UNITED STATES

NUCLEAR WASTE TECHNICAL REVIEW BOARD

WINTER BOARD MEETING

Environmental Issues
Socioeconomic Impacts
Exploratory Studies Facility Update
DOE Waste Isolation Strategy and Program Priorities

January 11, 1995

Beatty Community Center
Beatty, Nevada

BOARD MEMBERS PRESENT

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Dr. Clarence R. Allen
Dr. Garry D. Brewer
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P R O C E E D I N G S

(8:30 a.m.)

DR. CANTLON: Good morning. If you could take your seats, we'll get this session underway. This is the second day of the winter meeting of the Nuclear Waste Technical Review Board. My name is John Cantlon and I'm chair of the Board.

Yesterday, we heard from DOE and some of the affected and interested parties about the socioeconomic and environmental impact dimensions of this project. Yesterday was chaired by Garry Brewer and, if there's continuing interest on any of those issues by people who were unable to make their comments yesterday, please see Dr. Brewer some time during the break.

Before we start, Lake Barrett would like to make an introduction to one of the people who now has a role with the project that you would be interested in. Lake?

MR. BARRETT: I'd like to formally introduce to the Board Dr. Steven Hanauer. Steve has joined the Department of Energy staff as senior technical advisor to the director. Steve has been over 40 years in the nuclear business. He started at Oak Ridge in the very early days and on through and for the last 12 years has been a consultant in private industry on utility matters. Steve's forte is primarily in the engineering area, the nuclear engineering area, and he is stationed in Washington in our office--his office is on the other side of the wall from mine--and, advises Dan and myself on the engineering matters. He will compliment the chief scientist who will be stationed at the Yucca Mountain Project in the office of the project manager at Yucca Mountain. So, Steve is working on a lot of the integration areas, on the criticality safety case, on MPCs, and a lot of those integration matters that I know has been important to the Board since the Board's conception. So, I wanted to formally introduce Steve to the full Board.

DR. CANTLON: Thank you, Lake. We look forward to working with Steve.

Today's session will focus on two very central technical issues; first, what is DOE's waste isolation strategy and, second, what are the program's priorities for ascertaining whether, with acceptably low levels of uncertainty, the Yucca Mountain site will be acceptable for a deep geologic repository.

This session will be chaired by Ed Cording who is a geotechnical engineer on the civil engineering faculty at the University of Illinois. Ed, it's yours.

DR. CORDING: Thank you, John.

Today, we're going to be discussing priorities for exploring and for testing at the Yucca Mountain site and discussing the site characterization activities that lead to the decisions on the suitability of the site and, if it is declared suitable, to license application.

In the first presentations this morning, the DOE, specifically the group from the Yucca Mountain site characterization office, will continue the dialogue that began at our October meeting in Las Vegas on the strategy for isolating waste and the resulting priorities for site exploration. This will then be followed by presentations on underground exploration and exploratory studies facility, the ESF, and on the exploration of related to surface-based testing.

Almost a year ago. Dr. Dan Dreyfus, director of the Office of Civilian Radioactive Waste Management, proposed a new approach, the program approach. Over the past year, DOE has made to the Board a series of presentations as this program approach has evolved. The approach focuses on the investigations required for technical site suitability decisions and for initial license application and gives dates for some of these events.

In a Board letter of December 6 to Dr. Dreyfus, the Board noted the program approach is resulting in a much needed prioritization of exploration and testing activities. The program approach should ultimately lead to a linkage of the waste isolation strategy with the budget and schedule required to accomplish the technical objectives. The Board has noted in its report and in that letter some of the high-priority testing and exploration objectives and noted that these objectives needed to be reached and technical evaluations completed prior to some of these decision points.

Primary emphasis and high-priority that was outlined and has been discussed over the past years in the Board's reports and in this letter included the hydrologic investigations to evaluate groundwater flow and vapor transport in the mountain; the exploration then required to accomplish that consisting of items such as extension of drifts east-west across the repository at site to cross the major structures, most of which are north-south trending structures, in order to see what the faults--not only to see what faults are present, but how they look when water flows in them and what sort of conditions they might have related to the hydrologic condition--the hydrologic behavior.

They also discuss the exploration of representative zones at, above, and below the repository level including the Calico Hills where there are a lower frequency of joints and it's one of the planned geologic barriers to flow away from the repository level. Looking also at another important area is the thermal hydrologic interactions and even at lower thermal loadings water will be mobilized and there will be a flux related to the thermal effects.

I think the project is on the threshold of obtaining a significant view of the conditions in Yucca Mountain. A wealth of information is going to become available to the project as the exploration continues, construction gets down to the--the tunnels get to the levels at which information needs to be collected and the testing is carried out. DOE has probed around the perimeter with surface mapping, remote sensing, boreholes; but what is now needed is to cross the major structures in the mountain in, and around the proposed repository level. As has been indicated to us, the tunnel machine is now operating. It's capable of rapid progress and how well this construction operation has managed, how well it has integrated with regulatory demands and test requirements, that is going to be a key to the ability to get to key locations in the mountain and in conducting the high-priority tests there in a very timely manner.

I'm looking forward to our presentations today on the strategy and how some of this is going to be accomplished. My own perception at this time is that much more can be achieved than the present schedule provides. I'm looking forward to seeing much progress in this next year in accomplishing some of the objectives that are going to be discussed today.

I'd like to just outline briefly our format. It differs a bit from the original announcement. Russ Dyer will begin our presentations today and he'll be talking on the linkage from waste isolation and containment strategy to key exploration studies, facility decisions, and testing programs. Russ is a deputy project manager for the Yucca Mountain Site Characterization Office. Now, with him at the head table here is a panel and they will be discussing and presenting as a group in this morning's session. Rather than making separate presentations, there will be individual presentations at different times and discussions of the items related to the waste isolation strategy and where we're going with the testing to accomplish the objectives of testing to evaluate that strategy.

And so, we have the panel then with Steve Brocoum. Susan Jones is on the right next to Dennis Williams. Jean Younker is also part of that panel. So, those presentations will continue this morning. And, during the presentations, we will entertain comments from the Board and staff or questions from the Board and staff because it will be a fairly long session and we'll have times at which the Board and staff can ask questions or interrupt even to ask questions and we'll try to make available time when questions can be directed to the panel from the audience that are related to the topics we're discussing this morning. In addition, we will be having a public comment session this afternoon after the session where questions related to the topics today, as well as other questions that you might have, the public might have, or anyone in the audience might have related to the Yucca Mountain Project itself, the waste isolation strategies, the entire nuclear waste program. Those can be discussed, questions can be offered, and comments made. If you would for that, you can contact our staff, Helen Einersen, or Linda Hiatt to indicate your interest or can come directly to the microphones to make those comments.

So, we'll begin then this morning now the morning session with Russ Dyer's presentation.

DR. DYER: Thank you, Dr. Cording.

Before we start with the presentation, I have a couple of announcements that I think will be of interest to the Board and also to the audience here. Lake announced a new member of the headquarter staff and I would like to introduce a new member of the project staff. He's been around for a couple of months, but this is his first appearance in front of the Board. You'll be hearing from him a little bit later, but I'd like to introduce Richard Craun who takes over as our assistant manager for engineering and field operations. Could you stand up, Rich?

(Pause.)

DR. DYER: Rick replaces Bill Simecka. He comes to us from DOE Rocky Flats. Actually, probably the qualification that made him most desirable for us is 15 years of experience in the nuclear industry at the Fort St. Vrain Power Plant.

The second announcement I have is a reminder that last year we started a new type of symposium at Yucca Mountain, the technical program review. We will be having our second annual technical program review this year in February, February 13 through 18. That will be at the Palace Station Hotel. As last year, this will be an open meeting with observers invited to attend. The theme for this year's technical program review will be suitability, site suitability.

With those preliminary things out of the way, let me set the stage here. My task is just that. Set the stage for the discussion that follows which we've tried to integrate into something a little more meaningful than just a series of presentations where one speaker will have to defer to the following speaker. So, it's going to be an interesting challenge here, but I think you'll find that we will be raising issues and trying to say what we're doing on those issues as we go along, rather than deferring to different speakers.

Dr. Cording mentioned the Board's letter of December 6 and we're going to address some of the comments and concerns raised in that letter, not all of them. We are still in the process of drafting the response to that letter.

But, these are the things that we're going to concentrate on today. Is DOE continuing to focus on developing a clear definition of the waste isolation containment strategy for the repository? Secondly, our major decisions about the exploratory studies facility excavation sequence linked to the waste isolation and containment strategy? And, thirdly, is the testing program focused on the right work?

In the suite of presentations that we have, our goal is to cover these four things. I'm going to be focusing on the first bullet here; to review the basis for key decisions related to the sequencing of exploratory studies facility construction. There are essentially five issues in there and I'm going to address the programmatic basis for our current position. To review the waste isolation and containment strategy, and Jean and Steve will be doing that, as well as looking at key uncertainties associated with that strategy. That's the next one; to show the linkages from the surface and underground testing activities to these key uncertainties which are derived from the waste isolation and containment strategy. And, lastly, to provide a status of surface-based and exploratory studies facility activities. Part of that will be addressed during that presentation and part of it will be addressed in some summary talks by Dennis and Susan.

If I could take the Board back in time about two years, this is a graphic that was used wherever we were explaining a thing called the integrated test evaluation effort, the results from that, which was an effort to prioritize the testing program. Whenever we did that decision analysis based study, we found that it was hard to define just a single reason for fielding a particular test. There's really, at least, six different underlying rationales that lead you to desire to field a particular test; anything from providing support for design information, detecting unsuitable site conditions, demonstrating regulatory compliance, building scientific confidence which happened to have a high value in the studies we did, building constituent confidence. All of these are reasons for fielding the tests.

So, building on that, over the years we've discussed the need for a balanced program in the site characterization program that includes both surface-based testing and underground testing. The surface-based program is important for improving our 3-dimensional hydrologic/ geologic framework and for getting information regarding process models, and it also enhances the representativeness of the underground ESF, exploratory studies facility, results.

Both surface and underground testing provide information needed to design regarding seismic hazard and rock stability and the environmental conditions around the waste package. The ESF, on the other hand, provides access, underground access, to key features; key lithologic contacts such as the Paintbrush/Tiva contact, Paintbrush/Topopah Springs contact, and also structural features such as the Ghost Dance Fault. In addition to these, of course, there is a laboratory testing program that augments the field program and it's an important source of information regarding materials, geochemical, and rock properties data.

If we look at the program plan, Volume 2 of the program plan specifically, the program plan was developed on the basis of key decisions and assumptions. I'm going to go over the basis for some of those, not all of which are explicitly called out in the program plan. I should also add that there were a lot of decisions that are in there that based on constraints that we had to work with. There obviously are constraints on the resources that were available.

The five things that I'm going to look at are Calico Hills exploration, distributed testing alcoves versus a main core test area, in situ thermal testing, and east-west extensions of the north ramp, and completion of the 5-mile loop as opposed to going and doing either Calico Hills or the north ramp extension.

The first topic is the Calico Hills exploration position. Our current position as laid out in the program plan, Volume 2 of the program plan, shows us with around 4,000 meters excavated by fiscal year 1999 with an addition 1500 meters in fiscal year 2000. The basis for this position is as stated here. We're going to have information from surface-based testing and from a suite of studies which we're fielding this year in P-Tunnel that's up at Rainier Mesa on the Nevada Test Site that we think will provide an adequate basis to support bounded flow and transport predictions for the 1998 technical site suitability evaluation. The program approach places the highest priority in developing a high confidence regarding the waste package performance and the near-field environment. This is for the license application in 2001.

If I continue on the basis for the position here, we think that it will be critical to develop a high confidence about the performance of the Calico Hills unit as a natural barrier for transport, radionuclide transport, for the 2008 update to the license application. The north ramp extension, if you look at the prioritization of our efforts after the excavation of the north-south main, the 5-mile loop if you will, after that excavation is complete, the next highest priority for underground excavation has been given to the north ramp extension to look at features to the west of the Ghost Dance Fault before the Calico Hills, before access to the Calico Hills. These are things that could be revisited if need be, certainly; but one thing that's associated with the north ramp extension getting a higher priority is that this would allow an earlier initiation of the long-duration heater test. As Dennis and Susan will tell you, we're looking at other ways that we might be able to initiate heater tests earlier in the schedule. As I said, this current position has to be continually re-evaluated. We have a series of ongoing evaluations. There's a system study currently underway which reviews the sequencing to insure that it's consistent with suitability and licensing data needs and we'll evaluate this system study results and update the excavation plan, if appropriate.

There has been a change from the concept of a concentrated core test area to a testing strategy that's based on distributed testing alcoves. Our current position is that we will use distributed testing alcoves rather than the core test area. We have seven alcoves in the plan right now which will be completed by 1997 and I'll tell you what those are in a minute. But, we've got an additional 20 that are currently in the plan that could be completed by 2001.

The basis for this position is that the distributed testing alcoves became practical whenever we came to the decision to develop a ramp access where one could access various stratigraphic and structural features. The locations of the first seven alcoves were tied to data needs that were identified to support technical site suitability evaluation. And, as a practical matter, the ease of access and operations is considerably improved using an alcove approach.

The testing in the range of rock units and we would look at the ability to field the test in an alcove at essentially every one of the stratigraphic contacts for units above the potential repository horizon provide us a better basis for correlating with the information derived from the surface-based program. This testing at lithologic and fault contacts may be important to understanding the fluid flow process which we think certainly the NWTRB has appropriately pointed out as one of the major areas of uncertainty in our testing program. Again, this is not sealed in concrete, if you will. If we encounter some unexpected feature, we have the flexibility to develop additional alcoves to explore those features as we encounter them.

In situ thermal testing, the current position laid out in the program plan is that thermal-mechanical measurements on samples from the ESF and from the surface-based boreholes will be adequate to support the technical site suitability evaluation. Accelerated short-duration in situ heater tests will provide an adequate basis for the 2001 license application. Dennis and Susan will give you a little bit more detail about what kinds of tests will be available to support this. Then, post-2001 testing will provide the basis for evaluating whether higher thermal loads are acceptable to support an amendment to the license application.

The basis for the position is that the 1998 technical site suitability evaluation will rely on performance assessments that bound the range of thermal loadings under consideration with the reference case being on the low end of the thermal range. I think this is consistent with some of the statements in the letter of December 6.

The licensing conditions for the 2001 license application will be on the low rim of the thermal range and again that's, I believe, consistent with the understanding of the Board in their December 6 letter. Any move to a higher thermal loading would require an update to the license application; would, of course, need to be supported by the information developed during the longer duration, higher thermal load testing that we have planned. There are, of course, a series of ongoing evaluations regarding this suite of studies also. We have system-wide trade studies that either are underway or planned that will provide insight into the adjustable parameters; that is, those having to do with system parameters such as receipt rates, age of fuel, surface storage, partial loading. There could also be parameters associated with operational parameters relevant to thermal loading. There's, we think, a good likelihood that streamline in situ test designs may allow earlier heater test initiation.

The next one I'd like to look at, the next position that we have in the program plan has to do with our position on the east-west drift of the north ramp extension. The current position is that we would have a 1600 meter north ramp extension completed in fiscal year 1998 and this ties to the next topic that we'll be talking about. And, the basis for this position that we looked at was that we will have some information that we think will tell us something about potential structures west of the north-south main, west of the Ghost Dance Fault, that's primarily going to be based on geophysics; refluxion, shallow and intermediate refluxion, gravity magnetics. We'll be doing some magnetotellurics this year. That may or may not provide some useful information, but we will have a suite of geophysical information available that we can use. There's also, of course, information from the surface-based drilling program that will provide additional controls on structure and stratigraphy, and Susan will be going over the drilling program; specifically, the holes that will be available to support this. The north ramp extension provides us, of course, an east-west section and provides access to the Solitario Canyon Fault prior to the license application in 2001. And, if we rely on the north ramp extension as being the location by which we will field the long-duration heater tests, then we are providing access into those testing facilities at an earlier time to initiate these tests prior to the 2001 license application.

DR. ALLEN: Russ, you asked us to interrupt; so, may I? Are you optimistic that the NRC will accept a license application without a drift to the Solitario Canyon Fault actually within the block because the north ramp extension is outside of the block, right?

DR. DYER: I'm trying to remember the--I think it's just on the north side of the block, yes. Yes, it would be just north of the north part of the block.

DR. ALLEN: Outside?

DR. DYER: Right.

DR. ALLEN: My question is do you think the NRC would be willing to accept an application without a drift actually within the block over the Solitario Canyon Fault?

DR. DYER: I don't think we've explored that adequately with the NRC yet. I don't know what their position would be on it. I think, first, we'd like to understand what kind of information we could develop prior to doing the underground excavation. We're going to have some excavation--some east-west excavation, but it's going to be east of the Ghost Dance Fault. The two testing alcoves down on the Ghost Dance will provide us some east-west information, but not to the west.

It may be that we need to develop something; a more robust east-west excavation underground. And, I think we'll just have to evaluate the information at that point in time.

DR. ALLEN: I just ask that because although the geophysics may tell you where some major structures are, it will give you no indication of what the nature of those structures really are at depth in terms of water flow and this sort of thing.

DR. DYER: Right, concur.

DR. BROCOUM: Russ, can I make a comment? In terms of whether the NRC accepts our application, whether we have an east-west drift, I think they'll look at our whole application and our whole case and argument and they'll make their call as to whether they can docket for licensing. There is an NRC member here. Mark Delligatti, I believe, is here if the NRC wants to say anything.

MR. DELLIGATTI: I don't want to say anything.

DR. REITER: Russ, I just wanted to amplify on something that Clarence said about the Solitario and north ramp extension. Another problem is that Scott & Bonk show possible splay of the Solitario going into the repository block. It doesn't reach the north ramp extension. How would you address that?

DR. DYER: Well, I guess, I'm going to have to say that again this is not a decision that is set in stone. We're going to have to re-evaluate things as more information becomes available. If we determine that we think we're going to have to have more underground excavation to support that case and if all of our oversight regulatory agencies also seem to point us in that direction, then we're going to have to accommodate that within the program.

MR. WILLIAMS: Are remarks going to be based on--where did you get the new information that we're able to get or--how dependable that information is, the level of confidence that we have in it, and whether or not we feel good about taking that to the NRC at licensing. But, I think as we get into today, you'll see that we may have a little bit more in the way of surface mapping, geophysics, boreholes, et cetera, than we had--than some of the folks here had obviously thought.

DR. CORDING: I think it would be good to come back to this topic as we go through the discussions today and there's several ways of thinking about east-west extensions even in the Calico Hills, for example, to get some of that information and also I think it has been an interest in having something--if you could have the best location, to do it in the central part of--a fairly significant east-west extension in the central part of the repository block. But, I'd like to continue this as we go through because I think there will be more material that--we should put this on the table so we can continue to discuss it.

DR. DYER: Let me go down to the last bullet on here, ongoing evaluations. There is a footprint for a potential repository which was based on a presumed thermal loading. If we decide to go with a lower thermal loading, we may need to develop a larger footprint for a repository. Those potential expansion areas which would accommodate a larger repository footprint were laid out in some potential expansion areas in the site characterization plan. The current characterization program does not really focus on those areas and we need to develop contingency plans to investigate those expansion areas if it looks like we're going to need them.

The last topic I'd like to touch on is completion of the 5-mile loop. Why complete the 5-mile loop at the expense of some of the other things that could be done in the way of underground construction and exploration. The current position is that we would complete five testing alcoves in the north ramp and main drift and two in the Ghost Dance Fault access in the '96/'97 time frame to support the 1988 technical site suitability evaluation. This would be the existing alcove in the starter tunnel, alcove at the Bow Ridge Fault, alcove at the Paintbrush/Tiva contact, alcove at the Tiva/Topopah contact, alcove at the Drill Hole Wash structure, and then the two alcoves along the Ghost Dance Fault; one of which might also be at the confluence of the

Ghost Dance and Sun Dance Fault. And, that the 5-mile loop would be completed in 1997, fiscal year '97, with no additional test alcoves constructed after the second Ghost Dance Fault access.

The basis for the position, accesses to the Ghost Dance Fault would provide key information regarding the potential for fast flow paths to support the 1998 technical site suitability evaluation. By looking at the Ghost Dance in several places, we'll see how the characteristics of this fault, some of the hydrologic properties, change as a function of displacement. If you'll remember, the Ghost Dance Fault is a scissors fault with displacement increasing to the south. So, we'll examine it in places where its character should be somewhat different. Continued exploration will be gained through completion of the main drift and the south ramp. This is going to increase the spatial coverage, the underground exploration that we have again primarily along the Ghost Dance Fault. Additional testing alcoves are planned after 1998 to support the licensing process. This was the number 20+ that was on the first slide that I had.

