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NUCLEAR WASTE TECHNICAL REVIEW BOARD

A REVIEW OF PROGRESS IN THE YUCCA MOUNTAIN ENVIRONMENTAL PROGRAM

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I N D E X

PAGE NO.

Introductory Remarks - Purpose of Meeting
Dr. Garry D. Brewer, Chair 3
Panel on the Environment and Public Health

Overview of Yucca Mountain Environmental Program
Wendy Dixon 7
Department of Energy
Yucca Mountain Project Office

Terrestrial Ecosystem Program
Kent Ostler 12
EG&G Energy Measurements, Inc.

Biological Surveys
Cathy Wills 20
EG&G

Reclamation
Cathy Wills 41
EG&G

Desert Tortoise Studies
Danny Rakestraw 66
EG&G

Site-Characterization Effects Monitoring
Ron Green 102
EG&G

Anticipated Repository Effects
Kent Ostler 140
EG&G

Summary
Wendy Dixon 157
DOE/YMPO

Nevada NWPO Concerns
Carl Johnson 159
Nevada Agency for Nuclear Projects

Round-Table Discussion 187

Closing Remarks
Garry Brewer, Chair 216
NWTRB

P R O C E E D I N G S

DR. GARRY BREWER: Good morning and welcome to the meeting of the Nuclear Waste Technical Review Board's Panel on Environment and Public Health. My name is Garry Brewer. I'm the chairman of this particular panel. I'm also the Dean of the School of Natural Resources and Environment at the University of Michigan, where I'm a professor of resource policy and management and business administration.

We have with us other members of the panel. John Cantlon, immediately to my left, is chairman of our Board, and he's also a member of the panel. John, before he became an administrator, was a real ecologist, in fact, he brings a certain expertise. As an administrator, he was the vice-president for Research and Dean of the Graduate School at Michigan State University.

John McKetta is the Joe C. Walter Professor of Chemical Engineering emeritus at the University of Texas. Dr. McKetta brings to the Board over 55 years of experience in the practice and teaching of chemical engineering.

Warner North, immediately to my right, is a consulting professor in engineering and economic systems at Stanford and a principal with Decision Focus, a consulting firm specializing in risk analysis and decision analysis.

We have invited to serve as consultants to the panel today, and for the next several activities of the

panel, three experts. Michael Bowers--Michael, would you raise your hand--of the University of Virginia. He's experienced in the study of desert animals, especially the structure of desert rodent communities.

James Ehleringer of the University of Utah has broad expertise in the ecology and physiology of plants, including those in desert environments.

John Koranda is retired from Lawrence Livermore. He's an environmental scientist with extensive experience at the Nevada Test Site.

Also in attendance and sitting with us at the table is Dan Fehringer of the Board's technical staff, and the staff member most responsible for arranging this meeting.

There are some comments that I'd like to make now about the Waste Board itself. Most everyone here knows that we were created by Congress in 1987 by virtue of the amendments to the Nuclear Waste Policy Act. The Board is charged with providing an unbiased source of expert assessment of the technical and scientific validity of the Department of Energy's work in high-level radioactive waste management. We're required to report twice a year to the Congress and the Secretary of Energy. Many of the Board's detailed technical reviews are conducted by panels composed of Board members with special interest and expertise in a particular subject area. And, today, this Board, this panel

on Environment and Public Health will review the environmental monitoring activities at Yucca Mountain.

The DOE is required to meet a number of federal and state statutes and regulations to protect the environment during site characterization. In order to demonstrate compliance with those requirements, the DOE is currently conducting a program of environmental monitoring in parallel with site characterization activities at Yucca Mountain. One of the purposes of today's meeting is to review the technical adequacy of those environmental monitoring activities. Today's meeting will concentrate on terrestrial ecosystems studies, including activities to protect the threatened desert tortoise, studies of methods for reclaiming disturbed areas, and programs to monitor and mitigate the potential impacts of site characterization activities. At a later date, tentatively in March of '94, March 21st and 22nd, the panel may consider reviewing other components of DOE's environmental activities, such as radiological monitoring, water resources and socioeconomic impact.

A second purpose of today's meeting is to lay the groundwork for a workshop which this panel plans to host early next year. Next year's workshop will concentrate on the potential long-term environmental effects of the Yucca Mountain repository and, most importantly, on experimental studies that might be needed to project such long-term

effects. Today's meeting will familiarize this panel and its three consultants with the ongoing studies at Yucca Mountain and will allow a determination of the usefulness of those studies for predicting long-term environmental effects.

Today's agenda, copies of which are here available in the back of the room, consists principally of presentations by the Department of Energy and its contractors describing ongoing monitoring programs and some of the monitoring results that have been obtained. This afternoon, representatives of the state of Nevada will present their views on the adequacy of Yucca Mountain environmental programs. Finally, the agenda provides for a round-table discussion involving panel members, consultants, and speakers at the end of the day. If time permits, members of the audience may also make short statements addressing the technical merits of the Yucca Mountain environmental programs. To budget time efficiently, I ask that anyone wishing to speak please notify our staff member, Dan Fehringer, of your desire to speak and of the approximate length of time needed to make your statement. That would be at the end of the day.

Now, it gives me pleasure to introduce Wendy Dixon, our first speaker. Wendy is the Director of the Project and Operations Control Division of the Department of Energy's Yucca Mountain Project Office. She is the DOE manager

responsible for environmental activities at Yucca Mountain, and she'll give us an overview of those activities. And we've agreed that Wendy will introduce subsequent speakers who will make more detailed presentations on their specific areas of investigation and expertise.

Wendy, welcome. Please proceed.

MS. DIXON: I'd like to start off by saying that it's a pleasure to be here today. What I have to present is basically setting the stage for our environmental program.

We have several drivers in what our current environmental program is. One of them most certainly is compliance with regulations. We review the regulations and basically establish a program that meets those regulations. Most certainly sound scientific practices is a driver for our program, and right now, our emphasis on a large part of our environmental program is the site-characterization phase of activities. So most certainly as site characterization changes, we need to adjust our environmental program to the changes of the site characterization program.

The plans that describe our program equate to a document hierarchy that looks something like this. These are all approved plans. The Environmental Management Plan is our top tier document that basically provides the road map to the lower tiered documents in the hierarchy.

We have an Environmental Regulatory Compliance Plan

that basically spells out what all the regulatory drivers are in the program. There's a plan called the Environmental Monitoring, the Mitigation Plan that has lower tiered environmental field activity plans associated with it for air, water, cultural resources, as well as ecosystems, a Radiological Monitoring Plan, a Meteorological Monitoring Plan, a Hazardous Materials Management Plan and a couple of Reclamation Plans.

Underneath the DOE plans, the contractors themselves have lower tiered detailed plans, as well as very detailed work instructions.

We felt that a document hierarchy such as this was the best way to describe the components of our program, with the EMP tying them together, and that we needed to recognize that there were different users of these plans in our program, there were different oversight reviewers of these plans for our program, and that structuring it as we have would ease in document modification and updates as time went on.

Most certainly if one tried to have the details of all of these plans in one plan, it would not be very user friendly. You'd have to carry around the document in a front end loader or forklift or something equally sizable.

Right now, we have a couple of major elements of our program. Really everything deals with environmental

compliance, but for ease of description, we have the permitting activities, hazardous waste management activities, a full compliance surveillance audit program that we've established, as well as a suite of field programs, with the focus today being on terrestrial ecosystems and reclamation.

As I mentioned earlier, the focus of our environmental program today is on site characterization. Congress did not consider site characterization a major federal action in the Nuclear Waste Policy Act, and specifically precluded site characterization from the requirement of an Environmental Impact Statement. It did require a Statutory Environmental Assessment.

Congress, through the Nuclear Waste Policy Act, did require DOE to conduct site characterization activities in a manner that minimizes any significant adverse environmental impacts to the maximum extent practicable.

So if you look at our environmental objectives of our current program, again, obviously through all phases of this program, you're going to have compliance with environmental regulations. And right now, two of our major objectives deal with monitoring for potential significant adverse impacts and the mitigation of impacts. And when we talk mitigation, we talk about a number of different things that would roll into mitigation. It would include things such as a requirement for pollution control equipment, the

requirement to construct spill collection berms around equipment that need it, such as drill rigs, an environmental input to design where part of the design review of all things that go on in site characterization are dealing with this program.

We have exclusion/inclusion flagging that we've set up to let our workers know where they can and cannot go, and try to minimize the amount of land disturbed, floodplain assessments, water resource monitoring. Our preactivity surveys themselves for both archaeological and biological resources are mitigation activities. Waste minimization falls into that category. Our desert tortoise studies fall into the mitigation category. When we require our engineers to deal with topsoil stockpiling and erosion control, that's a mitigation. And, obviously, when you disturb a site, our ultimate form of mitigation is reclamation.

If we look at NEPA, the National Environmental Policy Act, it requires a number of things. It does require early planning to consider environmental effects and alternative actions. It does not dictate an agency's choice of action, and it most certainly understands that most programs will have significant effects. It does require a description of existing conditions at the time of the EIS. It does not require a description of conditions that are pristine. It requires the establishment of mitigation

actions. It does not require total ecosystems studies, and it clearly espouses the rule of reason, best available information and common sense.

The Nuclear Waste Policy Act provides a road map to NEPA for our particular program, and in effect it streamlined the NEPA process in several different ways.

Congress stated in the Nuclear Waste Policy Act that the EIS required for the repository need not consider certain things, such as the need for the repository itself, the alternatives to geologic disposal, and alternative sites to Yucca Mountain.

If you break down what the component parts of an environmental impact statement are as it relates to a repository or any activity, there are really four major steps. One ties with scoping. That basically takes a look at what is significant and not significant to include in an EIS. One deals with, based on the output of that scoping, data gathering and publications of a draft EIS, public comment on the draft EIS, and finally the publication of a final EIS and the Record of Decision. Right now, if we turn to our current mission plan, it does not call for scoping to begin until about 1997.

If I want to look at where I'm at right now and the future direction of the environmental program, as I've mentioned, the focus right now is on site characterization.

It's recognized that the information that's being derived from our studies right now during the site characterization phase will be utilized to feed into the environmental impact statement.

Additional studies are normally addressed through the scoping process, but there is nothing that precludes us from moving into studies at an earlier point in time than scoping. One of the issues that we do need to be cognizant of, however, are other programmatic consideration, and budget most certainly falls into that category.

One of the issues that do tie to repository studies right now that we are in the process of working on is a thermal loading study design. That, in fact, is being prepared, but no actual thermal loading analyses are being done.

Right now, the purpose of our presentation today really ties to the background of our current program, and hopefully we've met what you are looking for within that frame work. We're trying to provide you with a foundation of what we're doing right now.

And to start off in a more detailed method, Kent Ostler, who heads our Terrestrial Ecosystems Program, will give you an overview of our Terrestrial Ecosystems activities. Kent?

DR. OSTLER: I'm very grateful to be here this morning

to talk to you about our Terrestrial Ecosystems Program. What I'd like to do, and I'll just provide you an overview outline of what I'll be talking about during this presentation. I'll cover some of the guiding documents, talk about the focus of our efforts, the various elements that make up the Terrestrial Ecosystems Program, how those integrate within the program, and then with the other complete environmental program at Yucca Mountain established, and then talk about some of the project and public review of our program and how we get public feedback.

Wendy has mentioned some of the upper tiered documents that guide our program. Let me just discuss two that are specific that outline the Terrestrial Ecosystems Program. Those are the Terrestrial Ecosystem Field Activity Plan, and then there's a set of three reclamation plans. The first program plan covers the objectives and goals of the reclamation program at Yucca Mountain. The second feasibility plan identifies some of the studies necessary to develop a cost effective reclamation program there. There's a lot that we don't know about reclamation in the Mojave Desert, and that's what this program, this plan, identifies. And then there's also the reclamation implementation plan which talks about how then does the reclamation actually get implemented.

I believe you all have copies of those documents.

They have been sent to you. You'll notice they don't include detailed study designs or how we actually go about accomplishing work. They are general and provide us a general frame work for how we are conducting our work at Yucca Mountain.

We will, with the later presenters, will be providing you some of the greater detail on statistical design and how we accomplish the individual experiments that we conduct.

As Wendy mentioned, and I'll again cover it, the primary focus of the Terrestrial Ecosystems Program is really to mitigate direct impacts of site characterization activities. Now, mitigation may take several different forms. First, you may avoid the impact altogether by relocating a proposed activity. You may also minimize the impact by reducing the size of a planned activity. Or, finally, you can go through restoration where you restore or revegetate, re-topsoil in the area, protect it from erosion.

There's also another focus of our program, and that is to monitor to assess if indirect impacts have occurred. And for that assessment, we have selected what we consider is key species or indicator species that will provide us hopefully a measure of which to evaluate impacts. What we have selected is vegetation, which is the primary producer, major primary production in that system. A number of

parameters that we are measuring along with vegetation, biomass production is one, species diversity, cover and density. We also selected desert tortoise, small mammals and reptiles, and we'll discuss why those were selected in some of the later presentations.

There is a secondary focus of our program as well, and that is to gather data about the biological resources that exist at Yucca Mountain that can be used following EIS. We have compiled numerous species lists for birds, mammals that occur on the site, for the insects, invertebrates, for bats and some of the other carnivores, as well as the vegetation.

We have gathered a lot of information, and that is available. Whether that is going to be adequate for an EIS will really depend upon the scoping process.

The Terrestrial Ecosystems Program, as we have developed it, consists of five components. The first is biological surveys. The second includes reclamation. Cathy Wills will be talking about both of these in greater detail following my presentation here. Then there is a desert tortoise component and site characterization effects studies. Danny Rakestraw will be talking about our desert tortoise program, and Ron Green will talk about the site characterization effects studies.

A final component of the program is the support and

radiological monitoring. We won't be discussing that today. That really just entails our administrative support to Yucca Mountain and providing samples for the radiological monitoring program.

What will be discussed, though, by the presenters will be details of the objectives and goals of each one of these components, what are the regulatory drivers that require us to do that work. They will get into the experimental design, some of the statistical analysis, talk about the data that has been gathered to date and how sensitive that data is to detecting change.

One thing I really want to mention is we feel that our program is an integrated program, and not only is information shared among the different components of this program, but personnel are as well. And we feel that this is important because as people are working on different components, they have an understanding of what the other tasks are and the data coming out from those other components, then they can see how it can apply to other pieces of the entire program.

Let me just give you a quick example, three examples of how some of the data is shares among the different components of our program. First, the vegetation data that is gathered during our Site Characterization Effects Studies relates to plant cover, density, production,

species diversity can be used in assessing reclamation success.

Second, desert tortoise food studies have identified many plant species that can also be used in reclamation studies, since the biological opinion talks about putting the species back that are suitable forage for desert tortoise in our reclamation program.

And, third, as we conduct preactivity surveys, we've often located desert tortoise which we were then able to mark and radiotrack later.

Those are just some examples of how we interface within our program. We also feel like we integrate with the other components of the Yucca Mountain Environmental Program, particularly with construction activities that are ongoing at Yucca Mountain.

Probably the best example of this interface is in the land access and environmental compliance procedure that each principal investigator has to go to before they can start a study at Yucca Mountain. And you're probably all familiar with that process. But it involves conducting pre-activity surveys, and these are not only biological surveys, but they include archaeology surveys, surveys for rad., and reclamation inventories as well. And from that, that information is fed to the project office along with reclamation stipulations, and they issue the principal

investigator a set of environmental stipulations that they need to follow in order to develop that site.

Once that has been issued and the principal investigator is going to start his work, we go out and monitor desert tortoises that we know are in that area during the site clearing process. We also coordinate with the construction crews for the removal of the topsoil and where they place that topsoil.

So there's a number of interface points where we provide information to the project office and to contractors, and they in turn provide us information that allows us to mitigate a lot of the construction impacts at the site.

We also integrate with the project office director in the exchange of information so they are aware of the things that we are doing and they are up to speed on the latest data that we are gathering. We provide them with weekly highlights of our work. On a monthly basis, we provide them reports. On an annual basis, we have our annual progress report, and I think those have been sent to the Board as well. We also sit down and have a presentation of that information to the project office where we give feedback and exchange of how the program is going.

We attend many participant meetings, not only with DOE, but with other participants in the project, such as REECo and Raytheon and SAIC. DOE also reviews all the

publications that come out, publications and presentations that EG&G produces that talk about the Yucca Mountain program. And, finally, we provide reports to the Fish and Wildlife Service on a monthly basis regarding locations.

We attempt to communicate what we're doing with the public through a number of measures, not only the public, but our scientific colleagues as well. We participate in the public tours at Yucca Mountain. We have attended and presented information at public meetings. We have attended national symposia, and presented papers at those, the High Level Nuclear Waste Symposia and the National Archaeological meetings this past summer. We also attend and present papers and poster sessions at regional workshops and symposia. The Desert Tortoise Council meetings which are held annually, we present information there.

There was reclamation symposium that was held here in Las Vegas last month, and we presented five poster sessions and one paper at that meeting. We also provide peer review publications.

That is just a general overview of our program, and I think it will provide the foundation for the rest of our discussions today. And those will include in greater detail about the various components, which I'm sure is what you want to discuss today. But we feel like we have an effective program mitigating the impacts of site characterization at

Yucca Mountain on the terrestrial ecosystems.

So, with that, I will introduce Cathy Wills, who will be talking about the biological surveys that we conduct at Yucca Mountain.

DR. BREWER: Thanks very much, Kent. We are running very quickly through the schedule, and what I propose is for the Board and consultants to hold questions until after Cathy's presentation and before the break. Then there will be a period I think created in the schedule where we can sort of cover what we've done in the first set this morning.

MS. WILLS: I will be presenting an overview of the Biological Surveys Program at Yucca Mountain, one of the first components of the environmental program.

The objectives of this program, there are three; one is to identify the potential direct impacts of site characterization activities on important species and any of their important biological resources, also to recommend impact mitigation measures, and to implement recommended mitigation measures as they relate to important biological species.

Listed here are several legislation and regulatory requirements that either point us to conducting surveys, recommended it's something that we should do that's prudent to conserve important resources, or else indicate what important species we actually look for, as you can see listed

here.

As an example, the Biological Opinion that has been issued by the Fish and Wildlife Service for site characterization activities at Yucca Mountain indicate that we need to conduct preactivity surveys to identify the presence of desert tortoises. And the rest of these help to identify for our purposes what species we actually look for out in the field. And I'll have more detail on that later.

Here then are the lower tiered documents, some of the DOE orders, policies and procedures that dictate more how we conduct preactivity surveys. And Kent mentioned pretty much in detail that administrative procedure YAP30-2, which prescribes how preactivities fit in as the very first activity that goes on that identifies important species. There's other components. There's a reclamation component, radiation monitoring components, and that is the administrative procedure that we follow.

There are three major components in the Biological Surveys Program. They are conducting preactivity surveys themselves. This involves conducting 100 per cent area search, flagging any species or resources that we find and radiomarking desert tortoises. Then there are preactivity survey reports that are written, and within those reports, we make recommendations on what mitigation measures may be necessary.

Then there is the actual mitigation implementation phase, and in that, we actually may conduct resurveys at a site based on the density perhaps of desert tortoises that are in the area that we know could be affected by construction. We do species monitoring during construction of those tortoises that we radiomark. We also may relocate some important species. That may be desert tortoises. In some cases, it may be state protected cactus. They're protected against commercial exploitation, but we may protect them for use also in our reclamation program. So there may be some species relocation, and also conducting post-activity surveys.

The first component that I mentioned is actually conducting preactivity surveys. And the objective is to identify the potential direct impacts of site characterization activities on important species and their important biological resources.

And I put up here the definition of important species that the project office has adopted. It comes from the Nuclear Regulatory Commission's definition of important species. And you can see them listed here. They are either species commercially or recreationally important. They are species that are designated as threatened or endangered. They are those that affect the well being other either (a) or (b), or species that are critical to the structure and

function of the ecosystem.

The definition for the Yucca Mountain project office has been expanded to also include candidate species for federal listing, and also any critical resources for important species. And in the case of the desert tortoise, which is our only federally protected species threatened, that may be a burrow, because that's a valuable resource for a desert tortoise, and we feel that that's an important resource to be protected. It may also be a natural water source, for example, that free roaming animals can utilize, and that would be protected.

The important species and resources at Yucca Mountain specifically involve the threatened desert tortoise and of course any important resources of that species like burrows. There are eight candidate species. There are six plant candidate species. They are Category 2 species. There are also the Loggerhead Shrike and the Chuckwalla. There are also four Nevada game and furbearer species that have been identified as protected under Nevada state law, which we conduct surveys for. There's the golden eagle, wild burro and migratory birds which you saw listed. These are species that are protected by other federal acts like the Migratory Bird Species Act and the Bald and Golden Eagle Act and the Wild Horses and Free Roaming Burros Act.

How we conduct preactivity surveys is that first we obtain a project description to identify any direct impacts. Then we identify known species or resources that are in the area. We do this by going back to former preactivity surveys, any former surveys within the area, adjacent to the area, and then we go out into the field and we conduct 100 per cent coverage survey. We flag any species or resources that we find, and we radiomark tortoises that we find during a preactivity survey. We also conduct a reclamation inventory, which I'll discuss in my next presentation.

The status to date is that we have conducted 179 surveys since FY1989. There have been 17 tortoises that have been radiomarked which have been found during preactivity surveys.

The next thing we do is we write a preactivity survey report. The objective of that report is to report the results of the survey and make recommendations on how to mitigate any direct impacts of the proposed activity. And I put up here the definition of impact mitigation as it stands in the National Environmental Policy Act. And possible recommendations that we include in our report would certainly all fit into this definition of mitigation.

Some of these possible recommendations include proceeding as planned following standard mitigation

practices. And then I'll show you that; that even if we find no resource, even if we find no species out there, there are standard things that are done in order to lessen the impact of that activity on the environment.

Other possible recommendations may be to avoid any flagged species or resources that we have found. The other is to perhaps redesign the activity. Perhaps there is an access route that we can redesign and we can have it go around an area perhaps of higher tortoise density, or to avoid some resource.

We recommend monitoring species that may be near construction. For example, desert tortoises that we know occur in an area, we could recommend that during construction, we monitor those tortoises to ensure that they are not directly impacted by construction. And then we can recommend that we relocate any species, that we salvage topsoil for future site reclamation, and we could also recommend that the activity be cancelled.

As I mentioned, there are standard mitigation practices that are carried out regardless of whether there is an important species or resource that's been found and flagged for avoidance. And these include the following, and they are written up in project-specific land access agreements that are provided to each project engineer. They

include making sure that all workers on a project attend a worker training program so that they are aware of what flagging in the field means, they are aware of the terms and conditions of the Biological Opinion.

There's also these other standards like reporting any unflagged species or resources that are found. For example, if a worker finds a desert tortoise on an area, they are required to report that to the project office. They are directed to keep activities within the flagged project boundaries. There's environmental area tape that is put around proposed construction site to instruct the workers to keep all land disturbing activities within a prescribed area that has been surveyed.

They are also recommended to suspend activities if a tortoise is seen, and a biologist must be available within one hour. That's a standard mitigation practice, so that we can respond to any tortoise sighting. Also, another standard mitigation practice is that there is no off-road driving, no unauthorized off-road driving.

This is a summary for the last two years, FY92 and 93, on recommended mitigation measures which we have included in preactivity survey reports. They include these listed here. The recommendation for no additional modification or mitigation. Out of 109 activities for which we conducted surveys, 32 of those activities we recommended that no other

mitigation activity occur, or need occur. For 43 of these activities, tortoise burrows were found and had been flagged for avoidance. You can see here Chuckwalla dens. Chuckwalla is the other Category 2 reptile species that I couldn't think of before as a candidate.

Down here we had 68 activities for which we recommended that a resurvey occur before construction begin. Also, here we have 54 activities that we recommended that there were some form of reclamation that would be required. And at none of the activities did we recommend cancelling.

The last phase of the Biological Surveys Program is actually implementing our mitigation recommendations. And the methods by which we do this is we conduct resurveys. If we prescribe that they should be done to protect tortoise, then we go out and conduct resurveys. During those resurveys before construction starts, we search burrows that are in the area, and if they are empty, we collapse them. We monitor radiomarked tortoises within 100 meters of construction areas. We respond to tortoise sightings in the Yucca Mountain project area and we conduct post-activity surveys to assess direct impacts.

The status to date is that there have been 34 resurveys conducted before construction. 57 tortoise burrows during those resurveys were searched and collapsed. Tortoises near 17 activities have been monitored during

construction. 16 tortoises have been moved away from construction sites to avoid direct impact. One tortoise sighting has been responded to during construction, and there have been post-activity surveys conducted at 53 individual sites for a total of five activities. 39 of these sites were 39 separate walk and soil test kits.

In summary, I'd like to state that there are certain benefits of our Biological Surveys Program other than the main objectives to which it addresses. One is that, again, it mitigates direct impacts on important species. It also provides us a database by which to evaluate the efficacy of required tortoise mitigation activities prescribed by the Biological Opinion. It also assists the Desert Tortoise Program to meet their objectives by providing radiomarked tortoises for inclusion in some of their biological and ecological studies, which Danny Rakestraw will address later.

They also provide additional data on the abundance and distribution of important species in the Yucca Mountain area. It also promotes environmental impact awareness among project personnel.

And I guess with that, we will go to the break, and I will introduce myself for the next talk.

DR. BREWER: Actually, we have time, I'd like to entertain questions from consultants and other members of the Board. John?

DR. CANTLON: I think I'd like to have Kent address the question. In your comments, you talked about the integrative activities between the environmental program and other studies. I didn't see on your list any of the USGS hydrologic studies. It wasn't mentioned. And since the whole evapotranspiration dynamic is fairly important in terms of determining whether or not this site is going to be an effective repository, I would have thought there might have been some kind of way of coupling the transpiration component of the evapotranspiration into the whole hydrologic dynamic. Has anything been thought of or under way or any discussions going on in that regard?

MR. OSTLER: Yes, we've had some discussion with Alan Flint, who is principal investigator for those activities. And we're aware of what they're doing. We've had some limited exchange of information related to, you know, how we gather precipitation data out there. They've got a series of climatic stations, as you know, and we do as well, and we're sharing that data to help them build a better rainfall model for the Yucca Mountain site.

