Cambray, S. W. Carothers, J. I. Drever, J. T. Einaudi, D. E. French, K. V. Hodges, R. H. Jones, D. K. Kreamer, W. G. Pariseau, T. A. Vogel, T. Webb, W. B. Andrews, G. A. Fasano, S. R. Mattson, R. C. Murray, L. B. Ballou, M. A. Revelli, A. R. Ducharme, L. E Shephard, W. W. Dudley, D. T. Hoxie, R. J. Herbst, E. A. Patera, B. R. Judd, J. A. Docka, L. R. Rickertsen, J. M. Boak, and J. R. Stockey, 1992. Report of the Peer Review Panel on the Early Site Suitability Evaluation of the Potential Repository Site at Yucca Mountain, Nevada, SAIC-91/8001, U.S. Department of Energy, Washington, D.C.

Younker, J. L., W. B. Andrews, G. A. Fasano, C. C. Herrington, S. R. Mattson, R. C. Murray, L. B. Ballou, M. A. Revelli, A. R. Ducharme, L. E Shephard, W. W. Dudley, D. T. Hoxie, R. J. Herbst, E. A. Patera, B. R. Judd, J. A. Docka, and L. R. Rickertsen, 1992. Report of Early Site Suitability Evaluation of the Potential Repository Site at Yucca Mountain, Nevada, SAIC-91/8000, U.S. Department of Energy, Washington, D.C.