Again, we will continue evaluation to determine whether completion of the 5-mile loop is the best use of the resources and some of these considerations include the value of additional east-west drifts with the current resource constraints we have. It is very difficult to undertake construction exploration on two different headings. One option would be to cease exploration on the north-south/main and to look at an east-west drift of either the north ramp extension or perhaps something a little to the south of that. Trade that against the value of an earlier Calico Hills access and one thing that needs to enter in here is the cost of maintaining a tunnel boring machine in a standby status. That may be minimal or it may be somewhat more than minimal and we haven't made this evaluation yet.

With that, that pretty much concludes my introduction. This might be a good place to get questions from the Board or the audience regarding my part.

DR. CORDING: Certainly, let's have a few--any questions for Russ on his presentation?

DR. LANGMUIR: Russ, I want to endorse the statement made on Overhead 10 and, in fact, go further than that. You're talking about testing area versus distributed testing alcoves and there's a statement made here that the basis for moving to the alcoves is testing at lithological and fault contacts may be important to understanding fluid flow processes. I would argue that it is essential for understanding fluid flow processes and it's one of the--it is perhaps the biggest reason for going underground is to find the fast pathways and characterize them. So, I agree;

motherhood, whatever. And, also further in that sense, attempting to find samples of water coming from those fast pathways and age dating is probably the most important that you're going to do underground in terms of hydrology, at least in my view.

A different topic, though, having lectured to you, the in situ thermal testing analysis here, I was doing some back of the envelope--lots of these envelopes. After our last meeting, we decided we would make them provide back of envelopes for lots of activities like quick calculation. But, my sense of low loading--and I'm not sure I've heard this articulated by DOE yet--is that if you go low loading, what it's doing for you is it's allowing you to use almost all the information you've obtained from site characterization of the mountain in the absence of a repository to extrapolate to performance of a repository. In other words, for the low loading scenario, you're saying that the bulk of the flow into the system is the infiltration flow, gravity driven, and that's what it will be after the repository is in place. I think you're hoping without saying it that that's going to make it easier to get a license because then you could just take all the models which have been verified and validated and all the data obtained identifying fast pathways and say that's the way it's going to go with a repository, too; period, no need to do testing.

The problem I have, though, is that you're making the assumption that a repository in place will not perturb the system sufficiently to alter that gravity driven flow. That's an assumption you're making which you haven't tested. So, I think that's an essential direction to be testing in the next few years before '98. Is there, in fact, a condition with an adequately sized, not too--your current footprint, if you like, or something you could obtain which will allow you to assume that--that the characterization information in itself is sufficient to go for license assuming that the characteristics that you obtain from that, the models you obtain from that, and they'll work. You've got to find that out and that's the first thing you've got to find out before that assumption is a valid one. Because then you superimpose the refluxion repository driven flow on top of that and how important is that superimposed flow envelope, if you like? I've got some schematics where I've said, well, okay, if the low loading ideally is 98% or it's dominately the gravity thing. And then, the only water in contact with waste is the water in the mountain that comes from infiltration. As you kick up the temperature, then you're talking about repeated contacting of water from the refluxion process and how much is that and how important is that as a function of time and what is that doing to your performance?

So, anyway, these are the kinds of things that are running through my head now as you propose a baseline low loading strategy which you've got to worry about.

DR. DYER: You're right on, Don. Whatever Jean and Steve talk about, waste isolation strategy and major areas of uncertainty, that's going to show up as one of the big ones, as "What is the adequacy of the existing models." The system is going to be perturbed to some degree. It will not be an ambient repository. The system will not be the same as the ambient system there now. Well, what are the areas of uncertainty associated with that? You've listed, I think, the major ones. There are a few more that will be talked about. And, what is the testing program that you need to resolve those uncertainties? And, that's what Dennis and Susan will try to address here shortly.

DR. LANGMUIR: Well, see, what I see here in your proposed activities prior to '98 or 2001 is that ESF studies that you can do before then, surface-based boreholes stuff, accelerated short-term tests, is enough. It's an implication that that's enough which tells me that you're having to assume that you already will know from characterization is what's going to provide the bulk of the information you needed. Because this provides almost nothing additional in terms of allowing you to predict.

MR. WILLIAMS: I think, as we get into some of the details of the thermal testing, you'll see that we are--to some extent, we've got a little bit of a difference here because we're not following exactly the thermal repository loading strategy. We're talking about a thermal testing strategy that runs up to relatively high temperatures even in some of these early tests. So, I think that might give us a little bit of confidence that we're seeing the full range of effects from the perturbations of thermal load from low to high.

DR. LANGMUIR: I can't see how you can see them because you're talking about mountain performance in a repository. You're talking about a few meters in a block in a thermal test. It's these mountain phenomena with the refluxion, condensation, chemical changes, hydrologic changes that are going to really determine performance.

MR. WILLIAMS: I think I can agree that we won't get to the full scale that you are interested in, but there are certain--there's a certain level that I think we will be able to answer some questions on.

DR. YOUNKER: Yeah, I was just going to make a couple of comments. I think there's two things. One is in terms of the impacts that just the excavation and the site characterization is having. We get a little bit of a handle on that because with everything that we do, we ask the question what kind of potential impact could this have on future performance. So, although it isn't quite getting at what you're after, in a sense at least I think it will give us some insight into what kinds of changes and impacts we could have on site conditions, you know, by introduction of organic materials or by the excavations themselves. So, that's a little bit of help, I think, that is something that we do in parallel with all the surface and underground testing and construction activities.

The other point was that--and, this is jumping ahead a little bit, but I think it's appropriate right now. One of the things you might well expect, since we've gone with the lower thermal loading concept now as our licensing strategy and as our basis for technical site suitability, the Livermore folks, especially Tom Buscheck, are already out there looking at what kinds of thermal hydrologic effects you'll get at the lower thermal loading and what you could do by changing the pattern of emplacement. I think we're going to probably in the next few years see some pretty interesting results where there may be some ways that you can look at the actual emplacement of the heat load and get a handle on what kind of redistribution of flux you get and control that to a certain extent or actually tailor it.

So, that's some of the things I think that you're going to see coming out of some of the modeling efforts. We still need the data, as you point out, to determine some of those modeling results are correct, but I think you're going to see some interesting results coming out. As you well know, we couldn't stop Tom Buscheck. He will be doing those studies and we'll all know about them very soon, I'm sure.

DR. CORDING: Other Board, staff?

DR. DOMENICO: On Viewgraph 13, I see under ongoing evaluations, Russ, contingency plans in the event that you have to expand a footprint. It seems to me I recall a few years ago that under low thermal loads, the existing footprint was demonstrated to be not sufficient to accommodate the load that you wished to put in it. So, if you go into licensing with a low thermal load, it seems automatically that that footprint is not sufficiently large to accommodate it and it seems to me like the contingency plans are really not contingency plans. It seems to me there would be a large part of that repository that will not be investigated by the year of the license; is that true?

DR. DYER: Well, if you look at--Susan will have some information a little later about borehole distribution. There is a considerable amount of information in the potential expansion areas already because that surrounds the block. The early stages of site characterization avoided the block, but penetrated the ground around it. So, we have information in the potential expansion areas. We may have to augment that with some other information needs as we identify them, but I don't think that we would have to undertake a whole new site characterization program. There may be some needs for underground information and potential expansion areas.

DR. DOMENICO: Thank you.

DR. BROCOUM: One other point here is, you know, in our initial license application, if our thermal loading is such that we cannot accommodate all the--we may actually apply for some other amount and then, as we get the information later from the expansion areas, amend the license application.

MR. MCFARLAND: Russ, on Page 7, you make the statement that DOE's program approach places highest priority on developing high confidence about waste package performance and near-field environment for 2001 license application. You say nothing about site suitability. There are two statements made with regard to site suitability; one on 7 and then the other on 9 that (1) Rainier Mesa non-welded tuff will be used for the bounding calculations for site suitability, even though this formation has been altered appreciably by nuclear weapons tests. And then, on 9, you say that essentially the only other reference to site suitability in your presentation was that locations of first seven alcoves tied to data needs for technical site suitability. What is the data that you feel needed for a site suitability determination?

DR. DYER: Well, we're still developing the explicit data needs for site suitability. If you remember in the program plan, I think it lays out the eight different basis reports that will be completed. And, there obviously is going to need to be some information developed about the hydrologic system and about the various compliments of the barriers, natural and--well, primarily the natural barriers. We're going to have to--we've got an idea right now. We're going to have to refine these ideas as we go along. What information is needed from the natural parts of the system? As Dennis said, one of the first things that we need to do is to collate all the existing information, see if we can make a bounding case which is what we were talking about, the P-Tunnel information, to help us construct a bounding case for what the Calico Hills' contributions to the natural barrier system might be. But, that's not the only component of the natural barriers. Probably, as the Board I think has appropriately identified, the amount and properties and sequencing of water that might reach the waste packages and be available to transport materials out is probably one of the most critical things that we can understand. You're going to see that a large part of the testing program is focused on getting that information.

DR. BROCOUM: I'll just give my more regulatory answer to this. You know, site suitability is defined fundamentally by 10 CFR 960. So, the information to make those findings, both the qualifying and disqualifying conditions at such a level that we think additional information will not change our minds, having that information is sufficient to make a site suitability; you know, in terms of the technical site suitability as we've defined it.

MS. JONES: I was going to give you a very practical answer to that question because right now the suitability team that Steve has working is in the process of developing the outlines for each of those technical basis reports that will precede the regulatory evaluation. And, in those outlines, it's very similar to the annotated outline process for the license application. Basically, it's going through and listing the types of information that are needed to provide that technical basis. And, those are going into internal review, I believe, within a week or two and will form the basis for the discussions, both the planning and discussions, that take place at the technical program review. We're going to be stepping through literally each one of those technical basis reports that are tied to the incremental suitability higher level finding decisions. And, like I said, those should be available within about a month and will be the focus for that technical program review.

DR. BROCOUM: We're trying to bring both the people that collect the information and the people that analyze it in to determine what you need to make a finding together to reach a common understanding on the information necessary. We think that kind of a forum would be a very interesting meeting because the exact goal is to reach, in a sense, closure on the information needed for each of the technical basis reports.

MS. JONES: And, I was going to say that--yeah, some of the initial outlines that I've seen aren't just arm waving and very generic. They are listing right down to the fact that specific cross-sections or maps are needed, as well as specific types of data.

DR. CORDING: If we would, just remember to identify ourselves. You have the names at that table. Fine; so, that's all right.

Russ, I wanted to just comment and perhaps you would respond. On one of the concerns I have is that you have a--time is short, there's a lot to be accomplished. I think it's going to be very--one wants as much flexibility as possible in doing an exploration program. At the same time, it's going to be very difficult to do something additional if plans are not in place, for example, for a contract to--you know, for example, to do the Calico Hills tunnel project. The contract has to be prepared now to do that. If we're going to be doing drifting off to the sides, tunneling equipment has to be procured now. So, a lot of those sorts of--there can be some flexibility in locating things, but there's a lot of procurement and there's a lot of contracting that has to be done. And, if it isn't planned now, it just won't occur. So, I'm somewhat concerned about our saying, well, when we look at it, we'll make our decision. In doing that, we have to have a plan in place that can be put immediately in place if we're really serious about doing that potential alternative.

I was kind of wondering what your thought was on that in terms of the preparations being made for some of these options?

DR. DYER: You're absolutely right, Ed, but before you change a plan, you have to have a plan to change from. What we've put in place is the initial plan. This is going to become the baseline for the program and we can modify that. You're right; it's going to--these are not instantaneous things. There has to be a forethought put into this. But, first, we've got to get a baseline program that we can work from.

DR. PALCIAUSKAS: Just a followup, it's really concerning this Overhead #7 that DOE's program approach places high priority on developing high confidence about waste package performance--and I stress--the near-field environment for the 2001 license application. I read into that that you are going to be focusing in and I presume you'll be talking about the fact that something more about the engineered barriers, that they would perhaps replace certain uncertainties that the geological system was not able to provide. This seems to be a shift from the previous focus that the Department had. At least, I believe it was not enunciated. So, I was just wondering if you could clarify that?

DR. DYER: We still have the multiple barrier concept, but I think the strategy has--in fact, I know the strategy has been to go with a more robust engineered portion of this multiple barrier. That's probably more demonstrable in the near-term and may help us deal with some of the uncertainty and there may be--there will be some residual uncertainty in the natural systems. So, it's a way to--

DR. PALCIAUSKUS: I'm not objecting to that. I was just curious if we'll hear more about it today or not.

DR. DYER: Yes, you will.

DR. LANGMUIR: Russ, more of these off the thought, quick things that have come to mind as I considered your low loading strategy. It strikes me that given that, you have a terrific urgency to continue and define the nature of groundwater flow in the mountain from both surface-based testing and underground, whether it's fracture or matrix or both and the ages of the waters you identify in the ESF or from surface-based testing, as part of that process of characterizing the flow since that's presumably the same flow you're expecting to have there when the repository is in place. But, because you're going to maximize corrosion with a low loading strategy, at least in terms of time of contact of water with the waste packages, you're going to have to, as you're proposing to do, put more energy into the EBS effort to minimize the consequences of that. So, these are just some of the things that--in the Calico Hills, frankly, you're putting it off, it looks like, until later. But, the geochemists will tell you and I think I can agree with them within your program that if you go low loading, Calico Hills is a critical barrier for slowing up anything that move out of the site. So, it becomes an urgent issue not in 2001, but through '98. It should be part of your early process in my view. Anyway, those are the things that I see now becoming the priorities between now and '98.

The high loading scenario, there's no way you're going to know what's going to happen without long-term tests, presumably in a repository, because you're changing the pathways and you're changing the groundwater travel-times in those pathways in ways you can't predict. You can only determine that by long-term large scale tests. Block tests aren't going to do it in my view; small scale tests aren't. Anyway, enough pontificating.

DR. DYER: Well, Don, I absolutely agree with you. The challenge we have is allocating the resources, doing the right thing at the right time. That's where the advice of the Board will become very important to us.

DR. CORDING: Okay. Thank you, Russ. I think we've had good opportunity here to begin the discussion. And, now, perhaps you might indicate to us what the format is going to be for your next presentations. We will continue this all morning, by the way, and then we'll have in the middle of this a break and sometime during this period we'll have some opportunity for public comment or audience comment on the topic.

DR. DYER: Before I move my bulk out of the way here, let me introduce the tag team that's going to take over for me here. Steve Brocoum and Jean Younker will be talking about the waste isolation and containment strategy, the focus on that. And, part of the things that they will be bringing up are key uncertainties associated with each element of the waste isolation and containment strategy. And, also, at the same time that we talk about the key uncertainties, talk about the testing program that we have planned that will address and, we hope, those key uncertainties. So, if we do this right, this should all flow as one fairly seamless presentation here. I think Steve is going to start off.

DR. BROCOUM: I think someone just hit it. You know, in large measure, we're talking about how can we best put together our case for TSS and for the year 2001 and we are talking about allocating resource. So, we're really talking strategies in some cases versus the best technical approach in others. It's kind of very important.

I'll be talking the role of waste containment and isolation within the overall program approach. Some of this was discussed by Jean in the October meeting, but we're kind of setting the stage. Jean then will get into talking about how we're going to implement this strategy. She'll talk in more detail what the elements of the strategy are, what the uncertainties associated with each element are, and our approaches for reducing those uncertainties. Then, when we get to the areas where there is testing either on the surface or in the underground which contributes to reducing those uncertainties, she will turn it over to Susan for the surface-based portion or Dennis for the underground portion who will give you the details. I think we're going a step further than we did in October. So, we're going from a top level strategy to how we're implementing it to what the uncertainties are, how we're going to approach addressing them, and what the specific tests are that will get the information for reducing uncertainties. That's the whole outline of presentation. We didn't actually dry run this in this format. So, we may have a few rough moments here. We made this change very late in the game to do it in a panel format, but we thought it would be more effective in conveying our messages to the audience. That's why we did that.

DR. ALLEN: Steve, did you say panel format or panic format?

DR. BROCOUM: A little of both. A little of both. We apologize for that late change, but we think it will lead to a better overall presentation.

One little caveat here that we are very much worried how the repository may perform and that's one of the key goals we're trying to find out. We're also trying to address all these other things. Looking for unsuitable features or conditions as defined in 10 CFR 960; making sure that we can comply with pre-closure criteria during operation and open phase of the repository; doing tests to support design development--for example, many of the, SD holes which support repository design--testing to support other tests--for example, part of the information of the large block test is going to be used to make better and better tests--scientific confidence and Russ discussed that. One can get into a big philosophical discussion on scientific confidence. You know, there's many reasons for testing.

Now, we want to again review what we said in the SCP, show that our strategy hasn't changed very much. It has changed in some degrees, but not greatly from the SCP, and show what our elements and our strategy are today. In the SCP--again, these are briefings giving, when the SCP was issued in 1988, the strategy that said they place primary reliance on low flux, slow water movement, and long radionuclide transport times. It also recognized that we had to understand low probability, potentially disruptive processes, and we have to identify them and understand them and what their impact might be on the baseline repository. And, finally, there was a recognition that we had to worry about seismic design criteria in a pre-closure operation superior to repository. We have a meeting coming up on that whole subject with the NRC on the 26th of January.

We have diagrams like this and, if you look at these diagrams, for example, we're talking about the engineered barriers in the post-closure period. We were talking about depending on the unsaturated or on the rock/air gap in those days, We were going to put the waste package either in the floor or in the wall of the repository and put a little air gap around it. Limit the water available to contact and corrode containers and dissolve the waste. So, part of the strategy was low water flux contacting the packages, a low amount of water dissolving the waste. The container itself served as a barrier during the early high peaks of radiation and when the waste was very hot. The waste form again the strategy was to limit dissolution and leaching by limiting water contacts. That's all consistent with our strategy today.

With regards to natural barriers, we're depending on the unsaturated units below the repository to act as a barrier to radionuclide transport by providing long radionuclide travel-times. The attributes that we think the site has, unsaturated zone, low water flux, would add to this objective. And, finally, for the saturated rock below, we would extend the total travel-time of radionuclides; not very heavy emphasis was placed on this during the SCP days.

With regard to the pre-closure, during construction, we wanted to make sure we didn't do anything to impact the post-closure performance or, if anything, it would be beneficial; and we wanted, of course, be sure we could operate the repository under safe, under normal, and accident conditions.

What has happened since then, there has been increased recognition of a potential for fast flow paths. We always were aware of the possibility of fracture flow, but the thinking back in the SCP days was to let that negative potential in the rock would suck in all the water and there would be very little free flowing water. And so, fast flow paths has gotten a greater significance over the last few years.

Potential role of thermal load on performance, you know, in the SCP we assumed we'd keep it very hot and we would keep it dry. We didn't quite understand all the uncertainties associated with characterizing and understanding that feature. Today, we're talking about, as Russ said, going in at the low end of the range. As we get more information to understand the uncertainties associated with the high temperatures, we may be able to increase the thermal loading.

The multi-purpose canister as a component is a new feature of the waste management system. It would reduce handling of bare fuel at the repository to be an advantage. The large, robust waste packages; the robust would add more confidence in the waste package, more confidence in containment, help compensate for any uncertainties we have in the near-field. The one issue related to large, of course, is how you handle--operationally, it's a problem, and also the local high thermal loading in the vicinity of the waste package would be something that has to be addressed.

In-drift emplacement and new backfill/airgap options. Okay. Here, the fact that we're emplacing in-drifts allows us to have an air gap if we decide that's the best way to go, but it allows us to look at other actions like backfill if that would increase performance for very long periods of time. Such things like diffusion barriers have been talked about. There's tradeoffs--backfill with diffusion barriers around the waste package. You may raise the temperatures too high in the waste package. All those things have to be looked at.

A lot of debate whether we're going to have a dose-based standard. We know the National Academy is, we hope, completing their report in the next few months. There are bills that have been introduced to Congress that relate to a dose-based standard. And, if we do end up with a dose-based standard, we then have to--there's an increased role as compared to what was in the SCP of a saturated zone with regard to diluting the radionuclides when they get to the water table as they move away from Yucca Mountain.

Whatever type of strategy we have, the longer one has to observe it and study it, the more confidence you might get that you understand all the interactions, and you understand the physical processes, and you understand all the interface between the engineered barriers and natural systems. So, to me, the longer you can monitor it, the better off you are.

How are we implementing it? Well, you know, the new program approach is prioritized to testing to support the key milestones. The key milestones mean technical site suitability in 1998, site recommendation report in the year 2000, the license application in 2001, draft EIS in '98, the final EIS in the year 2000. I think those are all the key milestones that we have. We've put a early emphasis on technical site suitability. We've also put an early emphasis on demonstrated progress or measured--to be able to measure progress. The way we're doing that in technical site suitability is every year we're doing one or more high-level findings so that we will have completed all the findings for me to make or we have to do those before we can make a technical site suitability evaluation. But, one will be able to look at our schedule and see how we're doing by the schedules we've laid out. If one looks in the program plan, we have a very detailed schedule in the program plan on site suitability. Several hundred milestones.