DR. CANTLON: You know, it's one thing to look at the density, let's say, of water input, but looking at the microgeographic context of evapotranspiration loss, since you have several things, one would be the seasonal pattern. When does the rainfall fall, how much evapotranspiration leaf

surface is available at that time, you know, how much of it actually gets into the system. What about the fault and fracture rooted species and their dynamic in that process? Nothing like that, I take it, is under way.

MR. OSTLER: The USGS is doing some of that kind of stuff, gathering that kind of information.

DR. CANTLON: Tying that in with your vegetation cover and the density work of the herbaceous covering and so on, some of the precipitation obviously gets slurped right back up by the plant cover. If it comes at a different point in time, its penetration will be much deeper, particularly on the faults and fracture systems.

MR. OSTLER: Right. And, you know, we have talked with them about providing some of that kind of data. They were interested in the data we were collecting. We have as yet not done that. You know, we've talked about it in general and then they never pursued it. But that's really important I think, you know, if we get to a point of trying to model a soil, plant, water interface, that would be very important information that we would want to pull together.

DR. CANTLON: And since the knowledge of the site has matured dramatically since the site characterization plan was put together when, you know, fracture flow was not really so dominant in thinking as it is today, the whole business of site characterization and the changes in surface water flow

through the road development and drill pad, obviously the water is going to be going in at different places after site characterization than it did before. And, again, is anything being looked at in that?

MR. OSTLER: I'm not aware of anything on that.

DR. BREWER: Thank you. Other questions?

DR. BOWERS: Yes. Michael Bowers, Consultant.

What is the spacial extent of site characterization studies? What sort of area are we talking about?

MR. OSTLER: You know, it's different for each one of the studies. For example, you mean within our program or within Yucca Mountain as a whole?

DR. BOWERS: Within the program that we're talking about today.

MR. OSTLER: Okay. Even within that, let me give you a broad outline, I guess. We go as far as the Bear Mountains on the west, which is the west side of Crater Flats, and we go as far east as Calico Hills area. We go not quite down to U. S. 93 on the south, and then up to the Yucca Mountain itself, which is the east-west ridge on the north side.

DR. BOWERS: So how many square kilometers?

MR. OSTLER: I never figured it. I don't know.

DR. BOWERS: Okay. That seems like a fairly important question.

MS. DIXON: You're talking about an area overall, if you

look at the land use that we've set up, the area overall that site characterization activities will be taking place on is approximately 70,000 acres. But within that area overall, the amount of area that will actually be disturbed will be very, very small. So you're probably talking about an area of disturbance that runs between 450 acres to 750 acres maybe, if that helps provide a database. Plus, as we're moving through time, our policy is that we're not waiting until the end of site characterization to do a reclamation program. We're reclaiming as we go. So the minute a site characterization activity is complete, the person responsible, the appropriate PI, notifies us that it is complete and we'll turn on EG&G to go back in and do a reclamation program.

So you're basically talking about a moving target over time. And we're talking primarily of areas that are very distinct, very small areas, an acre here, an acre there, you know, but the major areas of disturbance, quite frankly, if you want to look at where the biggest disturbances are, are associated with the north and south portal. Everything else is fairly small, distinct areas of disturbance.

DR. BOWERS: Two points; the first is as far as an integrated approach, if you're measuring these things at different spacial scales, do you anticipate problem in integrating them?

MR. OSTLER: Well, that's one thing that we've tried to eliminate in our site characterization effect studies is that those are set around our ESP's all at the same scale. So we tried to avoid that where possible. But as you know with other species that have a broader range, such as desert tortoise or birds, that they can't be studied at a smaller scale, so we anticipate that there will be, you know, problems in trying to put all that information together if one was going to look at how all of those components interact with each other. We've tried as much as possible to keep that scale the same, though.

DR. BOWERS: The second part of that question is, and I don't know if this falls under the purview of the site characterization plan, but biologically it seems like an important question to ask, just how the Yucca Mountain ecosystem differs from the ecosystems around other mountains within the area. Is it a unique ecosystem? I guess the geology suggests that at least that facet of it is. What about the ecological component?

MR. OSTLER: I have not found it to be particularly unique. To me, it's fairly typical of, you know, the northern boundaries within the Mojave Desert. It differs somewhat in not having, say, limestone as a base for the soil. So the pHs are generally, you know, in the high sevens, which is often different than other desert

ecosystems. But as far as the plant species are concerned, there's certainly nothing unique about the Yucca Mountain area. As you go south into the Amargosa Springs, then you do pick up a number of unique and rare threatened endangered species there. But the Yucca Mountain area is really rather depopulate when you look at the plant species and animal species that occur in that area.

DR. BREWER: Other questions? Jim?

DR. EHLERINGER: Jim Ehleringer, Consultant. I have two quick questions.

The first is I missed the definition of success in reclamation.

MR. OSTLER: We have not defined a specific criteria for that yet, Jim. What we will be looking at is what DOE is committed to is that they will restore to the environment to the level that is equivalent to what existed prior to disturbance.

DR. EHLERINGER: Does that mean the same species composition?

MR. OSTLER: We are trying to put back, yes, the same species that exist in that area. Now, you know, to the extent that we can do that; obviously, you know, often times some species just do not perform well once a site has been disturbed and we may have to go back with successionary species first and try to establish those that perhaps are

more climaxed by some other method, via transplants or something along that line. We are trying to restore the system that existed previous to disturbance.

DR. EHLERINGER: The second question is is anything being done to look at the soil structure, the role of caliche, the role of crust, either infecting the species that are there or how would one go about reconstructing that if these turn out to be important?

MR,. OSTLER: We have, prior to any disturbance out there, part of our reclamation preactivity survey, which Cathy will cover after the break, we gather soil samples. Those are primarily focused, though, at identifying quote, unquote, topsoil. We have a pretty broad definition of what that is out there. And that is suitable material that could be used in a revegetation program, so we may get into B horizons or even C--well, generally not C horizons, but potentially if the C horizon has suitable characteristics for salvaging, we may even take that, because there are a number of sites up there where topsoil wasn't salvaged. So if we can identify deeper soils that we can salvage extra topsoil, then we can use that to reclaim some of these other disturbances that, you know, occurred back in the early Eighties.

As far as looking at all of the interactions within the soil, we're basically limited to, or at this point in

time, we're just gathering data to describe what those physical characteristics of the soil are, the water holding capacity, some of the nutrients that exist there that would be important for reclamation.

DR. EHLERINGER: Is anything being done to characterize the surface microbes?

MR. OSTLER: Yes. We have a program within our reclamation component, again which Cathy will talk about after the break, that we are looking at the soil microbes that exist there, the bacteria, fungi, some of the microphysae, particularly as it relates to topsoil storage and how we keep that topsoil viable until we can use the topsoil for reclamation. We've got a number of studies that address that.

DR. EHLERINGER: Thank you.

DR. BREWER: Are there other questions? John?

DR. KORANDA: John Koranda, Consultant.

You may be doing this, but I haven't seen it mentioned, but I would think that you would be integrating the literature on this region backed times zero. Are you doing this? Have you done deep intensive literature searches?

MR. OSTLER: Yes, we have conducted literature searches, you know, for a number of the different components. There are some where a lot of literature is available. A lot of

the work done at IBP in Rock Valley, which is really not very far from our site, they've done some fairly extensive ecological programs where they've described a lot of the plan biomass production, some of the water cycling, a number of those things.

When one gets into the areas in reclamation, for example, there really is very limited information in the Mojave Desert. Romney and Wallace have done some on the test site. That was mostly restricted to transplants. They weren't looking at large scale reclamation. Much of that is usable for what we're doing at Yucca Mountain.

DR. KORANDA: They did do work on propagation of shrubs, though?

MR. OSTLER: Yes, they've done a little, you're right. There's a lot more information out there that's done by a lot of other people, too, in the last 15 years, you know, as many of these organizations have gotten into reclaiming the strip mines for coal and gold mines and other areas. So a lot of that literature is really building up now, and that is available. We've got a database started for the species that occur out there, what are their germination requirements, stratification requirements. We have had seed grown by commercial contractors to transplant back onto the site as well. So we've got a lot of information that we've compiled on the reclamation area, but a lot of it we felt like we also

needed to conduct site specific studies because there isn't a great database available to us from the literature.

DR. KORANDA: Is this database in an available form? In other words, could it be available on a computer disk or disks?

MR. OSTLER: Right now, it consists of mainly publications that the U. S. Forest Service has put together, and some that we have added to that from various sources. But it's not on a computer file at this point in time.

DR. BREWER: Jim?

DR. EHLERINGER: Jim Ehleringer, Consultant. A brief question for Cathy. Are any of the plant species that are threatened, are they in soil endemics?

MS. WILLS: Yes. None of those six species have been found on the Yucca Mountain study area. They are in the southern portions of the test site and down in Amargosa Valley area.

DR. BREWER: Warner? Warner North.

DR. NORTH: Warner North, Board Member.

As part of the orientation, I wonder if Wendy Dixon can give us a sense of the budgets for the activities, perhaps one level breakdown, just an idea for our consultants; where does the money go, and the number of people involved in the various aspects of the program.

MS. DIXON: Okay. Preactivity surveys, they run about

$400,000.00. A reclamation program is about 650K. Tortoise study is about $850,000.00. You haven't heard the presentation yet, but site characterization effect studies program is approximately $900,000.00, and then we have something called biological support, and that's around $300,000.00. So the total is just a little over $3 million for the entire program.

DR. NORTH: And about how many people are involved?

MS. DIXON: On a full-time basis, EG&G employs 25 FTEs. We have additional hirees that we bring in during the summer. There's approximately ten part-time summer help that come in. So if you averaged it out, it would probably average about, on the whole, 31 over a period of one year.

Dr. Brewer? I'm sorry, I was going to ask if you would have a problem if I readdressed a question of Dr. Cantlon.

DR. BREWER: No, not at all. Please do. We have the time. This is a workshop and we are having a conversation, which is just fine. Please do.

MS. DIXON: Wendy Dixon. Dr. Cantlon was asking a part about our efforts on dealing, if any, with evapotranspiration rates. And I guess I wanted to again clarify that that was not a parameter that was established for site characterization effects. Although we are monitoring changes in the biota over a period of time and how does that relate

with precipitation changes, that type of study was more perceived as something that would be related to repository effects, of which we have not entered into.

DR. CANTLON: I'll follow up on that. Again, I think that relates to the way the program was put together in the site characterization plan in which fracture flow was not presumed to be the predominant characterization of the hydrology of the site. And I wonder whether or not in really stipulating what the site or how the site will perform, if that isn't really an oversight. Now that we've matured in understanding of the subterranean hydrology as being dominantly fracture flow, the microgeography of the transpiration component and the seasonality of the water inputs would change that quite a little bit. It would seem to me, as part of site characterization, having nothing to do with repository, but just is the site appropriate, wouldn't that be an important element?

MS. DIXON: As a criteria for suitability?

DR. CANTLON: Yes, exactly. Exactly. If you're changing the pattern, if the dominant flow is going down through a relatively limited number of fractures in the mountains, which is what the hydrologists are now beginning to suspect, then the water dynamics of the transpiration component and the seasonality of those water inputs and the whole business of climatic change all relate to what's going

to happen on that site long-term, and so site characterization ought, in my judgment, be looking at the water dynamics in a somewhat more process oriented way.

DR. BREWER: Yes. She says yes. Other questions? Dan?

DR. FEHRINGER: A couple months ago, one of the trade newsletters reported that the Nevada field office of DOE and the University of Nevada at Reno had cooked up some kind of an agreement to do some studies at Nevada Test Site, and one of those was said to be water dynamics of native Mojave desert plant species. Are you familiar with that? Can you tell us anything about whether that will have any applicability for your work?

MR. OSTLER: I am not familiar with what all that consists of. I think it's very interesting and I think, you know, if it's done correctly, I think it may be very valuable to providing some of the data that may be needed in looking at this water flow model.

DR. BREWER: Okay, any other comments, questions?

I am proposing that we have a hydrological break until 10:00. Let's reconvene at 10 o'clock as opposed to 10:05, which is on the agenda. Thank you all very much.

(Whereupon, a recess was taken.)

DR. BREWER: Cathy, are you ready?

MS. WILLS: The reclamation program is one vital component of Yucca Mountain's environmental program.

Reclamation program activities directly mitigate land disturbing impacts of site characterization by rehabilitating and restoring the affected environment, which you will recall were mitigation measures, as defined by the National Environmental Policy Act.

The purpose of the program is to return sites disturbed by site characterization activities to a stable ecological state with a form and productivity similar to the pre-disturbed state.

There are several federal acts, regulations, commitments and project specific policy statements that have shaped our reclamation program. These include the acts, DOE orders and project documents listed here. All of these require DOE to take reasonable and necessary steps to reclaim lands disturbed by site characterization activities.

Under FLPMA, the Federal Land Policy and Management Act, for example, DOE must comply with BLM requirements for site characterization activities conducted on BLM administered land. These requirements include reclamation, and DOE has committed to meet these on both BLM land as well as on non-BLM lands within the site characterization study area.

In compliance with the Endangered Species Act also listed here, the DOE follows the terms and conditions of the Biological Opinion issued by the Fish and Wildlife Service

regarding the effects of Yucca Mountain activities on the threatened desert tortoise. This Biological Opinion calls for the implementation of a habitat reclamation plan to stockpile topsoil, revegetate abandoned sites and attempt to grow plant species that tortoises can use as forage.

The DOE has developed three documents which describe the reclamation program. They include the Reclamation Program Plan, the Reclamation Implementation Plan and the Reclamation Feasibility Plan. The purpose of each document and the distinctions between them are shown here. The RPP specifies that all land disturbances will be reclaimed with plant species present before the disturbance, and that certain interim reclamation activities will be conducted prior to and during construction.

The RPP also states that certain final reclamation activities will occur after construction is completed and no further land disturbance is anticipated.

The RIP, however, provides the general description of what these interim and final activities will be, and they include preactivity surveys, site clearing, topsoil storage and management, erosion control, site abandonment activities, recontouring, revegetating and post-reclamation monitoring.

The RFP prescribes that on-site and ongoing field reclamation studies be conducted at Yucca Mountain, and that information from these field trials will be used whenever

possible to determine site specific details, such as seeding rates, species and techniques to use that will enhance seedling germination and plant survival.

There are four major reclamation activities that occur at Yucca Mountain. They include feasibility studies, interim, final and post-reclamation activities. Not all elements of each of these activities have been initiated. For example, the mined spoils revegetation studies have not yet started. The muck pile currently being created by excavation of the north portal tunnel will need to be reclaimed, and there will be a series of studies to chemically characterize the spoil as a growth medium and to investigate revegetation methods.

As another example on this overhead, wildlife use monitoring is not scheduled to begin for several more years at sites that have been revegetated. The remainder of this reclamation program overview will focus individually on the status of each of these four types of activities.

The feasibility studies, I'll discuss first. These studies were included in our implementation program based on our search of the land reclamation literature. There was a paucity of information regarding direct comparison of various seeding and seed bed preparation techniques in the Mojave desert.

The disturbed habitat studies are conducted in the

Yucca Mountain area at sites which have been disturbed prior to site characterization. Some of these disturbances were caused by site selection activities begun in 1978. An inventory of these sites was performed which gathered historical information, and a GIS base map and an inventory database were created.

Database information includes the age of the disturbance, the type and severity of the disturbance, and the type of vegetation in which the disturbance occurs. This site inventory was conducted to identify areas to be reclaimed, as well as to select sites that could be used for natural succession studies and revegetation field trials.

Based on inventory information, 57 disturbed sites were selected for a natural succession study. The criteria for selection was based on the size of the disturbance and in obtaining complete information during site history inventory. The objectives of this activity are to describe the native vegetation growing on disturbed sites, to identify the early successional or pioneer plant species that may be specific to particular vegetation associations and which can be used for interim and/or final site reclamation, and also to identify species that may need to be included in reclamation field trials to determine which planting techniques may enhance their establishment.

The sites were categorized by the type of

undisturbed plants surrounding each site, the age of the disturbance and disturbance severity. At each disturbance, three to six, two by twenty meter belt transects were established, and in these transects, total vegetative cover, plant density by species and species composition were measured. These vegetation parameters will be compared with those measured at 48 undisturbed sites known as ecological study plots or ESPs. And ESPs will be discussed later in detail this afternoon during the presentation of the site characterization affect studies.

All 57 disturbed sites in the study have been sampled. This overhead shows the approximate location of the study sites around Yucca Mountain. I'd like to show you some of the data from these sites. This figure shows the relative plant densities of most of the common species found in all disturbed sites pooled across all vegetation associations. The plant names are presented as four letter codes along the bottom here.

This species, Chrysothamnus teretifolius, which is a species of rabbitbrush, had the highest relative density across all disturbed sites. This same species, however, was not a major component in undisturbed sites, as you will see from its absence in this figure.

This species, Ambrosia dumosa bursage was also present on disturbed sites, but its relative density on

disturbed sites is approximately 70 per cent less than that in the undisturbed sites, as you can see from this figure. Here, Ambrosia dumosa had the highest relative abundance in undisturbed sites across all types of plant associations at Yucca Mountain. Also notice, as I mentioned, the absence of Chrysothamnus teretifolius here.

Data like these will help identify those species such as bursage Ambrosia dumosa, which may need to be seeded at higher rates during interim or final site reclamation, and studied in field reclamation trials to assess the best revegetation technique to use to enhance their establishment. Based on these data, species like the rabbitbrush, labeled Chrysothamnus teretifolius, may be selected to quickly stabilize and revegetate sites in the major of vegetation associations where disturbances occur. These cover and density data from disturbed sites will also provide reference points with which the efficacy of our reclamation efforts may be assessed.

Another type of reclamation feasibility study conducted at Yucca Mountain is the field reclamation trial. To date, five existing disturbance sites that were identified during the disturbed site inventory have been selected as areas to conduct reclamation trials. They were chosen to represent the common types of disturbances that will occur throughout the site characterization study area at Yucca

Mountain.

The objective of the trials is to test a suite of native plant materials, planting methods and revegetation products. Those plant species, methods and products that enhance plant densities and diversity will be identified. Results will be incorporated into reclamation plans to make them as site-specific as possible, and also to implement them in a way that will hopefully increase plant survival and reduce any additional revegetation efforts through time.

This overhead shows the general location of the five trial plots. They're numbered 1 through 5. Sites 1 and 2 are existing disturbances on the crest of Yucca Mountain at the north and south ends respectively. Topsoils have been scraped from these sites and there's a shallow layer of subsoil over bedrock.

Sites 4 and 5 are drill hole pads that are in deeper soil and at a lower elevation. Here again, topsoils have been disturbed during construction and the subsoil compacted. Site 3 is an old equipment staging area. It's located on the north side of H-Road just east of Forty-Mile Wash. And this is the site that many of you may already be familiar with on your trip out to the test site last April.

The next series of overheads provide an overview of the types of field trials being conducted at each site and the current status of each field trial. The study objective

at Trial Site 1 was motivated by the fact that this and other sites requiring reclamation will have shallow subsoil and perhaps no native topsoil. Because it's costly to bring in topsoil, we want to assess if existing subsoil at disturbance sites and from nearby borrow pits can be used, and if topsoil is hauled in from off-site, how deep does this topsoil have to be.

Our analysis of spring 1993 seedling density data from this site indicates that there is a significant interaction between our two treatments of soil quality and soil depth. This figure shows spring seedling density data pooled across all seeded species. Median seedling densities in the subsoil, which is the dark here, were high in the shallowest depths and low in deeper depths. The mean density trend for the topsoil, however, were just the opposite. This interaction was also evidence among the unseeded species which germinated in the plots.

When individual species responses were examined across all soil depths, the same six species responded best in both the subsoil and topsoil treatments. These preliminary data suggest that soil depths and quality do not significantly affect seedling germination. This is a multi-year study so we will be able in the future to assess the impact of these treatment factors on long-term plant survival.

Here is the objection and the treatments, the methods and status of the study at Reclamation Trial Site Number 4. The objective of this site was to examine the effects of soil depth and of mixing topsoil with subsoil during seedbed preparation. Our two treatments are soil depth and how we mix topsoil with subsoil. This was initiated in FY93. It's an ongoing study and density data were collected June and October, '93.

These are the objectives, treatments, methods and status for Reclamation Trial Site Number 5. The objective at this site was to examine the effects of two water conservation treatments and two topsoil redistribution treatments on seedling emergence and survival.

The two treatments were imprinting and pitting, and also topsoil redistribution where we were going to redistribute the topsoil prior to imprinting and pitting and then after imprinting and pitting.

These also were initiated in FY93. Density data were collected in June and October, and this will be re-implemented this field season, winter '93/'94, due to low seedling emergence and survival.

Our objective at Reclamation Trial Site Number 3 was to demonstrate a wide variety of revegetation methods and materials that can be used at Yucca Mountain and to describe the effects of them on seedling emergence and survival. And

this is the site where the Yucca Mountain buses have stopped, and that some of you may have visited last April.

These are a list of some of the treatments that were examined. This was initiated in FY92. It's an ongoing study. There were 68 treatment plots established and seeded. All treatments were randomly assigned to the plots, and some of the spring 1993 plant density data is shown here. The treatment numbers along the bottom indicate each unique combination of treatments that were used.

What I want you to notice is that seedling densities were highest among these treatments at the end, and they represented broadcast seeding at a rate of 42 PLS kilograms per hectave (ha), and the second one was the use of a polyacrylamide gel in the soil.

Treatment Number 1 was our control where we didn't seed. We didn't do anything. This next figure shows the overall effect of fencing, which is in dark here, which protected seedlings at this Reclamation Trial Site Number 3 from herbivory and resulted in higher overall plant densities. The trends that we observed here at this demonstration plot will assist us in choosing selected treatments for use in further studies at other trial plot sites and for use in interim or final site reclamation.

As a result of these preliminary data, three treatments were selected for use during final reclamation at

one of our well sites named JF3. These treatments were broadcast seeding at that rate of broadcasting that you saw on that previous slide, and also the use of polyacrylamide gel, and fencing the site.

The third type of reclamation feasibility studies which have been implemented at Yucca Mountain are topsoil stockpile studies. At site characterization effect sites, the salvageable topsoil is removed and stockpiled for later redistribution and revegetation. The topsoil stockpile studies examine both the short-term, meaning less than six months, and the long-term effects of stockpiling on the microbial activity of the topsoils.

Soil microbial populations which include bacteria, fungi, algae and nematodes, play an important role in ecosystem stability. Microbial processes include soil structure development, the synthesis of various plant nutrients through biogeochemical cycling, and the improvement of adverse physical and chemical conditions.

The productivity of an ecosystem whether disturbed or undisturbed is dependent on the resident microbial community. Information from these studies will be used to provide guidelines for maintaining the viability of topsoil stockpiles and to provide guidelines for the re-establishment, if necessary, of the microbial population during final site reclamation.

The largest stockpile currently being studied at Yucca Mountain is the Area 25 borrow pit stockpile. This overhead shows the objectives, treatments, methods and status of this study. Four different seed mixes were used. They were native seeds with varying proportions of shallow and deep-rooted native species, and a legume mix.

The borrow pit was seeded this last April and monthly soil viability samples were collected once a month for six months from May through October, 1993. Microbial analysis of results from the May sampling were just received last month.

After presenting the types of reclamation feasibility studies currently being conducted at Yucca Mountain, I'll continue to just briefly describe the other three components of the program. Again, they include Interim, Final, and Post-Reclamation activities.

Interim reclamation activities include conducting reclamation inventories at a site that is proposed for use in site characterization prior to any land disturbance. These inventories are performed concurrent with the preactivity surveys which I discussed previously for important species and biological resources. During a reclamation inventory of a site, undisturbed vegetation is described, soil samples are collected, the horizon is identified, and site-specific erosion and reclamation potentials are evaluated.

To date, we have conducted inventories at 54 different site characterization activities. As a result of these inventories, site-specific reclamation stipulations are written and provided to DOE and then to the project engineers. These stipulations direct field personnel on the depth of soil to be removed and stockpiled, how to construct the stockpile, which may include where to place it at the activity site to best protect it from erosion.

To date, there are stipulations which apply to a total of 192 sites. These sites vary in size from very small test pits which may be two to five meters in size to very large drill pads. To comply with these stipulations, we've either stabilized topsoil stockpiles with a co-polymer, because the stockpiles are going to exist for less than six months, or we have either stabilized them with a co-polymer and then seeded them with a seed mixture because they are long-term stockpiles.

Final reclamation activities occur when a site has been abandoned because testing at the site is completed, or else a substantial portion of the site, such as a well pad, can be reclaimed even though the well may still be actively monitored. After construction is completed at a site, a site inventory or a post-activity survey is conducted. The purpose of the survey is to document the areal extent of disturbance, to document the compliance with site-specific

reclamation stipulations, and to collect any soil samples if needed.

To date, post-activity surveys have been conducted at 53 sites. 49 of these have been at small rock and soil test pit locations. Based on these inventories, current results from our reclamation trial plots and literature, a site-specific reclamation plan is prepared which specifies what needs to be done at the site. To date, there has been plans written which apply to 14 sites. Ten of these sites are rock and soil test pits that have been abandoned and backfilled. Actual final reclamation has occurred at four sites to date.

Post-reclamation activities will include monitoring both the plants which have been seeded or perhaps transplanted onto a site, but also the wildlife use of the site. This phase of the program we have not yet entered into.

In conclusion, these reclamation activities are but one component of the Yucca Mountain environmental program. They will continue to be modified as needed to best mitigate the loss of wildlife habitat, to refine reclamation guidelines and implementation procedures, to reinforce good engineering practices, to generate revegetation data which can be utilized by the DOE, other federal agencies, as well as by academia and by private industry faced with a similar

challenge of arid land reclamation.

DR. BREWER: I think because there's a break in terms of subject matter, it would be appropriate to ask questions of Cathy now before we go onto the desert tortoise presentation. From the consultants or Board members, questions? John?

DR. KORANDA: John Koranda, Consultant at large. Do you have data on soil morphology chemical and physical characteristics? How different is this topsoil from the subsoil?

MS. WILLS: Those are some of the results we have on our Reclamation Trial Site Number 1, and the topsoil was the soil that was at Reclamation Trial Site Number 1. We've done this for all the sites. This is a table, an example of what we have from one site. But, yes, we've measured for these basic soil properties, and there is a statistical difference here between subsoils which we used in that study, which was borrow pit fill material, and the topsoil, which was the soils that were remaining at Trial site Number 1.