We've put increased emphasis on the near-field environment and substantial complete containment. That's a strategic decision because we think we will have the information to make that case in the year 2001. We think that understanding the near-field will provide an environment that allows the engineered barriers to perform very well. And, basically, that's the crux of our case when we say increased emphasis on near-field environment and substantial complete containment.

There will be more uncertainty in 2001 associated with the far-field and testing will be continued after 2001 to reduce those uncertainties. And, that will increase even further our long performance and, as we understand the higher thermal loads and the impacts on the mountain, we may be able to support higher thermal loads in 2008 or perhaps even later during the operation period of the repository.

So, the key elements and these are again not very different than we had in the SCP. They're stated in different words, but they're the very same. We have a graphic here for people that like graphics. A favorable environment for the waste package provided by the unsaturated rock. Again, that's low amounts of water, low water flux shown in #1 on that slide or diagram. The robust waste packages which will perform well if they have a favorable environment and help address uncertainties in the near-field that we may have. The fact that we'd have a little bit of water, we have limited mobilization because we don't have a means for mobilizing the radionuclides within the waste package. Once they fail again, the low amounts of water or low flux will mean slow release of radionuclides through the engineered barriers, and once they get out, again if we have low flux and low amounts of water, slow migration of radionuclides to the geosphere.

So, all of these things depend on the fact that we have low ambient flux and low amounts of saturations. The feeling of the people thinking about the strategy of the most uncertainty has to do with the modeling, how you model the transport of radionuclides away from the near-field into the far-field. So, that's why we're making our case very strong in 2001 on these first four bullets.

So, now, to go back a slide for a second. So, for each of these key areas, each of these five key areas, Jean will give us the key uncertainties related to each of these for each of these elements; and she, in fact, will expand on these with some bubble guide graphs she has in her presentations. Also, we will break down the uncertainties of the three groups. Those have occurred in nominal, undisturbed conditions; those uncertainties that are added when you perturb the mountain thermally; and then, those uncertainties that you would have if you have disruptive features, events, and processes. She will then describe the uncertainties, describe the approach for addressing those uncertainties, and in the areas--if you go back again one viewgraph, particularly, in the areas in the near-field and the areas in the geosphere or the natural barriers. She will turn it over to Susan and to Dennis who will then give you more details about the testing program on the surface from Susan and the underground from Dennis that will get information and allow us to reduce those uncertainties.

That's it, I think.

DR. CORDING: Thank you.

Jean, why don't you go ahead and then we can have questions unless there's some specific questions right now from the Board. Okay.

DR. CANTLON: I have one question. In your Overhead #7 where you're talking about the strategy having matured, I don't see anything there that identifies concern about the long-term daughter cell problem, the out-year, the 100,000 year, which is also a thing that has made a major change in what we're thinking today over the site characterization plan.

DR. BROCOUM: As I think we've said several times, we have no problem analyzing the long-term to help optimize how the repository operates. What we said, we--but we want to be right. This would be very difficult to demonstrate in 100,000 years or a 500,000 years in a kind of a license hearing what the performance of the repository might be. So, we've never had any--and, we've done several studies, given some to the National Academy looking at long-term releases, for example. The type of things you might do, for example, the--what is that called? The diffusion barrier would have an impact not over the 10,000 years, but it would have an impact over the longer term, for example. It would be something that would spend several hundred thousand years on before you could get significant releases. So, I think we covered things like this, but did not cover it explicitly. Again, it's not a regulatory requirement; that's why.

DR. CANTLON: It isn't yet a regulatory requirement.

DR. BROCOUM: But, you know, we'll see what happens.

DR. LANGMUIR: Steve, I'm glad to see a diagram that shows all the details of what you're proposing, but for the first time I notice something that I should have noticed long ago; concrete. My driveway lasted 10 years. That's just an aside. Maybe it will last longer in a year, a little drier. But, the chemistry of concrete from the way this is designed is going to dominate the chemistry of radionuclide releases. The radionuclides, if they get out, are going to move down if they can make it--ultimately, they will--through diffusion barrier, whatever way they get there. They'll be contacting concrete which will dominate the pH between 8 and 12-1/2 as long as it's there. That's a major effect in the source term definition for the repository having that concrete sitting right there.

DR. BROCOUM: I think Jean is talking about geochemical aspects. I'm not sure you were going to address the concrete. But, the geochemical aspects--

DR. LANGMUIR: You've made a major contribution, you know, to what's going to happen in there by putting that concrete in--

DR. BROCOUM: Remember, that's just a kind of a--

DR. LANGMUIR: We're going to have to have something there to support the waste package and the concrete is the obvious choice.

DR. YOUNKER: Yeah, I might comment, even at the time of the SCP, the folks were worrying about waste package and materials' behavior. We're very concerned about the type of concrete; particularly, I remember discussions about that. I don't know if Hugh Benton could comment on the current thinking in terms of what the concrete does to us or for us.

MR. BENTON: We are certainly looking at the effects of concrete. This diagram might show sort of the maximum amount of concrete that we have been thinking about in terms of how much concrete would help us. If we could raise the pH a little bit for an extended period of time, that would help our corrosion situation. So, in our total test program, we are considering the possibility of whether concrete would help us and what type of concrete would result in some kind of diffusion barrier.

DR. LANGMUIR: I can't see how this is going to help corrosion if it's underneath the package and, if it was on top of the package, it won't pre-influence the chemistry of fluids getting to the package. It will be--it's below so that it's going to affect the releases, isn't it?

MR. BENTON: I agree, sir. This diagram only shows the concrete below. We're also considering the possibility of whether concrete around the package would be a benefit or not, in addition to whatever concrete would be placed underneath the package to support its weight on its carriage.

DR. LANGMUIR: Presumably, after 100,000 years, it's going to fail and collapse into the tunnel.

DR. DI BELLA: Jean, I wonder if you would put that slide back up? I've got a question. The right hand slide, that fifth bullet, talks about new backfill options, and on the left hand overhead, Item #4 talks about a possible diffusion barrier. You just delivered to us the technical implementation plan a month ago and I'm virtually certain there's no work in '95 on diffusion barrier or backfill options. I wonder if you can say when this sort of work is planned to be done?

DR. YOUNKER: Let's see, I don't know. Hugh, are you the right person or Tom Geer? Do you want to comment on what our overall approach to consideration of backfill options is going to be? I think you're correct, Carl. I don't think we have anything in writing right now, but I know that it's something that we've been debating internally.

DR. BROCOUM: But, isn't the issue here is that the PA people have been looking at what these things might do for you? In other words, from a PA perspective, they have been looking at these in their PA. I know they've been thinking about backfill and stuff. That's what Abe was telling us. Is Abe here somewhere? And so, yeah, they've been conceptually thinking what can be done now that they have in-drift emplacement and in parallel, once we see whether these things can help us or not, they would I think--so, yes, in fiscal year '95, we may not be doing anything, but that doesn't mean we won't do anything later.

DR. YOUNKER: Yeah, one of the concerns, obviously, you saw in our TSPA results that in the case where we did backfill, we shot the temperatures up real high. And so, one of the considerations is whether you can get something that would help you with it as a diffusive barrier, but also wouldn't cause your peak temperatures to go higher than what you would like. And, I know that's one of the considerations, but I think we're really at a pretty early stage of talking internally about what kinds of testing and what kinds of concepts should be looked at.

DR. LANGMUIR: If you wait, presumably, you're going to have 50 to 100 years retrievability. If you wait until then to put your backfill in, do you still kick the temperatures way up high or do we know? Has the test work been done to really prove that that's what happens?

DR. YOUNKER: Yeah, I think Hugh Benton can give us a comment on that.

DR. LANGMUIR: At a hypothetical 100 year retrievability?

MR. BENTON: Yes, sir. Clearly, going from 50 to 100 year retrievability reduces the temperature and makes backfilling have less effect on exceeding our peak temperatures. So, probably, at 100 years for essentially all of the packages, we would backfill without exceeding the 350 degree centerline temperature. I'm definitely not a mining engineer, but there are some practical problems with getting backfill into a long emplacement drift where you have hot and radioactive waste packages in there. So, our basic approach for the engineered barrier system is to see if we can adequately meet all of the requirements with sufficient margin for uncertainty without having to rely on a backfill. But, the backfill possibility can still be kept available and we can bring that in later if we have to. So, we're not spending a significant amount of money on backfill at this stage. We can bring that into the test program later.

DR. LANGMUIR: Couldn't you blow it in? I mean, isn't there a size that would permit you to have the properties you want and just blow it into the tunnel, fill it--

MR. BENTON: Well, we've considered, so far, crushed tuff is the likely backfill. I'm told that the average length of time that a steel pipe would last blowing it in is on the order of days, two or three days. Ceramic line pipe which is the other possibility, very heavy, very expensive, and just putting the pipe in is a major evolution. So, it would be difficult, but possible.

DR. LANGMUIR: Just a suggestion on your design. If you're trying to get the effective concrete, I would suggest that powdered carbonate within the material you backfill with is a better choice than a concrete pad and that a compacted base made out of the tuff is a much more long-term design than a concrete pad. It will still be there because it's consistent with the geology.

DR. VAN LUIK: For the gentleman that asked the question about backfill, if you'll recall last year we provided to you a document by the M&O which was many TSPAs in support of the 801 studies. Duguid was the major author on that. In there, he informally explored if you allow diffusion over a gravelly backfill, what would that buy you? And, interestingly, it bought us about 200,000 years worth of performance. What we're doing in TSPA-95 which will be done at the end of this fiscal year is formalizing that kind of analysis with and without backfill into a main line TSPA, a full TSPA. So, stay tuned. And, coming from the results of that, we will then ask the designers to take this into account and do the tradeoffs and the judgments. So, the reason it's not in the '95 funding is because we wanted to see what these results of these studies were first.

DR. CORDING: All right. Did you want to take a break now or after your presentation, Jean? We can go for another 20 minutes.

DR. YOUNKER: Okay. As Steve told you, we're going to show you some new diagrams. I think the other one I used in the October presentation. This one, you haven't seen before. We're just trying to figure out different ways of laying this out and presenting it so that those of you who have the graphic versus the literal text type of perception can get the most out of the talks. So, we'll probably end up putting up that other one that's on the other viewgraph machine at various times, too, because I think that one kind of helps you. As Don Langmuir said, all of a sudden, he saw the concrete and the 2-dimensional view there and said, whoa, there's going to be something under the waste packages emplaced in the in-drift mode that I haven't really thought about before. I think just drawing something simple like that really sometimes does crystalize it for you.

At any rate, what we want to tell you about this one is that these numbers that you see now repeated, we've tried to use that as a key for you. You're going to end up with a little bit of logistical difficulty in this presentation in that we did not intermesh the viewgraphs or the hard copy briefings that you're going to see me go through and then, in the middle of mine, both Dennis and Susan are going to talk. So, you are going to end up having to juggle three different presentations in order to follow us along. I wanted you to know that ahead of time. Oh, you've merged yours. Excuse me, all right. Only two; you only have to juggle two. So, theirs are merged. So, when I get to a point and break and Susan takes over, then you need to go to the other briefing for the ones that she's going to cover as a part of that key component. Okay. Right, the one that looks like that. So, if you get both of those in your hot little hands, you'll be ready to follow this presentation.

All right. Now, in terms of the various elements that we're going to talk about, Steve has already outlined these for you very nicely. So, I don't need to go into a lot more detail other than to say that we've laid them out in a way so that you can kind of look at them as barriers, if that's how you want to view them. We're kind of looking at them more as functional components of this overall system that we're trying to describe for you and that we're trying to look at kind of the strategy for how the whole system is going to work together to provide waste containment and isolation. An aside on this, as well; you know, in the top level strategy in the SCP that Steve just reviewed for you, that top level strategy covered the broader pre-closure and post-closure system that we have to be concerned about in terms of meeting the requirements. What we're talking about here is the focus on the post-closure part of that, the waste containment and isolation. So, as a result, I want to make sure that you understand that there is some testing driven by the need to meet the pre-closure design requirements, for example, in Part 60 that we won't highlight today. Now, some of it does get brought in kind of peripherally in our discussion, but we're really looking at the post-closure containment and isolation part of the overall program mostly today.

And, that also leads me to another point which is when we talk about pretty much the waste package degradation, the mobilization of the radionuclides, and the actual EBS. This part of it, you'll find that most of the testing program for that is laboratory testing, a little bit of in situ in the ESF that Dennis will talk about, but an awful lot of it specific to this work is laboratory. And so, because of the kind of questions that you posed on the agenda, we didn't build that presentation into this day's talks partly because we thought your real interest was how we're prioritizing the surface and underground testing program. That laboratory work that supports this kind of effort or this kind of performance is really a whole other day's set of talks and you've had them recently, I think, anyway, at least some of them. So, I think what you'll see today, there will be a fair number of topics that come up on my talk when I go through the key uncertainties on 2, 3, and 4 where we have people who can respond to questions, but we don't really have a well-developed testing program to describe to you today. It's there, but we just didn't put it into today's presentation.

So, stepping through this then, just as Steve talked about, here's your overall near-field environments that bring the flux to the engineered system that we have to worry about. We'll talk through the key uncertainties in near-field environments, then in the waste package, and how it responds to that near-field setting, how the radionuclides get mobilized, and then any additional diffusive protection that we get through a backfill and, in fact, is moving through the air gap and the concrete underlying the in-drift emplaced canister. Then, out into the unsaturated zone rock and finally into the saturated zone and out to the accessible environment, the biosphere.

The way we've set this up just so you understand that we've kind of segmented this, we'll talk about thermal effects on that system that I've just described separately after we've gone through the nominal kind of undisturbed or the system with its natural variability that we expect. We've taken thermal and put that kind of as an overlay separately. We've also taken our external features, events, and processes, the unanticipated scenarios if you think of Part 60's wording, we've added that also as a separate kind of overlay so that it allows us to really talk about these as specific topics and I think give you a better feeling for which pieces of the surface and underground testing we think are most important to help us get a better handle on those disruptive scenarios.

Okay. I think that probably gets us ready for moving out here. A couple of background comments. There's been a lot of question about whether the way the strategy is being described in any way moves away from a multi-barrier approach. And, we wanted to reiterate for you that this strategy fully utilizes the multi-barrier approach to increase confidence in post-closure performance. The near-field environments contribute as a system. I hope the way that we've displayed that in the bubble helps you to visualize it as a total system. The unsaturated environment and the engineered barriers are equally important in this system. I think Steve already describe this very nicely, the far-field barriers add confidence that waste isolation will be achieved. That's confidence that we believe we'll have to gain through longer term testing, some of that testing to be completed after the initial license applications. Uncertainties in all these elements and barriers must be addressed and that's what we'll try to walk you through today.

Okay. So, the first barrier--and, you would maybe want to put the 3-D slide back up, that one--or the 2-D slide, sorry; that one. The waste package environment, the first component of the strategy that we want to talk about, what are the key uncertainties that we have identified today? By the way, they're not other uncertainties that we have to address, but we're kind of trying to get focused on the things that seem to have a pretty good consensus as being the most important uncertainties.

Obviously, we've already mentioned this before. It's the extent of perched water and seeps coming into the ESF. So, this is the basic--How much flux under the natural unperturbed conditions will the waste package and the engineered system have to see over the time of performance? How does that groundwater behave? How will it get across air gap? How will it get through whatever type of packing material we include in our engineered system design? And then, also, How would it move through the backfill if we do use some kind of backfill? How long does it take for that water to reach the repository horizon? Another important question in terms of the overall hydrologic understanding of the site. What kind of focusing and channeling of that flux do we see? You'll hear Susan talk about some of the surface-based programs that are aimed at trying to help us get a handle on what kind of potential we have for rapid pulses of water episodically to go to great depths and potentially act as a short-circuit for the overall system of repository performance that we're expecting to rely on. We need to understand that. And then, of course, the chemistry of that water that's contacting the engineered system is very important. Basically, if you get down to the bottom line, the key is how much moisture, how much seepage into the drifts, and then what's the chemistry of that water is really the most important.

The approaches to address that uncertainty in the broadest sense, I have on my second slide for this first element of the strategy. And, as I just said, infiltration monitoring; all of our observations in the ESF; then getting to a site and drift-scale hydrogeologic modeling to get a better handle on how that water behaves especially when you get some openings in the rock; hydrogeologic testing to get at fracture-matrix coupling. Under what conditions do we get fracture flow? What level of saturation does there have to be? And then, our observations from deep boreholes that help us get a handle on potential for episodic deep pulses of water.

Okay. So, at this point, I will turn it over to Susan who is going to talk about the surface-based program.

MS. JONES: This would be Page 3 of the Jones/Williams. First, just let me show you how we've laid out this presentation because you'll see one of these charts in front of every one of the segments of the testing program. In the upper left corner, you'll see an ellipse with the key uncertainty and those tie back to Jean's presentation.

DR. YOUNKER: He's trying to decide whether we should take a break.

MS. JONES: Oh, gee, I would suggest that we do it right before we start the second area that you have because, frankly, we have a fairly short piece here for the surface and ESF. And, we can go through that and then stop.

DR. CANTLON: Good, good. Whatever will fit with your presentation.

MS. JONES: Anyway, up here, you'll always see a key uncertainty and that ties back to Jean's briefing. Then, you'll see some cryptic notes about the surface-based testing program or the ESF activities and that's what Dennis and I will primarily be focusing on. And then, you'll see an icon in the lower right that gives you an indication of which particular model or activity that our field programs are supporting. And, to reiterate what Jean said, we're primarily focusing today on the field activities in the case of surface-based testing, hopefully addressing directly the Board's concern that we're giving an impression that we're having a much reduced surface-based testing database available. I would hope by the end of the day that you'll see that we really do have fairly good coverage both aerially and spatially from the surface testing programs. That what particularly the maps are designed to address.

DR. LANGMUIR: Will you be defending what appears to be a substantial reduction in the number of surface-based tests that were originally proposed in the SCP and arguing that, in fact, without that large number originally proposed, you still will learn enough to reach '98 the way you want to?

MS. JONES: That comment in the outline of the agenda that you sent us caught me off guard because what I will summarize, you'll see pieces through the day, but what you'll see is at the time of the suitability decision, there are going to be 33 deep boreholes available for testing or sampling, whatever is appropriate; not the four to 10 that it appeared the Board thought was going to be in place. And then, at the time of licensing--and Steve hates it when I use this word--but, basically, when you have to more or less cut off your surface testing in order to have time to process the samples or conduct the tests, write your reports, incorporate it into your documentation. I think the number is 54 deep holes.

DR. LANGMUIR: Sure, what proposed in the SCP, though? Wasn't it several times that?

MS. JONES: No.

DR. LANGMUIR: No?

MS. JONES: No. Actually, I'm going to be showing you --

DR. LANGMUIR: Okay. That's the impression I have gotten is that it was a substantially truncated program and, if that's not true--

MS. JONES: No. I think the misconception arose because by going to this step-wise set of evaluations against the siting guidelines of 960, you are making some of those determinations earlier than you would have if you had done it--according to the SCP, all of that was done at the end of the site characterization program. By doing it in the phases, you do see that there are fewer holes available or ESF accesses available at those earlier points in time. And, that's exactly what my briefing will address, Don. I'm going to literally show you maps that say these are the holes for suitability, these for licensing.

DR. LANGMUIR: Okay.

MS. JONES: This one is fairly straightforward. To address the key uncertainty on the extent of perched water and seeps from the surface, it's simply an ongoing program to collect samples whenever we encountered perched water, such as we did in UZ-14, UZ-16, SD-9. There is no specific drilling program associated with that and I suspect, in earlier Board meetings where we talked about the hydrology program, you've seen the results of those activities. Basically, we also have some holes that we believe, coming up in the near-term such as WT-24, SD-7, that are giving us a better aerial distribution and we'll be looking to see if we have perched water. We collect the samples and run them off to the lab for analysis at that point.

DR. LANGMUIR: Before you go on, I hate to do this, but it looks like the only discussion we'll have today on perched water may be right now. Something that occurred to me, I understand perched water analysis relates to an attempt to determine the sources of the perched water and the age of the perched water. My sense, thinking about it and correct me if I'm wrong, is that the perched water, to the extent that this is perched water below the repository horizon, represents a unique opportunity to--if you can determine it from that chemistry, determine the fractions of mountain water that have gone via fractures or matrix-flow. It's integrated for you historically as perched water. If you could somehow reconstruct from your chemistries of moisture chemistry versus episodic fractures if you can get them anywhere, you might get proportions then of those two kinds of waters that have gone through the mountain historically and, therefore, you have a lot of information from that related to weeps versus matrix-flow dominance in the mountain which is critical for characterization and performance. I don't think anybody has looked at perched water that way. At least, I'm not aware that they have. And, it would be very interesting, I think, to have someone attempt to reconstruct it as a mixture of two proportions which then define the dominance of flow mechanisms in the mountain.

MS. JONES: Good point.

MR. WILLIAMS: Okay. With regard to the ESF part of the activity, it's always going to be in the upper right hand corner there and again, as Susan mentioned, the perched water activity is something that in the ESF it is a specific activity that we have identified with a plan to sample any seeps that we might find in the tunnel envelope and in the alcoves as we excavate the tunnel. The reason I put down the activities of construction monitoring, geologic mapping, and consolidated sampling, those are the first opportunities where we actually have the people right in close to the fresh excavation. The people that are doing that will be looking for the occurrences of these waters and we will sample them and send them off to the labs for analysis.

MS. JONES: On Page 4, for the surface-based program activities that are explicitly addressing here, this is where we bring in Alan Flint's infiltration program. I'm sorry, going to the one that was handed out just before the meeting started, it's Page 4. We'll we're dealing with the one on focusing channeling of infiltration flux. Okay. Oh, I'm sorry, I forgot June Fabryka-Martin; how terrible. It's this double sided xeroxing. I can't cope with that. Yeah, and here, the surface-based is again programs that you've heard discussed several times; namely, June Fabryka-Martin's chlorine-36 studies and Al Yang's studies of tritium, for example, from core water samples. And, again, the only tie to the surface-based testing, obviously, is this is the source of the samples. And, again, hydrochemistry of perched water also ties into this key uncertainty at the time for the water to reach the repository.

DR. LANGMUIR: I had one more thing to bug you with here. Looking over the data on the isotopes, it seems to me that what's been totally left out of the pneumatic arguments is your carbon-14 information because the carbon-14 data is giving you a sense of the gas flow of CO_2. I've never seen this discussed by interested parties of the DOE as insights into the pneumatic pathways in the mountain. It gives you a historic record of CO_2 movement in the mountain. That's a gas. So, this is an insight into how gases would move from a repository assuming low loading and so, therefore, the same pathways. I assume that's part of the surface-based activity that's continuing.

MS. JONES: It should be, yeah.

DR. LANGMUIR: Yeah.

MS. JONES: Excuse me, this is Russ Patterson who is the DOE team leader for hydrology program.

MR. PATTERSON: Okay. Actually, Al Yang is looking at carbon-14 in the tritium samples. And, your previous question about mixing of water, June Fabryka-Martin has been doing a lot of looking at that of mixing of matrix waters with fracture waters and how it affects your chlorine dates and that sort of stuff.

DR. LANGMUIR: I know she's doing that to correct the data, but I haven't seen anybody looking at the data as providing insights into mixtures as a purpose of analyzing the data. I mean, her big problem is trying to interpret her data as you--as the chlorine-36 is affected by subsurface processes. But, I've not seen anybody looking at it to decide if you can determine mixtures once you have your date information and your other chemistries. I know that Al is doing carbon-14, but I haven't seen anybody looking at the CO_2/carbon-14 story as a way to view rates of pneumatic movement of CO_2. I'm aware of Al's work.

MR. PATTERSON: Okay.

MR. WILLIAMS: With regard to the ESF, basically we'll be doing the chemistry analysis of all the water that we may find from the perched occurrences. I wanted to just mention the heater tests here and then, as we start fielding the heater tests, any water that is driven off by the heater tests, of course, will undergo the same suite of sampling and also we'll be observing the distribution and precipitation of minerals.

MS. JONES: Now, can I go to #4, focusing and channeling of infiltration flux? This is Alan Flint's program on infiltration which you have discussed many, many times here. And, actually, this is one of the first times I was going to make a point I made somewhat earlier in that throughout your thinking about the surface-based program, you need to separate the drilling of new holes and the schedule for doing that from the idea that there are a number of holes available for testing. If you focus only on the drilling of the new holes, you really do get a skewed perspective on what we're proposing to do. This first map on Page 5 really points that out because this is a map that shows locations of all the holes that are available for infiltration. Granted, these are shallow holes, but it makes this point. If you had looked at our plans, we only drilled 24 of these, but the reality is there are 98 that are available for his program. Now, the numbers aren't that large for some of the other deep drill hole programs, but the concept is the same that the new ones that show up in the drilling program are added to these pre-existing holes that make for a much larger database for the particular programs. Like I said, I'm going to be using maps to make this point throughout this briefing.

The rest of this surface-based testing in this particular instances deals not only with Alan's neutron logging program, but he's also doing some controlled artificial infiltration plots as just the test control on his natural infiltration program. A little bit later on just so I'm talking about it all in one spot, in terms of looking at where the channels for fast flow might occur, I'll be showing the seismic lines a little bit later, as well as the plans for our mapping program, that are looking for possibly previously unsuspected faults or fracture zones within the block. But, I'm going to deal with that under Item 5 which was the geosphere or under tectonics.

MR. WILLIAMS: With regard to the ESF, again back to the perched water, any water that's available, we will sample and analyze. At this point in time, we'll start integrating that with our fracture mapping in the tunnel envelope in the alcoves to see if we can get some kind of a distribution on where that water is coming from.

DR. LANGMUIR: Just for curiosity, has anybody found any water seeping from the beginnings of the ESF? I can't imagine there hasn't been something--

MR. WILLIAMS: To the best of my knowledge, I don't think we have. We've got our TCO out there somewhere. He could probably--

MS. JONES: TCO is test coordination office. He shook his head no.

MR. WILLIAMS: He shook his head no, okay. Ned Elkins shakes head no.

MS. JONES: Okay. With that, we are ready to start in on the waste package performance and I think that would--

DR. CORDING: Good time for a break? Okay, let's do that. We'll take a 15 minute break until 10:30.

(Whereupon, a brief recess was taken.)

DR. CORDING: Okay. Let's begin. We're going to be going until close to noon with this portion of the session and hopefully, we'll have some time for some audience participation just prior to lunch.

Can you give us a little idea as to how we're going to be conducting the session until that point?

DR. YOUNKER: Right, I'll be glad to. I think the way it will go now, there's not too awfully much testing from the field, from surface and underground in the field, in the three engineered barrier system components now that we're going to talk about. So, there's a little bit. There's a couple, but they're very brief.

So, it will be mostly me talking through the next --the middle part of the Brocoum-Younker package, and then when we get to the geosphere where we are talking about migration of the waste from the edge of the rock out to the saturated zone is when we'll have a fair amount more discussion from them, and then also in the disruptive events where we talk about volcanism and faulting and climate change.

DR. CORDING: Then, just to review for all of us, this afternoon we're going to be having then presentations on specifically on updating on what is being done specifically in the ESF and surface-based testing and on construction. Is that what's--

DR. YOUNKER: Yeah. I think, Susan and Dennis were going to wrap up with a little current status on underground and surface and then Richard Craun will talk about the current status of the ESF construction activities in a separate presentation.

DR. CORDING: Fine. Yes, Leon Reiter wanted to make a comment.

DR. REITER: I'd like to sort of extend this discussion a little further on this topic and perhaps on other topics also. That is in what we can euphemistically call features or things that could challenge the site, potential disqualifiers. This is one thing that the Board had specifically requested and, looking at the structure, I think you've identified the key uncertainties. You talked about the tests, but can you perhaps give us an insight as to what things would really give you some cause for concern? For instance, are you really concerned about finding lots of perched water? Suppose you go down there and you find lots of seeps of concern, you find lots of chlorine-36. I think these are important things that we've tried to pursue in the past and the idea is we want to make sure that it comes around 1998 or whatever it is, we focused in, and you've addressed those things which could really challenge a site and say, hey, this may be a bad site. Now, again, the question is we all realize that you can't automatically identify disqualifiers; there's analysis that has to be done.

But, really, if you could bring us along in that thinking, I think that would be very helpful.

DR. YOUNKER: Let me make a couple of comments first and then we'll see if Susan and Dennis want to add. I think the way we've tried to structure this is that the truly catastrophic failure modes, if you will, are unanticipated events. We're going to talk about the extreme climate changes, the probability of volcanism causing disruption of the system that we're describing, or the probability of faulting activity being severe enough to cause some disruption of our overall safety of the system when we talk about the external features, events, and processes. But, there's another aspect to that and this is what Leon, I think, has brought up and that is that in all of these elements of the strategy that we're talking about, there's uncertainties. And, the question is when would those uncertainties be so great either that you couldn't get to them to an acceptable level of risk such that that might constitute a disqualifying condition--you know, you just couldn't adequately characterize to get your confidence high enough or--and, this is what I think Leon is asking in the question--are there some kinds of features or conditions that, if found, would challenge our whole understanding so much that we would really have to say, wait, we just--you know, our fundamental underlying strategy and the way we've looked at this system just seems to have some real problems. You know, I think those are the kinds of things you're asking us to think about.

DR. REITER: Right. Challenge the waste strategy and challenge the Yucca Mountain site.

DR. YOUNKER: Do you guys want to make some comments?

MS. JONES: Yeah, I can think of the one that just pops into my mind all the time would be is if we were finding water flowing through the repository horizon not channelized, but sort of pervasive. I think that would be a different view than what we currently think is probably happening and it might not be something you could accommodate. I would also think that if we were to find factor zones or fault zones that are more pervasive, that might be a problem, as well, that we would have to seriously stop and think about both from a design or a performance standpoint. But, those are the two that come to mind.

DR. REITER: Fracture zones without water in them?

MS. JONES: I would think either with or without any. Fracture zone with water would be my first concern. That might be okay because then you're seeing it channelized; whereas, if you see the seeps coming more pervasively, you know, every few feet instead of every tens of meters or hundreds of meters, you might seriously have to look--reconsider whether you could actually then put these emplacement drifts in and avoid the seeps, for example.

DR. REITER: Because of fault emplacement?

MS. JONES: It's a tie to the--no, I was talking first about the water. It would be more tied to the design than the performance assessment, I would think. You know, could you actually then design emplacement drifts that aren't getting wet all the time? That would be a key feed to the design and the same thing would be a tie to design on the fractures or the faults because you have standoff distances you would need to worry about, as well. Actually, I'm not particularly concerned about offset.

DR. REITER: Offsets--

MS. JONES: Yeah, movement.

DR. CORDING: Movement, yes.

MS. JONES: Yeah, movement or--yeah, shaking or something like that. But, just from the physical layout standpoint. Dennis?

MR. WILLIAMS: I guess my thoughts kind of mirror that. The concerns over, say, more or less, diffuse flow that you really couldn't tie down to any fracture patterns and it would be unpredictable. You know, you couldn't tie them down to precipitation events. It's basically you're dealing with a situation that you don't understand.

DR. REITER: You mean, high-matrix flow; is that what you're talking about?

MR. WILLIAMS: No, not matrix-flow. You know, just diffuse fracture flow. Flow coming out of fractures over a certain stretch of the tunnel that you can't tie down to the specific fracture systems, that you can't--you know, if it's recent, you can't tie it back to precipitation events. You just basically don't understand the phenomena that's going on there.

My other concern is largely in the area--it's probably not tied to a waste isolation strategy, but just the ability to maintain the stability of the openings over a reasonable period of time.

DR. REITER: What about the perched water? Does perched water in your view represent a challenge to the repository or does it represent just a source of information?

MR. WILLIAMS: Well, I think that perched water in the ESF, I don't think we'll find very many occurrences of perched water in the ESF. But, as far as the challenge to the performance, you're going to have to talk to the folks in the performance part of it versus me.

DR. LANGMUIR: Isn't the perched water largely below the repository horizon, down lower in the formations near the Calico Hills?

MR. WILLIAMS: Right. The perched water that we've encountered to date is below the repository level. It's down at the vitrophere level. We haven't seen perched water in any of the fractures yet. I think that it's maybe a little bit overly optimistic not to expect some perched water. I would anticipate it would be recent water, but it would likely be in this near-surface environment as we start tunneling through these first few hundred meters.

DR. LANGMUIR: Hasn't Alan Flint pretty well been able to predict places you find it from his infiltration modeling? It seems to me he has.

MR. WILLIAMS: That's worth--

DR. LANGMUIR: The only place you've found it has been places he would expect it and so on.

MR. WILLIAMS: Yeah, that's with regard to the perched water that we're seeing down at the vitrophere.

DR. LANGMUIR: Right.

MR. WILLIAMS: He's quite good at those predictions.

DR. LANGMUIR: Which is--

MR. WILLIAMS: It sees other little fracture filling influences. Maybe something associated with some variability of the rock unit up at the near-surface, I think will be the other perched water occurrences that we will find and I would expect them, if we find them, to be in the early reaches of the excavation.

MR. SULLIVAN: Let me just add a remark there with regard to perched water. As you've already discussed, the perched water that's been identified today is below the repository horizon. In addition, along the north ramp and now the main drift, we've completed a series of boreholes adjacent to the ramp itself. No perched water has been encountered in any of those boreholes. So, any perched water bodies that remain would be very local. Susan will be presenting some maps in there in your package here that identify those borehole locations and you can see the spacings for yourself.

DR. CORDING: Thank you.

DR. DOMENICO: Excuse me, the holes you're talking about, did they penetrate to the perching zone that we're talking about here?

MR. SULLIVAN: Some of them did at the deeper holes. Further to the east on the north ramp, the holes did not--all of the holes did not go to the vitrophere. They went at least 100 feet past, though, the ramp horizon. So, water below that, say in the north ramp, of course, will not be encountered in the north ramp.

DR. DOMENICO: So, the vitrophere is the perching horizon. So, unless you penetrate it--

MR. SULLIVAN: As best we understand right now.

DR. DOMENICO: Yeah. Unless you penetrate it, then you really can't tell whether there's perched water present or not unless you at least get down to that depth.

MR. SULLIVAN: Right, but the question was will we see it in the ESF and the ramp, you know, dives to the vitrophyre along the north ramp. So, we wouldn't expect in my view to see it in the north ramp. Those maps will be coming up shortly.

MS. JONES: Okay.

DR. REITER: Dennis said something about TSPA today. Have you not talked with them about possibilities here? You seem to indicate that you weren't quite sure what they were saying about this.

MR. WILLIAMS: No, I'm not indicating that I'm not quite sure what they're saying about this particular issue. I'm just saying that I'm not qualified to make a statement with regard to that long-term performance.

DR. REITER: Okay. Is there any additional insight that the TSPA can bring on this?

MR. WILLIAMS: I'd direct that to Jean.

DR. YOUNKER: This is in terms of how perched water would be handled in--

DR. REITER: Well, no, in terms of this--again, what are the things that you have to really worry--again, I hope we can do this systematically as we go through each one of the steps and the strategy.

DR. YOUNKER: Sure.

DR. REITER: What are the things you have to worry about or could you really challenge a site if it's qualified, whatever you want--does the TSPA bring you any insight to this?

DR. YOUNKER: I can make a broad comment on the performance assessment approach or the view of perched water and I guess my sense is that it depends on how large and how it behaves when we encounter it and whether it has some kind of a source that continues to feed it or whether it just drains fairly fast and it's gone. And, I think the age of that, like Don was saying, being able to look at the components of that in any way we can. I know that's complicated to do, to get at the sources; but, if you can do something like that, it should give you a much better understanding of the overall way that water is moving through the system from a performance assessment standpoint. I guess, the only thing we've really specifically talked about is whether one of these perched zones could represent some part of a fast-flow path and that's what we'll have to look at because it would represent saturated conditions that could conceivably then act as kind of a short-circuit of your overall system that you're counting on for retardation. You'd like the radionuclides to travel through a matrix, if at all possible, and if there's a perched zone, presumably they would see that zone. So, I don't know.

Abe Van Luik, you're my performance assessment expert here. So, you want to comment further on that to enlighten us?

DR. VAN LUIK: Not really. I think you painted the picture quite nicely. I think something that we have to keep in mind is that if we look for TSPA to give us insights into these things, TSPA is taking the information from the site program directly and also indirectly as filtered through the unsaturated zone and saturated zone flow models that are being created by the site program. So, to ask TSPA to give you answers on this, until that information comes in, it's probably a little premature.

DR. DOMENICO: You know, as far as the perched water goes, it seems that if the vitrophere is the low-permeability horizon that perches it, the vitrophere does not preclude lateral movement through the material above the vitrophere which is highly permeable. So, if you maintain saturation in a perched layer, that must mean you are supplying it faster than it's moving away.

DR. YOUNKER: Exactly.

DR. DOMENICO: Exactly?

DR. YOUNKER: Yes.

DR. DOMENICO: I think there's a conservation theorem that has to be obeyed there.

DR. YOUNKER: Got to understand that.

DR. DOMENICO: Another point and part of your strategy, you know that--you know, we keep thinking of the Calico Hills as an important part of this. It's an important part. It's a vertical barrier. But, keep in mind that once you go off the mountain in the valleys, the Topopah Springs is a major, major aquifer. That means that you're going to have--the Calico Hills will be saturated in those valleys. If it's a barrier to vertical movement underneath the repository, this does not preclude lateral movement and eventually into a saturated Topopah Springs which, to me, is a very reasonably fast pathway. So, when we say that the Calico Hills is a major part of this strategy, yes, it is if you want to keep it out of the carbonates. But, there's other ways to get to the biosphere.

DR. YOUNKER: Yeah, right. The question of whether you could get a flow path along the top of the vitrophere in that saturated--I mean, whether it's continuous enough; that's what we keep thinking from a performance assessment perspective back to the process data acquisition end of it. The importance is how continuous is that perched zone?

DR. DOMENICO: Well, like I said, I'm not so sure that that's as important as the fact that you have saturated conditions in the valleys and the Topopah is saturated there. If the Calico Hills is "a perching layer", this does not preclude lateral movement through the Topopah which is, as everywhere we know it, a major, major aquifer. So, it looks like a vertical movement downward and possibly a lateral movement along this perching--

DR. YOUNKER: And, that's one of the flow paths we're going to have to consider. There's no doubt about that. I can't think how the geometry is. I know at J-13 we pump from the Topopah Spring. Is that right?

DR. DOMENICO: That's correct.

DR. YOUNKER: Topopah Spring is the very horizon--

DR. DOMENICO: You can't put a dent in that water level when you turn that pump on.

DR. YOUNKER: But, what I was going to say is that there is quite a bit along the flow path that we have to evaluate that I believe you still have a fair bit of Calico Hills above the saturated water level. So, I don't have a good--I don't know if Tim or Russ, somebody, has a better sense of the geometry on that, but a good part of the flow path out to 5 kilometers, I think, the Calico Hills is still above the potentiometric level.

MR. SULLIVAN: Just one quick comment. Let's keep in mind that perched water was not found in every hole that penetrates the vitrophere, only in a selected local region. And, if we could get to Susan's talk, maybe we could explore this a little further.

DR. DOMENICO: I wasn't concerned about the perching water and the vitrophere. I mean, I'm concerned about the Calico Hills being a perching layer and the inducement of lateral flow to regions where the Topopah is saturated; laterally, south-easterly.

DR. YOUNKER: Yeah, he's talking about kind of a short-circuit in the overall flow system.

DR. REITER: Just one quick question. What is the significance of the non-welded Paintbrush tuff in your strategy?

MR. WILLIAMS: I hate to put us off to a later time, but that's one of the specifics that we were going to address this afternoon in this afternoon's session on the ESF.

DR. REITER: But, how does it fit in the context of the strategy?

MR. WILLIAMS: In the context of the strategy--

DR. REITER: Of the waste isolation?

DR. YOUNKER: I guess I would say from the broader perspective that I would present here that we probably--we haven't really spent a lot of time thinking about it as a potential barrier to gaseous migration if that's what you were thinking about. We just guess its radionuclide migration. The idea that, you know, some of the early data has suggested that the ages of the gases in the pores are quite old and probably not mixing above and below that non-welded unit. And so, if it represents some kind of a potential low-permeability zone to gas migration, it could conceivably help us. I think my intuition as a geologist tells me that there's enough heterogeneity out there that I'm concerned about whether I could really count on it over a large enough spatial coverage to have it really be a gas cap, if you will. It just doesn't--I don't have a sense that we have that kind of homogeneity.

DR. REITER: There was always some talk in the past of it being a capillary barrier to downward flow.

DR. YOUNKER: Well, I think the saturation profiles that Alan Flint sees, very clearly in some places, it's acting that way. There's no doubt.

DR. REITER: So, you're not--what I'm trying to get at is do you not really--it's not an important part of your strategy? Is investigating it an important part of your strategy?

DR. YOUNKER: From the standpoint of understanding it so that we get as high confidence as we can on the flux that is going to see the near-field environment, of course, it's important because it's a part of the way the water is moving through the system. That, together with I think Pat's comments about the potential for lateral flow into the system and these perched zones, you know, if those turn out to have some kind of a source that we don't know about today, I mean clearly that's another important piece of our overall hydrologic system that we're going to have to understand.

MR. SULLIVAN: Leon, I think the bedded tuffs are an important part of the waste isolation strategy this year. We are evaluating fracture pattern and intensity both in the overlying Tiva and in the underlying Topopah, as well as in the bedded tuffs themselves, to test the hypothesis that the fracturing that we see certainly at the surface in the Tiva does not, in fact, continue through the bedded tuffs into the Topopah. So, we're evaluating these hypotheses this year.

DR. YOUNKER: And, all of that, I think, to get a better handle on our hydrologic understanding of the way the water is going to move through the material and get to the barrier number one which is our near-field environment.