DR. KORANDA: More fines in the top soil?

MS. WILLS: Yes. But we have this data from all of our sites.

DR. KORANDA: Okay, that's what I wanted to see. Most wild plants will respond to some nutrient amendments, in this case, probably nitrogen and phosphorus. Have you done this?

MS. WILLS: We are going to start a study on amendments,

soil amendments at Trial Site 1. We used fertilizer as one of the treatments at the demonstration plot site, Reclamation Trial Site 3, and we did not have, if I can recall, we did not have a significant increase in seedling emergence at those sites that we used fertilizer or any other soil amendment. So we think it's not beneficial right now for emergence. It may be for later establishment, although the effects may wear off.

DR. KORANDA: When you drill seeds in, do you use a conventional seed drill like you would do to plant a field of wheat, something like that?

MS. WILLS: It is a drill seeder. I don't know the brand name right now.

DR. KORANDA: A whole bunch of tubes and punches a little hole in the ground; right?

MS. WILLS: Yes.

DR. KORANDA: And drops a seed in.

DR. BREWER: Other questions? John?

DR. CANTLON: Let me get you to react to kind of a policy question on reclamation. DOE has been criticized in a lot of the nuclear areas, particularly in the clean-up of the sites and so on, that the intensity, the way in which they've gone at it is far more intense, far more intensive than the typical competitive commercial outfit would do.

For instance, how would you characterize a typical

reclamation for mining in Nevada? Is it at the level that DOE is doing it or are you, in a sense, guilding the lily? Because, in a sense, what I'm asking essentially is what's the cost effectiveness of the way DOE is going at its reclamation for these relatively small sites? You know, if you look at the total footprint, it's very small if you look at some mining sites many times the size of the disturbance.

Is the fundamental policy question on reclamation too prescriptive? For instance, restoration insofar as possible of the original species. We know enough about natural succession that that's not a very cost effective way to reclaim sites. Who would like to respond to that?

MR. OSTLER: I would like to respond to that, John. I think if you compare what Yucca Mountain is doing with what has been done in the state of Nevada, I think you'd see that the state of Nevada has been severely lacking in any kind of regulations as far as reclamation. It wasn't until 1990 that they had any kind of reclamation law enacted.

Now, if you were to compare the Yucca Mountain program with other states, particularly those states that have strip mining for coal, I think you'll see that it is not out of line at all with those kind of activities and standards that have been developed for reclamation and restoring ecosystems in those environments.

I think if you'd compare what Yucca Mountain is

doing with a lot of California reclamation that is occurring there, particularly in some of the wetlands and coastal areas, that we are probably doing less than is required in those environments. You know, they're talking at times of restoring individuals with the same genetics that existed prior to removing, you know, salvaging huge trees and replacing them, you know, which may, I've heard, cost up to $90,000.00 an acre to restore some of these areas. Well, you know, ours are going to be much less expensive than that.

So it's a matter of perspective.

DR. CANTLON: But in those very high cost reclamation sites, these are rare environments, coastal wetlands, that sort of thing. These are extremely rare things, particularly today. But it's a little hard to argue that Yucca Mountain is much of a rare environment.

MR. OSTLER: I agree, it's not a rare environment. There's a lot of Mojave Desert that exists. It's a very difficult environment to restore, even in trying to restore some of the successional species that occur there. That's part of the reason for our program. But, you know, we have seen even sometimes the climax species per se can be established. If we look at a program of going back in and only putting in successional species in there, that the succession is very, very long-term in the desert, and I think that we can have success by going in and putting in selected

quote, unquote climax species into that, and they will be successful.

DR. CANTLON: But you have literally hundreds to thousands of acres that get burned periodically and those are natural successions that follow up, and on these relatively small sites surrounded by very, very high populations of native species, the restoration rate on these small disturbed areas ought to be many times more rapid than recovery on big thousand, ten thousand acre burns.

MR. OSTLER: I totally agree, because you've got a seed source that yet is there.

DR. BREWER: Mike Bowers?

DR. BOWERS: Yes. Going back to the purpose of the reclamation program, you identified one goal is to return sites to stable ecological state with similar form and productivity. Could you flush that out a little bit for us? What do you mean by similar form and productivity?

MS. WILLS: We have a series of undisturbed study plot sites, these ecological study plots that are in different vegetation associations at Yucca Mountain. Those are all reference points and have been our reference points for disturbed sites that we will reclaim. Our attempt is to compare--is to measure production, plant production, compare those with plant production on our undisturbed plots. And also too, by similar form, we mean the relative frequency of

perennial shrubs, forbs, annuals in the community, as compared to our 48 undisturbed ecological study plots.

DR. BOWERS: Is there a time frame for doing this at all?

MS. WILLS: For monitoring, yes.

DR. BOWERS: Or to return it to the natural state, are you looking 50 years down the road, ten years, five years?

MS. WILLS: There is not a set time frame at this point. We have a monitoring program which we've established that we will do a qualitative assessment of how good the revegetation or transplants have taken to a site, and then there will be, starting the third year after transplanting or planting of the site, we will monitor for this productivity. I believe it's the fifth year or fourth year after revegetation occurs that we will begin to quantitatively measure and monitor the success.

DR. BOWERS: And one of the goals of this program then is to speed up natural successional processes, not necessarily to let nature follow the same pace?

MS. WILLS: Yes.

DR. BOWERS: Second question is we know from work done in forests that the size of the disturbance, or say a clear cut, is important to the recovery of the area. Is there any attention being paid to size of disturbance?

MS. WILLS: Well, so far as affecting our methods of

revegetating, yes. We find this is one of the values of our disturbed habitat studies where there is a difference in size of these areas, and if we see areas that they have a higher influx of the native plants that come in and establish well, if it's related to size, which we think it will be, then in areas that are smaller in size, we may not seed those species. We may let that natural process occur and pay more attention to getting a vegetative cover on the site to stabilize it from erosion and not seed with some of those other species because they would have a greater likelihood of coming in.

DR. BOWERS: Final question is you're using many different treatment combinations in a fairly short time frame to figure out which of those is best, and as we all know, deserts are highly variable with rainfall. So how do you figure out which particular treatment combination will be most effective in the long run over many years of different sorts of precipitation?

MS. WILLS: These reclamation trial sites are multi-year. Our Demonstration Plot Site 3 will be there for many years. And right now, obviously it is preliminary data, it's very short-term. We're using some of these to include in other studies that may be five year long studies, and right now, the only information we can glean from them perhaps is to assist us with some interim reclamation, how to seed a

site or small areas that have been turned over for final reclamation. But we realize that those are multiple year studies and we will need several years, particularly with the variability in rainfall that we have.

DR. BOWERS: Thank you.

DR. BREWER: Other questions? Jim?

DR. EHLERINGER: Yes. Jim Ehleringer, Consultant.

I'm going to go back. I'm not quite sure I understand the way that the data were collected. In the surveys, it looks like you have only perennial species. Have annuals been excluded?

MS. WILLS: No.

DR. EHLERINGER: So is the implication then that salsola is not very common on disturbed sites?

MS. WILLS: That was from the undisturbed study sites?

DR. EHLERINGER: Well, I'm taking the one which had the chrysothamnus teretifolius as the dominant species.

MS. WILLS: That's correct. If it had been present, it would have been measured. That's correct.

DR. EHLERINGER: So I don't see any SA, so I presume from that there's no salsola.

MS. WILLS: That's correct.

DR. EHLERINGER: Okay. The second question is that when I look at the comparison of these two here, the relative density in the disturbed and non-disturbed sites, I'm struck

by the difference in distributions in a way that suggests to me that the sites aren't really comparable, that there might be slope differences or aspect differences. For instance, in that transition zone, Larrea Ambrosia might be a dominant community, yet Larrea is even a minor, very minor component in the stable conditions.

MS. WILLS: Right.

DR. EHLERINGER: What factors have gone into assure us that the sites really were homogeneous except for disturbance, or similar except for disturbance?

MS. WILLS: I don't have the other data where they have been broken down by vegetation association. That is our intent. These were pooled data that were presented over all vegetation associations combined. What we need to do is break those apart, and we will do that analysis. I just don't have them with me here. I can certainly provide those for you for that comparison reason.

DR. EHLERINGER: Okay.

DR. BREWER: Any other questions, Consultants, Board Members? Oh, Jim, I'm sorry.

DR. EHLERINGER: My third question was going to be in treatment, you mentioned shallow rooted legumes. I was wondering if you could comment on what that is. Under reclamation feasibility studies, one of the treatments is going to be to add shallow rooted legumes.

MS. WILLS: What we did was we looked at the native species that occurred in the surrounding area, and we made a seed mix of those species that was proportional to their relative abundance in the community, and then we looked at those species within the native plants that were there, perennials, and we looked at whether they were shallow rooted or deep rooted. And perhaps it's a misstatement, but then we also added legumes as another treatment, and the legumes were not divided by deep or shallow rooted.

DR. EHLERINGER: Well, could you tell me what species?

MS. WILLS: Oh, yes. For the legumes, they were sweet clover, Melilotus officinalis, and alfalfa, Medicago sativa, and then Lotus scoparius and Cassia covessia.

DR. EHLERINGER: The reason I asked the question is sort of a philosophical question about how you approach revegetation. In the warmer deserts, the nitrogen fixing plants do form a major component of the nitrogen input into the ecosystem. But in cold deserts, it appears that nitrogen fixing organisms are a very minor component and that, in fact, it is the cryptogamic crusts or components of cryptogamic crusts that are important. And I'm wondering sort of philosophically as you approach a transition zone, is there a chance of being successful in trying to introduce a nitrogen source that's not adapted to that environment.

MS. WILLS: That's a good question.

DR. BREWER: Wendy, did you want to follow up?

MS. DIXON: I'd like to make a closing comment and, again, it ties back to Dr. Cantlon's question on policy.

But irrespective of the fact that the Biological Opinion requires for the desert tortoise that we do reclamation and the Nuclear Waste Policy Act, from a policy perspective, I think that our proceeding with reclamation as we go is the appropriate and right thing to do. What we'll do, you know, ten years from now or whenever we're finished with site characterization, I think is, from a policy perspective, inappropriate. I think from a cost perspective, it would be more costly because you're not spending your energies and your resources to protect the topsoil as you go.

And also, I guess in closing, one of the objectives of our feasibility test is not just to determine what is the best method of reclamation, but also to determine what is the most efficient method of reclamation as we proceed forward.

DR. BREWER: Thank you very much. And thank you, Cathy, for the presentation.

Next presenter is Danny Rakestraw on the Desert Tortoise Program.

MR. RAKESTRAW: Okay, I'm going to be talking about the Yucca Mountain Project Desert Tortoise Program, and I'll start off doing this by talking about the way in which we developed the program, the objectives of the program and the

studies that we developed to meet the objectives of this program.

For program development, I'll first talk about the history of our program, particularly the legal history, and I'll identify the goal of the program. Then I'll discuss the literature review which we conducted so we could develop the most effective program.

In 1984, the desert tortoise was identified as a candidate species for listing as threatened or endangered. In August of 1989, the desert tortoise was placed on the threatened and endangered list. This was primarily due to significant declines in the desert tortoise populations in Southern California.

As a result of this listing, the Department of Energy compiled a biological assessment to be used in the consultation process with the Fish and Wildlife Service. One of the mitigation steps proposed in this biological assessment was the development of a program to monitor and mitigate impacts on the desert tortoise.

The Fish and Wildlife Service issued a Biological Opinion which stated that site characterization activities would not jeopardize the continued existence of the desert tortoise. As part of this Biological Opinion, the Fish and Wildlife Service allowed an incidental take of 15 tortoises for site characterization. And also as part of this opinion,

a list of terms and conditions were identified in order to mitigate the impacts of site characterization. One of these terms and conditions required that the Yucca Mountain Project implement the program proposed in the biological assessment.

Upon receiving the Biological Opinion, we identified the goal of the program, which is to conserve the desert tortoise population at Yucca Mountain and to ensure compliance with the Endangered Species Act.

We then conducted an intensive literature review, which was more than just a literature review. We also spoke with project personnel to get additional information on the proposed activities for the project, and we spoke with biologists in this region to get a better understanding of desert tortoises from those people.

The three topics which we were addressing in this review was what are the potential impacts of site characterization activities on tortoises, second, what mitigation techniques are available and what is the effectiveness of those techniques, the third topic, what is known about the ecology of desert tortoises, particularly as it relates to the Yucca Mountain Project and our goal of conserving tortoises.

The first topic was what are the potential impacts. We reviewed a number of site characterization plans, alternative proposals and project and activity descriptions.

What we found was that there would be a number, a large number of small short-term activities occurring throughout the Yucca Mountain area. These would be things like small trenches, exploratory pits, small drill pads and access roads to these activities.

But in addition to these small short-term activities, there would be three or four large long-term disturbances. These would be things like the exploratory shaft facility, the north portal, south portal, and the muck storage areas.

We also evaluated each of the activities to determine what types of impacts might actually occur to the desert tortoise. And, first, the most obvious impact would be the direct or immediate impacts from site characterization, such as moving soil to create a drill pad. These would result in death, or could result in the death or injury of tortoises. But they could also impact the habitat features, such as burrows or other cover site types.

In addition to these direct impacts, we identified the possibility of indirect or cumulative impacts on desert tortoises. These could be things such as habitat fragmentation, the simple presence of humans in the area and human disturbance and the possible increase in predator populations, which could include ravens, coyotes and kit foxes.

We've concluded then that both these direct and immediate impacts and the subtle cumulative impacts must be addressed to achieve the goal of this program. And, secondly, we concluded that both these large long-term activities and disturbances, as well as the small short-term disturbances must be considered when developing this program.

We then addressed the issue of mitigation techniques and their effectiveness. There has been some information available, or there is some information available on the potential impacts of grazing on tortoises, of roads on tortoises, as well as off-road driving. However, there is little, if any, information available on the impacts similar to what we might see through site characterization, such as land surface disturbing activities or human presence.

There also is very little information on mitigation techniques with these types of impacts, or the effectiveness of these techniques. There have been some very cursory studies done on relocating tortoises, but there has been no conclusive information from those studies. Some studies have just been initiated in Southern California to address the use of fences and culverts to mitigate the impacts of roads on tortoises, particularly in areas of high tortoise densities.

So our conclusion here was that it would be necessary for us to study the effectiveness as well as to develop mitigation techniques if we identify any impacts from

site characterization.

The third topic of the literature review was what is known about the ecology and biology of desert tortoises. Well, there is a lot of information available on tortoise physiology, tortoise growth and relative abundance of tortoises, particularly resulting from studies conducted in Southern California and the western and southern Mojave Desert.

However, there is less information available on tortoise movements, behavior patterns of tortoises and tortoise survival, particularly of the small age and size classes of tortoises, including hatchlings. Almost no information is available on hatchlings in the wild.

Also, as we see with many different species, the desert tortoise does vary morphologically, genetically and behaviorally throughout its range. And as you can see here, the Yucca Mountain Project is right on the northern extent, in fact, the Yucca Mountain Project straddles the northern boundary of the desert tortoise.

Therefore, we believe that tortoises may differ somewhat from the information that was obtained in the studies that have been conducted in Southern California.

Based on this information, we conclude that it will be necessary to study some of those aspects of desert tortoise biology and ecology that apply back to the Yucca

Mountain Project area and the tortoises in that area, and those aspects of the desert tortoise biology which will be needed to fulfill the goal of this program of conserving tortoises.

As a result of the information review and the literature review, we identified four basic objectives for this program. First, to evaluate the impacts of site characterization activities on tortoises, both at the direct and immediate impact level, as well as the cumulative or the indirect impact level. Second objective is to mitigate impact of site characterization activities to the maximum extent possible in order to minimize incidental take. Third objective is to develop and test the effectiveness of mitigation techniques if they are deemed needed if we see impacts from site characterization. The fourth objective is to obtain this site-specific information on tortoise ecology which might be needed to achieve these other objectives.

We then identified or incorporated eleven different studies and procedures to meet our objective. I'll now discuss the first set of five procedures and studies which are intended to address the direct or immediate impacts of site characterization.

You've already heard about the preactivity survey process, so I'm not going to go into any details about it here. But I do want to emphasize that this is the one

procedure, this is the key procedure in which we mitigate impacts of site characterization activities. I'll also say that the results from all of our other studies feed back into this process. We review those results and modify, if necessary, our recommendations for mitigation from site characterization.

Preactivity surveys are very effective, at least we believe they're very effective, in mitigating potential impacts of short-term small scale disturbances. However, we were concerned that it would not be appropriate or adequate to meet the potential, or address the potential impacts of the longer term and larger scale activities. Therefore, we developed the Impact Mitigation Study.

The objective here is to obtain this necessary information to mitigate impacts on tortoises from these long large scale activities. Information that we want to collect here is movement patterns, home range requirements and habitat use patterns. We do this by identifying tortoises in areas where these large long-term activities will be occurring. We radiomark tortoises in these areas, and we monitor those tortoises over a period of time prior to the initiation of activities.

We've identified three areas so far. The first area, you can't really tell from this pointer here, but it's the Drill Hole Wash area on the left. This area was

originally surveyed in 1990 and 1991. This was the original site of the exploratory shaft facility. We surveyed this area. We identified and radiomarked 19 tortoises in the area. Later, the project office went to a two portal system rather than using the exploratory shaft facility, therefore, we went in, removed transmitters from all but six of the tortoises in this area, because those tortoises were going to be or were near some existing activities and we wanted to monitor impacts on those animals.

The second site is the Midway Valley North Portal area up here on the upper right. This is an area where large trenches have been developed, and the north portal has been sited and has been constructed now. We surveyed this area in 1990 and 1991 and radiomarked 30 tortoises in that area.

The third site is the Muck Storage and South Portal area. This area was originally surveyed in the spring of 1992 and we radiomarked 14 tortoises in that area.

We've been monitoring tortoises in these three impact mitigation sites and we've obtained a good bit of information on those in the way of movements and habitat use. This information is tied back into the preactivity survey mitigation recommendation process prior to the initiation of the activities in those areas.

This leads me into our next study, which is a relocation and displacement study, which is typically the

type of recommendations we make for these long-term large scale activities. This study objective is to develop and implement and test methods of relocating or moving tortoises out of areas to be disturbed.

Our original plan was two-fold; one, to move tortoises out of the Yucca Mountain area if more than 25 per cent of their home range was going to be disturbed. Our other plan was if less than 25 per cent of its home range was going to be disturbed, we would typically just move the tortoise out of the way of the disturbance and monitor that animal.

We did this with one tortoise, Tortoise 423. This tortoise was in the north portal area and we relocated this tortoise to an area right about here, 6 kilometers or so from its original home range. You can see this tortoise then promptly took off and moved down to the southeast, ended up in an area about 10 kilometers away from the original relocation site. By July, the tortoise had moved back up and was in an area here, had established a home range which was relatively, I guess, representative of tortoises of that size.

While we were monitoring this tortoise, we estimate that it traveled about 30 kilometers, that it rarely used burrows, and it was commonly active during the heat of the day. Based on this information, we determined that this

tortoise was at risk of exposure and at risk of exposure to predators and predation.

Therefore, we considered options and we revised our plan. Tortoises now will be moved within their home range, away from the construction activities, and then monitored whenever this is possible. If a large portion of their home range will be disturbed, the tortoises will be moved to a safe area somewhere within the Yucca Mountain vicinity. Tortoises will then we removed from the Yucca Mountain area only if they continue to return to construction sites.

After implementing this plan, we've had to relocate 15 tortoises from construction sites. Two of these tortoises we had to move outside of their original home range. 13 of these tortoises we were able to relocate from the disturbance site but keep within their original home range. Following every relocation activity, or every relocation event, we monitored tortoises and we evaluate the success of that relocation, as we did with 423. We then determined whether or not we need to modify our procedures and our overall relocation plan.

With the two tortoises that we had to move outside of their original home range, we did not see the extreme movements like we saw with Tortoise 423. And they did establish home ranges that were somewhat representative of tortoises their size. Of the 13 tortoises that we had to

relocate, or that we relocated to areas outside the disturbance but within their home range, one of these tortoises did move back to a construction site and was killed by heavy equipment traveling along an access road.

We evaluated our procedures, our monitoring procedures of relocated animals. We increased the intensity at which we monitor those tortoises during a construction phase of an activity. Though we have had one loss due to death of desert tortoises, we still feel that this is a very effective means of mitigating impacts of site characterization activities through relocation.

The next direct impact mitigation and evaluation study we have is road monitoring. The objective of this study is to minimize the impacts and mortalities of tortoises along roads. We do this by monitoring sightings of tortoises along roads and monitoring mortalities of tortoises along roads. Annually, we assess the information that has been obtained through these sightings and through the mortalities, and determine whether or not mitigation is required to reduce mortalities along roads.

If necessary, we will develop, or at least we will evaluate current studies being conducted to address mitigation activities or mitigation techniques of roads on tortoises, and then we will develop and test these techniques and, if necessary, we will implement them for site

characterization.

Since 1989, 155 sightings of tortoises have been made on roads. This map here is just as an example. This is the tortoise sightings in 1992 on roads. We have had four tortoises killed on roads in the Yucca Mountain vicinity. However, only one of these tortoises counts against the incidental take permit of Yucca Mountain Project. The other three tortoises, all small tortoises, were found to have been killed on roads that are open to other personnel from different projects of DOE on the Nevada Test Site.

However, Yucca Mountain is still concerned about these losses, therefore, warning signs have been placed in areas of highest tortoise activity and employees of the project have been informed that small tortoises are present and that they should be keeping an eye out in their driving for these tortoises. However, at this point, no further mitigation has been recommended. We will continue to evaluate tortoise sightings and tortoise mortalities on roads.

The final study which we have for mitigating or evaluating direct impacts of site characterization is the ground motion effects study. The objective here is to determine if ground motion caused by site characterization activities collapses tortoise burrows or causes tortoises to alter their behavior. The behavior that we were truly

interested in here is hibernation. Let me explain a little bit about what site characterization activities can cause ground motion.

There are two primary activities which we were looking at. The first is excavation of the two portals using explosives. And the second is seismic studies in which scientists place small explosives in the ground, and then place sensors in the area around that site, then make the explosion and monitor the ground movements.

Well, the way we were monitoring the impacts of ground motion is that we monitor behavior of tortoises during and after the ground motion activities, and then we measure burrows near the seismic shots and away from the shots before and after ground motion event. We have monitored one set of seismic studies so far and we've seen no changes in the burrows' structure or integrity in that area. We've also been monitoring the burrows and tortoises at the north portal and have seen no changes in the burrow structure and no changes in the behavior of tortoises in that area.

Since we've seen no impacts of this activity, no mitigation recommendations have been made.

Now, that's how we address direct or immediate impact of site characterization activities. Now I'm going to talk about our studies to address cumulative impacts or the indirect impacts of site characterization activities.

In order for us to do this, obviously we had to address the combined effects of all activities in the Yucca Mountain area. And since the cumulative impacts may be subtle, sampling is being done over a long period of time and on many different parameters which may be important to the tortoise population.

We've identified these six studies and six sets of parameters to address. First, I will talk about these first five studies because these five studies utilize radiomarked tortoises of the sampling unit. Also, they have a common experimental design and common objectives. I will present to you now the design of these studies, the objectives of these studies, and then I'll talk a little bit about each of these five studies. After that, I will address our sixth study, which is monitoring raven abundance in the area.

For us to monitor changes and impacts on the parameters that I just showed you, we identified three impact levels to be monitored. First is the high impact area, which are these areas on this map. These are tortoises which are in or adjacent to these large long-term disturbance sites or in areas where there will be a concentration of these short-term smaller activities.

The second sample is basically the area-wide sample. These are tortoises away from these high impact zones but still within the Yucca Mountain area where many of

these short-term small scale activities will be occurring.

The question earlier was what is the general size of the area to be impacted. And for our study, we've identified this block, and it's between 80 and 90 square kilometers.

We've also established a third sample, and that is our control sample where there will be no impact from site characterization activities.

Our goal was to establish 20 to 25 radiomarked tortoises in each of these samples. By the end of 1991, you can see here we had established that, or had met that goal.

As I said, these studies have a common set of objectives. The first objective is to evaluate the cumulative impacts of site characterization on tortoises, and the second is to obtain site-specific information on desert tortoises so that we can better conserve desert tortoises at Yucca Mountain.

Now I will discuss each of the five studies in this common design. I'll first talk about the parameter we're measuring and why. I'll talk about the methods and some of the results we're getting to meet these two objectives.

For reproduction, we are monitoring eggs produced per female on an annual basis. The methods we were using, in 1991, we began locating nests and excavating those nests so that we could count the number of eggs laid. We found many

nests that year, eleven in fact, however we were never sure that we had located all of the nests for all of the females. Therefore, in 1993, we incorporated x-rays into this methodology. By using x-rays, we were better able to determine competently that we had identified all of the eggs, or the number of eggs produced by each female.

Here's just some of the results. As you can see here, it seems that tortoises in the Yucca Mountain area average about eight eggs per year. Some of the additional information we've obtained from this is we now know approximately when tortoises lay eggs. We know the incubation period of tortoises, from 79 to 112 days, and we have confirmed that incubation duration is negatively correlated with incubation temperature.

Also, we've identified the hatching date of tortoises. This information can be compiled and will be compiled so that we can develop a predictive model so we can better identify, using this information, when tortoise eggs will hatch. We need this information so that we can better capture hatchling tortoises as they emerge from the nest so we can radiomark those tortoises and monitor those tortoises to try to determine hatchling survival rate.

Now, recently, biologists confirmed that desert tortoises do exhibit temperature dependent sex determination. Therefore, we began putting temperature data loggers in our

nests. This graph is an example of some of the data that we are obtaining from these temperature data loggers. The bar across the center here is the temperature above which a nest will predominantly produce female tortoises. Below that temperature, the nest will product predominantly male tortoises.

Well, this prompts two very interesting questions. First, does nest temperature limit the northern extent of the desert tortoise range. And if this is the case, you would likely see a skewing of sex ratios toward males. Well, in fact, at Yucca Mountain, we do see a slight skew of our sex ratios toward males, and it has been found that in the Las Vegas Valley where they have had to remove tortoises from large areas, that there is a skewed sex ratio toward males.

The second very interesting question is if the repository is placed here, what will be effects of thermal loading be on the sex ratios of tortoises at Yucca Mountain. Well, we will continue to monitor and collect this information and when we go into the thermal loading studies, we will expand on this information and use this information in developing those studies.