DR. DOMENICO: One more question, Jean; I'm sorry. With the perched water, has it yet been determined what part of that might be due to lost circulation? Has work been going on in that area, in terms of you encounter more and more of it, we know you've lost a lot of drilling fluids in some of those holes. And so, has it been determined yet whether or not this is natural water or are we looking at something that was injected?

MR. WILLIAMS: I think the prevailing opinion right now is that there is a component of that perched water that we're talking about, especially in UZ-14, that is a component of drilling fluid that was lost, but that doesn't provide an explanation for the perched water that we see in SD-9 and, likewise, I believe it was NRG-7A. So, close to where we lost fluid, there's a component of it. However, I think it's tied--or I think again the prevailing opinion that there's a natural system there that is perching the water.

DR. DOMENICO: So, what you're saying is where you're finding it now currently is that's water from natural precipitation or some--

MR. WILLIAMS: Yes, and I think there's natural precipitation in the water that is in UZ-14, as well.

DR. LANGMUIR: Could I come back in one second longer on the simple mixture game of mine for the perched water? I was showing some folks at the break a very simple equation where the concentration times the volume of the mixture equals the sum of that for the two components. Al Yang has provided us with bounding information on the matrix chemistry. The perched water is the answer to the equation. The only missing term is the fracture chemistry and volume. Two samples will do it. And, if you're got 10 parameters in the water, you've got 10 checks on the equation. So, it's a very, very simple thing to do and just that's what--I've got myself written down and I'm going to go back and do it myself. I'm going to go back and get his analysis. But, I think it's a worthwhile exercise that's quite straightforward. Admittedly, if you've got contamination from drilling mud, conceivably you can back that out the same way. If you have any parameters from that mud chemistry in your analysis, you can back it out and correct for it.

DR. YOUNKER: Okay.

DR. CORDING: I think we're ready.

DR. YOUNKER: Ready to roll?

DR. CORDING: Thank you, Jean.

DR. YOUNKER: All right. Dennis, will you put up that schematic for me; that one? Okay. Where we are now in this overall strategy is we're going to talk about the robust canister, the mobilization of radionuclides from inside that robust canister, and the engineered system and possible diffusion barrier. So, we're really going to--the next three barriers are elements of the strategy that we're going to talk about are in the engineered system. As I mentioned earlier, there's less mapping from the surface and underground testing programs to this because so much of this work is laboratory work that has to be done under the kinds of control conditions that you have where you do materials testing and that kind of thing. So, the questions that we'll address here as key uncertainties, we do have a couple of people here who can respond to your questions if you want to get into them, but our real focus was to give you a good in-depth understanding of the priorities that we're feeding into the surface and underground field testing programs.

Okay. So, for this element of the strategy, we're talking about--we're in the near-field environment and we're talking about waste package performance. Key uncertainties, we have a reasonable handle on some of the corrosion modes for some of the candidate materials. A lot of data that we do have is not really specific to Yucca Mountain type conditions. The type of corrosion that's our most concern right now and, therefore, listed as a key uncertainty is pitting corrosion of our corrosion-resistent materials. You'll recall that we have an outer barrier in our current concept with a corrosion allowance type material. The inner barrier is the one that's corrosion-resistant and there are several alloys under consideration for that. The behavior of that inner barrier under a pitting corrosion type of attack is what we're concerned about and, of course, the behavior of the zircaloy cladding which is another potential barrier that we don't really know yet how much we can rely on, but some people have the opinion that that could be quite a significant barrier, contribution to our overall performance of the waste package.

The other key uncertainty goes into the area of microbial induced corrosion. This is something that I think those of you who are familiar with the WIPP program know has become a very important issue for them and we do know that there are microbes present in the unsaturated zone waters that we have contacted. So, the extent to which the microbes would induce corrosion of the types of alloys that we would choose--we know there are some alloys that may be more resistant and so the waste package folks are taking a hard look at that. It looks as if, to us at least, we have to be very careful from a performance assessment viewpoint. One of the things we consider is making sure that we don't introduce materials as part of construction, organic materials that would be used in grouts and things like that that would actually feed these microbes and cause them to bloom. You know, oh, great, here comes lunch, but that's not so good for the engineered system that you're going to emplace in this environment. So, it's one of the kind of spinoff areas in performance assessment we've been asked to spend quite a bit of time and intellectual energy on.

DR. LANGMUIR: Jean, before you go on, I've lost track of what--not necessarily this figure, but what is the current concept for corrosion failure of waste packages that's in place in the TSPA that the M&O is working with? What assumptions and what's the basis for their failure model derived from corrosion? What's--

DR. YOUNKER: I will ask Abe if you want. I think it's a more specific question than I want to answer, but Abe can give you just a real quick review. He's reviewed both the Sandia contribution and then the M&O very thoroughly. So, he can give you a quick synopsis.

DR. VAN LUIK: I think probably Hugh Benton is the one that we are--not to pass things off, but to show you how integrated we are. In our TSPA, we went to both the M&O waste package people and the Livermore people who are doing the process level understanding of failure modes and corrosion modes and we got two models from them which are a general corrosion with a pitting enhancement factor for the corrosion allowance material. And then, for the corrosion-resistent material, we have a crack corrosion mechanism in there. These things were very conservative, and for this year's TSPA, we are being provided by the M&O at Livermore an update of those models and we hope to see significantly improved performance from those barriers in TSPA-95.

As far as microbiologically-induced corrosion, that's a real mouthful, Jean. You need a smaller word for that.

DR. YOUNKER: You heard me say microbial. I can't say that word.

DR. LANGMUIR: Abe, are you assuming uniform corrosion as the basis for failure?

DR. VAN LUIK: Uniform corrosion with an enhancement pitting factor which is usually four times the uniform rate. This is based on some experimental evidence that goes way back to--well, some of the references are 1946. I think what we'll see in 1995 is a serious update of this particular model and, like I said, it's coming to us from Livermore and from Hugh Benton's shop.

DR. LANGMUIR: All based on defensible, empirical data and models?

DR. YOUNKER: This is where you hand off to Hugh.

DR. VAN LUIK: This is where I should hand it off to Hugh, but I can also make a statement that the strategy up to this time was to focus on the site and neglect this aspect of things. The new strategy that we're implementing starting this year is almost flipped upside down where we are going to seriously address this by both laboratory and other types of tests. And, I think if Hugh has something to say, I'd love for him to say it.

DR. LANGMUIR: Yeah. The impact of thermal loading on this failure mode, the frequency of water content, the temperature that it takes place, this integration is going to be key to performance and the loading effect.

DR. VAN LUIK: I fully agree with you. I fully agree with you, yes. And, it's definitely time for Hugh to stand up now.

DR. BLINK: I'm not Hugh Benton; I'm Jim Blink from Livermore and I think maybe I'll try to field that one since the Livermore people are doing the testing and modeling. We're just getting set to start the first set of Yucca Mountain specific pitting corrosion experiments, as well as looking at some other potential corrosion modes. Some of the pitting work that's also going on is a stochastic modeling process of pitting that's being done by Greg Henshel. The models that were put into the TSPA last year were developed from empirical data, non-Yucca Mountain specific, from the metals testing community and so we'll take it as conservative. When you put microbiological into the mix, it just totally upsets the apple cart. We don't have very much data and, when you have microbes in pits mixed together, you can get down to pHs as low as 1. And so, we really have to look at that hard. To do that, we're very lucky in Nevada. We've got some of the world's experts on microbes; Dr. Penny Amy at UNLV and we have Dr. Denny Jones at UNR. Livermore is in the process of bringing those two together to help us with the microbiological corrosion.

DR. LANGMUIR: When you look at where you're headed right now, do you expect that these new improved models will extend the lifetime of packages over the assumptions in TSPA-93; and, if so, significantly? Can you tell us a little about it?

DR. BLINK: Well, they're just starting to collect the data. So, I can't predict what the results of the experiments will be. On the modeling, we're getting to the point now with the model that we're starting to compare the results of the model with the historical pitting data, non-Yucca Mountain specific, so that we can then adapt the model to the direct Yucca Mountain conditions. So, both of those are coming to a point where we'll have some real data instead of having to make engineered judgments.

DR. LANGMUIR: Nobody dares yet to say whether it's going to make the times longer or not? We finally got Hugh to stand up.

MR. BENTON: Yes, sir, we certainly expect that TSPA-95 is going to have more realistic and a longer lifetime for the waste package than we had in TSPA-93 where in the absence of data we were making some extremely conservative assumptions. So, a good deal of effort is going in this year, mostly at Livermore, to make sure that we get more realistic data in the TSPA-95.

DR. LANGMUIR: Now, this is independent of the more robust waste package that's come in since '93, isn't it? I mean, that's also come in? We've got a more robust waste package than we had in the original--

MR. BENTON: No, this is more realistic data based on the more robust waste package. All of our effort now is based on the concepts that were developed a couple of years ago which we are continuing.

DR. LANGMUIR: Well, I guess what I'm getting at is the length of the improved ages are not simply a function of the fact you've got a more robust package. Do they reflect improved assumptions about the performance of that package?

MR. BENTON: Both. The NRC and the NWTRB previously has been told that our goal is to develop a waste package which will provide substantially complete containment for much longer than 1,000 years. TSPA-93 had those assumptions in it, but beyond a substantially complete containment period when the waste packages fail, our conservative way in which that failure occurred can be corrected. And, that's what we're going to be working on in TSPA-95.

You also mentioned the more corrosive effect of the new licensing of the low thermal load and we have been developing two models of waste packages; one which we might be able to use in a high thermal load condition with a less corrosive environment and which might be less expensive, but also an alternate for a low thermal load environment. So, this doesn't result in our need to change what we're doing. However, admittedly, now that that is our strategy, we are putting more effort on the low end.

DR. LANGMUIR: This was the one with the corrosion allowance layer, the three-layered package, for the low loading?

MR. BENTON: Yes. Yes, sir.

DR. LANGMUIR: And, you don't have the allowance material in the high load?

MR. BENTON: That's correct.

DR. CORDING: Question from Ellis Verink on the topic.

DR. VERINK: I wonder if the comments of the previous speaker just before the last speaker give us comfort in expecting that the microbiological research is actually going ahead? I understood that was in some jeopardy for some particular time. Is it now on?

DR. BLINK: Ellis, we're in the process of letting those contracts and there's two sources of funding for those contracts. One is programmatic funding being funneled through Livermore and the other is through the cooperative agreement program. So, we're pretty confident that that's getting going.

Just an additional comment on the performance assessment. I expect a major difference between the '93 and the '95 performance assessment in the waste package area is a better definition of the water contact mode. In '93, what was so conservative about it is when the conditions got to the--when the temperature returned to the point where water could exist if it were available, it was assumed to be there and the corrosion models were turned on. In the '95 performance assessment, I think there will be a more realistic modeling of whether the water comes or not. In the '97 performance assessment, I believe we'll have more realistic Yucca Mountain specific data on the actual corrosion processes themselves.

DR. YOUNKER: All right. I think we've actually covered everything on my next slide which is the approaches to address the uncertainties except for one point and that is that there is some hope that some of the analog work that's going on, I think in New Zealand particularly, might give us some insights into waste package performance under our conditions, but otherwise, we've covered this slide. So, we can move right on to system element #3.

Excuse me, Dr. Reiter would like us to address the question of what kinds of results can we get or what kinds of uncertainties could be so large that this area would result in us questioning the suitability of the site. This is an area where I am certainly not the expert in the room. So, I'd have to ask Hugh or Jim Blink or someone who has a sense for this area to speak on that waste package performance; corrosion, you know, the topics we've just been talking about.

MR. BENTON: We are developing a waste package which we expect to perform under what we understand to be the worst conditions we are likely to see at the site; not perhaps the worst possible conditions, but certainly the worst likely conditions. That is driving us to a quite conservative waste package. Now, we have said that we're developing a waste package which will last for substantially complete containment much longer than 1,000 years. The regulation requires that it be 300 to 1,000 years. So, there's a little flexibility there if the conditions at the site turn out to be on the very highly corrosive end. Then, maybe, much longer than 1,000 years is going to be somewhat longer than 1,000 years, but we still expect to have a waste package which will meet the regulations under what we now think of as worst conditions.

DR. YOUNKER: I'm not sure yet that we quite answered Leon's question. He's really getting at where's the highest uncertainty and where could we really run into a problem in this area? And, it sounds like what you're saying is that you don't know anything from an engineering perspective that we would find out that would cause you to think you couldn't design something that would perform in that environment.

DR. BROCOUM: What we're saying is--I mean, we're not asking for a--something that would disqualify this site. Essentially, we're looking for features of a site that we would not be able under reasonable available technology to design a waste package. That's really his question. So, that's the question and I think we've tried to address that question. Is that--

MR. BENTON: We do not know of anything that we could now say would disqualify which would make us unable to engineer an engineered barrier system which would meet the requirements. I think the area of greatest unknown probably is the microbiologically influenced corrosion. To what degree we're going to have to expand our engineering efforts in order to combat that unknown, we'll have to develop.

DR. CORDING: If you're placing more emphasis on the engineered barrier around the waste package, then maybe you are having to look at something that is substantially more than 1,000 years. And so, perhaps that combination with a site that isn't allowing--that doesn't provide the--that provides faster pathways than you would like to have, that combined with engineered barrier that is supposed to perform much further than you've perhaps said in the past, might be a disqualifying situation. I'm still not sure exactly how this change is being fed into the whole program and approach of focusing on the engineered barrier.

DR. YOUNKER: Well, I think we're in the middle of doing it. So, I don't think we have really clear answers for some of your questions right now.

DR. CORDING: Ellis?

DR. VERINK: I just have a brief comment. None of the comments up until now have brought in the fact that the design of the canister with its several layers is actually crafted such that the exterior portions are very thick. The corrosion allowance material would also serve as an anode which would cathodically protect the underlying layer. And, the generation of corrosion products as a result of that would establish a chemical environment in the interstitial area between the two coatings which would be packed in there and not easily lost which would add considerable longevity to the life of the interior coating. So, I think that you haven't taken enough credit for some of the things that are possibilities here.

DR. REITER: Let me give you a hypothetical here. Let's assume that your climate studies cannot really show the presence of past water tables such that you can really not rule out the fact that, at least, a portion of the repository will be flooded during the next, say, 10,000 years. Does that pose an impossible challenge to your waste package?

MR. BENTON: Clearly, it poses a challenge; impossible challenge, we don't think so. We think, if necessary, we can design a waste package which will meet the regulations under aqueous conditions. Flooded, totally flooded, will not only complicate the longevity of the waste package, but also that provides one element in our criticality equation. That would be another thing, but again we consider that we can design to meet the regulations.

DR. DOMENICO: I don't know if meeting the regulations is really the important thing here. I mean, if you need a waste package--especially, if you went to 100,000 year containment, if a waste package--if you require 5,000 years --your models show you require at least 5,000 or 6,000. The question, I think, comes is can you design a waste package in that environment that could last substantially longer than 1,000 years?

DR. YOUNKER: I think that's exactly how we're viewing it. That's how--

DR. DOMENICO: I mean, that's the question, I think.

DR. YOUNKER: Yeah.

DR. DOMENICO: What's the answer?

MR. BENTON: The answer is we believe we can. As the environment for the waste package gets worse, the number of individual barriers that may be required and the various types of materials that we may have to use will probably increase. That will certainly increase costs, will increase some of the difficulty in handling and some of the other things. It will have other impacts on the total program. But, we do not believe that we've exhausted in any way our options yet for things that we may be able to add to make our current robust waste package even much more robust.

DR. LANGMUIR: There's a limiting factor here of not only the cost of this thing, but the reality. My understanding is that no matter what you pick, if it's a reasonable material that's currently available for a waste package, it will fail early enough so that you'll still have high doses of neptunium and other long lived radionuclides no matter what you pick, no matter what reasonable thickness you choose. So, you've got to decide whether it's worth spending the money to go beyond a certain point. So, obviously, you're ahead of me. You've got it up there on the overhead.

DR. YOUNKER: Well, the next barrier gets at the question of mobilization and that's really what you're kind of jumping to. Jim?

DR. BLINK: If we think that the repository waste package environment will get very nasty--like, we'll have lots of packages flooded early-on--we would have to take some actions beyond the current waste package design. One of the alternatives that is being considered for some funding is looking at ceramic materials. For example, if you took the current waste package design and outside of the Alloy-825 you sprayed a ceramic coating, flame sprayed it, over the already sealed package and then inserted that in a corrosion allowance barrier, you would be able to take a submerged condition for a long time. So, there are options and that's one of the things that the DOE has charged the M&O with doing is considering whether that avenue should be explored in the near term for the 2001 license application. So, we are looking at alternatives. It's just not business as usual.

DR. VAN LUIK: I think we should remember that we're at Yucca Mountain to take advantage of the unsaturated nature of the site. If we really believe that there is a high likelihood that the site or a significant portion of it will be saturated in anything except a dramatic one time transient event, then all of our engineering assumptions and all of our TSPA assumptions are null and void. We're at the wrong place. So, I think one of the things that the site program has to determine is the likelihood of flooding to the repository level and, if they decide that there's a significant likelihood of that for anything except a very short transient perhaps, we're probably at the wrong place.

DR. YOUNKER: We, at least, certainly need to give it some consideration as to whether--if this is going to be a saturated system for some fair part of the performance period, would you want to consider other saturated systems? And, I think you would have to go back and kind of rethink how you got where you are. I agree with Abe on that one.

Let me move on to the third element in the strategy then and bear in mind what we're doing is we're in the near-field environment and at this point we're talking about the environment providing the conditions such that you have very limited mobilization of radionuclides. Clearly, some of the key uncertainties are the oxidation state of the spent fuel, the cladding breaching and surface area of waste matrix available for dissolution, and then the dissolution in the presence of limited water. As Abe said, one of the reasons we thought this would be a good site from the standpoint of performance of engineered materials is because we expect a fairly low water content, moisture content, in that near-field environment. All three of these then limit the release rate from the waste form into that liquid phase, however much of it there is.

But, new information that suggests that you get some colloids from very early in the spent fuel on the spent fuel surface, the question of breakdown of materials through any kind of colloid formations, seems to be some new information that's going to have to be looked at. It may not have a large impact, but we don't know that yet. Then, as Don Langmuir suggested, the neptunium and technetium solubility. Certainly, when you look at the long-term performance, getting some handle on whether the solubilities that we're using right now that were done under conditions probably are not real similar or certainly not typical of Yucca Mountain yet, but are they basically the kinds of solubilities that we will have to use and it's very hard to get at what kind of solubility you have under a very low liquid saturation content.

Then, this other one that I've added on the suggestion of people that it's something we do have to consider, although I think from a long-term performance viewpoint we suspect it won't end up being a major player, but the probability of any events that would lead to criticality during the period of performance of concern needs to be looked at to see whether that would cause some of the radionuclides to be in a different state of exposure or in different forms that would be more soluble; different species, perhaps, would become stable. So, that's one specific that I've only just kind of added as a tickler because we don't have a whole lot to say about it.

DR. LANGMUIR: Jean, on the colloid issue, this certainly gives you a vote for an EBS. If you put in a diffusion barrier, you've stopped the colloids pretty much in their track. So, if you're concerned about them, that's one solution.

DR. YOUNKER: And, I think many people think that just the--you know, assuming that we don't have problems with short-circuiting, if we get some matrix flow, certainly there's good chance for trapping the colloids in just the pore space of the rocks, as well.

DR. LANGMUIR: The only way I can see you're going to get them out of there is if they're irreversibly associated with colloids which can make it to a fast pathway.

DR. YOUNKER: Right.

DR. LANGMUIR: That's the only way they're going to get out of there.

DR. YOUNKER: Okay. In terms of approaches to address these uncertainties, approaching the cladding performance from the standpoint of using conservative assumptions and understanding enough to know that they are conservative assumptions. The waste form dissolution laboratory testing that is ongoing. As I said, most of this is stuff that we won't really get into today, but you've already heard some discussion of it and it may be a topic for one of the next meetings, I would guess. Colloid investigations, we've mentioned briefly. The solubility experiments that Los Alamos is doing and Livermore is, I think, also involved in some of those. And then, some work that is going to be done and some general conceptual work is being done now on probabilistic analyses of the criticality potential to use as a part of your design of the waste packages.

All right. A question in this area of where are there uncertainties, where are there features of the site that we could encounter that would lead us to something that would cause the mobilization of radionuclides to be such a severe concern that it would lead to a concern with disqualification or suitability of the site, as I usually phrase it. This isn't something I can easily respond to. I would have to say I don't know if the people who are the geochemist types in the audience want to offer anything to do with the mobilization of the radionuclides that come to mind? I don't know if we have the right people here for this one, Leon.

DR. BROCOUM: I guess it's the same issue. Is there anything you can't handle with easily available technology?

I mean, that's where the site disqualification would come from. So, if there's something that pops out of this that can't be handled with easy available technology, then you might have a real problem. Other than that, I don't think you have a problem.

DR. YOUNKER: Jim Blink, do you have anything to add on this? Yeah, I think, Leon, we will think about this one for you, okay, because we don't really--I don't think we really have anything jumping into the collective minds present today.

Okay. Now, we're moving out through the EBS to get out into the near-field environment again. And so, we're at our component #4, release through the EBS. And, our key uncertainties here, fraction of waste package surface that has been degraded such that then water can contact it; a potential for a liquid film to support a diffusive release. This whole issue of if you don't have a continuous liquid film, what kind of diffusion do you support?

Dennis?

DR. PRICE: Jean, with respect to the first one on fraction of waste package surface degraded, one of the key factors is the relationship between human beings and machinery and emplacement operations. What are your assumptions about that? Do you assume that that's site independent? It has nothing to do, particularly, with site characterization? Does it have something to do with the various alternatives and how do you account for this particular area; the human machine emplacement operations?

DR. YOUNKER: I think I'd have to say looking at this from the post-closure strategy perspective, that isn't something that we really thought about. I'm sure there's someone here who could probably address that question in terms of does--what do we do to make sure that our whole operational period doesn't induce or doesn't make this any worse than what it is when we get it? I mean, not to add some kind of--something in your operations that causes degradation that you then--that degrades performance in the future.

DR. PRICE: And, for example, in a high thermal load scenario, you're going to have a different set of operations than you're going to have in a low thermal load scenario which may impact this surface degradation issue.

DR. YOUNKER: Uh-huh. Yeah, I know. Is there anybody here who can really comment on that? Tom, is that something that you--it sounds like Tom Geer is going to give us his insight on this.

MR. GEER: One of the things that we'll be doing as we continue the development of the conceptual design is flush out what the various operational concepts are for handling the waste and the waste packages underground, making sure that we've given the right consideration to protecting those. I would anticipate we'll even end up with license specifications on scratches, damage, handling loads, induced G-forces, et cetera, things of that nature to protect the integrity of the package during handling.

DR. PRICE: Does this relate, at all, to your site characterization activities decisions?

MR. GEER: I think we would have to consider the results of the performance assessments to help us establish figures of performance for how much integrity we had to preserve and that we would--

DR. YOUNKER: Tom, he may be thinking about--are you thinking about things like a seismic event that could happen and our ability to deal with it in the pre-closure time without it adding some problem that would cause degradation in the post-closure?

DR. PRICE: That could be involved, but you have issues about retrievability and issues about thermal loading. I see the thermal loading, for example, related to site characterization and related to whether or not if, for example, you found you had to go to a higher thermal load because there wasn't sufficient area available because of the characteristics of the site, that affects the operations that you're going to be doing which affects then perhaps some things with respect to this issue.

DR. BROCOUM: Let me just ask Tom. Isn't it true that this would be handled through the concept of operation of the repository? That would feed in to the design and then the information needed to make a design from the characterization program so that the connection would be through the concept of operations which would have to cover the thermal load you're considering.

DR. YOUNKER: I think Richard Craun was going to make a comment on this.

DR. BROCOUM: Is that a fair--

MR. CRAUN: I think the concept of operations and the qualified procedures and then qualified operators to those procedures would not be restricted to just this site. It would be independent of whichever site was selected as the final repository. So, as the critical parameters that you need to control during the operation are identified, then we would qualify our operators and the procedures to insure that we met those parameters. I think that's the right answer.

DR. PRICE: So, I think your answer then was that you see that operations are not related to site characterization activities?

MR. GEER: There may be certain limits on operations that we impose because of the characteristics of the site and how those influence the performance of the components of the engineered barrier system, but that would relate to establishing operational constraints that would protect the integrity of those parts of the system for their role later in post-closure.

DR. PRICE: I have difficulty in seeing how you separate operations and site characteristics.

DR. YOUNKER: Well, from the standpoint of something like your accident expectations due to seismic events--I mean, I'm thinking of that kind of an off-normal condition--you're going to have to--yeah, you're going to have to consider a site specific, you know, solution to that particular potentiality. But, from the standpoint--I think the kinds of things that Richard is talking about are the standard operating, kind of under normal conditions. I guess, what you're saying is you think you would do it--you would have a certain way you would handle them to insure you don't cause damages that would be pretty much site independent.

MR. CRAUN: But, you would identify the critical method or the critical issues. For example, if you can only lift it a certain distance, you can't dent it, whatever the issues are, and then you would make sure that the procedures would insure that if you--that the procedures and the qualification of the operators are such that you don't damage the cask in handling or the waste package in handling. And then, also identify what would happen if those damages did occur during the handling of the package. That would apply no matter whether it was at this site or any other site. So, those procedures would have to be developed.

DR. PRICE: But, whether this site goes to a high thermal load or a low thermal load has a lot to do with site characteristics and that then brings in operations. And, with that, I'll not pursue it.

DR. YOUNKER: Yeah, we agree.

MR. GEER: The thermal loading studies are looking at the impacts of the thermal load on not only the post-closure performance, but on what ramifications that has for operations during the pre-closure phase, as well. But, they are linked together.

DR. DOMENICO: Before she leaves this because I may not see this again, I've heard of capillary barriers and now I'm hearing diffusion barriers. Is that just diffusion of liquids through the backfill to the wall rock as opposed to dripping on the wall rock? Is this where you're buying time?

DR. YOUNKER: For this one, I'm talking specifically about any kind of diffusive barrier that we put between--as part of the engineered barrier system prior to release to the wall rock. So, here, I'm just talking about diffusive--

DR. DOMENICO: So, you're adding time and someone said you can get 200,000 years?

DR. YOUNKER: Well, Jim Duguid's, I think, sensitivity studies that he did as a part of support to the National Academy evaluation of the new standard, I think, suggests something on that order, you know, with the set of assumptions that you make, of course.

DR. DOMENICO: Yeah. You'd have to have a very, very low porosity in that backfill material.

DR. YOUNKER: Yeah, I think it's the saturation that controls it, yeah. I mean, it's real sensitive to.

Right. So, this one then, the question of a continuous film for diffusion, question of diffusion rates in the backfill material, and then if we do get to--when we get a little bit more realistic with our modeling, if we have drips coming in, we have to figure out how the drips contact the engineered barriers and how radionuclides get mobilized. So, this area then is one, I think, if you look at what we've done, so far, our modeling of releases has been very unrealistic. It's an area where we've just made assumptions of saturation, all radionuclides get mobilized. So, this is an area where probably from the standpoint of our performance assessment modeling it's one way I think we have the greatest desire to improve the realism partly because of the very point that diffusive type of rates through a backfill material, if one is used, could really be quite long and add quite a bit of protection in this element of the strategy.

Abe?

DR. VAN LUIK: Your comment reminded me of something. We were recently in a meeting with some British gentlemen who said that we could guarantee a diffusion controlled environment if we would pack very densely with bentonite. It would also guarantee a saturated condition around the waste packages, but they said that's a tradeoff you'll have to take. Our approach is just the opposite. We would like to have a very tortuous path in an unsaturated condition using probably a crushed tuff gravel so that we would constrain diffusion to this tortuous path just on the surface films on that gravel. That is the assumption that was made in Duguid's analysis. We don't think we want to engineer it such--you know, the same way as for a saturated site. The gravel, it takes advantage of the unsaturated condition.

DR. DOMENICO: But, bentonite is not very compatible with your thermal loads anyway if you were considering that.

DR. YOUNKER: That's right. Exactly right.

DR. LANGMUIR: It's a different kind of a diffusion barrier for the saturated and unsaturated condition, right?

DR. YOUNKER: That's right.

DR. LANGMUIR: The bentonite, you want to have low transmissivities, low flow rates through it, low diffusion rates, but it's going to hold the water.

DR. YOUNKER: You're trying to increase surface area, right.

DR. LANGMUIR: And, it's going to hold the heat.

DR. YOUNKER: Yes.

DR. LANGMUIR: So, with an open gravel, you've still got low diffusion rates, but you've got high porosity and you've got ventilation.

DR. YOUNKER: That's right.

DR. LANGMUIR: And, water stays out.

DR. YOUNKER: Okay. We've probably pretty much talked about this already, but the approach is to address the uncertainties. Clearly, we're very interested in how much water the engineered system will see and we've talked about that already under our first strategy element because we were talking about kind of flux into the system. Laboratory measurements of diffusion rates and variably saturated materials; hard to make, but very important if we could get a handle on it. And then, sensitivity analyses for drift-scale thermohydrologic models. So, the modeling end of our program becomes very important, I think, in trying to get at releases through the engineered barrier system.

In terms of--I just got the high sign. In terms of the potential for this area to represent something that would lead to a decision of the site being unsuitable, what kinds of uncertainties related to this area are going to be very, very difficult to deal with. This is another one I need some help on from those people who have thought a lot about this whole kind of release from the engineered barrier system. Abe, do you have anything to offer on that or Leon's question about what in this area could really lead to such high uncertainty that we would--what site feature, what site condition could lead us to such high uncertainty that we would say this is not a suitable site for this particular--you know, related to this type of performance?

DR. VAN LUIK: I'm sorry, I was involved in another discussion in the back. But, basically, I think what we have been evaluating in TSPA, so far, is looking at the effects of having discrete fracture flow coming into the system which has some consequences in some locations of the system and statistically determining, you know, what level of that discrete fracture flow is acceptable. As far as, you know, pre-judging what the actual site data is going to show us, we don't want to do that. We're just doing sensitivity studies at this point.

There is considerable discussion with the PA community about the advantages of having some discrete fracture flow with a limited amount of water available as a way to localize the water and make sure that a large portion of the block will be restricted to a very slow rate of matrix flux. And, if site characterization shows that that is the case, that's very good. But, we have an open mind and it could go either way.

DR. LANGMUIR: In the same vein, I was just thinking, Jean, of the worst case--and, this was mentioned by Dennis and Susan earlier--is that it turns out all the infiltration from one square mile, it all comes down a fracture zone or a wide fault zone with lots of fractures and breaks in it, and lands on the existing repository. If it does that, that makes that repository horizon unsuitable. But, next to it, which is now going to be dry, is the way the repository has got to go.

DR. YOUNKER: Right. That was my comment to Dennis just now is I think of that diffuse fracture flow model as the one that I suspect where a whole large percentage of your waste packages see dripping water is the one that would give us some cause for concern.

DR. LANGMUIR: That implies you focusing it there, but not over here.

DR. YOUNKER: Yeah, so move it over there.

Okay. We're ready for the fifth element or barrier in our strategy and this is the--excuse me. Oh, excuse me, there was one map. I'm sorry.

MR. WILLIAMS: It's very short and very sweet.

DR. YOUNKER: Yes.

MR. WILLIAMS: Really, with regard to the field testing program, we don't really have a whole lot of things going on that directly relate to this from a testing standpoint. I've thrown up a couple there. Microbiologically induced corrosion, I have trouble with that word, as well. In the ESF side, we monitor the microbe populations. That's under biological sorption and transport activity and when we actually get some of the engineered barrier system field tests underway, the thermal tests, the material test coupons that would be located in the hydrologic portion of that test.

I'll mention the surface-based side for Susan here out of concern for time. Basically, some of the samples of man-made materials that we pull out of existing boreholes. We do have some tubular--some tubings down in boreholes that's been there on the order of 10 to 15 years. WT-2 was an example of that. When we pulled that tubing out, it was corroded. Samples of that went off to the laboratories to analyze it for corrosion and for microbes.

DR. YOUNKER: Okay.

MR. WILLIAMS: The other item--

DR. YOUNKER: Keep going?

MR. WILLIAMS: Sorry, Jean, a little slow here. The other area of key uncertainty had to do with the diffusion rates and the advective flow. Basically, the things that we're doing in the ESF activity again associated with the thermal testing. Mode of contact, whether or not that's drips, humidity, flows that we were talking about before. The quantify of water and the water chemistry that is driven off from the tests and, of course, sending samples off to the laboratory for rock testing interaction.

With regard to the surface-based part of the program, basically there's nothing that can directly relate to this particular key uncertainty.

DR. YOUNKER: Okay. Now, we go to back into the natural system, radionuclide migration. Dennis, put up that other little schematic one more time so I can point to that. Now, we're coming out from whatever engineered materials that are beneath the emplaced waste. We're talking about the migration through the geosphere. In this case now, we go back to, of course, a strong reliance on what the natural system provides; magnitude of the infiltration flux, travel-time of water in the unsaturated zone. Our key uncertainty related to when you get fracture flow, the fracture-matrix coupling question in the kinds of partially saturated material that we have, what kind of dispersion we get by small-scale heterogeneities. Then, a question that's a little bit broader and that is kind of an overall understanding of our hydrologic system. One key element is a good explanation and a credible explanation for the steep gradient to the northwest; just enhances our overall confidence that we have a hydrologic system fully understood. And then, when we get down into the saturated zone, the question of how much dilution by groundwater mixing we can count on is another uncertainty that with a dose-based standard will have to be addressed.

In terms of the approaches, let me run through these real quickly because Susan and Dennis will spend adequate time on this for you to see what they're doing to address these uncertainties. Tracer experiments in the C-well complex, aquifer testing, some drill holes to look at the steep gradient to get some additional information there, mostly bounding analysis to get at the whole question of mixing depths, sensitivity studies for our flow and transport models for both unsaturated and saturated zone, some regional-scale aquifer testing, and then the very important item that Don Langmuir has bought up that we know is important, as well, the ages of samples of seeps from both ESF, as well as from boreholes.

Let me turn it over to the testing crowd.

MR. WILLIAMS: Okay. This is where we really start getting into the testing program addressing the key uncertainties associated with the unsaturated zone travel-time. I'm going to kick off with the ESF first in this case and go down through just a few of the testing activities that are associated with this. They're listed up here in the right hand corner; radial borehole testing, diffusion testing, fracture mapping, major fault test, and of course, the monitoring of the seeps that we've talked about all along with regard to the perched water.

One of the things that I think you will see as you look at the program a little bit more, things like the radial borehole testing. That's actually a configuration of boreholes that we do field in the alcoves. We do cross-hole testing in there. We do air permeability testing. We capture the cores for hydrochemistry testing. We also capture gases, water vapor, also for the hydrochemistry testing. Radial boreholes again is a specific test. We have the major fault test which looks very similar only it's fielded at major faults. We have bulk permeability tests that also use a triangular configuration of three boreholes. Often, the only difference between the configuration of the three is the length of the boreholes. Obviously, in the case of faults to get across the fault, bulk permeability to get out 60 meters. Normally, for radial boreholes, you're only going out 30 meters. Diffusion tests, also basically configured around boreholes, 10 to 11 meter long boreholes, and other very short boreholes; hydrochemistry test boreholes that follow the excavation that are 1 to 2 meters long. But, all of these different layouts of boreholes and different locations that we capture this information is based on either getting core for hydrochemistry tests, getting gas samples for hydrochemistry tests, getting the air permeability testing, and eventually we'll go into some actual water testing in the cross-hole configuration to compare against the Air-K tests.

I'll jump back to Susan here in a minute. Before I do that, I would like to show a couple of diagrams that show some of the tests that we're talking about. Here, I've got an example of the detailed fracture mapping that we are doing in the ESF and in the alcoves. Some people refer to it as a developed surface map; others, full periphery map. It's based on an inch to a 10 foot scale. It tries to capture all the fractures and the full periphery of the tunnel. This is where we would also note the locations of seeps, note the locations of samples that we will take, and then do those comparisons to see where--if we encounter water, where is that water coming from and how does that relate to the fracture patterns? We also look at these fracture patterns when we set up the actual drilling for the radial borehole test and the other drill-based tests.

DR. DOMENICO: What are you going to do with that fracture mapping? Are you going to analyze it with some of Jane Long's models or something of that sort to try to get some sort of permeability?

MR. WILLIAMS: We've had quite a few discussions with Jane Long recently with regard to mapping all these fractures. Of course, she's indicated to us that in a lot of cases where they've done fracture studies, 85% of the flow will come out of one fracture. I mean, does that--then, what's the validity for mapping all these fractures?

DR. DOMENICO: What's the reason for mapping all the fractures?

MR. WILLIAMS: What's the reason for mapping all these fractures? We haven't got any flow yet. So, I think we have a need to do this mapping to understand the fracture patterns that are associated with flow if that does, in fact, develop. This is the initial effort that's underway.

DR. DOMENICO: Well, it's a very qualitative understanding unless you do something with that information and they have some very sophisticated models that can analyze that from the measurements you're taking.

MR. WILLIAMS: Well, and likewise, remember that we're doing Air-K testing in a lot of these localities in the alcoves with the radial borehole test. Hopefully, at some point in time, we'll be able to start doing comparisons between Air-K testing and actual water permeability testing to establish that relationship and the knowledge of these fracture patterns will help us understand that a little better.

DR. DOMENICO: Have you talked to people running FRACMAN?

MR. WILLIAMS: Yes, we have.

DR. DOMENICO: And, they don't like this either or they're not interested in this either? They're consultants; of course, they're interested.

MR. WILLIAMS: Yes. Everyone who is doing the work is interested. And, I think the big thing that we're always confronted with is is this detail of information necessary for us to get the site characterized? I don't know for sure whether we're at the point yet to make that determination. But, I know one thing about it. This information is to some extent irretrievable because after we get the shotcrete lining in that tunnel and all the other initial support systems, we can't go back and find this. So, I think we've got to capture it right now. We've got to evaluate it. We've got to evaluate it with regards to our information needs in specifically the hydrology program and, hopefully, we've done the right thing.

MR. DOMENICO: Well, it seems to me like the map itself has almost zero information content unless it's analyzed and some numbers are produced. I don't want to carry this out any further, but I mean there have been methods to analyze detailed mappings like that, and those are very painstaking, time-consuming measurements that you're doing there. It seems to me that they should be analyzed with the current technology.

DR. ALLEN: Well, you have no way of comparing with other parts of the excavation. I mean, you've got to do it continuously if we're going to be able to compare different parts of the ESF.

MR. WILLIAMS: It wasn't our intent here to get into the detailed analysis of this fracture information. We have captured the information. We are using it in our analyses. I guess, I'd like to point out one other thing, too, and this goes back to Russ' six rings of information needs. This information also helps us define the stability of the opening; the joining pattern for rock quality analysis, key block theory so that we can understand whether or not the openings are going to remain stable over the long-term. So, we have to satisfy a variety of needs. This particular product is satisfying unsaturated groundwater fracture flow type needs, as well as the more basic civil engineering needs. But, I agree it's a tremendous amount of effort. We will in the end have a great deal of data, you know, if we continue to capture the data at this rate.

DR. VAN LUIK: I think we've actually had the opposite problem when it comes to this data. For a little while, we had three teams that were using FRACMAN and other codes trying to interpret this data and I think we finally convinced the GS that we only need one team doing it. So, there is definitely some interest in this data. We're hoping that we'll encounter a flowing fracture sometime so that we can get serious about interpreting things.

DR. DOMENICO: A fracture does not have to be flowing. You actually have pads on the test site where you've brought in pneumatic hoses and cleaned them off and the USGS has done similar mapping on rocks just like this. You've done it there and now you're doing it here where you have greater access. My only question is there's a way to analyze this. You don't need flow. There's a way to analyze that in terms of the directional permeability and these techniques are well-developed and there's a few different ways to do it, but we've spent an awful lot of money, like I said, cleaning--what do you call them--those pavements out in the desert where you can map--do the exact same kind of mapping. So, effort has been spent here, but to me, it has zero information content until it's put in the context of some sort of analysis that gives you the permeability in the heterogenous material and directional permeability.

DR. VAN LUIK: We fully agree and from a PA perspective, we are very interested in this data and its interpretation to see what the fracture characteristics are that we should be putting into our modeling.

DR. CORDING: I think we're going to find as we get underground that everything isn't--all the problems aren't embodied in a Ghost Dance Fault zone or in one location. You know, our experience in looking at fractures and fault systems and things like this, we're going to see more widespread features, some of which may be carrying water and some of which may not. And, I think it's going to be very important to understand some of those relationships. And, we often do find that major faults don't carry as much water as some other feature and we often find water coming in in places where it's somewhat difficult to predict from fracture systems. But, in characterizing this site, I think we have to understand some of these relationships and understand how it's distributed across the site. So, that's why I think, you know, just running down and penetrating the Ghost Dance Fault is not the highest priority on the project. We have to look a little more generally at it in terms of we need to understand not just the Ghost Dance Fault, but what is throughout the site. And, that's going to be key and it's not--I don't believe we're going to find everything in one location. And, I'm not saying that we're going to find a totally distributed flow system either, but we need to understand this and this is part of, I think, what we're going to be needing to look at. The detail that one goes to on this, you can be varied across the project certainly, but you are set up to do this in an efficient way, I believe, with a setup that will allow you to advance the tunnel and you can still obtain this information.

MR. WILLIAMS: That's right. With the mapping platform behind the TBM, I mean we can efficiently--we have the team set up to capture this information. I guess, the area that I'm really particularly interested in is what happens when we meet contacts like with the PTN. Do these fractures actually extend across contacts, are these going to help us define flow barriers, boundaries to the system?