The next topic is survival. We're monitoring the survival rates of adult tortoises, hatchling tortoises and tortoise nests. We do this by monitoring our radiomarked tortoises at least weekly, and we monitor nests weekly

whenever nests are present in the area.

You can see here that we've monitored about 60 or more tortoises, and we've only had two animals die over a two year period. In your handouts, this 100 is probably 00. You may want to make note of that. We've only had two animals die, both females, one each year in the area-wide sample.

So far, the hatchling data, or hatchling survival data, has been inadequate for us to address comparisons between treatments. However, we have found a very interesting bit of information. In this area, native fire ants appear to be a significant predator on hatchling tortoises. Four of the five carcasses we have found this year have been killed by, or appear to have been killed by these native fire ants.

We have monitored all the nests which we have found over the past two years from our reproduction study, and so far, of the 30 tortoise nests which we have found, 21 of these tortoise nests have been preyed upon, and this is probably by a kit fox.

The next study is what we call behavior or habitat use study. We've identified these four parameters for addressing behavior and habitat use.

We feel that behavior may be one of the first responses or reactions that tortoises may have if site characterization activities are having an effect.

We monitor these parameters by locating radiomarked tortoises twice each week during the activity period and once every two to three weeks during hibernation period. Whenever we locate a tortoise, we record information on location, use of cover sites and behavior of those individuals.

We have calculated home range for 1992 using the standard estimators of minimum convex polygon and harmonic mean. What we found was that our data violates the assumptions of these home range estimators. Therefore, we are in the process right now of evaluating alternative home range estimators using our data.

We have found that length of hibernation and the percent of time active have not differed among the three treatment levels over 1992 and '93.

Some of the additional information that is interesting and of use is that 97 per cent of our radiomarked tortoises had started hibernation by the 15th of November. Also, 97 per cent of our radiomarked tortoises were still in hibernation as of March 1st. We have used this information to better hone our time periods in which we will monitor tortoises during construction activities and when we will conduct resurveys, the resurveys that Cathy mentioned earlier.

In order for us to better address individual health and condition of tortoises, we identified four parameters

which would be measured to monitor health. The first is growth, annual growth of the individual tortoises. The second is condition index, which is simply a mass to volume ratio. The third is presence of antibodies to Mycoplasma agassizii, which has been identified as the probable cause of the upper respiratory tract disease. Upper respiratory tract disease, or the outbreak of the upper respiratory tract disease is one of the factors that led to the listing of the desert tortoise. And the fourth parameter is blood profiles. We want to try to monitor blood profiles to evaluate the physiological condition of the individual tortoises.

Well, how do we do this? We measure growth and calculate condition index on an annual basis in the fall whenever we take a number of measurements of all of our radiomarked tortoises. This past year, we began collecting blood from our tortoises so that we could assess and measure the antibody presence or response in the tortoises, and so that we could monitor these blood or health profiles.

Condition index did not differ among the three groups over the three years which we have data for measurements of tortoises. The growth data so far has not been measured or has not been evaluated and analyzed. The blood profile data was just received from the lab, since we've just completed collecting that this past fall.

We do have information from the antibody presence

or response for tortoises. So far, the presence of antibodies in the tortoises has not differed between the three treatment levels. However, we are concerned that there may be a trend here in the antibody presence in these tortoises. We'll continuing monitoring this and evaluate it in the future as to what, if anything, needs to be done.

The fifth of the five studies in which we are addressing cumulative impacts using radiomarked tortoises is our diet study. Site characterization activities may have an impact on the vegetation at Yucca Mountain. Therefore, it may have an impact on the diet of desert tortoises. Therefore, we are monitoring the species composition in the diet for desert tortoises. We do this by counting the number of bites per forage species during foraging observations, and we collect scat from our radiomarked desert tortoises at Yucca Mountain and in the control area.

Composition analysis of the 1992 and '93 samples has not been completed by the lab. However, we do have some information from some of the other data. 1990 and '91 scat samples were evaluated and the 1992-1993 feeding observations have been compiled. Here's a list of the ten most commonly eaten species of the desert tortoises that we have seen so far. This information has been compiled and has been forwarded to our reclamation specialist.

As has been stated at least once, the Biological

Opinion requires that we consider or take efforts to incorporate species palatable to desert tortoises in our reclamation efforts. The reclamation scientists have incorporated at least one or two of these and will be considering whether or not to incorporate any of the others.

Okay, that's the last of the five studies to address cumulative impact using radiomarked tortoises. The sixth study is the raven abundance monitoring program.

We are monitoring raven abundance because Fish and Wildlife Service stated that ravens have been increasing in their numbers throughout the southern Mojave Desert, and they have been identified as a predator on small tortoises. Therefore, our objectives have been to determine if site characterization activities cause an increase in the raven abundance in the area, monitor the use of site characterization facilities by ravens and identify where these ravens may be congregating. The third objective is to recommend how to discourage ravens from using site characterization activities facilities.

The way we're doing this is we are monitoring and counting ravens on two routes; one at the Yucca Mountain area and the other is in a control area in Crater Flats and Bare Mountain, which is about 10 to 20 kilometers west of Yucca Mountain. We monitor these sites five times every other month. When we see ravens, we record what facilities these

animals are using.

For the results, this is a graph of the results, and as you can see, there is a difference in the number of ravens at the control area and at Yucca Mountain, and there has been a difference between 1992 and 1993 in the number of ravens. However, since the treatment by time interaction was not significant, we conclude that Yucca Mountain site characterization activities have not caused an increase in raven abundance at Yucca Mountain.

Well, that's the last of the studies for addressing cumulative impacts. Identifying and mitigating cumulative impacts is rather difficult. Changes in one parameter, which we have discussed, may not warrant mitigation actions. Each change in the parameter will be evaluated in context with the other parameters so we can possibly identify causes in changes in those parameters.

In other words, for example, if we see a change in the movement patterns of tortoises in an area, we may not recommend mitigation actions. However, if we see changes in movements of tortoises in an area and we may see a drastic decline in the reproductive effort of those tortoises, some mitigation action may be needed and we will then consider and recommend mitigation at that time.

To ensure that the information obtained from these studies is included in the mitigation phase of the program,

at least annually, often more often than that, we evaluate the results of those studies to identify mitigation measures which need to be incorporated, either in the preactivity survey process or elsewhere, so that we can minimize impacts on desert tortoises.

In summary, I have discussed the development of the program, I've discussed the studies and just a small part of the results which we have collected and gotten to date. I have skipped over some information to try to keep this timely. There's a lot of information that we do have. If you are interested in any of this information or other information regarding the development of the program, much of this is in our annual reports. Also, we anticipate that this year, we will have a lot of our, if not the most of our current results in either topical reports, journal, publications or symposia proceedings.

DR. BREWER: Okay, thank you, Danny. Are there questions from the consultants or members of the Board?

DR. BOWERS: I have a question.

DR. BREWER: Mike Bowers.

DR. BOWERS: Yes, thank you. I was wondering, you represented a few probability values, comparing the treatment plots with the control plot, I was wondering how you do that when there's basically no replication. You had one control plot, and so I was wondering how you do these sorts of

analyses with no replication at the plot level.

MR. RAKESTRAW: I'd like to refer that question to Jim, if he would like to take it. Jim Miller is one of our biologists and he has a bit more statistical background than I do.

MR. MILLER: On that particular question regarding lack of replicates, I really don't know the answer to that. One of the other people that we've developed this with isn't here, and I just can't answer that.

DR. BREWER: Okay. Other questions? Michael? Jim?

MR. OSTLER: I can help shed some light on that, I hope.

DR. BREWER: Kent Ostler.

MR. OSTLER: Again, our experimental unit is the tortoise observation, or the tortoise themselves. So it's true that we've got these three areas that we're comparing. It's the observations on the tortoises also through time that make up the replications.

DR. BOWERS: I figured it was probably females, number of eggs per female, but one of the things you're interested in measuring are population, sort of characteristics, like survivorship and mortality, which when you try to compare what's happening on Yucca Mountain to the control, you won't be able to do statistically, the way I understand the setup now.

DR. BREWER: Any response?

MR. MILLER: Jim Miller, EG&G. Explain to me, okay, these are actually treatments, we have three different areas and each of those areas is actually a treatment, and each animal is actually a sample of that treatment, so we actually would have 20 replicates in each of those.

DR. BOWERS: So if you're looking at sort of parameters that you can measure at the level of individuals, you're okay, like number of eggs per female. When you start looking at population level sorts of parameters, like survivorship or mortality, which is not an individual parameter, then you're in trouble.

MR. RAKESTRAW: Yes, you're right. And that is the one sample point, and we've accepted that. The option was to set up many large control areas, and this is the way we're currently planned.

DR. BREWER: Okay. Jim?

DR. EHLERINGER: Jim Ehleringer, Consultant. My first question is sort of a basic biology. Is the purpose of the burrow for hibernation, or is it used also to escape from heat?

MR. RAKESTRAW: Tortoises use burrows for hibernation and they use burrows throughout the year. They'll use them on a daily basis to avoid heat. They'll use them in the evenings to avoid the cold, and they use them in a lot of cases to build nests in. So they're a multi-purpose

function.

DR. EHLERINGER: Is there a geographical or orientation preference? Are they in particular sides of the mountain?

MR. RAKESTRAW: As of right now, we are evaluating that information, but on cursory review of the data, no. We have not seen any preferences on aspect, slope, anything of that sort.

DR. EHLERINGER: The next question is the lifetime of a burrow, can you say something about how often they're habited?

MR. RAKESTRAW: We have a wide range of different types of tortoise burrows. We have some tortoise burrows near the Exile Hill and up on Yucca Mountain that are underneath rocks the size of this round table here. We haven't dated them. We don't know how long they've been around, but chances are they've been around for quite a while when you look at the pack rat midden debris there. We also have other burrows that are only there for a couple of weeks, depending on the rainfall patterns.

When we first started this work, we saw burrows that were there--this was during the drought back in '89 and '90--we saw burrows that were there for three years. We went back after one year of rains and the burrows were gone.

DR. EHLERINGER: I guess the question is the ratio of the number of burrows to animals and the distribution of

those burrows sufficiently large that the impact that you've had of destroying some of the mounds is inconsequential.

MR. RAKESTRAW: I am not certain of the exact number, but I believe our average right now for the number of burrows per tortoise is around eight or ten. And that's fairly common to see. So we think by losing one or two burrows to construction is not going to have a substantial impact. We are currently taking measurements on hibernacula and we will in the summer evaluate other--well, actually we have been collecting also dimensions on the other burrows to see if we can identify a potential hibernacula for a tortoise. We have seem some fidelity of tortoises coming back to hibernaculas each year, but it's not consistent. We are seeing some tortoises have hibernated in different burrows all three years that we've been monitoring them.

MR. EHLERINGER: My last comment is on food sources, and I find it rather striking that the distribution of species that are being monitored in terms of vegetation studies shows virtually no overlap with what the animals are eating. The exception appears to be Erioneuron. And so it looks like what you guys are studying has nothing to do with what the plant guys are studying.

MR. RAKESTRAW: Well, tortoises primarily feed on annual species, and I believe Ron will be addressing the annual species in our studies addressing annual species and their

presence throughout the vegetation associations later. Am I right, Ron? Yes, he'll be addressing that. So maybe we have not been using or seeing the annuals in our reclamation efforts, but we have been addressing the presence of annuals throughout the area. So at the end of Ron's talk, if you still have questions, we can get back to you.

DR. EHLERINGER: Well, I just want to make sure that there's a good meshing.

MR. RAKESTRAW: Yes, we are addressing annuals at several different levels, in fact, I believe its presence and then continued existence in the area. Tortoises do feed on the annual species, and then during the first couple of years we were out here, there were none, so Bromus rubens was present in the diets, in fact it was high in the diets, that's why we were very interested to see the 1992-1993 scat samples to see if it still has a high presence in the diet.

DR. BREWER: Other questions? John Koranda?

DR. KORANDA: What's the weight of the telemetry package these fellows pack around?

MR. RAKESTRAW; We have a limit of no more than 10 per cent of the body weight of our tortoises. We strive to go to 5 per cent if we can. Our hatchlings transmitters are less than 2 grams, about 1.8 grams per package. I believe our adult transmitters are right around 25 grams. The adult transmitters, they last for about a year and we were able to

leave them on there for that length of time.

DR. KORANDA: They don't seem to put the animal at a disadvantage then, you know, if he gets tipped over?

MR. RAKESTRAW: We have seen, I couldn't give you a number, but we have seen quite a few tortoises on their backs, both with and without radiotransmitters. In most cases, those animals can get up. Many of our field biologists have sat there and watched tortoises with radios on them right themselves. We currently are concerned--not concerned, but we have that consideration in mind whenever we put these radios on the tortoises. Our transmitters are probably some of the flattest and less obtrusive transmitters that are being used right now on desert tortoises in these studies. It's our belief that there's no impact. We've seen no indication that there's been an impact.

DR. KORANDA: They're just epoxied to the carapace?

MR. RAKESTRAW: What we do is we have, on everything except our hatchling tortoises, we have developed a means of attaching these transmitters to a brass plate which has a screw welded to it. This brass plate is attached to the tortoises to a single scute of the tortoise using epoxy. This epoxy, from what we've seen so far, lasts about three years before it just basically falls off the tortoise. We then are able to bolt this transmitter to the tortoise and then we surround that with a silicon to ensure that the

transmitter doesn't snag on shrubs or anything else out in the area. We then can remove the bolt and remove the transmitter and replace it on an annual basis or every six months, depending, with as little impact on the animal as possible.

DR. KORANDA: What's the range of your telemetry effectiveness?

MR. RAKESTRAW: Our larger transmitters it's been 2, 3 kilometers we've been able to pick them up, depending on the location. If they're in a deep caliche burrow, we may not be able to catch those unless we're right near there. Our hatchling transmitters, that's about 50 meters is the best we can get on some of our hatchling transmitters, which is fine because hatchling tortoises just don't move as far as our adults.

DR. KORANDA: And there's no shielding from a deep burrow then?

MR. RAKESTRAW: In the caliche burrow, we have some that are easily 10 meters deep, we have had some, more of a funneling effect. If you're in front of the burrow entrance, you'll be picking up the signal. But if you're behind it, you may not.

DR. KORANDA: Okay, thank you.

DR. BREWER: Other questions? Dan Fehringer?

DR. FEHRINGER: I'm a little unclear about how much of

this work is effectively dictated to you by your agreement with the Fish and Wildlife Service, and how much you're doing at your own initiative for other reasons. Can you give me some indication of that?

MR. RAKESTRAW: I didn't put the slide up, but the Fish and Wildlife Service has identified a set of parameters to measure in doing this work. We are not doing any study that has not been listed there in that term and condition. However, you could question whether or not at what level this work needs to be done. We've established that this work and this effort at the level we think is necessary to obtain the information and to the best extent possible gets statistically sound samples.

There's a couple of studies that we've identified, such as the habitat evaluation model, which is one of the criteria or one of the items that were listed as a parameter to measure. We've evaluated over I guess it was 1990 whether or not that would be a very effective way of monitoring impacts or even if it would be feasible to do that. We did some surveys, we did some measurements, and we found that there was just no way--it could have been done--but with the scale of information available on habitat features at Yucca Mountain and the low densities of tortoises in this area, that we could not come up with a very effective model, so we abandoned that one.

So what it comes back to is we have identified many of these parameters that have been listed. Some of them we've said can't be done. Others we have modified our procedures to incorporate, let's say, the reproduction study and we're going to monitor relative abundance and we were supposed to monitor relative abundance of tortoises, however, we did an initial study and found out that we'd have to survey such a large area that it would not be possible, or at least not feasible to monitor relative abundance. Therefore, we've expanded our survival study and our reproduction studies to try to get at this relative abundance in monitoring those parameters.

So in answer to your question, the program and many of the aspects of it are required. Like the temperature data loggers, it's interesting information and it costs us hardly nothing to expand that, so that's the type of thing we've been doing.

DR. BREWER: John Cantlon?

DR. CANTLON: Yes. In looking at survivorship, have you increased the intensity of your monitoring immediately after emergence of the hatchlings from the eggs?

MR. RAKESTRAW: We monitor hatchling tortoises daily. We, at least for the first few weeks, what we noticed is that tortoises died within the first two weeks, I believe it was, usually, of emergence. So we were monitoring those animals

at least daily, sometimes twice a day, to try to identify the cause of mortality. But then we monitor those at least three to four times a week after that.

DR. CANTLON: And what picture are you getting in terms of cause of mortality?

MR. RAKESTRAW: Well, let me explain a small problem we're having. Our hatchling transmitters do not have much of a range--getting back to your question--so we have a tendency, or not tendency, we tend to lose a lot of our animals--not a lot, some of them. But the ones that we are monitoring, what we are seeing is that they are crawling into these deep rodent burrows and dying. The cause of mortality we've speculated is either they're just getting lost in these burrows and can't get out, or they're being attacked by the rodents themselves or fire ants or other ants are moving into these burrows. It's a very difficult question because we can't see the animal and confirm that it's alive. If we had a fiberoptic scope, we can't get those down into these small burrows.

As I mentioned, surprising to us was that ants have been playing a big part in killing our hatchling tortoises. We have had some where the heads are missing, so the question is whether or not rodents were involved.

DR. CANTLON: How do you separate post-mortality scavaging from cause of death, though?

MR. RAKESTRAW: We've had a couple of animals that weren't quite dead when we found them, and they were covered with the fire ants. We were able to look at them and see that the eyes were gone, but not much else in the way of the soft tissue was gone. We've had several others that the animal may have just died and the fire ants were scavaging. It's very difficult, if not impossible.

DR. BREWER: Other questions? All right, thank you very much, Danny, for an interesting presentation. Thanks to everyone for this morning's input. It was informative and nicely done. We're going to break now for lunch, reconvening at 1:00 p. m., taking up with Ron Green on site characterization effects monitoring.

(Whereupon, a luncheon recess was taken.)

A F T E R N O O N S E S S I O N

(1:00 p.m.)

DR. BREWER: Ladies and gentlemen, can we reconvene the meeting for the afternoon session, please?

We have two presentations this afternoon and a summary. The first presentation is by Ron Green of EG&G, Site Characterization Effects Monitoring. Ron?

MR. GREEN: Okay. I'm going to talk about the site characterization effects monitoring program for the Yucca Mountain Project. Here's an outline of what I'd like to cover today. I'd like to start out with a brief introduction and talk about our objectives and the drivers behind our program and then get into what I call sort of a historical development and talk a little bit about some of the assumptions that we made, some of the decisions, some of the decision processes that we went through while we were developing our program. I'll talk a little bit about the design of the monitoring program in a statistical sense and then present some preliminary monitoring results. Then, I'd like to conclude with talking about some of the changes in our program for the coming year.

The Nuclear Policy Act stated that site characterization activities will be conducted in a manner that minimizes effects on the environment. Then, an

environmental assessment was prepared and projected that there would be no significant adverse effects. Then, DOE developed an environmental monitoring and mitigation plan and with the objective of biological resources will be monitored to insure that any unexpected impacts would not occur. So, the overall objective of the site characterization monitoring program is to monitor and document potential effects of site characterization activities on biological resources at Yucca Mountain.

Okay. In the way of a historical development, again like I said, my purpose here is to provide an overview of the decisions and the decision process that we went through in developing the monitoring program just to kind of give you a feel for some of the things that we looked at. And, this involved looking at the location of site characterization activities, looking at the site characterization plan, the original plan that was published in 1988. Then, we went through and looked at a description of activities, looked at the types of disturbances that may occur out there based on the description of the activities, and then we looked at the potential sources of impact. So, this is sort of the process that we went through in developing our monitoring program.

If we looked at a map of Yucca Mountain here, just to give you an orientation, most of you have been to the site

and visited the site. A few of you may have not visited the site. So, I'm just going to give you a quick orientation. Here's the crest of Yucca Mountain. It runs north/south, maximum elevation of about 5,000 feet. Midway Valley here is about 3500 feet. So, you've got an elevation difference of about 1,000 to 1500 feet between the lower valleys out east here and the crest of Yucca Mountain.

What I want to illustrate here is just sort of the original site characterization plan. You can see that there were a few large disturbances originally planned for Drillhole Wash. This was the site of the original exploratory shaft facility. And then, associated with these activities, there is a wide variety of much smaller disturbances that might occur throughout the Yucca Mountain area. By small, I mean usually less than one acre in size. So, the picture that you get from here is an area of centralized disturbance of large disturbances that may range from five to 10 acres and then a widely distributed area or wide distribution of much, much smaller disturbances less than an acre. Just for reference, the area of this map is probably about 70 to 80 square kilometers. It kind of gives you a feeling for the areal extent.

DR. NORTH: A question for clarification. What is the circle with the question mark in it to the left of Fran Ridge?

MR. GREEN: That, I don't know. This was produced by our geographic--

DR. NORTH: I didn't either. That's why I raised the question.

MR. GREEN: This was an original map. I'm not sure. I can't answer that. The purpose is really to illustrate the distribution of activities and the spatial extent of them.

If we look at a description of activities from the site characterization plan, here is just sort of a brief listing of the major types of activities that will occur or may occur out at Yucca Mountain. They include things like trenches, drill pads, top soil stock piles, muck storage areas, equipment storage pads, road construction, and areas cleared for doing pavement and ponding studies where they're looking at infiltration rates.

Then, if we look at the potential types of disturbances out there from these types of activities, we can generally categorize them by land clearing which is essentially removal or covering of vegetation. There is a potential for human disturbance. By human disturbance, I mean things like noise and simply presence of humans out there. There is a potential for increased dust deposition and possibly habitat fragmentation as areas are cleared. And, finally, there's a potential for release of water from such activities as ponding studies and other human activity.

So, these were some of the types of disturbances that we came up with that could occur out there during site characterization.

If we look at the types of impacts, we can generally categorize them into two types. These are direct impacts, those that are associated with direct loss of habitat. Certainly, if you look at those list of activities I put up there, most of them are land clearing activities; drill pads, trenches, covering areas with top soil stock piles. So, it's a direct loss of habitat. Associated with these are potential for indirect effects; those effects that may occur adjacent to these disturbed areas that may result in a change in habitat quality. These may again result from presence of human activity, changes in the vegetation, say, from runoff, from cleared areas into adjacent areas, release of water, possibly effects of dust deposition on adjacent vegetation. So, there's a potential out there or we thought there was a potential for, say, indirect or cumulative effects of activities on vegetation out there. Obviously, the result from direct impacts is that you lose an acreage of habitat. So, it was rather an either/or situation. It's either disturbed or there's a potential there for additional impact.

So, what we decided, since it was sort of an either/or situation, that we would try to--we could measure

the area that was actually disturbed. In other words, you could account for the land that was disturbed by simply adding it up over time. What we really didn't know was what if there's any other added indirect effects that may occur out there in addition to the direct effects and these may accumulate over time. So, we decided to design our program to try to monitor and detect these subtle effects that may occur from these potential indirect effects. So, what we did is we identified areas that were adjacent to existing disturbances out there. When we originally did this in 1988 and 1989, there were a number of roads. There were several drill pads from previous activity at the site. So, we decided we would identify existing disturbances using the geographic information system. We identified all those. We mapped those and then we subdivided those up into 200 meter-square plots. These were going to be our sample plots or sample units that we were going to use to measure indirect effects.

So, we took a random sample of those plots. We identified four major vegetation associations in the Yucca Mountain area. As you can see by the letter codes here--let me just go through them very briefly here. LG stands for Lycium-Grayia which is a pre--a wolfberry hopsage. It occurs primarily on the upper elevations and on the ridge tops. We have Coleogyne which is a black brush association. It occurs

up in the upper elevations on the northern end of Yucca Mountain and it also occurs in the lower elevations in the northern end of Midway Valley. The other type that's in the immediate vicinity of the major exploratory studies facilities is the Larrea-Lycium Grayia which is a creosote/wolfberry hopsage association and then a Larrea-Ambrosia association which occurs out on the eastern side of Yucca Mountain in the more sandy soils, creosote/bursage association.

So, we identified four vegetation types and these were based on work that Beatley had done earlier in the test site in the '70s and earlier studies that had been done at Yucca Mountain in the early 1980s. So, we have four vegetation associations throughout the Yucca Mountain area. We went through this selection of selecting random plots in each of the four vegetation associations and we situated them adjacent to existing disturbances in an attempt to identify additional indirect effects that may occur. As you can see, a majority of them are adjacent to roads. That can happen by chance because roads were the largest disturbance out there when we did this in 1988. There were very few drill pads and other types of disturbance present in the area. We assigned random plots until we had six plots in each of the four vegetation associations. So, we ended up with four vegetation associations with six treatment plots--what we

called treatment plots--in each vegetation association for 24 plots. Okay?

Then, we're going to identify control plots. In other words, those plots that are removed from existing disturbances that we could use as spatial controls over time. The process that we went through there, we used a criteria of 500 meters and we identified on a map all those areas that were greater than 500 meters from existing disturbances using a GIS system. Then, we graded those areas and then randomly selected plots again until we had six plots in each of the four vegetation associations. Okay?

We were successful in doing that except for a few areas where we would not find good control plots within--at a distance greater than 500 meters. So, for a couple of plots, we relaxed the 500 meter criteria and we established it at 200 meters. Of the 48 plots that were of the 24 control plots that we have out there, there is only four--no, excuse me, five that are within that 500 original distance that we defined. So, the majority of our control plots are greater than 500 meters from any existing or expected future disturbance. Two of the plots--I think these two up here and this one and this one here, I think, are four of the ones that range anywhere from 200 to 375 meters from any existing disturbance areas. So, what we have is a control/treatment type situation with plots distributed throughout the Yucca

Mountain area.

Okay. Let me get into the design of the monitoring program a little bit. I want to talk about--a little bit about the statistical design and talk a little bit about parameter selection. What things did we decide to measure? Why are we measuring them? And then, talk briefly about integration of these studies.

Okay. This is sort of a schematic of our experimental design. Let me just walk you through it. Over there on your left there, we have location which is treatment control. Across the top, we have time and then, within each one of these, we have the four vegetation associations. These could be kind of viewed as blocks in a random like block design, if you would. Within each one of these, we have sample plots that we selected and these are the six ecological study plots that we established. Okay? So, each one of these cells here has six plots for a total of 48 study plots.

Okay. Across the top, you have time. At some point prior to site characterization, theoretically, you start your pre-disturbance measurements which for us started in 1989. At some point, site characterization starts and this is sort of the operational phase, if you will, and you have sort of repeated measures over time where you have a pre-operational phase and an operational phase and possibly

eventually some type of post-operational phase. So, what we're looking for in terms of possible effects is we're looking at a location by time interaction to look for significant effects on the various parameters that we're measuring. Obviously, you can have significant differences here, but if they occur both here and here, you would probably conclude that you don't have a statistically significant effect because they're occurring both during the pre- and the operational phase. So, it's really the time by location interactions that you're really interested in this experimental design.

Okay. Let me talk a little bit about parameter selection. Here's a schematic or a diagram of some of what we thought were some of the major relationships between abiotic and biotic components of the ecosystem. By no means, is this supposed to be a detailed systems analysis diagram, but used rather as sort of a conceptualization or a thinking tool in terms of trying to identify what are some of the important relationships out there and what are some of the things that we think we ought to be measuring.

Okay. If you look at the top there, two of the inputs, of course, are the solar radiation and precipitation. Precipitation relates into soil moisture which in desert ecosystems is a major driving variable. So, we thought that was a very important parameter to be measuring out there

because in all practical purposes that's going to be a major driving factor. Then, we have plant growth which depends on soil moisture. You can have a variety of measures of plant growth and then you get into connections with the primary consumers there. You have bird communities, small mammal communities, invertebrates, reptiles. So, this was sort of a systems diagram that we used to identify some of the major relationships and the things that we thought we should be measuring.

Okay. Let me get into some of the parameter selection. In terms of abiotic variables, we're measuring soil temperature and these measurements are being done in each of our 48 ecological study plots distributed throughout the Yucca Mountain area. We're measuring soil temperature at 15, 30, and 45 centimeters. We're also measuring soil moisture at the same three depths. We're measuring precipitation throughout the year. At the same time, we record soil moisture and temperature readings; we also record the max-min air temperature since the previous time that we sampled. During the growing season, we do this on a weekly basis. During the non-growing season, we do this on a monthly basis. And, during this last year, we also collected soil samples from each of our ecological study plots to do general soil parameter estimates, texture, and we will eventually send those into a lab for chemical analysis which

has not been done yet, but will be done during this coming year. So, we have soils information from each of the study plots.

Okay. Biotic parameters, vegetation communities is probably one of the forms--probably the foundation of the communities out there. We selected three measures of the vegetation communities out there for measurement. These are cover, density, and production. For the cover measurements, we're separating by annual and perennial life forms, as well as on an individual species basis, recording the amount of soil, rock, and litter cover. Cover measures give us a fairly good idea of community or species composition of each of the vegetation communities on the site.

We have done density estimates, primarily on perennial shrub species. We have taken some width and height measurements to get an idea of habitat structure. Certainly, when you measure density, it gives you a number of stems per unit area, but in some cases, we're also interested in the size of individual shrubs. Certainly, a density of one shrub per square meter is different than 20 stems per square meter, but if that one shrub is very large, that gives you a very much--a very different habitat structure than if you had 20 small ones. So, that was the purpose of doing some width and height measurements.

We're recording vegetation production in each of

the vegetation communities. Again, we're separating by annuals, perennial forbs, perennial shrubs, and perennial grasses.

Okay. If we look at animal communities or the primary and secondary consumers, these are the major species groups out there. Our focus right now is largely on the small mammal and reptile community, although we have collected data on the avifauna or the birds. We have collected data on invertebrates and predators and lagomorphs. For the small mammal studies, it wasn't feasible to establish trapping grids in each of the 48 study plots out there. It was just impossible to do so. So, we have selected one plot in each of the four vegetation association and one plot in each of the controlled treatments. So, we have a total of eight study plots where we have small mammal trapping grids for fairly intensive studies of small mammal communities and population dynamics. Some of the parameters that we're going to be measuring or estimating include abundance, survival rate, recruitment, or if you will, reproduction, and again species composition.

We're doing similar types of studies for the reptiles. For the reptiles, we have established plots. We're focusing in--we initially started looking at species composition of the reptile community out there and we used a series of pitfall traps, fences with funnel traps, and

noosing as an estimate to abundance and survival rate. Unfortunately, it's a fairly labor intensive process and we were only able to really sample about three plots and we felt this was insufficient to really be able to use it as an indicator of impacts. So, we changed two years ago. We attempted to, instead of using the pitfalls and the funnel traps, we went to a system where we're using noosing on the side blotched lizard which is the most abundant lizard at the site and we're going to use the side blotched lizard as our indicator species of the reptile communities. And, we're using noosing with mark recapture techniques to estimate abundance for side blotched lizards. We're also hoping to be able to estimate survival rate for those individuals.

We are continuing our pitfall trapping and our funnel trapping on those three plots that we originally established to look at species composition because one thing we did find is that there are a few species of reptiles out there that are very--they're uncommon. And, without an extended effort, you would never know they were there and we were able to document the presence of a few uncommon species out there. So, we've got a fairly good idea of what reptiles are present in the Yucca Mountain area.

We did not select bird communities as an indicator group or a group of species because we felt they were too variable in space and time to be able to use them as a

reliable indicator to estimate impacts of site characterization. We do have information on species richness out there. We have compiled a breeding bird list for the Yucca Mountain area that can be used later and that can feed into the EIS process, if need be.

We did some preliminary work on invertebrates. We did some relative abundance estimates of the major invertebrate groups out there. Again, we found those to be quite variable and we did not feel they were extremely useful as an indicator to estimating the types of impacts that we were looking at and that is from site characterization effects.

The last two items are the predators and the lagomorphs. They're really not directly a part of the site characterization effect studies. They're part of work that we were doing for the radiological monitoring program. I mention them here because it is part of the database that we have and we do have presence/absence data on the major predators in the region and we also have some time series trends on lagomorph populations out there using spotlight counts along with the major roads.

If you'll go down that list of parameters that I just went over, you'll notice that many of them are structural components of the system out there. One of the reasons we decided to select structural components is there

is a tendency to be less variability. We thought we would get a faster response to the structural change and they're relatively easier to measure. One of the problems with using maybe some of the functional processes out there is that sometimes you can get functional redundancy at ecosystems. In other words, you can get a shift in species composition, that is structure, but your productivity may stay the same. And so, we felt that focusing a little more on the structural components was more appropriate for trying to detect the types of impacts that we were looking at.

Just a note on integration of studies. Again, I want to emphasize that these measurements are all being taken on these ecological study plots. In other words, we have site-specific data on most of these parameters for each location. In other words, we have rainfall data on the site. We have small mammal data possibly for that site. We have vegetation cover data for that site. We have production data for that site. So, the measurements--these various measurements are integrated on a site-by-site basis so we can look at changes on a plot-by-plot basis.

Okay. The other point I'd like to make before I get into some of the monitoring results is just because we selected a parameter to measure does not necessarily mean that we're going to use that particular parameter to indicate impacts from site characterization effects. In other words,

we may be measuring a variable out there to help us interpret another variable out there that we will use to make a judgment about the effects of site characterization activities. For instance, if you were using an abundance of small mammals to make a judgment about whether there was an effect, I would also want to look at the production of annual plants. I would also possibly want to look at the rainfall data and other variables that would feed into and explain those changes over time. So, all these variables are being used in concert with each other to explain other variables. So, just because we decided to select a particular parameter doesn't necessarily mean that we're going to focus in on that one parameter to say, okay, there was a significant effect, say, on primary production.

Okay. Now, what I'd like to do is to get into some preliminary results and some of the monitoring activities we've been doing. We're in sort of a preliminary stage of data analysis. So, I'd really--three areas that I'm going to present some data on is precipitation, some preliminary data from vegetation studies, and then wrap up with some data from the small mammal studies.

Okay. This is a matrix that shows you various parameters that we're--things that we have been measuring. Across the top is time, down on your left is a list of variables and parameters. We started our data collection in

1989 through the current year. Here, you can just see the various parameters that we've been measuring. We established and got our weather stations at each of our study plots established in 1991. There is weather data available here from the other contractors. SAIC has been collecting similar type of data for the meteorological studies, at least for 1989 and '90, possibly earlier. We started our vegetation, the small mammal studies in 1989. The reptile work, that started a little bit later and it just sort of shows you the time sequence of what we've been measuring.

I want to make one comment here on the spotted bat. The spotted bat is a species that's a candidate--Category 2 species; in other words, a candidate for listing. There was some question whether the spotted bat was present in the Yucca Mountain area. Based on habitat characteristics, we did not think it was, but we decided that we would make an effort and see if we could detect its presence there. So, in 1991, we initiated a study where we did some mist netting over some of the water ponds in the Yucca Mountain area to see if we could collect a specimen of the spotted bat. We were unsuccessful. In 1992, we sort of shifted our emphasis or our technique. For those of you that may not know anything about the spotted bat, it's one of the few species of bat whose feeding call or vocalization drops within the human hearing range. So, it has a vocalization that you can

hear, a very distinct vocalization. So, we focused our work in 1992 on listening for vocalization to see if we could detect the spotted bat. Again, we were unsuccessful in the Yucca Mountain area. However, we did go to a site farther north on the test site. It was probably, I think, about 40 kilometers north on the test site in more typical spotted bat habitat. And, we were able to detect the spotted bat and were able to capture a vocalization on a digital audio tape and were able to confirm the spotted bat on the test site, but again it is not present in the Yucca Mountain area and we have discontinued those studies because we've achieved our objectives.

Okay. Let me start out by presenting some precipitation data starting in 1989. I want to point out the 1989 and '90 data was provided by SAIC from their main Met tower, the 60 meter Met tower, that's in the south end of Midway Valley. The data from 1991 through '93 is our data that we've collected on our ecological study plots. I should point out these are summarized--well, it was a fiscal year basis, but I left it on a fiscal year basis because it made sense from a biological standpoint; that is from October through September. So, it corresponds to the growing season out there. As several people have mentioned, we were in a drought back in '89 and '90. This is in millimeters just for your reference. The long-term average precipitation is about

six inches which falls in about right in here. 1991 was about five inches. That was basically--I don't want to say normal because I think this is normal, but it was close to long-term average. In 1989, the precipitation was about one and a half to one and three-quarters inches. It wasn't until 1992, we got about eight inches, and then during this past year, we've had a very wet year. We've had almost 10 inches of precipitation. Most of this occurred early in the year in February and March just before the major growing season. I want you to sort of remember and keep this in mind as we look through some of the other data that I'm going to show you because you're going to see this shape/this trend over and over again here. Again, this is a major driving force behind a lot of the systems out there.

Okay. Let me show you some of the vegetation cover data. Again, we're looking at total vegetation cover here including annuals and perennials. Okay? On the left hand side here, we have percent cover and the solid bars are the control sites, the stippled bars are the treatment sites. And, again, if you remember the precipitation data, there are very fairly low total cover here. We had a fairly normal rainfall year here, but it still remained low, probably residual effects from the drought. And then, in 1992, we had a major increase. So, basically, it follows the rainfall pattern. The other thing that I want to point out is the

tracking, the temporal tracking, of control/treatment plots and this is one of the things that we look for in detecting defects out there is the fact that the control/ treatment plots are tracking each other. And, indeed, they are.

This is a similar bar graph except this is for the Lycium-Grayia association which is on the top of Yucca Mountain, which is on the crest of Yucca Mountain. Again, we get a very similar pattern of lower cover during the low rainfall years followed by a large increase. And, again, we get this sort of parallel tracking of control and treatment plots out there. So, our control and treatment sites, we feel, we have a fairly good comparison between control and treatment sites that are tracking each other through time.

I want to address sort of a sample size statistical--or sampling question here. I want to look again. We had decided early-on that one of the criteria was that we wanted to be able in terms of our sampling to detect a 20% change in our parameters. So, we wanted to look a little bit and see how our sample size--how adequate our sampling is out there. And, this table here shows the sample size--or the number of samples required to be able to detect a 20% change based on the estimate of variation that we're getting out there. Again, I should point out that what we're actually sampling out there, six plots. Okay? And so, what this is telling you in 1989 in the control plots for this

vegetation association, we really only needed to sample four ESPs out there to get--to be able to detect a 20% change. So, if you look at these numbers, we feel fairly comfortable that we're able to detect that type of change in our vegetation parameters.

You know, there's one that looks sort of suspicious here. Basically, what that's telling you is that our variation among our ESPs was low enough that you could have selected any one of your six sample plots and it would have been a good estimate of what you had out there. Here, in 1992, when we had the flush of growth with our first year of really above-normal rainfall, we had a little bit more variation. We probably weren't able to detect a 20% change. It was probably more like a 25 to 30% change that we were only able to detect. But, all in all, I think, we feel fairly comfortable in our sample adequacy out there in terms of being able to detect changes in total vegetation cover.

Okay. Let me move in and look at some of the small mammal data that we've got. We started our small mammal studies in the fall of 1989. This is data from the Coleogyne vegetation association for the Long-tailed Pocket Mouse, Chaeotipidus formoses. Over on the left, you have expressed individual captures. These are not population estimates. Eventually, we will be estimating actual population size for each one of these points or density, if you will. This is

sort of a minimum number alive. But, for comparative purposes, I think it will suffice.

Again, we started out with fairly low numbers in the early years when we had very low rainfall. We had fairly normal rainfall in the spring of '91 and again we got this increase in reproduction. Again, we hit another good year in 1992; boom. And then, we had another good year in 1993, but at least for the Long-tailed Pocket Mouse, we saw a decline in overall numbers. And, this response for Pocket Mice was actually fairly consistent across all eight plots. So, the fact that the Pocket Mice declined from '92 to '93 in this plot is not unique. It was a consistent change across all our plots.

The other thing that we want to point out here is again the close tracking of these populations over time. Again, in a control/treatment paired design, such as this, one of the fundamental assumptions is that your populations track each other. Okay? And, again, in this case, not only do we have proportional tracking, but we actually have almost absolute tracking of each other. In other words, the abundance is almost the same on each of these two plots. Again, diamonds are the--I don't know if you can see it. The diamonds are the treatment plots, the squares are the control plots.

Okay. This is also data for the Long-tailed Pocket

Mouse except this is in the Larrea-Lycium-Grayia association. This is the association that's in the immediate vicinity of where most of the exploratory study facilities are going to be built. The point I want to make here again is this question of tracking over time. Again, we have--what we have here is an actual absolute--or a difference in absolute abundance. In other words, they're probably statistically different from each other, the two sites, in absolute abundance. But, the important thing is that these track each other over time and, indeed, that's what's happening. Because when you go out and select, say, two locations out there, there's no way that those two locations are ever going to be exactly the same. So, what we're looking at is the proportional abundance change.

In fact, if we plot that proportional abundance change--and this is for that last plot that I just showed you; over here where you divide the abundance index for the control by the abundance index for the treatment plot and basically if they were identical, they would be equal to one here. The fact that they hover around two here just means that one is twice the size of the other. But, you should get very little variation off this line. If you did a regression line through that, you'd probably get a non-significant line through there indicating they're tracking each other through time. And, this is the value that we would actually probably

feed into an analysis to estimate impacts. In other words, the K value here--in other words, proportional abundance--is the data that we will use to detect whether there is a change between the operational phase; in other words, pre-disturbance versus operational phase. And so, what we're looking for is a significant change in proportional abundance between pre-disturbance and operational phase or post-operational.

This is date for Merriam's Kangaroo Rat, again on the same plot that you just looked at for the Long-tailed Pocket Mice, the Larrea-Lycium-Grayia association. The point I want to make here, you noticed in 1993 we had declines of the Long-tailed Pocket Mice. Well, on almost all of our plots, the Kangaroo Rats continue to increase. So, we're getting some different responses between individual species out here, as well. So, there's possibly some dynamics going out there. We haven't taken the time yet to really interpret those patterns yet. But, again, you see the trackings of abundance over time. In this case, they track very well. In other words, you find very little deviation off of--one is about half the size of the other, but it stays the same over time. So, these calculations do an excellent job of tracking each other.

Okay. I'd like to conclude with a couple of comments about--oh, one point I want to make before I leave

the results. We will be in the process of continuing to analyze the data this winter and we will eventually be publishing this information in topical reports. Eventually, hopefully, we will be presenting these at professional meetings and probably will be publishing them in the refereed professional journal. Those things will occur in the next year or two.

I'd like to wrap up here with some comments about program changes. We went into this program in the design phase assuming that things would change. In other words, we didn't know exactly when and where particular activities would occur out there and that was one of the problems in designing a monitoring program. And, indeed, the location of the exploratory studies facility has changed based on review and recommendations of the Technical Review Board. You remember that earlier graph I showed you or map I showed you of location of the exploratory shaft facilities. All the disturbances were up in this area and then scattered throughout the Yucca Mountain area. The current scenario right now, where things are occurring right now, is Exile Hill. This is the north portal facility. Here's the proposed location of the muck storage area. There's some existing disturbance right down here related to top soil stock piling and this is the proposed site of the south portal facility. So, you can see over the last year or so

there's been a major shift in the location of some of the major activities. So, what we're faced with is trying to change our program as some of the locations of some of these activities change.

Okay. What we're going to be doing for this coming year is probably--we've basically summarized or wrapped up and we're going to just reallocate our efforts. Most of the disturbance is going to occur on the Larrea-Lycium-Grayia association. Those are those areas in Midway Valley. That's around the existing north portal area and where the muck storage pile is going to occur. And, very little activity is expected to occur out in the Coleogyne vegetation association which are in the north end of Midway Valley or the Larrea-Ambrosia vegetation association which occurs farther east out in the Jackass Flat area, east of Fran Ridge and east of Fortymile Wash. So, what we're going to do is we reallocate our efforts that were being spent on monitoring these sites and we're going to locate new monitoring plots in the Larrea-Lycium-Grayia association and near proposed sites or adjacent to those new disturbances that are going to occur in the Midway Valley area; namely the muck storage area, possibly the south portal facility, the north portal facility. And so, we're going to take the sampling effort that we're spending here and establish new plots near the new proposed disturbances. And, many of those disturbances have not

occurred yet. So, we still have time to get some pre-disturbance data on those sites. We will also establish some far-field control sites. These sites probably will possibly occur as far away as the Little Skull Mountain. We haven't made a final decision on where those will be, but they'll probably be farther away than some of the existing control sites. So, we're going through sort of a change in our program right now in response to changes in the exploratory study facility changes.

With that, I'll wrap up.

DR. BREWER: We'd like to ask a few questions.

MR. GREEN: Okay.

DR. CANTLON: You were commenting that you got a good tracking on the vegetation cover and the precipitation and I think that's certainly true for the letup following the drought. But, the amount of moisture coming in last year was still larger than the year before, but you got a decline in cover, you also got a decline in some of the small mammal population--

MR. GREEN: Yeah, I would say the overall response of the cover data would have stayed about the same. There was one there that showed a slight decline. You're talking about 1 to 2% decline.

DR. CANTLON: Right. But, you had fairly substantial small mammal population reductions, not following the

moisture ride up and the recent studies in connection with the viral human disease outbreak and its relationship to the small mammal population suggests you have other biological processes going on that dampen the buildup of the species population. So, now, coming back to the cover set of issues, have you looked at insect herbivory, at all?

MR. GREEN: No, we have not.

DR. CANTLON: So that--you see, it's conceivable that as that builds up, the insect populations build up and you're simply measuring the same thing you're getting in the small mammal thing and which you get biological activity which you're not monitoring.

MR. GREEN: Yeah, it's very possible. We have not measured insect herbivory out there, at all, and certainly we had--at least ant populations, I know, were very abundant this year.

DR. CANTLON: Well, there were a full series of things that--

MR. GREEN: Yeah, right. Oh, yes.

DR. KORANDA: Ron, how are you measuring cover?

MR. GREEN: We're using optical point technique where we're using a short-focus telescope and projecting the cross-hairs down.

DR. KORANDA: So, you're looking at the horizontal--

MR. GREEN: Vertical projection.

DR. KORANDA: Horizontal projection of the vertical projection of the canopy?

MR. GREEN: Right.

DR. KORANDA: Certainly, there are no more individuals now than there were in the dry years?

MR. GREEN: Right.

DR. KORANDA: And so, you're measuring--you're not measuring canopy volume or are you?

MR. GREEN: We have some measurements of canopy--we have some width and height measurements on some of the perennial sub-species.

DR. KORANDA: Okay. Ben Romney was doing this a few years ago and he was attempting and thought he did develop a pretty good regression of canopy volume against total bio-mass for the individuals of the plant.

MR. GREEN: Um-hum.

DR. KORANDA: And, I wondered if you had seen his work on that? So, what happens when you get more rainfall is you just get a flush of foliar growth, right?

MR. GREEN: Right.

DR. KORANDA: More branches and more leaves.

MR. GREEN: Right. And, we also have got that cover broken down by life form and for cover we have individual--we call them hits, you know, on individual species. So, we do have it broken down, but in the--for instance, the annual

plants out there, as well.

DR. KORANDA: And, you feel comfortable with just the vertical measurement?

MR. GREEN: As a general description of the vegetation communities, I would--yes, I would feel very comfortable.

DR. KORANDA: Okay. The other thing was in the meteorology, you had the solar radiation layer and, in view of the ultimate concern here, I would think that you would put a few more gadgets to that and measure the radiation budget. You should have a net radiometer there and you should have a cell flux plate. Is there a trailer there with electricity in it?

MR. GREEN: There is--Kent?

DR. OSTLER: We don't have that set up in our ESPs. Now, I think that is being--that kind of information is being collected as part of the meteorological monitoring program.

DR. KORANDA: By whom?

DR. OSTLER: By Yucca Mountain.

DR. KORANDA: Not by your people?

MR. GREEN: By SAIC, yes.

DR. KORANDA: SAIC. Is that this tower thing?

MR. GREEN: Right. Yeah, I don't know--

DR. KORANDA: Okay. Because, you know, if we're going to perturb the heat budget of the site, we should know what the heat budget is before this happens. You're going to have

to measure the three components. So, you should make sure that's being done.

MR. GREEN: Again, you know, our studies right here are focused in on the potential effects of site characterization activities and that's how we designed it. But, we recognize that, yeah, that is an important driver in a system.

DR. KORANDA: Right.

DR. OSTLER: Can I just make a comment about the vegetation sampling, as well? You know, we do recognize that, you know, cover is one component of measuring vegetation. Really, it needs to be taken into balance with the other components that we are measuring which is density and production, bio-mass. We have noticed that at the end of the drought that there were a number of species--a number of individuals that were lost, died from that drought period. So, we were seeing new individuals come in in '92 and '93 as seedlings into the system.

DR. KORANDA: But, they wouldn't contribute very much to the total cover?

DR. OSTLER: No. They won't contribute very much to the cover.

DR. KORANDA: Right.

DR. OSTLER: As Ron mentioned, the annual component certainly does. It reflects that.

DR. KORANDA: Well, the reason why I brought it up was a

lot of good guys have struggled with this out at the test site and I just wondered what you were doing, how you were measuring this, and the optical method he described didn't seem to take into account the horizontal increase in canopy which might be maybe the larger parameter that was drawn.

DR. OSTLER: Again, we looked at--as part of our density studies, we will be taking shrub volume, but it won't be on a yearly basis.

DR. KORANDA: I see.

DR. OSTLER: We've set that up into a database where we have a computer locate where each plant is in our belt transact. So, we can go relocate that and then we have a width--two width and height measures for each one of those plants. So, we will go back on a multi-year basis to look at the increase in shrub volume on those.

DR. KORANDA: Okay.

DR. OSTLER: But, you know, it's very expensive data to get.

DR. KORANDA: Oh, yeah.

DR. OSTLER: So, you know, we haven't done that every year.

DR. EHLERINGER: I have a basic question that relates to, one, how you set up the experiment for this phase and potentially for the EIS phase, as well. And, that is that you show this matrix table where you had treatment and

control and then you had a pre-site characterization and SCA starts and a post-site characterization. Each of those cells represents a year. Can you give us some feel from the experience you have right now and the variability that goes into making up a desert environment to give us an idea of how many years you have to conduct a study in order to detect a difference?

MR. GREEN: Well, this is essentially a repeated measures design. Fortunately, within the five years, you know, it really depends on the years that--you know, the variability you get from year to year and your different rainfall or whatever. Fortunately, we've been able to observe within our five years sort of the low and sort of the high. I certainly wouldn't say that we've seen all possibilities out there. I think that's a thing all ecologists sort of struggle with in different ecosystems is how long is a sufficient baseline. But, that's why you have sort of spatial temporal controls is that you can, you know --

DR. EHLERINGER: I'm asking more from the regulatory or the legal aspect because if, in fact, you define a certain variation or you see a certain pattern in this period of time, it might be the five years that are above-average in the 100 year sequence or it might be the five years that are at the low end. You might be stuck with this from a

reclamation standpoint.

MR. GREEN: Um-hum. Yeah, I mean, in a way, that's something that you can't control, you know, depending on whatever your particular project stops and starts. Yeah, you would like to see the extremes of those driving variables in your data set. Fortunately, I think, right now, we've got some of those. I mean, certainly, the manifests are over a fairly short length of time. I think the next couple of years are going to be very interesting in the standpoint of, you know, particularly--well, no matter what type of year we have, I think it will be interesting because we've had good years. If we continue on that course of above-average precipitation, you may start seeing sort of a lot of indirect interactions among species and things like that that you'd have to deal with. If you get a drought situation again, you might see the typical drop-off in numbers, changes in vegetation cover, those types of things.

DR. EHLERINGER: So, is the answer the period '89 to '96 is going to be sufficient?

MR. GREEN: That, I'm not sure I can answer.

DR. OSTLER: No, that's a decision for DOE to make.

DR. EHLERINGER: Well, I mean, part of it is a scientific decision and part of it is a legal decision. So, I'm asking from a scientific standpoint.

MR. GREEN: From a scientific standpoint, I would say

we're in a very good situation right now simply because of the years that we have had. I would feel comfortable because we've had bad years and we've had good years and we've captured a lot of the variability in the system. Certainly, if you had five years of drought and that's all you've had, you've probably established a minimum for that system. If you had five wonderful years and that's all you had, I would feel uncomfortable.

DR. EHLERINGER: Okay. Thank you.

DR. BREWER: Anyone else?