MS. JONES: I just want to--this might be a good time to interject a brief discussion or, at least, a recap of the logic that went behind the program we laid out in '95 because it directly addresses this concern about the fact that we've been collecting data, but not emphasizing the analysis of it or its incorporation into models. There was a conscious effort as we were looking at the program approach and laying out '95 and beyond that this year to start shifting--to very much start shifting that emphasis from just simple drilling of holes and the collection of the data and re-emphasizing--or, now, starting to emphasize the models and that will really show up in the quick status where the things that I'm highlighting aren't so many feet of tunnel or so many holes drilled during the year. You'll see that, but the real key deliverables for the year are indeed the models and the attendant analysis that fall behind them. And, that also probably is a contributor to the perception that we have been cutting back on the drilling program because again we decided as a conscious management decision to emphasize the use of existing facilities--is what we call them--existing drill holes rather than drilling new ones so that we get them instrumented or get them tested, get those samples out into the labs for analysis to form that underlying basis for the models. And, again, emphasize that back end; the processing and the modeling effort rather than the up front data collection.

DR. ALLEN: To some degree, this is like any other geologic map. It's very hard to know when you start what subsequently is going to prove to be important. It would be easy to argue that Scott & Bonk should have spent only half the time or a quarter of the time on making their initial maps here; yet we've now found a lot of the details were terribly important and to some degree, we should have had even more. So, I think, as long as we're not slowing up the TBM, which we're not--well, I assume the TBM is going forward and that it's at the maximum rate of--

DR. DOMENICO: The mapping is going faster than the TBM.

DR. ALLEN: My main point is I don't think it's possible now to say what might turn out subsequently to be very important. Once it's gone, it's gone forever in this case.

MR. WILLIAMS: Okay. The second diagram I'd like to show that's in your packet just is basically the alcove layout in Alcove #1 of the radial borehole test. Again, we talked about the hydrochemistry tests that we do on the core that comes out of the boreholes here and the fact that this is a long-term monitoring exercise in the radial boreholes. At some point in time down the road, we'll do the water injections to make those comparisons between the Air-K and water permeability tests.

With that, I'll put this back on and Susan can talk about the surface-based portion of the program that addresses these key uncertainties.

MS. JONES: If you go right to the maps, as I said earlier when I showed the infiltration boreholes, this is the format that I selected to make the point. This shows the location of the UZ boreholes that we already have. There are 10 of them there. In some cases, they're actually deep enough to hit the water table. So, they're kind of serving two purposes there because when we get down to the water table, we can actually sample there for water quality. Again, it ties into the comment I just made earlier that we have these holes. They weren't in my mind being utilized effectively. So, we have at this point emphasized the instrumentation or the testing within these existing drill holes.

One thing I wanted to point out on this one and I'll point out here just to kind of save time. Later on this afternoon, there is an entire table. It is our five year drilling plan and our five year testing plan for surface-based testing. It's in my summary this afternoon. It's less than three weeks old. We actually sat down and, as part of our rebaselining effort, have laid out that program and it does show you year by year what we're going to drill, what we're going to stem, what we're going to do geophysical logging in. It also briefly touches on the trenching programs and it hits what I would consider to be the four main drilling programs which would be the water table program, unsaturated zone drilling program, systematic drilling, and the geologicals. And, collectively, I think you'll hopefully put to bed this concern about lack of areal or spatial coverage.

This particular unsaturated zone program, I wanted to point out a couple of additional things about this map. Primarily, I want to show two places here. One thing down here where we have UZ-12 and 11, those are located along the Solitario Canyon Fault and are going to be used for cross-hole testing on the Solitario Canyon Fault. Later on when I show WT holes up here, you'll see that there's going to be a pair of holes that we're going to be able to do cross-hole testing in the north end of the Solitario Canyon Fault. And then, over here, UZ-9 series, those are located near the Ghost Dance Fault and would be available for cross-hole testing, as well.

We talked about the infiltration studies a little bit earlier. This map shows the existing holes. The next map is additive. It shows then the additional holes that would be available in the unsaturated zone program for technical site suitability decision making. Basically, that's by the end of FY-96. And, again, the table that I show later shows that this year we're actually just--would be drilling one additional hole, UZ-12, but we would be instrumenting and testing three additional holes during that year. And, again, moving on to license application time frame, you can see that we've added again--in this case, by this time, you've added UZ-11, the 9, 9A and 9B series, UZ-2, and then testing you've added the UZ-7A, 11, 6, the 9 series, and 8A. So, again, just the number of drill holes isn't indicative of the number that are available for testing and this shows it through time for those key decision points.

The same thing, the pneumatic testing maps show the same kind of story. Again, what's available for the technical site suitability input and the license application input in the next one. And, I think just as a planning assumption, the basis for the schedule that you'll have in your packet and you'll see later this afternoon is we--to try to tie the site program to the suitability and licensing schedule, we started with the schedule that was--we call it the waterfall diagram, the one that shows the technical basis reports which is our key flange to the regulatory program. And, from that then, we backed up the modeling that we have to do, the analysis that we have to do or the testing, and then into the drilling program.

The bottom line is we feel that probably for most of the technical site suitability, technical basis reports, the drill holes that you have at the end of fiscal '96 are the base. Then, for licensing, you continue going with additional drilling and testing. Probably the end of fiscal '99 represents the last window of opportunity to put in a new drill hole and conduct any kind of testing in order to go through the sequencing for license application time frame. So, those are kind of the way we have been approaching the overall surface-based testing program.

DR. LANGMUIR: Susan, the Board has seen from George Zylovski and also Bo Bodvarsson over the last several years these 3-dimensional flow models of a mountain which when they presented them to us, presumably, had a lot less data than you're going to have in a year or two or three from existing holes. My question relates to the use of that data. Some of it, presumably, had to be--what was used must have been used to define the initial models we've seen. The proof of the pudding is going to be to the extent that the modeling and the data that's been provided to those people initially is validated by new samples that you get from these holes and these ongoing tests. How are you proceeding with that? I mean, what's really going to be the proof for the public and the licensing is going to be the extent that you can predict what you measure in the next three or four years from new holes or from the holes you've got, rather, with additional data collection to the extent they weren't used in the older models. How are you proceeding with that?

MS. JONES: Okay. Well, I know Bo--since you used him as an example--is looking at and predicting prior to the drilling of each hole what he's expecting to find in the unsaturated zone. And, we'll do the same thing with the geology, the stratigraphy. So, that's the type of program that we're trying to really start emphasizing as these models are developed. As I said, we admittedly focus very much on data collection earlier. Now, we're trying to move into this exercise of the model against the--prior to the conduct of the field activity and then the comparison afterwards. For example, Bo has just completed putting the ESF north ramp into his model so that he can start looking at and predicting what we might be running into down the north ramp.

DR. LANGMUIR: Has any of this been done, so far; and, if so, how have these comparisons worked? How successful have you been in predicting what you have just measured? Is that--how far have you gone with that?

MR. PATTERSON: There's been predictions by Bo on UZ-14 and UZ-16, possibly, but those were done informally and not in any reports or anything else. A new milestone that I developed this year for Bo was to do these predictions for all the boreholes that are going to be done in the future. He will be predicting ONC-1 which is the Nye County Oversight Hole. That should be in a--it will be in an informal letter report to us at DOE. That will be here probably by the end of this month. And then, we'll see how his prediction flanges up with what we found in ONC-1. That will be the first kind of test that I'll have. And, there's other ones spaced out over this next year.

DR. LANGMUIR: And, we're on the mailing list, I assume, for--

MR. PATTERSON: I assume so, too.

MS. JONES: If not, you will be.

DR. DOMENICO: How many more deep holes do you anticipate by 1999 and, whatever the number, is it realistic in view of the history of that program and the now even more limited funding?

MS. JONES: I had a sneak preview that that might be a question.

DR. DOMENICO: That's two questions.

MS. JONES: Actually, the total, like I said, I can't give it right now how many new. I'd have to add them up real quick, but we would have 54 deep holes available for the testing program at the end of '99.

DR. DOMENICO: How many do you have now?

MS. JONES: 33.

DR. DOMENICO: You're going to put 20 holes in in the next four years?

MS. JONES: Yeah.

DR. LANGMUIR: Yeah, but these are not LM-300 holes. These are--

MS. JONES: These are not--that's exactly right. See, we were prepared--these are not LM-300 holes and that's really important because we took a look at this--

DR. LANGMUIR: These are USGS, right, and a separate contractor--

DR. DOMENICO: So, you're not collecting core on these? These are drill holes. These are regular, normal, logical drill holes. You're not collecting core all the way down, is that correct?

MS. JONES: Oh, boy, do I want to tackle that adjective by adjective or not? No, actually, this really is a good point because we had sneak preview, like I said, that this kind of discussion might come up. But, the last time you all were briefed, we believe, on the total surface-based testing program was probably by Uel Clanton back in October of '92. So, it's been a while. Actually, that had been the plan that we were operating. At that time, he was showing a drilling schedule--and, again, let me just focus on the deep holes; forget the infiltration, those four programs. That plan had a total of 66 holes in it and--well, I won't go into the detail. But, one of the key underlying assumptions was--this was prior to any drilling, at all, with the LM-300 or after the restart of site characterization and that had one underlying assumption that was important and that was a five foot per shift drilling rate. And, based on the first set of deep holes that we've done, we're actually somewhere between 10 and 11. So, first of all, we're actually drilling faster than that original schedule predicted.

The second thing is we aren't just using the LM-300. We only using that when we absolutely have to have that really deep dry core with that diameter hole. So, we've gone to other rigs to accomplish our needs, as well. Plus, we have deferred some holes, without a doubt, and we've also combined some where originally the SCP--say, the systematic drilling program and the UZ program were individually crawling out a hole. We've combined them. So, we're reducing the number of holes, as well as drilling more efficiently than that original schedule was predicted on.

DR. DOMENICO: This is good and bad in a way because apparently now we aren't going to get any more information from the cores on the chloride-36 or tritium or information such as that. We're shut off on that now except what you'd get from your--whatever that drilling rig is unless you can get those from cuttings, right?

MS. JONES: No, no, no. Different core holes--I mean, different rigs capable of doing coring.

DR. DOMENICO: You are still coring?

DR. CORDING: You have other dry drilling rigs?

MS. JONES: Yes.

DR. DOMENICO: Okay. All right.

MR. WILLIAMS: Yeah. The only reason that the LM-300 was unique for the drilling capability was the fact that it did the reverse circulation and it could handle the 12-3/4 inch dual wall pipe. That was the unique thing about that drill rig. We can go out there with a Stratmaster and basically drill a dry core hole of six inch diameter down to 2500 feet if we don't encounter a great deal of rock quality problems. So, the dry drilling capability is not unique to the LM-300. It's just those large diameter holes and that reverse circulation system that we're talking about.

DR. DOMENICO: I was just wondering whether you were still continuing to take core which, of course, if you stop taking core, you can go a lot faster yet. But, you're still obtaining core only a little bit more efficiently than in the past.

MR. WILLIAMS: We're still taking core. Right. And, in some cases like with the Stratmaster of just straight coring without that large diameter reaming, we've gone up into footage rates of 17 to 24 feet per shift here in the past.

So, that's helped us out significantly.

I think I'd just like to throw up an overhead I happened to bring along because this was a briefing that I gave to you folks back in '93.

MR. PATTERSON: Also, one clarification. The chlorine-36 is done from chip samples and Al Yang's work is done from the core samples.

MR. WILLIAMS: In this particular scenario, what we did was laid out the 40 borehole program in a variety of years with different rigs and different shift configurations and different dollar amounts on what it would take us to complete the program. I think if you look down there about the third one, I think that's about four and a half years basically with two rigs and it comes in around $180 million. I think you'll find as we get into it, that right now over the five year plan, we're probably in about $150 million dollar drilling program basically with two rigs in about a five year time frame and that amount of core nominally flanges up with what we're planning on doing right now. So, it's not changing very differently from what we briefed you back in '93.

DR. LANGMUIR: I know you're short for time here, but while you're--Pat mentioned the chlorine-36 data and this is a very important question, I think. My understanding is that June Fabryka-Martin has a backlog of hundreds of samples yet to be analyzed for chlorine-36 that have been collected from the unsaturated zone. My sense is that that's critical stuff to get a handle on. I know she's very busy and there's just one person trying to interpret that data, correct it for chlorine-36 generation at depth and other factors that need to be used to determine--take an apparent age to a true age. But, my sense was that perhaps you had enough samples already collected to fully characterize the mountain for chlorine-36 if those got analyzed without sampling any more for chlorine-36. I guess, I'd like to hear the story on that.

MS. JONES: I'd have to defer--

DR. LANGMUIR: Do I have misconceptions in there? Am I correct as far as--

MS. JONES: The team leader was nodding his head that, yes, she does have a large backlog of samples. I think that really ties back to what we were saying earlier is that we were very much focusing on collecting samples and not really focusing on the analysis and then the subsequent modeling of it. And, that has been the change in the philosophy starting right now that we need to work off either backlogs of samples or--and, I was going to say in the drilling program, as well, we're looking at the actual need for core. Rather than just coring continuously, let's target the areas based on the needs of the principal investigators. You know, rational requests there and then that would also help the other issue of them being able to finish these holes quicker if we weren't continuously coring, but just targeting the areas.

DR. CORDING: This will be one last comment. We're going to be breaking this discussion right in the middle of it. We'll be coming back to it after lunch. If you'd make your comment and then we'll break. Don't forget some of the things we're discussing, but we'll be moving on and continuing the discussion after lunch.

Please, go ahead?

MR. PATTERSON: I just wanted to make the point that in the future June has a lot of samples, like you said, to be analyzed and we realize that. But, it doesn't really cost a lot of extra money to go ahead and grab those samples and put them in the barrel. So, any future holes that we're drilling and any as ESF is going by, we'll continue to bag those samples, put them in a barrel, and have them there for her to analyze if we decide that they need to be analyzed. So, I just wanted to point out that that is--the big part of the program is analyzing the samples right now, but it's not collecting new samples.

DR. LANGMUIR: It's apparently also interpreting the analyses. That's non-trivial.

DR. CORDING: Okay. Thank you very much then. We are going to be back at 1:10.

(Whereupon, a luncheon recess was taken.)

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

DR. CORDING: We changing the schedule just slightly and going ahead with Richard Craun's presentation and then we'll be coming back to the topic that we left at lunch time.

MR. CRAUN: If we're ready, I'll go ahead and get started.

DR. CORDING: So, I'd like to introduce to you Richard Craun who is the assistant manager for engineering and field operations. He's relatively new to the Yucca Mountain site characterization project. We're pleased to have you here and look forward to your presentation.

MR. CRAUN: Great, thank you. It's a pleasure being here. I have only been with the project a couple of months and they told me all about it before I joined. So, it's been quite an experience.

I received five questions over here and if you read down through the five questions, the first four really talk about tunneling rate and costs of excavation. So, what I've done is I've put together a brief presentation to address the costs to answer these questions specifically and I've also put together some information that would allow us to focus on, I think, the underlying question on the first four topics which would be why is it costing us so much and why are we going so fast.

This is the first question. What is the current ESF configuration? And, what I've done is I've had the artist put together a sketch that everybody should be familiar with, more so than I. I'll go through this kind of quickly. Just basically, we've tied the milestones to the sketch so that you can see. For example, what I've done is I've had them identify Point A which would be the north ramp and then we just put it up here and then the completion date would be March of '96. Again, Point B, two-thirds of the Topopah Springs level, again Point B down here. And, that really is an important date. I'll come back to this because this represents the excavation that will be done during '96. As everybody is aware of, our goals are 1280 meters. That will put us about in here for 1995 and then, obviously, our rate is going to have to increase substantially in order to make our '96 goal which will be substantially more.

Part of the question also was to relate the excavation to the technical site suitability and also the license application. These are the objectives or the goals and milestones for the technical site suitability and these would be for the license application. This would be to support licensing; these would be the milestones.

The next question, I'm missing one of the questions. Well, we'll just fake it. The second question had to do with the detailed sixth level financial data, this one right here. Now, what I'll do is I'll just give you the data, go through it quickly, it's in the handouts, but I won't really talk through it because I think the objective of the questions was to really identify basically why is it costing so much per lineal foot of excavation and why it's taking so long. So, I'll give you the data. I'll quickly go through how to roll it up, how to read it so that you can read the handout.

The ESF total work, WBS Element 126 is approximately $99 million. To obtain that figure, you would --this is the Level 3. You would add all of the Level 4 totals together which would then total up to your 99 million. You can leave that one there and I'll put the other one over here. So, that gives you a breakdown as requested by the question on how we plan on spending the money for the ESF. Then, it also gives you more information, for example, if you want to understand the subsurface access of $42 million, we would add up these fifth level elements to go ahead and then total up. So, it would all balance up and you get a very good idea then of what the total cost, $99 million, would be again over here and that is the summation of all the Level 4 elements. Then, all of the Level 4 elements would be summations of the corresponding sub-Level 5 elements. So, that is the breakdown of the costs for the ESF.

MR. MCFARLAND: Dick, may we ask a question?

MR. CRAUN: Sure, any time.

MR. MCFARLAND: In looking at the previous schedule and now the costs, in 1995 you have planned about 1280 meter excavation and you're allocating something like $41 million to that 1280 meters?

MR. CRAUN: Yes.

MR. MCFARLAND: This is something on the order of $10,000 a foot. Now, how does that break down? It surely is not into the operation of the tunnel boring machine, per se.

MR. CRAUN: Let me kind of come back to that question if you can because what I did is I took the $99 million and divided it by 1280 and got more like $60,000 a foot. So, that was the number I was looking at.

MR. MCFARLAND: I wanted to give you the benefit of the doubt.

MR. CRAUN: Well, no, that's all right. I appreciate that. But, I think again if you look at the four questions and you look through the four questions, it's basically why is it costing so much and why is it taking so long. Okay?

MR. MCFARLAND: Exactly.

MR. CRAUN: So, let me jump forward and I will come back to you. I won't ignore that question.

Then, what is the production? And, this is why is it taking so long? So, what I did here is I put together a schedule which is the basis of the '95 budget. I'll quickly just kind of go through that to give you a feel for those periods of which we were planning on doing the operations and then those periods when we were not going to operate the TBM.

These would be the operational periods as originally planned in FY-95. Then, this would be Alcove 3, the conveyor installation, actually the conveyor tie-in, Alcove 2, and then the mapping platform. Now, the times associated with those, we had a three week downtime for the mapping platform, again a four week for Alcove 2, a five week for the installation of the subsurface conveyor system, and four week down time for Alcove 3. This is all data right out of the program plan and it's all the basis for the '95 budget.

Now, the operating times, those times when we were planning on operating the TBM was based on a five day a week/ three shift operation. The first part of the basis of the excavation was on 8 meters a day and then toward the tail end of '95, the July/August time period when we get the conveyor system installed, the schedule is based on 12.5 meters a day. So, that's again the basis of our construction and cost estimates.

Now, I thought what we really wanted to talk about was really more in this area which would be efforts to reduce cost and improve actually the schedule or performance. I also brought another slide as a backup which I'll go ahead and use which is the lessons learned to date. It's been a learning experience. I think, as Lake indicated earlier, it's unique to try to combine an NQA-1 program with a tunneling operation. And, I don't believe the full effects of that were realized, specifically in the area of Q ground supports. As of today, we've spent numerous, numerous hours on the engineering staff and quality assurance staff to resolve the procurement issues. We are--why don't I back up and give you just a little bit of where we are today. Here it is.

On about November 21, we were mining and we actually ran out of steel sets. So, we had to stop operations. So, at that time, we looked at what efforts could be put into place in order to allow us to get the machine back up and running as quickly as possible. We decided at that time to go ahead and shift the schedule and move the mapping gantry installation earlier into the sequence of events and we started looking very closely then and that's when we really started getting heavily involved in how difficult is it to buy steel sets under a QA program and how difficult is it to install all of the devices in the field. From that time, from November until now, steel sets are still a critical issue on our supply schedule. They still are affecting operations as of today and will continue to affect operations until we get through Rainier Mesa.

Right now, the current status of the machine is that we're sitting currently at Station 1+35 and we are modifying the machine so that we can install the steel sets underneath the shroud, I believe it's called, or the hood-- the shield, thank you. So that as we get into Rainier Mesa where the ground conditions are going to be worse, we can go ahead and install them faster and easier. We can kind of keep the machine moving. But, in order to broach or enter into Rainier Mesa, we need approximately 150 steel sets projected to get through the mesa. Right now, we do not have those in stock or available for us. So, we're now looking and spending a lot of time trying to again find alternate suppliers and that sort of addition for the steel sets so that we can get sufficient quantities for us to go ahead and attack Rainier Mesa.

So, one of the lessons that we've learned is to look much more carefully at the materials needed to support the operation of a machine and start getting them here sooner and in greater stockpiles. So that when we need them, they're available for the operation of the machine.