DR. BOWERS: I want to kind of follow up on kind of more statistical sorts of aspects of what Jim started. And, that was basically there's two sort of time factors you're dealing with here. There's the pre-site characterization activities that go on during site characterization and then afterwards. Also, compounded with that are rainfall patterns. It seems to me according to your repeated measures design that any sort of effect that you're looking for that would conclude that there was an effect of site characterization would be a treatment by time interaction. So, I guess, my question is or comment is it's going to be--it seems it's going to be very difficult to separate the precipitation time effect from your pre-, during, and post-site characterization studies which is another time factor.

MR. GREEN: That's why the tracking of parameters

through time is so important in the control treatment. Let's just take a scenario here on the small mammal data where we had the fairly decent--fairly nice tracking over time. No matter what the rainfall pattern is, if your treatment plot changes in the opposite direction and does not track what your control plot is doing under that given rainfall pattern which is what you would use to make a judgment about a significant effect--do you follow my reasoning?

DR. BOWERS: Yeah, I think this is a really complex statistical problem.

MR. GREEN: Um-hum.

DR. BOWERS: That in your model, so far, you're treating here as kind of a fixed effect. I think when you start getting into rainfall, it becomes a random effect. I think that you should get hold of a really good statistician that can figure out--

MR. GREEN: Yes, we are in the process of doing that.

DR. BOWERS: Okay.

MR. GREEN: We are.

DR. BOWERS: Another statistical question or comment and that goes back to your sample size table. I think in some of the other documents I read that you're using a Type 1 of 10% and a Type 2 error rate of 90%.

MR. GREEN: Right.

DR. BOWERS: Which is, I think, great for the purposes

of this. However, you cannot have just a single observation of a unit, as you have here. This probably is replicates. So, your ones probably mean twos and you add one to everything else.

MR. GREEN: Right.

DR. BOWERS: Okay.

DR. BREWER: Any other questions before we move on?

DR. FEHRINGER: You were expending a fair amount of resources to control dust at the project site and in years in the past you were monitoring dust levels on these 48 study plots. Today, you didn't acknowledge that that had even happened. You dropped that or what's the--

MR. GREEN: Well, we're evaluating and I should point that out. We've identified increased dust deposition as one of those possible effects, in addition to human disturbance, those types of things. And, maybe, we've given people the impression in past meetings that's something that we've focused on. I wouldn't necessarily think that we focused on it. It's just something that we thought we had--if we were going to consider it, we felt we should maybe measure it and, you know, see if it was there. I don't necessarily think that the dust deposition thing has any--possibly has any more effect than, say, maybe human disturbance.

DR. FEHRINGER: Well, in some of your write-ups, you have identified that as the only plausible mechanism that

could cause an impact on the vegetation. And, now, all of a sudden, we hear nothing about it today.

MR. GREEN: No, we did consider it, but it certainly is not the only thing that could potentially occur out there. And, the reason we even brought it up is that it could manifest it through indirect pathways like, you know, decreasing primary production and then that would have an effect on small mammal communities and reptile communities, et cetera. We are in the process of re-evaluating our measurement system simply because we're not confident that we're getting the measurements that we need or that were accurate enough in our measurements to detect an increase in dust deposition.

DR. FEHRINGER: Okay.

DR. BREWER: Ron, thank you very, very much. We have to move on.

Kent Ostler is going to talk on the anticipated repository effects.

DR. OSTLER: Well, for those of you who were at the July meeting of the TRB in Denver, you can go to sleep because much of this presentation is the same as was presented there. But, for those of you who are new to it, I felt it was important that we cover some of the anticipated effects that we might possibly see from a repository.

There's an outline of information I want to cover

today. I'll talk about the delineation of the impacts, where we expect them to occur, discuss what those anticipated effects would be particularly as it relates to biological systems, talk about what we know on those possible effects, what we don't know, and then some of our plans on how to address some of those uncertainties.

Delineation of the impact zone, we first expect to see increased soil temperatures. Much of this information was presented here as developed from models that were put together by Sandia National Labs, particularly Eric Reiter who developed those. What they list then are the most probable increase in soil temperature would be--at the surface would be from 1 to 1.5 degrees Centigrade.

DR. CANTLON: At what thermal strategy?

DR. OSTLER: I believe they used 57 kilowatts per--

DR. CANTLON: This is the site characterization plan base design?

DR. OSTLER: Right. Correct.

DR. CANTLON: Which has virtually been abandoned at this point.

DR. OSTLER: Yeah, there's a number of them. I don't know what the current level is. I know there's a number of different scenarios on spacing and thermal loading.

DR. CANTLON: Okay.

DR. OSTLER: Anyway, the maximum temperature increase

then at that loading rate would be somewhere less than 6 degrees Centigrade. The increased surface temperature would be expected to occur on about a two to three square mile area. When you put that into perspective, if you flew into McCarren Airport this morning or yesterday, McCarren Airport is about around five square miles. So, you're talking about an area that's half that size. If you compare it to the Nevada Test Site which is 1350 square miles, you're talking about two-tenths of a percent of your impact zone. That temperature increase is expected to occur about 1,000 years after emplacement. For the next 2,000 years, it will increase and reach a maximum about 2,000 to 3,000 years after emplacement and then will slowly decline.

What are some of the most likely impacts that could be anticipated from that? I think, as we consider the desert environment that exists here, the first and probably most important is going to be the altering of the water mass balance. But, we may also see altered timing of biological processes and the resultant change in the ecosystem structure and function. I'll go over each one of those in a little more detail. And, there certainly are other possible effects that could occur. You know, this isn't meant to be all inclusive.

Let me quickly talk about the water balance out there because I think it is certainly one of the most

important to consider. We anticipate two things occurring. One is that you will see increased evaporation from the site. Secondly, you'll see increased transpiration as plants try to cool themselves under those conditions and increased respiration from the animals who also will be trying to cool themselves. What this will do is cause less water to be available for biological processes, particularly for growth in a system.

Another possible effect is changing of the timing on biological processes. Many species use environmental cues to initiate certain phases in their life cycle. For example, many animals use soil temperature as a key to emerge from hibernation. Plants use soil temperature and soil moisture, the seeds to initiate germination and break dormancy. Also, they may use--plants often use daylight as a key to initiate flowering. By altering particularly the soil temperature, you may cause these processes to be out of synch in that area that would be impacted from thermal loading. What that might do is cause seeds to break dormancy earlier than they would in a normal year. So, they would be--could be subjected to killing frosts and also may cause them, if they come up and do flower, they may be flowering earlier than when their pollinators arrive to a site. Secondly, animals may emerge from hibernation earlier than would be conducive for their survival.

Let me give you an example. Paragnathus has shown up in Washington in warm years to emerge up to four weeks earlier in a year with average soil temperatures of 4 degrees Centigrade higher. So, it turned out for every degree Centigrade, it was about a one week earlier emergence from hibernation. Now, if we were looking at 6 degrees Centigrade increase in there, we may have a small mammal emerging rather than on April 1, February 15. That may be a significant shock to their system.

We anticipate there may be four changes expected to occur in that small impacted area. One is because of the less water that is available is that you would see a shift toward the winter as far as the growing season for many of the species, as well as the animals, that may occur there. There will be a much longer summer dormancy period or estivation period for animals. That summer period is already a very difficult period of time for many of the plants in this area. When you see that in severe drought conditions, which we have just experienced, there was a significant loss of plants. Anticipate that there may also be a shorter growing season due to the less moisture that will be available in the system. Also, as you push the growing season towards the winter period, there are less light resources available for the plants to fix energy and also for the small mammals and other animals that are the primary

consumers. Further, there would be a reduction in resources and food available for animals.

What that would tend to do then is to cause changes in the structure or function of the ecosystem. As I mentioned, many of the species that we deal with in the Yucca Mountain area are near the edge of their threshold limits and, you know, we've seen it as a response to the drought that occurred. There may be species that are lost from the ecosystem that exists there, that two to three square mile area, which would result in a change in the composition of species diversity. There may also be a reduction in the primary productivity that occurs on that system, again primarily linked to the lack of moisture. As Danny mentioned earlier, there may be a change in the sex ratios of desert tortoise or other reptiles where incubation temperatures are critical for sex determination. Finally, there may be an enhancement of other detrimental processes that occur there, specifically related to the decomposition rate for organic matter, for example. Organic matter is very critical in the desert ecosystems. It serves not only for water holding capacity, but also for nutrient exchange. And, if that decomposition rate is enhanced, then there's less nutrients or water available for plant growth and production. And, finally, they may enhance other plant pathogen or animal pests.

Also, you know, the models to date have just described this uniform change in temperature across that entire two to three square mile area. Well, we certainly don't think that that will happen, that you're going to see localized impacts where that temperature may be higher along these fissures that--rock fractures that exist at Yucca Mountain. So, there may be areas where you see localized impacts. All of those changes may not be negative, though. If there is a switch--or kind of a shift in the growing season earlier into the spring season and there are forage available, it may be beneficial to the animals that are multiple where they can come into this site, such as deer, and find a resource that is available to them that would not be available in a normal growing season.

So, let me talk about what we know about some of the possible repository effects. We've done a cursory literature review and concluded that there is abundant information available out there on the impacts of increased soil temperature on plant production. Most of this, though, relates to agricultural or agronomic crops. There's information on the impact of reduced soil moisture and there's less, but some, information on the interaction of those two. There is this general information. What there isn't is very good site-specific information on the air environments that occur and the species that exist at Yucca

Mountain.

Let me cover briefly some of the information that we have gathered from the literature and from some of the work that Ron did in the site characterization studies and that is to discuss--that's what I'll discuss next, the geothermal, and then some of the site-specific variability that occurs at Yucca Mountain itself. Let me just start with one example here and that is work done by White in 1978 on lodgepole pine forests in Yellowstone National Park. He went in, noticed that there were stunted pines associated with thermal areas. He categorized those into three zones. Normal which had--all the lodgepole pine that occurred on there were normal size. There was a mixed zone where there was some stunted trees mixed in with full sized lodgepole and then a zone which he called stunted. They then went in, took heat flux measures, coring through the soil profile to describe what the near-surface heat flows were. And, those are reported there. They are in watts per meter squared. I think if you look at the--convert that to watts per meter squared at 57 kilowatt per acre, it would come somewhere in between 10 to 11 watts per meter squared.

So, one thing that I found interesting in this that is, I think, particularly important as it applies to Yucca Mountain is his discussion of the important temperature measurements are really the maximum soil temperatures during

the growing season. And, we know that Yucca Mountain, plants are already experiencing tremendous soil temperatures there. So, any additional heating that we can see and particularly that coming up from above may be--have an impact on many of the deep rooted species.

We also do have some information that I think is important in describing the natural variability that exists at the site. Here, we have data from the vegetation associations, the four associations that Ron described. Again, each one of these numbers reflects a mean of 12 ESPs that occur in that vegetation association. Our soil temperature measures for this graph were made at 45 centimeters depth. It's important to note here most of the repository block will be under the--or in the Lycium-Grayia vegetation association and you can see the difference there between the lower elevation, Larrea-Ambrosia, and the higher elevation, Lycium-Grayia, communities. I think the important thing to bring out from this table is the range in January temperatures and the range in August temperatures. Now, those are the range of the 12 ESPs that make up that vegetation association. You can see there's a range from--well, 3 to 4 degrees Centigrade that exist naturally out there and it does not cause a change in the dominant vegetation association on the site. So, you can see a natural variability in soil temperatures that does not impact

the vegetation association.

The other thing that we can look at, again a very similar chart, only we now can look at time from 1991 through '93. It's important to point out here the differences in temperatures between January where we see a maximum of 3.4 degree difference between those vegetation associations through the same vegetation associations just through time. I think it's fascinating for me to see the difference in-- winter temperatures are quite high, but those in summer temperatures are much more narrow. Again, that's probably the time period that is critical as we look at impacts on vegetation.

So, what are some of the uncertainties and certainly there are many of them that we have on the impacts then of a repository. I think probably the biggest one in my mind anyway is what will the environmental conditions be like in 2,000 to 3,000 years from now when we expect to see impacts from thermal loading. We do know that there will be species--or we do anticipate that there's going to be species responses. There will be most likely changes in phenology or activity periods. There may be a decline in bio-mass production and food resources available. And, there may-- certainly will be less water available for biological processes. We know those are going to occur. The magnitude of that change, though, is an unknown at this point in time.

A lot of that depends upon the thermal loading level and individual species' responses to those.

Finally, from an ecosystem level, we anticipate that there may be losses of species from the ecosystem. You know, it's certainly not uncommon for ecosystems to experience loss of species and a number of things can happen. A species can come in and invade and assume that niche that the species have before. The other species that occur in that vegetation association may simply expand their niche. And, the ecosystem can continue to function. We don't know what those ecosystem responses are going to be. I think you can take a look at center of vegetation associations in warmer environments around Yucca Mountain and assume that even with thermal loading that you will have a viable ecosystem there. We have a viable ecosystem functioning in Death Valley which is certainly much, much warmer than any change that we would see at Yucca Mountain.

And, finally, from an evolutionary scale, we're talking about changes in thermal loading over a long time period, 1,000 to 2,000 years. We certainly know that species have the genetic flexibility to change and adapt to changing conditions. And so, you know, the species may have the genetic flexibility to just adapt and you may not even see a change of species composition on the site.

Again, what are our plans then for this upcoming

year and looking at possible repository effects? We have been given funding this year to conduct a thorough literature review. This will include interactions with other scientists and hopefully with members of this Board to help direct that program. From that literature review, we will then attempt to develop study designs which may include any of the following things listed here. We may measure existing ecosystems components along latitudinal or elevational gradients. Some of those components may be this soil/plant/water interface which I think is a very legitimate one to look at. I think it's a key component to look at in the ecosystem. We don't think that one needs to study the entire system. I'm not sure whether it's even possible to describe the entire ecosystem out there, much less practical to do that. But, I think we need to identify what those key components are and use those to develop models to predict changes in the ecosystem.

Secondly, we can look at natural analogs, the geothermal areas as those exist both on a local and a regional level. And, finally, we can look at simulating effects of thermal loading through glasshouse studies or small field trials. Those do have a drawback in that you're really looking at just the genetic plasticity of the individuals that you put into that experiment, not the total genetic flexibility that exists in the population. So, that

information again can all feed into the development of a model or improving existing models which will really be required to predict long-term impacts.

So, let me just draw some conclusions then. You know, we think that--I think, anyway, that thermal loading would have an effect on the biological resources. You know, the significance of that effect is going to depend on the actual increase in soil temperature. I really believe the biological systems have a tolerance for change. Otherwise, I mean, they have experienced a lot of change in the last 10,000 years already and I think they have the genetic flexibility to do that. I think there are a number of uncertainties that exist as it relates specifically to what the actual temperature increases will be at the surface, what the environmental conditions will be in 2,000 to 3,000 years when those temperature increases are anticipated and then their resulting effect on the species that exist on the side. Certainly, we can resolve some of these uncertainties through a research program and we are very eager to take a look at the possibilities of doing that in the future.

With that, I'd entertain questions.

DR. BREWER: We have time for a couple of questions. We're running a bit late.

DR. CANTLON: In looking at your list of conclusions, if you'll put that back up there for just a moment.

DR. OSTLER: Sure.

DR. CANTLON: I think it's probably not useful to think of that in terms of just the surface temperature, but rather the temperature profile. See, it's the temperature profile in the soil that really is the difference because that's extremely steep grading that takes place there from the summer and from the very coldest part of the winter. And so, it's really upsetting the profile of temperature differences. And, again, it's not just temperature; it's also the moisture--temperature/moisture relationship.

DR. OSTLER: I totally agree.

DR. CANTLON: So, your second dot really needs to be expanded, I think, to look at that.

DR. OSTLER: When I use surface temperature, you know, I'm using it kind of in the way the geologists are using it. They talk about surface--when they talk about temperature profiles, you know, they're starting at 1500 feet down. And, when they get, you know, within 20 feet of the surface, that's what they consider surface. So, you're right, though. We're talking about that zone where we've got root growth and we've got biological activity. I think that's important.

DR. CANTLON: There are some explicit ecological effects at the surface.

DR. OSTLER: Um-hum.

DR. CANTLON: The real surface temperature can, in fact,

be lethal and there are some studies on that--mortality as a function of surface temperatures where you get well over 150 degrees.

DR. OSTLER: Oh, yeah, we've melted some boots out there.

DR. CANTLON: You bet. So, I think that needs to be developed a little bit more elaborately.

The other thing that I have, I didn't notice explicitly in some of your early things in the modeling. You could do or get some of the people working on these thermal heat transfer systems to really do some modeling on what kind of temperature profile to expect seasonal with the heat flux. Not only at 57 kilowatts per acre, but at the extended dry, the extended high model, because the approval of the site that NRC engages in is going to be key to a conceptual model of the repository. That's what will be approved. And, if there are no ecological data to look at that, only ecological data looking at a base plan that dates back to 1986 and '87, if I were on the other side of this issue, you know, I'd raise questions. You simply have not done your homework in order to justify what the ecological impacts are going to be. So, it would be useful to get some modeling studies done and look at 57 kilowatts, look at the load temperature, and look at the extended dry.

DR. OSTLER: Yeah, and you're right. You know, we have

not really pursued the repository issue at this point in time.

DR. CANTLON: I understand. I understand.

DR. OSTLER: But, you're absolutely right on. That if we're going to look at other thermal loading levels, we need to get hold of those modelers and have them predict what that impact is going to be at the surface so we can take into account what those biological effects would be.

DR. CANTLON: But, just to emphasize that it's been, I think, one of the criticisms the Board has had of the environmental program is that the perception was there need not be any look at these sets of issues because that's really a repository and, therefore, an EIS question. But, site characterization is really will the site work or won't it? And, you will not have the data input of that decision which has to be made before the EIS is triggered. You're missing a set of data that feeds into site assessment and that was never in the site characterization plan adequately at the beginning. And, you know, we've said this a number of times, but we haven't said it every well because, clearly, the message hasn't gotten across.

DR. EHLERINGER: A quick question. I think we might agree as a first approximation that the 6 degree impact would probably be most critical in winter. And so, a very simple assessment that one might be able to make is how far down an

elevation do you have to go to get an on-average 6 degree increase in temperature? And, you know, you made reference to the valley and I would not be surprised that you might have to go down several thousand feet in elevation to get on-average a 6 degree increase in temperature. In which case, you would not have what I would call a minor change in the ecosystem; you might have a rather major change in the components.

DR. OSTLER: You're right. You know, you may see a major change in that two to three square mile area. I think if you look at--if you compared the Lycium-Grayia communities with the Lycium-Ambrosia communities, there's roughly a 2 degree difference in their temperatures with about 1500 feet difference in elevation between those two sites.

DR. EHLERINGER: Yeah. The other is is it fair to assume that we're dealing only with a 2 degree--I mean, you're talking about a two to three mile square area for a 6 degree change. Shouldn't the inverse square law say that at about four miles out, it's going to be a 4 degree change, and that eight miles out, and so forth? So, you might have a larger regional impact.

DR. OSTLER: Yeah, and I don't know exactly how the model is built, but I think that repository--well, I'm not sure of what the actual boundaries would be. They identify the impact zone and again that's where they expect to see

surface increases and it won't be uniform across that. When Eric presented that information, it was my understanding that that was the edge of where you would see temperature increases. So, the maximum levels would be towards the center of that.

DR. BREWER: Thank you very much, Kent.

Wendy, would you like to try for a summary?

MS. DIXON: Thank you. I can make up for some lost time.

This is just a close of basically the conversations that we've had since earlier this morning and again we recognize that our program is driven by regulatory requirements and sound scientific practices. I think that if we weren't making sure that we were living with the requirements that were set up by the regulations, we would be open to an awful lot in the line of criticism. So, that's point number one.

And, point number two--and Dr. Cantlon, you made comment of it and I've emphasized it all the way through this program--we do recognize that the emphasis of what we've been doing for terrestrial ecosystems is on site characterization and, as such, the major objectives have dealt with the monitoring to assess, you know, impacts and mitigation of impacts. We have an emphasis on study design and data analyses with also an understanding that as data is made

available, you know, from time to time, we need to go back and adjust our study designs. The program is dynamic and by that, I mean, right now site characterization, but most certainly where we're heading with repository studies, as well, and that as the program over our program changes, that environmental program needs to adjust, as well.

Information gathered through the environmental activities that we're doing right now can and will be used for the environmental impact statement, but you know, it is important to note that we are not in that stage right now. And, a lot of the issues that will come up requesting or identifying additional studies will come up through the scoping process of an environmental impact statement.

We also are very interested in receiving your input; not only on the current program that we have defined for you today, but also your input as to advice and suggestions for where we might need to go in the future. We appreciate the opportunity to present our program to you today and, especially since we've been out of the picture here for a few years, bring everybody up to speed on what we're working on. And, again, thank you all very, very much.

DR. BREWER: Well, thank you and thanks to all of your colleagues.

We are going to take a 10 minute break to get us back on schedule and then we will hear commentary from the

State of Nevada. If everyone would, please, reassemble by five minutes until 3:00.

(Whereupon, a brief recess was taken.)

DR. BREWER: May we, please, reconvene?

The State of Nevada has been particularly active in reviewing environmental activities at Yucca Mountain and has frequently corresponded with the Department of Energy and offered the state's views. Because of the state's intensive and long-term involvement, the panel has invited representatives to brief the panel on the state's view.

Carl Johnson is the administrator of technical programs in Nevada's Nuclear Waste Project Office. He'll provide initial remarks and then introduce the other speakers who will give more detailed presentations on Yucca Mountain environmental programs. Welcome, Carl, and please proceed?

MR. JOHNSON: Thank you, Mr. Chairman.

My name is Carl Johnson. I manage the technical programs within the Nevada agency for nuclear projects, also called the Nuclear Waste Project Office. Our agency was set up by state statute for the particular purpose of overseeing this particular project for the state. The office has its --one of its goals is to assure that the public health and safety of the citizens of Nevada are protected by this project. But, also, one of the goals is to assure that the environment is also protected. As the Chairman just

mentioned, we have been reviewing this program and especially the environmental portion of this program since 1983 and have provided comments at various times to the DOE on this through the years. We've developed three published reports on our views of which, I believe, the Board has copies of those documents.

Today, we're going to focus on a couple of aspects of our concerns with the environmental program. The first presentation is going to be by Dr. Charles Malone who is our environmental specialist within the office and he is going to make some comments on DOE terrestrial ecosystem program at Yucca Mountain. He'll be followed by Mr. Steve Frishman who is the technical policy coordinator within the office and he is going to be making some comments on DOE's policies which drive their environmental program at Yucca Mountain and comments on DOE's interpretation of environmental regulations applicable to Yucca Mountain.

Mr. Chairman, if there is no--or if there's some initial questions or amplifications that I can add on about the state office and that sort of thing, I'd be glad to do that. Otherwise, I'd like to turn our portion over to Dr. Charles Malone and let him start out.

DR. BREWER: I think the latter course would be fine since we know you well unless there's a question from one of our consultants who have just met you.

(No response.)

DR. BREWER: Please, proceed?

MR. JOHNSON: Thank you.

DR. MALONE: The comments that we want to make today regarding DOE's ecosystem program arise from our reviews of the terrestrial ecosystem field activity plan and the annual reports on the status of ecosystem studies underway at Yucca Mountain. Also, we've been fortunate enough to have a significant number of field tours of the study site by DOE.

The comments that I'll make today are organized as shown here. First, I'll discuss the background of the state's comments. Then, I want to discuss some important ecological concepts that should apply to the issues at hand and to the DOE program. This will be followed by specific comments on the DOE program and what the state believes DOE should be doing. And, lastly, I'll close with two conclusions.

Our comments address the efficacy of the ecosystem program for making decisions with respect to determining ecological impacts at Yucca Mountain, both from site characterization and from a potential repository.

There are three principal components to DOE's program that merit reviewed. The first one is reclamation studies, the second is the desert tortoise studies, and the third is the site characterization effects studies. A fourth

component of the program that is of some interest to my comments today is the radiological support program for small mammals which at this stage seems to be an adequate program. We're also continuing to review the reclamation and the desert tortoise programs. Most of the concerns that we want to make today address the site characterization effects studies which we believe have some problems.

A general criticism of the overall ecosystem program is that each major component is responsive to individual environmental requirements and the separate elements of the program are not integrated in an ecosystem sense. While it's easy to determine which aspects of the DOE program respond to which compliance requirements, it isn't possible to perceive any comprehensive or integrated scientific rationale from which the overall program is based.

The unintegrated nature of the program was one of the state's principal concerns as early as 1986 when the statutory environmental assessment called for by the Nuclear Waste Policy Act came out. A second early concern of the state's was that DOE lacked a comprehensive environmental baseline for the pre-disturbance conditions at the site. Now, this, we felt, was a major weakness that should have been corrected by DOE once the site was selected for characterization. Efforts have been made to convince DOE that the National Environmental Policy Act requires that

environmental programs like those associated with developing a repository justify conducting ecosystem level studies. In the case of site characterization, DOE doesn't agree with that, saying that--or in the past, they've said that in the context of NEPA site characterization is just another construction project, that it's unrelated to repository development, and it requires no greater attention to environmental measures than a routine construction project.

What's missing from that is that following site characterization, DOE hopes to develop a repository that may require as many as 50 years to complete. The site characterization shouldn't be viewed as a traditional stand-alone construction project because it's intended to be followed by a repository. Now, DOE has already been working at Yucca Mountain for almost two decades and they want to continue doing so for at least another five or six.

The fundamental shortcomings that the state sees in DOE's ecosystem program stems from DOE's emphasis on regulatory compliance to the extent that an ecosystem approach has been excluded. One can ask how did this deficiency come about? The importance of compliance, of course, can't be ignored and can't be argued, but why didn't DOE initiate ecosystem level studies during site characterization that can be used for the repository environmental impact statement? Insight to that question is

provided by a 1987 DOE contractor report that reviewed the biological information needed at Yucca Mountain to meet the applicable environmental requirements, including a NEPA-based environmental impact statement for a repository.

With respect to NEPA, the report stated that the majority of the information needed to meet the requirements for a description of the area to be affected is available. And then, the report went on to say, for the most part, the information needed to evaluate the significance of potential impacts is available. Now, remember that these conclusions were made in the context of the environmental impact statement that's required for a repository. And, the findings or those conclusions were based on the information DOE had available in 1986 and they came at a time when plans were being developed for the ecosystem program that's been discussed with you today. There was no awareness on DOE's part of the need for an ecosystem approach at Yucca Mountain. Instead, it was believed that traditional biological inventories and monitoring studies would suffice. It seems that DOE largely believes that today, although they have made some statements to indicate that they're softening a little bit in that regard.

Now, before going into some specific comments on the program, I think it's helpful at this point to consider some of the important ecological concepts and concepts of the

science of ecological impact assessment that should be reflected in the DOE studies.

To begin with is the issue of spatial scale and what delineates an ecosystem. A fundamental conceptual question is whether Yucca Mountain is a discrete local ecosystem in the form of a biogeographical island or is simply another area within the transition desert that lies between the Mojave and the Great Basin Deserts. This issue is unresolved and neither the spatial extent nor the controlling biophysical factors for the ecosystem have been identified.

Related questions like the following also remain. What is the balance of habitat types at Yucca Mountain that's needed to maintain integrity of the ecosystem? How much of the surface area at Yucca Mountain can be destroyed before the ecosystem loses its cohesion or integrity? And, what kind of ecosystem and landscape will be at Yucca Mountain after a few thousand years and is that significant or not?

The second concept worth exploring is that of an ecosystem approach to investigating biophysical impacts. The ecosystem approach involves holistic, interdisciplinary studies and process-based systems modeling, the goal being to integrate the component parts of an ecosystem so that the system can be considered and worked with as a functional unit. Prior to the maturity of the ecosystem approach,

traditional ecological studies were carried out by ecologists trained in natural history and biology who were typically uncomfortable with disciplines like chemistry, physics, geology, and math that are needed to understand how ecosystems work. Modern state-of-the-art approaches to ecosystem ecology integrate inanimate processes with biological ones. This calls for a level of knowledge beyond that of traditional ecologists, something that the state believes is missing from DOE's program.

In response to comments regarding the need for an ecosystem approach in the site characterization effects program, DOE recently stated in a letter to the state, "It is not the intent of the program to describe the ecosystem and the numerous functions that occur in an ecosystem. The intent of the site characterization effects program is to identify and monitor key or indicator species or species characteristics that could be used to assess if impacts from site characterization have occurred."

Now, even this limited objective fails to stand for the fact that too little is known about the ecosystem at Yucca Mountain to objectively identify the key or the indicator species. We saw this morning in a list of important species that one of the definitions of important species was species that were important to the structure and function of an ecosystem. But then, when the important

species being studied by DOE were listed, all we saw was ones that were covered by regulations and so forth. They didn't see the important, functional, structural kinds of species at Yucca Mountain. Subjectively selecting dominant or conspicuous species as fulfilling keystone and indicator roles in an ecosystem is unjustified without first understanding the role of the species in maintaining ecosystem function and integrity.

Now, the state isn't trying to have DOE implement an ecosystem approach in order to understand the impacts from site characterization. It's too late for that. All those impacts have largely occurred. Many of them have occurred before DOE initiated its studies. However, it isn't too late for DOE to conceptualize and implement an ecosystem approach that would provide the information needed for an inquiry into the potential long-term impacts of a repository. Such a framework would combine the structural approach DOE has adopted with the functional or process oriented approach. To achieve this, the approach to studying the ecosystem should have a strong focus on modeling the critical biophysical processes that are likely to be influenced by a repository. An example of this would be understanding the soil, water, plant atmosphere system in order to have a basis later for assessing the consequences of both thermal stress and pneumatic pathways bewteen the repository and the surface

environment.

A third concept that should be recognized by DOE is that of ecological impact assessment. DOE sometimes loosely uses the words "impact assessment" to describe its current ecosystem program. The concept and formal discipline of ecological impact assessment implies predicting future impacts with simulation modeling. Ecological impact assessment involves measuring baseline conditions, and objectively, as opposed to subjectively, predicting the changes to these conditions that are likely to occur as a result of a proposed action. This has never been done at Yucca Mountain and, instead of doing so now, DOE is merely trying to detect impacts after they've already occurred.

The fourth concept is that of cumulative ecological impacts and that deserves a role in the program. Cumulative impacts result in two ways. First, the additive effects of individual actions of a similar nature like the three construction phases that DOE is following to develop a repository; that is, the site investigation phase, the site characterization phase that they're in now, and then lastly, the repository construction phase. These all grade in over a period of several decades. The second way cumulative impacts occur is from the interactive effects of actions like construction with the effects from actions of a different nature like those that might result over the long-term from a

repository.

The concept of cumulative impacts is a key one within the discipline of ecological impact assessment and means for dealing with it do exist. However, dealing with long-term impacts can be complicated by the concept of non-equilibrium ecology which is fifth on the list before you. The concept of a natural equilibrium or the balance of nature is being replaced by the reality that nature is ruled more by flux and disturbance rather than being in a natural steady state. Humans, climate, and weather are foremost among the naturally occurring factors that keep nature in a state of flux and make it difficult to predict the long-term conditions of the site.

To attempt such predictions requires an understanding of the future ecological potential of the site based on knowledge of ecosystem processes and ecological integrity. Knowledge of past climate variations and the associated changes in environments and communities, the kinds of things Kent Ostler spoke of earlier, also is essential. In this respect, the concepts of landscape ecology and spatial pattern, last on the list, may be helpful. The state believes that these concepts are among the things that need to be considered by DOE regarding long-term impacts from a repository.

We're turning now to the current DOE program at

Yucca Mountain. What is the program's objective? The stated purpose of the studies described in the ecosystem field activity plan is compliance with legal requirements which stem mostly from the Nuclear Waste Policy Act and the Endangered Species Act. What's missing from that, however, is compliance with the requirements flowing from the National Environmental Policy Act.

Is the program meant to meet requirements other than those of NEPA based on ecological concepts? The answer to that is no because there are no aspects of the DOE program that emphasize ecosystem process and ecological integrity. Aside from the reclamation program and the tortoise program, the studies consist largely of monitoring biotic components of the ecosystem in the context of attempting to detect impacts. The principal focus of this objective is site characterization effects program which concentrates on fugitive dust along roads that were built several years before site characterization started; that is, during the site investigation phase from the late '70s to 1986.

Because of the importance of the site characterization effects studies, a closer look at them is worthwhile. The program consists, we've heard today, of time series monitoring studies intended by DOE to determine the biological effects of site characterization. The site characterization effects study involves study plots allocated

among four vegetation associations in a classical treatment and control situations. However, the four vegetation associations have numerous interwoven sub-associations, both within and among them, thus creating a mosaic of habitats. This natural diversity and complexity, number one on the list, makes the biological resources at Yucca Mountain difficult to characterize quantitatively. Consequently, statistical variances for the data from DOE's monitoring studies are likely to be large making impacts difficult to detect. In many instances, the monitoring data have standard deviations that are about 25% of the means in both the treatment and the control plots.

The parameters selected by DOE for monitoring are meant to indicate the condition of the ecosystem at the site. However, there's no apparent empirical basis to allow an extrapolation from the monitoring data to the biophysical state of the ecosystem. Most of the treatment plots distributed among the four vegetation associations largely are adjacent to roadways and the principal disturbance factor is dust deposition. Now, the basis for being concerned about the impacts of fugitive dust on the biota may or may not be understood by DOE. In other words, what are the linkages between the ecosystem indicators selected by DOE and the intervention of dust on the ecosystem at Yucca Mountain? Did DOE know when it established the study plots what responses

to look for from dust and how they relate to ecosystem health? And, given that the roadways were in place prior to site characterization, had impacts from fugitive dust already occurred before the study plots were established?

And, number four on the list is the extent of the affected area at Yucca Mountain. How secure was DOE in knowing that the intervention of site characterization disturbances would not spatially impact the entire study area such that a traditional treatment and control field plot study all within the same affected area would be invalid?

This raises again the issue of spatial boundaries over which the effects of site characterization might occur and the question, number five, of comprehensive site-wide impacts. Why site-wide impacts were not addressed in the site characterization effects program? The possibility that site-wide impacts might occur negates the usefulness of comparisons between treatment and control plots because some or all of the plots could be within the affected area and there would be no valid controls.

The desert tortoise program recognized this problem and sought to avoid it by designating a single off-site control area away from Yucca Mountain. Likewise, the small mammal radiological support studies, mentioned earlier briefly, have treatment areas located proximate to the major disturbance areas, not just roads, but close to the north

portal and other large areas and controls that are situated away from the site characterization activities. Now, in responding to issues and questions like these, DOE has stated that some of the 24 control plots, in fact, are as far from disturbances as the control plots for the tortoise and the radiological support studies are.

This raises another set of questions like how large is DOE's ecosystem study area. That question was asked this morning. Are the contiguous surrounding areas and any off-site controls located within the same ecosystem at Yucca Mountain? If some of the ecological study plots are off the site, how does the experimental design accommodate that?

Now, at issue is the validity of comparisons of data gathered at the site with data collected away from the site, as is the case with the desert tortoises and the control removed away from Yucca Mountain. Trying to compare two different locations in accordance with the discipline of ecological impact assessment typically lacks credibility because the ecological conditions at the two sites may not be sufficiently similar unless you've done a lot of studies to confirm that they are indeed similar enough statistically to be pursued in that manner. It takes a lot of effort to credibly establish the ecological comparability of two separate sites.

Last on the list in front of you comes the question

about the study design and statistical analyses regarding the site characterization effects studies. At issue is determining whether ecological conditions monitored through time in a series of plots change following a disturbance. This is a very difficult challenge under the best of circumstances and, given the diversity of the habitat at Yucca Mountain and the lack of a sound and comprehensive baseline, it may not prove possible.

In the practice of impact assessment, it's recognized that process-based simulation modeling founded on solid baseline information prior to disturbance is essential to ecological effects monitoring. In the case of Yucca Mountain where baseline data are a problem and where there's been no simulation modeling, DOE is forced to use temporal pseudoreplication and inferential statistics about which there's a lot of disagreement and argument among biostatisticians. At some point, the issue of study design and statistical analyses merits a closer look.

Now, from what's been said to this point, it's clear that the state believes that the efficacy of the site characterization effects study is questionable. Not only are the studies of doubtful merit for detecting ecological impact, they seem to contribute little to determining cumulative impacts or consistent future impacts to the ecosystem at Yucca Mountain. This leads to the question of

what should DOE be doing now regarding repository impact assessment?

First, answers to this question require consideration of concepts like those showed earlier, such as ecosystem integrity, feedback mechanisms, ecosystem evolution, and ecosystem processes such as nutrient budgets and water and heat budgets. Second, an effort should be made soon to identify what the critical functions of the ecosystem are at Yucca Mountain for conducting an ecological impact assessment for developing a repository there. And, third, performance of an adequate impact assessment will necessitate the use of process-based simulation modeling for forecasting ecosystem impacts into the future.

Will DOE pursue an ecosystem approach in preparing for the EIS required for NEPA compliance and for repository licensing? If so, the work leading to the information must begin soon and not be delayed until EIS scoping and implementation planning are completed which probably won't be until 1998. However, DOE seems not to recognize really a need or requirement to undertake ecosystem level studies now. The state's concern is that unless DOE adopts an ecosystem approach at Yucca Mountain, little more is going to be known after the completion of the current program and subsequent assessments based on it than was known in 1986.

Now, in conclusion, we can say if DOE's current

approach prevails at Yucca Mountain, ecosystem processes related to thermal impacts will remain ignored. Second, aside from some work on the natural history of the desert tortoise and the reclamation procedures, little of substance will result from DOE's ecosystem field activities. Last and most important, the site characterization effects studies won't prove credible with respect to evaluating impacts from site characterization or with regard to providing a data for assessing potential long-term impacts from repository development.

Finally, the challenge to DOE is that if they persist with this inadequate approach that we've discussed, their environmental impact statement for the repository will be challenged for its insufficiency.

Thank you.

MR. FRISHMAN: Well, Charlie captured my usual spot of being the last one to talk and give the worst news of the day, but I'll see if I can't recapture my position.

First of all, as I have done in the past, I always take sort of an extreme opposite position from any way the Department makes its presentation and today I'm taking that extreme opposite again. I not only don't have any overheads, but rather than having two cover pages on every one, I have no cover page. I'm very curious about the doubles. That's interesting to see.

I think Charlie gave you a pretty focused rundown on our view from a policy standpoint where the program is going wrong right now and maybe some of the missing components. I know there's going to be another meeting on this subject that probably will again come at it from a different perspective. I wanted to give a few views maybe from sort of a different angle from the way Charlie was talking, but I think they still hang together and maybe will give the Board some additional way of thinking about the environmental program and the context in which we, at least, believe it ought to be thought about.

Wendy, I think, is correct in describing the program the way it is. She ought to be. She manages it. She has just recently or today offered up some little slippage from the adamant refusal in the past to start looking at what will become some EIS issues. The problem is, first of all, it's the--I guess, the approach which is you go very cautiously into a little plan for a plan and then you go for the plan, for the plan, for the plan, and it's not temporally in the way the program is described at all adequate and probably still doesn't get at the real question of the need to start establishing the information and understanding of the site that is going to be necessary for an EIS. I think one of the reasons for that is there's still this failure to appreciate within the program that the

purpose for writing the EIS is not just so you have this big fat pile of stuff mixed with suitability determination because we know the way the program is going, there is going to be that suitability determination because we discussed in other context why that's going to have to happen. The Department, the way it has organized its program, I believe, can't find the site anything but suitable. So, now, let's get on with looking at this EIS that's going to have to sit next to it. That doesn't mean we agree with the site suitability. It just means that their program from our perspective is designed to where you can't get a no answer out of it.

So, with the EIS, it's not just that it has to fill up that second box that the Secretary delivers to the President. Part of the purpose for the EIS is to analyze a set of alternatives and also--and, to provide all of the factors into that analysis. The Department may have excused --or the law may have excused the Department from looking at some alternative, such as alternative to geologic disposal, alternative to Yucca Mountain, but it did not excuse them, any more than the NRC does in licensing, from looking at alternative ways to design and operate and close a repository if it's at Yucca Mountain or wherever it might be. They are not excused from what NEPA is all about which is informed decision making and it isn't just the bottom line action that

is the informed decision.

So, for instance, I thought Dr. Cantlon's question this morning was a very good one in terms of how do you account in the program in terms of your environmental program for, for instance, changes in thinking about how the water works at the site? You know, how the hydrology works in the unsaturated zone. And, I didn't hear a real good answer to that. In fact, I'm not sure I heard an answer. This is the kind that needs to--that NEPA drives within a program as that program is being sort of planned and investigations are being done.

So, one of the reasons that NEPA should be very important to the Department right now is in terms of evaluating these ever-changing alternatives for how to accomplish a repository at Yucca Mountain. We have seen, what, at least three major ESF designs that are one way or another responsive to conceptual repository designs, all of them very different, all of them leaving open major questions about thermal loading, all of them leaving open major questions about surface facility, about operations, about longevity of operations, about modes of closure. These are all things where a realistic environmental analysis going towards an EIS and beginning to understand this ecosystem will, in fact, or should, in fact, be built into these final decisions that may be made at some point about what is the

preferable overall concept, first of all, maybe of site characterization because conceptual design seems to be driving that, but ultimately what is the preferable concept if you're going to have to put it into an EIS? And, you can't do that starting to think about it in 1997 when you say you want to write a license application and have it done by 2001. You just don't have the time to do it.

All right. If that isn't compelling enough, then maybe there's a couple of other pieces of reality that are going to have to be dealt with. The desert tortoise approach is a fascinating one. For about a 10 year project, the agreement with Fish & Wildlife Service is you can have a take of 15. We have no idea what happens when the 16th take is there. But, because of he Department's approach to we shall meet regulations that that biological opinion will be treated as a regulation and it will be thought that it is okay to take 15. Taking less is not necessarily a sin. There's no imperative to take 15, but it's okay to take 15. All right. Where does that type of an approach get you if you have to then go the step for a repository?

You're looking at, once again--you know, only 15 of these tortoises went away and we're looking now at a project that probably is--if it goes forward, will operate for, oh, we'll give it 50 years, although I think it's zero and some people say it's 100. Now, are they relying on the Fish &

Wildlife Service saying, okay, 10 years is 15, 50 years is 75? I'm kind of guessing that they haven't thought about it that way, but I'm guessing that that's the prevailing logic for inaction at this point. Now, take 75 and go back and add up all these guys that have transmitters on them and you just about killed all of them that are there if what is there right now represents a stable population. These are the kinds of things that I think kind of drive the necessity to start looking at the bigger question. And, the tortoise is going to end up being a real driver in this partly because of the Endangered Species Act, partly because the long-term survival of the tortoise as a species is real important, but also for endangered species type thinking, it's very important in these marginal areas and it is very important to be able to demonstrate if you have a very long-term project that, in fact, you're not going to wipe out the population in that particular area.

And, the way that this project sort of is intending, it seems that that really doesn't matter and it seems that an ecosystem approach is the only thing that is going to make it matter. I was kind of surprised to see on the list the favored perennials didn't make it over into the reclamation program. It seemed kind of surprising to me that that wouldn't be because, if nothing else, if you wanted to please the Fish & Wildlife Service for another biological

opinion if you're going for a repository, it would seem that they would smile more about that than almost anything else; if, in fact, you could demonstrate that you were sensitive to the need of that species. And, that's just a little piece of the ecosystem look that you've got to take. What supports those species?

Ultimately, I think it's going to be a major consideration of do you understand the ecosystem well enough to know about the long-term survival of desert tortoises in this area? And, what does it take to know enough? Well, obviously, the tortoise has been around for a very long time. We're talking long-term impacts. We're talking such things as thermal impacts and what do they do to the ecosystem that the tortoise depends on when we don't even know how much of it it really depends on. And then, is there something unique about this area other than its just geographic and elevation position that makes this the boundary, under climate conditions, essentially the northern boundary of habitat for the desert tortoise under current climate conditions? What happens to it under other climate conditions and what happens to the ecosystems it depends on? And, you know, we can make some intuitive guesses about what is the northern range and how it moves around with climate. But, I think it's going to take more than an intuitive guess if there's going to be any type of a favorable response from Fish & Wildlife Service

when it gets down to desert tortoises that might live after site characterization.

So, I'm just trying to point out a few things that may be drivers beyond the current logic in the Department's program and the Department's current thinking that we can still put off the idea of the fact that we're going to have to write in the EIS, going to have to write one that is sufficient in the sense that it meets all the legal requirements, and in the course of meeting those legal requirements, is supportive of whatever decision they want to make. It's ours to talk about later from another perspective, but this is what's missing from the Department's approach right now.

I just want to make one other observation or actually two. They're both fairly short. I was intrigued with the question that came up today about is there anything unique about the Yucca Mountain site. And, the answer was not a totally resounding no and I can't remember the word that was used, but it was one that hedged a little bit. It's not exactly unique or something fairly close.

But, the big question is given some of the notable things, such as it was pointed out there's a rare lizard that this program has managed to capture--well, it's rare because there's something unique about where it is as opposed to someplace else in the nearby area. But, the big question is

how can you say that it is not unique until you understand how it works ecologically? And, there's something about it, as I said before, something about it that makes it the northern range of the desert tortoise habitat, something about it that makes it function biologically the way it does, and it seems that you can't make that statement unless you can do more than just a statement of general experience. And, with a little probing, it was kind of interesting that the statement of general experience is primarily based on a calcium carbonate substrate or at least a lot of calcium carbonate in the substrate. Now, either caliche or limestone changes the soil pH drastically. Soil pH probably has a lot to do with the ecosystem at Yucca Mountain as opposed to what we may think we understand about the ecosystems relatively nearby on NTS with essentially the same climate, but functioning differently probably. So, that question about uniqueness, I think, can't be answered, but probably needs to be in an EIS ultimately and it can't be answered without understanding the ecosystem.

And, now, just one final point. I noticed there was sort of a scoreboard in one of the presentations having to do with how the environmental program for site characterization is working in terms of how many activities --pre-activity surveys resulted in revisions, relocations, other types of mitigation, and so on. Then, I noticed the

1 success story at the bottom of the line. Zero resulted in
2 essentially cancellation or no action. And, I can understand
3 why the Department would want to advertise such a record. It
4 just brought up the question to me that if that is the case,
5 maybe it's just a difference in interpretation; I don't know.
6 But, it seems to me that there should have been some type of
7 analysis by the environmental side for pre-activity survey
8 when the Department proposed in the use--or in its injection
9 well permitting, that it use freon as a tracer gas, and it
10 proposed that at a time when the Federal Government had
11 initiative to cut off all Federal use of freon with the
12 exception of some very narrowly constricted emergency type
13 uses. But, at the same time, here's a program, we have an
14 environmental issue that's in front of everybody literally
15 that day, and the Department proposes to use it, either
16 through ignorance or through arrogance--and, I'm not sure
17 which. So, it tells me that there is some kind of a glitch
18 in the program. The suggestion might be that the glitch is
19 we thought we knew all of the requirements, but we'll take
20 care of all of those. That's the danger of using a
21 requirements driven system and the interpretation of
22 requirements because new requirements come along and
23 requirements change. Well, this was one that we thought was
24 a particularly blatant one, even though in the grand scheme
25 of things that small amount of freon may not have been a

great influence on the atmosphere, but still, the idea of doing it in the face of executive order, we thought, was kind of interesting especially since it, theoretically anyway, should have been seen by the environmental side of the house.

Well, that's maybe a long enough list of bad news for now. I'm looking forward to the next meeting where we maybe can get farther into talking about what a repository EIS probably ought to include. It was a little disturbing today, first of all, to see just a repeat of the same piece on repository EIS that this Board has seen, I think, for the third time now. Also, a little disturbing to think that at this point the sum total of thinking about what a repository EIS ought to contain in terms of adverse impact is over thermal loading when we're talking about a major industrial type operation that's probably going to go on for 50 to 100 years. That has to be in the EIS, too. The connection of transportation one way or another has to be dealt with. But, that will be for another day and we look forward to that meeting, too.

Thank you.

DR. BREWER: That concludes the presentation from the three gentlemen from the State of Nevada. We can take some questions right now or we could go immediately to the round-table at which point questions could flow more freely.

I think we should go to the round-table. So, there

will be a momentary pause while we sort of get ourselves reorganized of about five minutes and then the round-table discussion where questions from the audience are in order and questions back and forth about all the presenters and the panel certainly are very much in order. It's a time for a free exchange. Five minutes, please.

(Whereupon, a brief recess was taken.)

DR. BREWER: Ladies and gentlemen, would you, please, reconvene?

We, as a Board, are not schedule driven. The plan is to open up the discussion in a round-table format and to try to conclude the day's activities by about 4:30. We're missing one of the participants, but she'll be here in a moment. And, rather than giving closing remarks because this conversation is obviously one that is not meant to end, but rather to continue, I'm going to take the prerogative of the Chair and just offer words of summary of what I think has been going on today and the reasons why we've had the panel kind of aware of the whole activity from the point of view of the Board as heading.

First of all, the convening of the panel on environment and public health was an opportunity to take stock and to focus. It's important because I'm a relatively new member of the Board and responsible for things environmental. We have new staff. We have new consultants.

1 It seemed to be a time to come to these very important
2 topics; not to say that they haven't always been important,
3 but the Board processes things in a fairly serial fashion.
4 There were just other things in the last year or so that the
5 Board has been, I think, appropriately focusing on with great
6 intensity and it's now time to get back to a collection of
7 topics and issues related to environment and public health.
8 This seemed to be a very good way to make that point.
9 A second reason for reinstituting and focusing,
10 reinstituting the interests of the Board and focusing the
11 interest of the Board on this range of topics, is that a
12 great deal has really happened in the world between 1987 and
13 today, 1993. It was noted several times that the site
14 characterization plan itself is hardly what it was in 1987;
15 the mode of emplacement, the thermal loading, whether or not
16 you should have engineered barriers or what, and the list
17 goes on and on and on. And, the sum collection of all of
18 those changes must by necessity be reflected in changes
19 elsewhere in the program. And, the environmental aspects of
20 the program are simply from the point of view of the Board
21 not that well-connected to a list and the list is very long.
22 There's also learning that's gone on, a great deal
23 of learning, as a consequence of trying to characterize the
24 site. I mean, that's an inevitable, it's good, that's why
25 we're doing this. Learning, having to do with the nature and

the character of the geology, what will happen under various thermal strategies, importance of fractures. Again, you can make a long list, some parts of which have direct and important bearing on how one thinks about the environmental aspects at Yucca Mountain.

In the larger sphere, the whole concept of ecosystem in the period from 1987 until 1993 has really undergone a remarkable transformation from ecology textbooks into law and one has to look at a series of pieces of legislation; the National Forest Management Act, the National Fisheries Conservation & Management Act, the Magnuson Law, and now with executive orders from the Secretary of Interior having to do with habitat as opposed to individual species in California and elsewhere, the Pacific Northwest, we find this important scientific concept being not terribly well-understood by many of those who are actually writing the laws and trying to concoct the rules and regulations to guide action. Again, it's appropriate and we saw reflections of this in the discussion throughout the day; what is an ecosystem, how do you think about it in management terms, the connection of science to the reality of what we're all about?

Another point worth mentioning in terms of change is that the Endangered Species Act itself is up for reauthorization this year. It is itself undergoing a sort of detailed scrutiny by the Committee of the National Academy of

Sciences. The outcome of any activity of this sort is never foregone. And so, again, another reason in terms of changes in the enveloping world in which this particular project is located, why it's appropriate for the Technical Review Board to be thinking and focusing on things environmental.

It has been mentioned several times that there are specific provisions in the Nuclear Waste Policy Act which create the environmental activities at Yucca Mountain that we've been hearing about today and that it causes them to have a certain character and a certain style and a certain content. It has also been noted that environmental assessment under the special rules of Yucca Mountain, at some point if the site is deemed suitable, must yield to a much different kind of analysis and scrutiny, the environmental impact statement, and all of its appendages as a part of NEPA. Again, another reason then, particularly given the schedule, that one looks at vis-a-vis Yucca Mountain, another reason to be thinking more intently on things environmental.

Now, the session today is not the end, as I've said in my introductory comments, of interest on the part of the Board. We're not simply visiting this and then moving off, but rather we are going to continue, as the case with a whole range of things for which we are responsible, to inquire into not only what goes on at Yucca Mountain--we have tentatively picked several days in March for what we would hope to be a

very interesting field visit--but, also, we have other responsibilities in the area of radiological monitoring, water resources, and indeed socioeconomics that really fall within the general rubric in terms of our responsibility of things environmental.

Before everyone begins to leak off and run for airplanes and other things--and that typically will happen--I wanted to thank very much and most sincerely Wendy Dixon and her staff for preparing for this meeting and for making very, very lucid and, I think, informative presentations of what it is you do. I'd also like to thank again beforehand because we're not finished all of the presenters who have really made a good effort to inform the Board and to bring us up to date which is indeed why we're here. And, finally, and I think we don't do enough of this, to thank the staff of the Nuclear Waste Technical Review Board for doing another miracle which is a meeting long-distance in Nevada. Thanks to everyone for doing a great job. It's an acknowledgement that they do the job so well, we sometimes forget and I thought I'd just say that.

Now, what I'd like to do is open up the discussion. This is a format which we have tried with, I think, satisfaction and success in the last few meetings. We have everyone sitting around and the initial round is whatever is on your mind and whoever you want to ask the question, do so.

1 At some point, it's appropriate, whenever you feel like it,
2 for the audience, individuals in the audience, if you have
3 questions, questions in general, questions for specific
4 individuals, please come on up to the microphone. I'll
5 recognize you and then we'll get on with it. And, the whole
6 thing--we've got about a half an hour for this--is an
7 interesting idea of free exchange.
8 Who wants to go first? The Chairman wants to go
9 first and I say, yes, sir.
10 DR. CANTLON: It would seem to me the thing that I would
11 like to sort of put up front is really the content and the
12 prioritization of the environmental program. And, if that's
13 the objective that we're really addressing, then as one looks
14 at that, we look at the needs. What drives that content?
15 What drives the prioritization among the components of the
16 program?
17 Starting with the site characterization plan which
18 really led to and, in fact, really fixed much of the
19 environmental program content, it was largely regulatory
20 driven. And, as you indicate, that is really the driver.
21 There was a basic presumption based on the environmental
22 assessment that no environmental input was required for the
23 site acceptability decision. I doubt that there's anybody
24 that has really looked seriously at the data at this moment
25 that would be totally comfortable resting on that old

accumulated expert judgment that says that there is no environmental input into the site acceptability decision. Now, if you disagree with that, I'd like very much to hear that.

So, if that is really now a scientifically unacceptable state of affairs, which I think it is, then what are the things that need to be answered in order to do the site acceptability decision, the environmental piece of that? One is DOE is currently looking at the basic conceptual design of the repository, totally different--almost totally different--from the site characterization plan conceptual design of the repository. It's ramps instead of shafts. The size of the waste packages now are moving in the direction of much larger as opposed to smaller. If we go into the extended hot, extended hot is going to give you a totally different thermal regime near the top and in the profile. And, the water movement in the site is fracture driven, fracture dominated, not diffusion dominated. Those fundamentals, essentially, make the environmental component very, very much different than we thought in 1986 and '87 and '88. That's all come in since this program was put together.

So, if you need, essentially, to look at a selection of the thermal strategy, there's an environmental component to that. Extended hot is going to be a very different environmental challenge to the site than low

temperature or short-term hot temperature. And, that impact is not only the direct impact on the ecology of the site, but it's feedback into the hydrology which is the fundamental principle of how safe a repository site is that going to be? How much water is going to go down through the fracture system which is really going to be related to the transpiration component of the evapotranspiration dynamic in regional hydrology. And so, that has to be in there.

Now, when does that data need to come in? They need to be designing and selecting the thermal strategy pretty darn soon in order to lay out a whole set of things; the thermal studies, the impact of the heating of the rock, and so on, and just as we need all of those geophysical data, we also need a set of environmental data to begin to understand what the environmental effect is. So, you know, if one now looks at prioritizing what the environmental program ought to look like, it's very different from what it ought to have looked like from what we were starting with in 1987. And so, the fundamental site acceptability decision now has an environmental component which was essentially out of the decision in 1987 in the site characterization plan.

So, it would seem to me in looking at--you have to look at that. When will those data be needed? You know, how are these different components to be prioritized? And, what does it cost to get them done? If you've got the modest

budget that you have, you clearly can't be adding big components on top of it, particularly the experimentally driven data sets. These are demanding things. These are going to take some conceptual design and so on.

So, I guess my question is are you comfortable that the environmental program that you've been defending very well--are you comfortable now that with this changing design of the repository whether you're really fitting what's going to be needed, you're going to have your data on time and in place, and is your budget really going to be opened up to let you get the data on time? I address this to Wendy.

MS. DIXON: The last part of the question, I wish I had the answer to. I guess, you know, there's two hats that I need to wear. One is the hat of the environmental manager and the other is the hat of, you know, a part of an overall team. I guess, you know, starting off with the latter hat, you know, the project manager has for a long time been faced with the major decision as to how to split his budget and I think he would say, you know, and the new project manager would say that the budget that we've had has never been sufficient to balance off all of the things that really need to be done on this program or that we would like to do on this program. And, he's had to make the decisions on priorities with respect to funding and I can say that I haven't always appreciated where those decisions have been

made, but I'm sure that if Russ Dyer or Bill Semecka were sitting here, they'd probably be saying the same thing because we all believe that we need bigger pieces of the pie to adequately perform our duties. So, I guess, that answer almost covered them both. Where the future might lie with respect to budget so that we can move off into other arenas, I don't have a crystal ball on that. I am hoping that the future is better than what the past has been with respect to budget.

DR. CANTLON: Let me address your budget-focused answer. I think I could suggest that if the scientific basis for the decision on site acceptability is as poorly grounded in terms of its environmental component as I think it will be with the study program moving ahead on the trajectory that it's on, then if Nevada or whoever delays the program two months, you've recovered your annual budget because the program is $300 million a year, plus, and moving towards $400 million a year. So, all you have to do is to look at the scientific credibility of the decision on site acceptability, and if that's the first point at which the program is now brought to halt, you don't need to delay it very long until you've consumed your budget. In one year, you will have recovered all of the expenditure that you've made and then some if there's only a single year delay based on the frailty of the scientific basis of what you're doing. I think that's the

argument you've got to take to your budget.

DR. BREWER: Anyone else care to reply to John's--

DR. CANTLON: --comment on the scientific issues. In other words, do you need more environmental data to go to an acceptable site decision than you're generating now based on the changing design? New thermal strategy, fracture flow dominating the movement?

DR. OSTLER: That's a difficult one for me to answer. You know, there certainly has been changes in the program. I think it really depends upon a lot of the criteria that they're using as part of the basis for even the new programs. They just went through a re-evaluation of what criteria that they wanted to meet in the new thermal loading setting and, you know, it was--the criteria still remained that, you know, a surface temperature increase of 2 degrees Centigrade is a maximum.

DR. CANTLON: Yeah, but the average surface temperature is not the environmental variable that you in the environmental area know. You, as a matter of fact, reported it to us a few minutes ago. It's not the average of the mountain that's going to be ecologically affected; it's what the point variation is going to be. If there are heat pipes in a high-thermal strategy load, it is not going to be uniform.

DR. OSTLER: Oh, absolutely.

MS. DIXON: Can I ask you a question?

DR. CANTLON: Sure.

MS. DIXON: Okay. Let me turn this around.

DR. CANTLON: Sure.

MS. DIXON: Okay. Hypothetically, let's say that from the site suitability standpoint, everything is, in fact--you know, the criteria proves that the site is suitable. And, let's say, hypothetically, that there will be a change to the ecosystem. And, let's say, hypothetically, that there will be some effect from thermal loading. And, we don't know that any of this is true, hypothetically, because we don't know what decisions are going to be made with respect to thermal loading and I don't know what the package is and we don't know the placement. We're dealing with a lot of unknowns right now. But, if we hypothetically say, you know, that there will be an effect on the ecosystem, that it will change somehow, that even in this change some species cease to exist, that other species may take their place, but there's a noted change, everything else being positive with respect to the Yucca Mountain site proving suitable as a repository, do you believe that the change in species composition in the area of a couple of square miles is a major effect on the suitability of the site as it relates to our regulatory or other considerations?

DR. CANTLON: Is that going to be the question, though,

in Court? Is that the scientific question in Court or is the scientific question do you know what's going to happen? I can't evaluate whether it's going to be significant until you can tell me what's going to happen. You're obligated in the site assessment issue to tell me what's going to happen. Now, if you can tell me what's going to happen, yes, there's going to be a total of maybe 12 acres on the thing in which there's going to be nothing alive because this is where the fracture system is going to generate enough thermal change that there will be virtually nothing there, high temperature bacteria, a few things like that. If you can now give me quantitatively roughly what you think is going to happen, then I can dismiss that and say, hell, that's trivial. It's biologically non-significant in terms of the total population. But, if you come into the site assessment decision not having laid down an information base, quantitatively assess what's going to happen, then I'll throw you out of Court and tell you to get back and get your work done. Don't bother the Court system with a scientific question until you've got the data to answer the scientific question. Because we're just talking about how many angels danced on the head of a pin; there's no underpinning to the discussion. No scientific underpinning to the discussion. Now, if you could tell me quantitatively what the impacts are, roughly, you know, a good educated guess, then, yes, I

would say probably it's going to be trivial. But, you'd better be able to tell me.

DR. BREWER: Warner, did you want to follow up?

DR. NORTH: I was going to emphasize the Chairman's point that the bad outcome is delay of the program. The way I do the arithmetic, the amount that is being spent in your general area and the terrestrial ecosystem is the order of 1% of the total and, therefore, it seems to me we're talking not about two months delay, but three days delay. Roughly, 1% of the year as the balance point. You think in terms of it of what potential we have for delay in this very complex regulatory process as the consequence of not having done the obvious homework well in advance. And, it seems to me there are a lot of good questions that could be asked about the management of a repository facility if that goes ahead. And, the point is you really need to have those questions answered in advance or you are asking for delay because those questions are going to invite all of the potential intervenors, a lot of whom may not be represented in this room, to come in and raise that issue as a way of slowing down the project. The cost for this can be very, very considerable. We might not be talking about three days; we might be talking about three years or even more. So, the potential downside of not having this information, I think, is extremely significant and that's why the Board has got it

rather high on our agenda now as an issue that needs to be explored.

I think, for example, supposing we find out that the reason that the northern end of the range of the desert tortoise has to do with some particular genetic characteristics of the tortoises that live around here? So, they are, in fact, a sub-species. And, furthermore, this particular sub-species is relatively localized. Okay, we accept that. So, under the Endangered Species Act as it may evolve in the next 10 years, we have a relatively unique ecosystem. That's the best way I can set up that hypothesis is to use this rather obvious case. Then, the issue for the program may be how do you manage the repository on the scale of materials handling that that is going to involve in such a way as to protect that species? Are we talking about 15 or 75 as the allowable kill? And, is that going to be something that works given that we have huge numbers of people coming in for a large construction project and we have perhaps trucks or perhaps railcars hauling in waste and other supporting material on a large scale? You're essentially going to be asked to show that you have this management program under control and that's a relatively tall order, something that's going to take not only some thinking, but some demonstrating that, in fact, whatever you propose as the mitigating actions to protect the tortoise, you can apply on

a sufficiently large scale so that it's going to work.

So, it strikes me that there is lots to explore in this area of going from the ecosystem as an area for scientific investigation to--I'll pick up Garry Brewer's phrase--it's an issue of management. How do you think about the ecosystem in management terms and convince a skeptical audience that you know enough about the ecosystem to be able to manage it successfully? I think that's the burden of proof that you have before you.

DR. BREWER: Anyone care to respond to that?

(No response.)

DR. BREWER: Other questions?

DR. FEHRINGER: I'd like to shift to a little bit different subject now. One of the big questions that I see, especially in the site characterization effects monitoring program, is the question about the particular species that are being monitored. The Department has chosen some indicator species that it thinks will identify any changes that might be caused by site characterization activities. Dr. Malone has argued that, instead, the Department should be trying to identify keystone species. When I tried to do some reading on that subject, I'm confused as to whether ecosystems typically have a keystone species or whether that's relatively rare. So, the question I would raise is whether or not it is worth expending the time and the

resources to try to identify keystone species at Yucca Mountain and what the likelihood is that one would be found if the Department were to search for one?

DR. BREWER: Who would like to try that? Ron, you were reaching for the microphone. So, you get to answer.

MR. GREEN: Well, I'll start out initially. We selected species or groups of species actually for the most common and abundant ones, the ones that we felt had the largest effect on the system out there. I think from past work in desert ecosystems, the ones that we have selected have been shown to be some of the major key species in those things. The desert granivore system, they're certainly very important out there. And so, in answer to your question, no, I don't think it was worth trying to identify the keystone species. I'm not sure the keystone species exist out there. But, I think we have selected the suite of species that--I think, we've pretty much covered the majority of the larger groups that are out there; the reptiles and the small mammals. Certainly, we can't measure everything out there, but I feel fairly comfortable with what we're measuring out there.

DR. CANTLON: I'm not asserting this as fact; I just raise the question. Let's assume that the most heat-sensitive--and, that seems to be one of the big variables--one of the most heat-sensitive in terms of the rhythm, the pattern, the annual pattern or rhythm of temperature pulse in

the system, is now upset and the key species that goes down are, let's say, two genera of the predominant microphysal fungae.

MR. GREEN: Um-hum. Okay. Well, again, now you're talking about thermal loading effects. Okay? Yeah.

DR. CANTLON: Well, that's going to be the big environmental impact.

MR. GREEN: Right. Well, Dan's question, you were talking about the existing site characterization effects studies. Yeah, if we're talking in that arena where we're talking about a different type of impact and type of effect than we have considered at this point, that's a very plausible situation.

DR. CANTLON: Take you into Court and ask you now what have you done in the way of laying down an information base to assure the people of the State of Nevada that putting this here isn't going to essentially depopulate the thing because you've knocked out two genera of microphysal fungae. What's your answer?

MS. DIXON: I think we have--I would like to stay away from the game of if we were in Court, Dr. Cantlon, because I think that if we were in Court, a lot of things would be a little different than they are right now.

DR. CANTLON: Well, I'm talking about the scientific basis, the scientific basis. That's what this Board is

1 asking, is asked by Congress to--look, what is the scientific
2 validity of the decisions that are offered by DOE
3 undergirding each of its decisions? One of the key decisions
4 is site suitability. What's the scientific validity of the
5 set of data you're bringing forward into that decision? Now,
6 you start off with an environmental assessment which, I would
7 say, is not very well grounded today based on the model
8 that's emerging. Do you disagree with that?
9 MS. DIXON: Would the conclusions of the environmental
10 assessment say that there be no significant adverse effects
11 from site characterization? I don't believe that there will
12 be any significant adverse effects from site characterization
13 nor have we found any.
14 DR. CANTLON: But, the site assessment--the site
15 suitability decision has to go beyond site characterization,
16 doesn't it?
17 MS. DIXON: Yes.
18 DR. CANTLON: It has to be grounded in terms of what is
19 the repository model? What is the conceptual design of the
20 repository? That's what you're going to have to offer.
21 MS. DIXON: I thought you were referring to the EA.
22 DR. BREWER: Carl, you have reached the microphone?
23 Carl Johnson?
24 MR. JOHNSON: Yeah. I want to pick back up on what Dan
25 asked because I was very uncomfortable with the answer I

heard. I don't see how--unless you've got some criteria that has not been articulated today that has gone into the selection of the species you've proposed to study. Because in my view, the only way you can define what are the "key species" or the important key species that need to be studied is do an ecosystem study. Now, if there's some other way of identifying what those species are, I'd like to hear about it because it's not been described today.

DR. KORANDA: Well, the species that have been discussed today--and at times, I began to wonder if ecological science wasn't a totally futile and inscrutable science. But, anyway, the species that were described today in his tables and other tables were the dominant species of this vegetation unit. You can call it an ecosystem. That's just a concept that's in the head of man. It probably originated from people that studied a discrete physiographic unit like an alpine meadow or something. There's not argument about where the meadow ends and where it begins. But, those species that he had in his tables compose probably 95% of the plant bio-mass on that area. Now, what other criteria could you use for establishing significance?

MR. JOHNSON: What is the scientific basis that those dominant ones are the key ones that drive the system?

DR. KORANDA: Because they're the ones that fix the most carbon.

DR. OSTLER: Could we define what keystone species are?

DR. KORANDA: I don't know what that is. I'm too old to know what keystone is.

DR. OSTLER: --but I don't know what it is.

DR. KORANDA: I don't know what the hell is it, either. And, a keystone is a block that sits in a bridge and, when you take it out, the whole thing falls down. Right?

DR. OSTLER: Yeah. From what I know of the ecological systems, you know, there is no keystone, but maybe I'm wrong.

DR. KORANDA: No, in most systems, there aren't. Now, in a monospecific plant assemblage, you may have one plant. You've seen a lodgepole pine stand. There's hardly anything else that grows in there, right? And so, one species characterizes that lodgepole pine ecosystem. There may be a few ferns underneath it, a few. But, the canopy is always complete. So, there's no extensive growth of undercover. But, anyway, in the desert shrub land, it's too bad Linnaeus gave us all these species. He should have just given us grass, shrubs, trees, sedges, and algae, you know. Then, we could call this Shrub #745, you know. But, the thing is we have all these species and we use them for tags.

You know, I worked up on the tundra for many years and I studied one beach ridge that was uplifted and it used to be the beach of the Arctic Ocean and it was now two miles inland. And, I studied that beach ridge. Well, you know, it

was totally insignificant, a little piece of land. But, that's what we have to do in ecosystem analysis. We have to define a physiographic unit and do like you fellows have done. You walk out in the field and, you know, you could go out there with a mower and you could mow everything and you could put all the Coleogyne in one bag and all the Larrea in another bag and weigh them. Now, what would you have at the end? You would say those are the biggies.

And, I think that's what we've done here. Those are the plants that are fixing the most carbon and those are the dominant species and I have no idea what other criterion you could use to establish significance of the vegetation bio-mass there. You could say, well, there's an astragalus linogenosis that grows here one week out of the year. Well, hell, that's not significant.

DR. BREWER: Anyone care to pick up on that and follow?

DR. EHLERINGER: I'd like to sort of try to link this point with the point that I made earlier. I'm not going to try to identify the keystone species, but if, in fact, what Danny said is correct, the tortoise is not a--Coleogyne, it's not even Larrea, it's not even Ambrosia. So, if you take those away from the system, well, so what, in a sense? On the other hand, if you take away the Amsinkia and a few of the other things, then you have a problem. From that standpoint, it could be a keystone. My question to you is

why do you have the focus on the reclamation of perennial species for site reclamation--or for the site description when it turns up they are not the key species that are of interest to the endangered species, the tortoise?

DR. OSTLER: Well, I'm glad you mentioned that because I wanted to bring it back up anyway. I think we got a--not all the information was brought up in that discussion of tortoise food. Now, Danny did identify 10 species that tortoises use as food, but he didn't talk about the importance of other species as cover sites, for protection, and those are equally as important to the tortoise as perhaps the food that they consume. We are including some of those species that were on his list. I think he had 10 there. Three of those were on our reclamation trial. The problem with the other ones that have not been included is because we cannot get the seed for them to use in our trials. Not that we don't want to use them, they've just not been available. Point three on it is that we often see that those annuals will re-invade into a site whether you seed them or you don't. If we go up to Trench A Prime, that is completely covered with Amsinkia this past year and bromus. It was never included in the seed mix, but they're back there by themselves. You know, you've got --most of the annuals have high seed volumes that disperse real well and they come back into the disturbances without much input from ours. So, we felt that if you can establish

the perennial plants so they don't--so they're not competing with the annuals. You know, we're finding in our research that it's very difficult to establish plants when you've got perennials that are using all the water from a system. If you can establish the perennials first, the annuals will come in after and have been very successful at doing that. So then, you can establish the ecosystem rather than trying to establish annuals first and waiting for who knows how many years until the perennials can come in and compete.

DR. CANTLON: I would expand that just one notch further. And, that is that if you look in drought years where the populations of those food species are, they're under the shrubs. And, particularly late in the year, when you've vented a lot of drying out, the only place that there is a food supply is underneath the shrubs. So that there really are dominants that play dominant impacts on--

DR. EHLERINGER: But, see, we are getting closer to an understanding of the keystone concept.

DR. CANTLON: Right. So, it's really putting that picture together in kind of a functional way that helps you to understand the system.

DR. NORTH: It seems to me one way you could look at the definition of keystone species is what does it take to have the ecosystem fail in the sense that the present system can no longer maintain itself in that location? Maybe it's

nitrogen, maybe it's moisture. It would be useful, I think, to explore some scenarios for what could go wrong as the result of the repository. What adverse conditions might occur that could lead to major changes in the system? We have lots of examples of ecosystems that have changed drastically through some human interference or, in some cases, natural events. Sometimes, the changes might even be beneficial as after a wildfire, you get lots of forms that the wildlife can--but, sometimes, as for example, when we introduce an exotic species in a lake, we virtually wipe out the indigenous species. So, what could the problems be in Yucca Mountain? What could happen as a result of the repository that we'd like to be able to understand better before we made management decisions?

DR. BREWER: Anyone care to respond to that?

DR. KORANDA: We have some examples of this in California in the San Bernardino Forest. We have an assemblage of coniferous trees and certain species are smog sensitive. If you go into the forest, you see trees that once had three years of needles only have one year. All the needles are out at the end. And, we modeled this effect at Livermore and we found that in a couple of hundred years, the composition of that forest was going to shift subtly to the smog tolerant species. And, the forest wouldn't look much different except if you were a botanist or a crazy forester

or something. But, there would have been a change and that's what I expect might happen in situations like this where we have one parameter that's inimical to one of the dominants, one of the dominant species. Not the keystone species, which I haven't learned to love yet, but one of the dominant species might be clobbered and it would slowly fade away and Coleogyne would be 75 per acre instead of 30. That's what I see as possibly happening here unless the heat flux reaching the surface is so strong that it would just totally desiccate root systems.

DR. BREWER: We have time for sort of one more comment. John?

DR. CANTLON: I'll bring this one back and then I want to bring up another issue. But, to bring this one back into context, I picked up Wendy's question that she wanted to drive me to respond to and I think it is the appropriate question. So what? If you're only going to impact those species on a patterned area over the primary fracture system, so what?

MS. DIXON: Let me ask another question, then. I mean, I guess, I want to make sure that whatever--that you all understand that I am,you know, committed to protecting the environment at that site and I am committed beyond any words that I can express to this group. But, we need to make sure that--and, I'm not arguing with any suggestions that have

been placed today; I'm just putting out an umbrella. We need to make sure that the studies that we are doing can contribute to the protection of that environment and, you know, the money that is being spent in a fashion that works towards that end. It's not, you know, what some of the criticisms have been for the rest of the program. You guys are doing science for science sake. But, we're doing science to protect the environment. And, I guess, you know, you've just tossed the ball back to me. Let me toss the ball back to you. Those questions that you just asked need to be addressed and are addressed by civilization on a daily basis. They were addressed when McCarren Airport was built and basically whatever wildlife existed in that area was denuded to build that airport. They are made on a regular basis and that is a balance that this country has had to face from the beginning of time as to whether or not we can deal with an effect to the environment and how big that effect is as it relates to the rest of the environment and the surrounding areas and how good of a job that we have as caretakers to mitigate those effects and protect the existing environment to the extent we possibly can. So, those are all important questions that we need to deal with and that we as people in this country deal with, I think, on a fairly regular basis.

DR. CANTLON: Sure. And, what we need to provide the decision making world which is Congress and the Courts

eventually is what is the scientific basis for your assertion on what that impact is? And, that really is what the Board's focus must be and is.

Let me pull up one very different area and that is --

DR. BREWER: He's on a roll.

DR. CANTLON: That is this interplay between the environmental studies and the hydrologic studies. I guess I'd like to get Kent to expand a little bit on what that pooling of data and the interplay of the data might look like. You indicate that you are gathering similar data, you're pooling and fleshing out the density of the precipitation and so on, but you also got a much, much broader soil moisture profile set of numbers, and so on. Aren't there ways in which we can begin to get a little bit better handle on the point variability so we could begin to get some understanding of that? Is anybody looking, for instance, at the behavior of the hydrology over some of the fracture systems? I think the hydrology people are. Have you thought about that and projected the areal extent based on the fact of the mapping that they're beginning to do up there? See, these are the kind of quantitative ways of coming at the question I was asking and you threw to me first. Tell me how much of an impact you're going to make on which species and then I'll make the societal judgment. Not

me personally, but that's what society is going to say. But, you've got to give me some scientific basis on which to make that decision. What's going to happen with regard to bringing your data into better interaction with the hydrology data of Larry Flint?

DR. OSTLER: I don't know how that data is going to interface or interact, particularly as we get towards the EIS process. I, you know, do think they need to be considered, but I don't know.

DR. CANTLON: Yeah, it worries me that you keep talking about until we get to the EIS process. You see, the EIS isn't really--the way it's set up now isn't really due to start until the site acceptability decision is made. And, if you need the information to make the site acceptability decision, you're going to delay however long it takes you to generate that data.

MS. DIXON: I think that if you're--and, I'm probably talking out of school right now and somebody else--

DR. CANTLON: That's all right. We're friendly.

MS. DIXON: My understanding--I mean, we're supposed to be looking at early site suitability all the way through and if there was a disqualifier, the program is done and we all go home. But, in my recollection, there is not a set date of--you know, site suitability will be determined in 1997 and the EIS follows that. There may not be a determination that

the site is suitable until the end of the site characterization program.

DR. CANTLON: Right. The deadline that's in all of the written material that DOE presents is 2001.

MS. DIXON: Exactly. So, we're not--

DR. CANTLON: Are you going to wait until 2001 before you start looking at integrating the hydrology data and--

MS. DIXON: Absolutely not.

DR. CANTLON: Yeah. See, that's the kind of thing that I think we need--

MS. DIXON: Right.

DR. CANTLON: You know, our next iteration to begin to look at.

MS. DIXON: Um-hum. No, the thought was never, Dr. Cantlon, to wait until after site characterization was over. I hope that wasn't the message that we were displaying here because that certainly is not the case, at all. You know, that information does need to roll into, if not before--you know, whatever is determined appropriate, we'll roll into an EIS, and then if that wasn't--to wait until the EIS until after site suitability and site characterization was completely finished. So, I don't know if that helps clarify it or not.

DR. BREWER: Let me take the prerogative of the Chair and thank everyone for a really good day. I think everyone

learned a lot; even he learned something.

Thanks to one and all and we'll do this again in March.

(Whereupon, at 3:40 p.m., the meeting was concluded.)

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