Let me just kind of digress here in that there is some additional lessons that we would have learned as far as how to launch the machine when we originally launched it. It dove down a little bit and some of those issues. But, the major lesson that is affecting the reason why we are having difficulty mining, the machine is capable of tunneling at a much faster rate than what we're able to sustain. The machine is capable of, once we get the ground support system to the point where we can install it faster and easier, then in fact, the machine rate will be able to increase.

So, some of the things that we are doing and have done is, one, we are looking at alternatives to some of the excavation techniques so that the down times for the FY-95 can be shortened so that we can get a larger production period, larger than the initial plan of 30 weeks. We have spent a great deal of effort. We've sent teams back to the manufacturers of the supports that we need for the tunnel to look at our specifications and the requirements associated with the installation of those components in the field and to identify those areas where we can streamline them. In order to do that, we've had to go through and identify the critical characteristics of those components because we want to make sure that we support the critical nature of those components that are critical to us in the design so that we don't loosen the specification or reduce the requirements on the specification in areas where we simply should not be loosening the specifications. So, we have gone through the steel sets and identified those areas where we can improve production at the factories and the installation at the machine itself.

As a result of what we ran into when we had to shut down operations in November and we had to go ahead and go and parallel and install the mapping gantry, we went through a process of breaking down the activities into a detailed schedule so that we could lay out the schedule of events for the tie-in. So, we're going to take those same lessons that we learned from that and apply it now to the conveyor system installation. It's a five week anticipated outage which we feel we can shorten substantially by basically going through the exact sequence of how to install it, making sure that the parts are staged for that installation, and what we'll attempt to do is to keep the machine producing or tunneling as much as physically possible and then shut it down just for critical tie-in periods. So, those types of up-front planning and making sure that the materials are staged in sufficient quantities so that we have them when we need them should allow us to improve the availability of the TBM and reduce some of the planned outage periods as we will be experiencing during the conveyor.

Let's see, we reviewed the procurement of consumables. Right now, we've gone from November when we were buying--we had no qualified vendors to procure steel sets from so that we were buying from non-qualified vendors and we were going through component dedication and that's how we were getting our steel sets. We've now got two suppliers of qualified steel available to the program and we have three teams out right now looking for two additional suppliers. So, it would give us some diversity, it will allow us to address some of the cost, and get them here at a little more rapid pace.

So, those are some of the issues to address the component costs of throughput and those sorts of issues. Did you have questions in that area?

DR. CORDING: Yes. I appreciate what you've been describing to us and I think that we've been looking at a schedule that has initially appeared very conservative and I think the efforts to get the startup--there's almost always startup problems with a system like this, but it's very important that we not have these sorts of things recurring and it sounds as if this is what you're really focusing on is what is it going to take to keep the machine going now again on the conditions that we have to deal with. And, I'm concerned that all the planning for the project including the timing of the testing, as well as the timing of support for the tunnel advance, not be tied to this existing schedule because it is such a slow conservative schedule. And, I think this is part of what you're saying is try to get the consumables in place so that you can insure the maximum advance rate. I think that's key. If we plan on the basis of this schedule, we probably won't be able to do better than this schedule and I think there is so much that can be done to improve the progress. I mean, as you're operating even now in the first month or so of advance which is very much a learning curve and learning period, you're still making in a three shift operation with one shift probably not involved much, at all, in any real tunneling and spending a lot of time trying to get set up, you're still making, what, something on the order of 25 feet a day or--

MR. CRAUN: That's correct. We've had several days where we've been in the 8 to 9 meter per day. One of our better shifts was, I believe, 4-1/2 meters in one shift and that was setting steel concurrent. So, yes, we've got some good production that we're starting to see, but I think, as we make some of the improvements on how we install the steel, we can even improve beyond that.

DR. CORDING: I mean, I've watched progress with 30 foot plus diameter machines where they were setting steel and making 500 feet and the crew could go home early in the week if they could make that 500 feet. So, if they could get 500 feet by Thursday, they went home and had that extra day on the weekend to hunt and fish. But, those are the sorts of rates that can be achieved; not in all cases, but can be achieved on a regular basis. I'm not saying that's what we're going to have here, but certainly to me 8 and 12 meters seem very slow for any type of mucking operation that one sets up for this project. Perhaps, some of that is related to the fact that there were a number of alcoves that had to go in during that period for electrical systems. I'm wondering was that part of that original rate and, if those electrical alcoves do not have to be placed, will that change this rate?

MR. CRAUN: You may be referring to the niches. The niches are in that rate. So, that would affect the calculations, but the regular alcoves are removed from that calculation.

DR. CORDING: I was thinking more of the niches in that. Okay. So, there's an area and--

MR. CRAUN: In fact, we already have a proposal. We are looking at a couple of alternatives as to how to eliminate the need for the niches and still meet the necessary requirements for the installation of the electrical transformer equipment.

DR. CORDING: Is it possible, for example, in installing the conveyor that that could be done at the same period that you're excavating Alcove 2? Was that a possibility for--

MR. CRAUN: Well, I'd really like to get the alcove excavation concurrent with TBM operation. That's what we're really looking at. We've got School of Mines and three other people that we've contacted. I didn't bring a slide on that, but we've contacted three others to look at the availability of the equipment and not necessarily for us to buy, but possibly for us to contract the services to have them come in and excavate the alcove. So, if we can get away from drill and blast and, even so, we've got a couple of very talented people looking at how we could do some concurrent drill and blast, but we're looking seriously at how we could do mechanical means in order to allow the TBM to run concurrent. That would give us another eight weeks of construction in FY-95 which would allow us to significantly improve our target of 1280. So, yes, we are looking at the different ways of excavating the alcoves.

DR. CORDING: If you look at rates that--you know, it would seem to me that rates that are running 16 meters a day are certainly not out of the range of possibility or they're actually--

MR. CRAUN: Even with muck haulage, yes.

DR. CORDING: Yes. And, perhaps even improvements in the muck haulage so that you can--initially, I know you're working with muck cars and it would seem to me that there are ways to increase that progress even with muck cars; with more muck cars, for example, and I don't know whether you can actually achieve that or not.

MR. CRAUN: We're actually looking at how to get the cars to be able to pass each other.

DR. CORDING: Yes. And, is it possible you can procure more equipment like that? These are no major capital expenses. They don't have to be, I would think.

MR. CRAUN: The primary focus that we've been working on is to get the machine up and running. Right now, I've had several weeks--December 28, we had to shut the machine down for six weeks again as a result of material shortages. A week ago Monday, we had to air freight in some lagging. I mean, we simply have to get beyond this method of operation of the machine in order for us to--we've got some very, very talented miners on the project. A couple of them are sitting back here in the back in the audience. We've actually started working on--we have done two things. We established a resumption project office and, there, Mike Vogel was appointed to that and what we found is that we were having a difficult time focusing the organization on those activities necessary to resume TBM operation. So, we established an operations resumption manager and that helped us focus those activities. That initial outage initiated on November 21 was originally planned to be back up and running the 15th of January. We were able to reduce that outage to December 21 is when we had the machine back up and running. So, those sorts of activities can be very beneficial.

At the same time we established that, we talked with the M&O to establish a production manager. There, we're wanting to establish production goals which would allow us to exceed the 1280 fiscal goal and we have been--a lot of discussions have gone into that group. Discussions have gone in then to identify different work-arounds, ways in which we can, more muck haulers, muck cars, rail passage systems, and those sorts of things. So, yes, we are starting those activities now.

DR. LANGMUIR: A question related. You've suggested, Ed, in the past that there be an oversight board of some kind. Would a board have helped this process, anticipated these problems, and maybe avoided many of them if a board like that was in place?

DR. CORDING: That's been a topic we have discussed and some groups like that, I think, are able to provide suggestions to management of the level that the very capable people you have down in the trenches are not able to sometimes be heard.

MR. CRAUN: Some of the issues are fairly fundamental. We need a schedule. We need not only a schedule, we need one that is resource consumption loaded.

DR. ALLEN: Could I ask another question, Clarence? Out of curiosity and ignorance and you're perhaps not the best person to answer it, but there's another lesson that might be drawn from this. That the original quality specifications on these particular steel headings was unrealistic and a mistake in terms of reasonable expenditure of the taxpayers' dollar consistent with safety of the operation. I realize you didn't do this. Someone some time ago somewhere did this. Was it possibly a mistake?

MR. CRAUN: Well, as soon as you mentioned taxpayer dollars, I became a little more sensitive to the answer, but relative to are the standards that are in the specification --and, I want to say the QA standards, but the procurement standards--are they those standards which are the necessary and sufficient standards? The answer is no. We are able to reduce and we are reducing. We're identifying the critical parameters of the device. Those parameters, we will support with whatever QA standard, engineering standard, construction standard that's necessary for that function of the device. So, there are some parameters that need to stay tight. There are many other parameters. Do I need to have a machine finish on a Dutchman? Do I need to have a machine finish surface on a Dutchman? Well, no. No, you don't. So, are there some standards in the specifications that we can alter that will improve efficiency of initial fabrication and installation?

Initially, at the factory where we were having our steel sets manufactured, for every two sets that they could build for the commercial industry, they were only able to produce one set for us. Okay? We've been able to change that. I believe the ratio is now four to five. There are some standards like do we want him to burn through the cutting oil with a torch as he's welding it together? No, we want him to remove those contaminants so that we have low porosity on our wells. We want to make sure that the fill-it (phonetic) wells are good fill-it wells on our steel sets. So, we want him to clean it; whereas, in a commercial industry and commercial application, they would leave the cutting oil on the steel and go ahead and draw the arc and burn through it and that's a perfectly acceptable way of doing it in their standards and to their standards in that industry.

So, there are some, to answer your question, requirements where we have revisited and we have been able to reduce those requirements and still yet maintain the high enough level of standards or those standards that are necessary and sufficient to insure that the device, in this case a steel set, is able to perform a safety function.

DR. CORDING: I think, going back to continue that, the steel ribs in--I don't know of any applications for projects where the steel ribs have been used as a final lining over long-term permanent support. And, I don't know specifically what the plans are in the ramp, but I would assume that in the locations where there are steel ribs that a cask lining would not normally be placed there if one were to say this is to become a 100 year repository, retrievable period for the repository. And so, one could go back and perhaps it's too late at this point, but one could go back and say why are the steel ribs an NQA-1 item anyway because the way I would look at it they won't be the permanent support even if this site does ultimately become a repository.

MR. CRAUN: I agree with you. We asked that question. But, I took a simpler solution. I related the steel sets to a regular hanger structure in a commercial nuclear plant of which they have hundreds of thousands of them. They build them very quickly and they build them very effectively. So, I asked a different question which was why are we having so much difficulty building this device which should be with some standards pretty much off the shelf? So, why is it taking us so long? So, we took it from a different direction. Instead of trying to lower the standards to say I'm overly conservative and I don't need to be Q, so therefore I'll take them off the Q-list and to try to justify that. And, I said, well, it shouldn't take this long to build them. It shouldn't be this hard. So, what in the process, what in our specifications, and other items, what's driving us to what we're seeing? You know, I think, we've not only identified ways to improve in the initial fabrication, but we're also looking at and have identified ways to improve actually the installation in the field. So, I think what we really need to do is just sit back and say, all right, let's assume that it is Q. Let's not try to fight that because fighting that may give the wrong appearance to the outside. It should be easy enough for us to design, fabricate, and install this type of device; Q or non-Q.

DR. BROCOUM: But, we are in parallel looking, you know, as to whether the support system can be removed from the Q-list, but it's something we don't want to just do unilaterally or just suddenly, especially when we have trouble procuring a steel set. So, we did have a meeting with the engineers and the systems people and they are looking into doing that. But, meanwhile, he's trying to improve the production.

DR. CORDING: Sure, I see that. As a first approach, I think that's obviously a very appropriate way and going on as many fronts as possible. I think at this point you may compare the fabrication problem, but--perhaps. It sounds as if you have made a lot of progress towards that.

MR. CRAUN: Yes, we have.

DR. CORDING: The other part has to do with installation and I don't know to what extent the installation would be affected by the NQA-1 rating and whether that will significantly affect progress. I would hope that one could install these sorts of supports very rapidly. And, if they're not required throughout a large percentage of this ramp, then when one gets to the rock bolting, the rates can increase. Although once you get to the rock bolting, you start with a new process and that tends to slow you down, as well.

MR. CRAUN: I think I can ask that question a little easier once I get a stockpile sufficient so that I can really make sure that the TBM is running and consuming the consumables, the steel sets, on an as quick as physically possible basis. Right now, it's not the machine. As was mentioned earlier, it's not the scientists trying to take data off the mapping gantry once we turn that on. Right now, it's being able to get the consumables there fast enough to leave the machine going as fast as it can go. Now, once I get to that position, then I can start sitting down with some of the mining people and finding out now what are we doing differently here in the installation? Why is this slowing us down? But, we're just taking it one step at a time, I'm sorry.

DR. CORDING: I think one other area has to do then with if you're able to achieve the things we're describing here, you have an opportunity to essentially cut the time in half required to get to the bottom of a ramp. And, if you can do that, then it would seem to me that the testing groups need to say, you know, perhaps we're going to be better off letting it get down to that point and then installing the initial thermal test, for example, at that location. And that we will be ready to do that at that location and that we will also be ready to acquire the equipment needed to extend a drift to accommodate the thermal tests and a north ramp extension. I mean, all those opportunities could be there and that means that if you're really able to achieve this, we ought to be moving in behind--the rest of the program should move in behind that and take advantage of this extra time that you've given the project.

MR. CRAUN: Well, I had a discussion with Ned Elkins a few weeks ago and I said I wanted to buy him a set of track shoes. Eventually, I do want to get the TBM running as fast as possible, so that I don't get ahead of him. We're tunneling simply so that we can gather data. So, I don't want to bypass the data, but I do want a tunnel at a rate faster than I'm currently tunneling. And, I think that is achievable.

DR. CORDING: At this point, is there a plan or procurement for the additional machine that would, for example, do a north ramp extension or is there a plan for that?

MR. CRAUN: Well, the north ramp extension, I believe, is the 18 foot machine, 18 foot diameter machine, and I don't believe we're in the process of physically procuring that now. So, no, not at this time that is not underway. I think, my primary focus has been trying to get the TBM that we've got at a much higher rate and getting some of its operational issues resolved.

DR. CORDING: What else did you do during the holidays to see that people have been on the project trying to make this--you know, down in the pits, as well as in the management, trying to make this move over this holiday period is very encouraging.

MR. MCFARLAND: About a year and a half ago, the Board did a report on the ESF and one of the recommendations made in that report was that the DOE/M&O consider bringing in expert consultants to assist in the program and particularly starting up the machine. This machine, you say up there that it requires additional learning because it is a unique machine. This machine is the fourth in a series of that type of machine. There is experience on other machines identical to this. In the reply back on the Board's report, there was a question, gee, maybe a board of consultants would not be cost-effective. Do you have any thoughts on that? Do you intend to seek outside expertise on some of these issues?

MR. CRAUN: I'm more than willing to. Right now, I have a wealth of input coming from people; Toby Whiteman, Dick McDonald sitting back in the back, and Ned Elkins. I've got a lot of people that are giving me input that says this machine should run faster. So, I think, once we are able to address the expertise that we've got here on site and on the project, I feel very willing to open the doors and have other people come in and give us recommendations.

MR. MCFARLAND: Have you asked Peter-Kiewit or Parsons-Brinkerhoff of the need for expert consultants?

MR. CRAUN: No, but I will. I will. I will. I've talked to Toby quite a bit about what his ideas are. Some can be repeated and some can't. But, I think, they are excellent miners and I'm trying to figure out under a QA program, under NQA-1, how then I can mine quickly so that it's no different than the fabrication of a power plant. You build them fairly quickly and you do it with the right amount of paperwork.

MR. MCFARLAND: You might ask them how many jobs commercially they've worked on where the owner did not make use of some sort of external expert.

MR. CRAUN: Overview board, okay. Good, I will. Thank you.

Okay. So, I guess, the purpose of this slide was to try to give you the impression and a lot of this discussion was to let you know that we have a variety of things that we're trying to do to improve. I think that really addresses the systemic issue that I saw when I read the first four questions. That's when I read between the questions, between the lines on the questions. You know, that's what I thought you guys were wanting me to address.

So, anyhow, that's where we're working. And, we're not done; we're not there yet. I don't want to give you the impression that we're satisfied. I mean, we are having difficulty getting the steel sets ready for us to hit Rainier Mesa. We should be ready to hit Rainier Mesa, Station 1+95. We should be ready to hit that on the 23rd. I, right now, do not have the steel sets to hit Rainier on the 23rd of January. We're ready to go to Phase 3 operation of the TBM which is with the mapping gantry at Station 1+45. And, I may even be delaying that a little bit because of the supply of consumables. So, the primary focus is to let us get that machine to the point where we can operate it consistently for a period of time and that's where our focus is. And, have sufficient quantities so that if we run into difficulty getting more material when we hit Rainier Mesa, we don't have an even worse situation on our hands.

Okay. The next question was what are going to do with the crew? This is easy. Basically, during TBM downtime, what will we do with them? We do have a crew there, three shifts a day and five days a week. Basically, it's easy. They're miners and/or operators or electricians; so they go to work. Basically, if the TBM is not running, they're mining. There will be drill and blast, they'll be doing maintenance on the TBM and/or modifications to the TBM. It's the same crew. The crews are about 14 or 15 people that are really on the TBM of which there's only about eight or nine true miners. The rest are operators or electricians and then you've got the yard support and that sort of issue. But, to answer your question, it's about $20,000 a day, but they do work. It's when we're in the throttled mode waiting for materials which is the most damaging mode and that's where that really starts applying.

DR. CORDING: I think the one thing in discussing this, some of the people involved in the testing, I received comments from some that the alcove--that there was some flexibility on perhaps locations of alcoves, but even if they were wanting to locate at a certain place that one could go beyond a distance that could be somewhat variable depending on the construction sequence before that alcove was actually placed; for example, the Alcove 2, I think it is. So, it seems to me there's flexibility in the program with the testing groups and the construction to optimize these to achieve the objectives which are testing and exploration.

MR. CRAUN: And, the other thing I've found kind of related to that also is once you get a machine up and running and it's running smoothly, you're more hesitant to shut it down. So, you want to get it up and get it running smoothly so that you can tunnel as much as possible. Then, the entire organization typically will get a little more synergistic and more creative on how to develop work-arounds on keeping it up and running.

Okay. I've got the last question which is kind of in my area and kind of not. So, that's why Jean volunteered to make sure she sat up here with me. Basically, assuming that the alcove construction and exploratory drifting is to be done by drill and blast, how is the introduction of water in the geology to be rationalized given the "to be minimized" mandate of 10 CFR 60? I didn't fully understand the question when it got down to this point; will 10,000 gallons per foot of excavation be used, as in the starter tunnel? But, the answer as best we could come up with is something more like we are exploring mechanical excavation which will reduce consumption of water in the alcoves. The north ramp extension and Calico Hills drifting will be done--excuse me, the current plan is that it will be done using a TBM. So, it won't be consuming water at the same rate as the original starting tunnel. And, the waste isolation, the WIE, for the excavation of the north ramp indicates an acceptable water use of 590 gallons per foot in the tunnel. I pulled the records, I believe, from last week's tunneling. We're currently running around 240 gallons a foot and that's really for dust suppression and those sorts of issues. Then, the total water usage is limited to 500,000 gallons. The original starter tunnel excavation, we pulled the data on that and it was about 2,000 gallons per foot. That was high, but that was the number.

And, that addresses the five questions that, I think, were asked. Any other questions?

DR. CORDING: Any questions, Board and staff?

MR. MCFARLAND: One last question, Richard, that may come from other presentations. Since the last presentation that the Board has had on schedule, I think it was almost two years back, at that time there was strong indication that the highest priority activity during the initial periods of excavating the ESF would be to operate the machine and that interruptions for alcove construction would--alcoves would come after the machine had completed whatever extent it was to be used. In the intervening period, that logic has been turned. What, I think, we'd be interested in hearing is the logic that led you to put the alcove excavation a higher priority than the operation--the efficient operation of the tunnel boring machine. What is the rationale that led you to develop this schedule?

MR. CRAUN: In other words, why did we have the four week outage periods of the TBM in the FY-95 baseline?

MR. MCFARLAND: Yeah. Just the thinking process that led you to these decisions?

MR. CRAUN: I don't know that I have the background to address that. I don't think I've been here long enough and I didn't ask that question in getting ready for this presentation. Does anybody else here in the audience--Ned, do you feel comfortable with that or somebody else? Or Dennis? Okay, great.

MR. WILLIAMS: I think with regard to the alcoves, I mean that's the test bed. That's where we do the important things of the characterization activities. So. we set it up such that there were deferable and non-deferable tests that we were going to field in this exercise. These seven alcoves that we're talking about in this first set have non-deferable tests associated with them. We want to understand the percolation. To understand the percolation, we need to get in there in a very timely manner in order to do this. So, we set up the schedule for the alcoves. I think there is something like seven alcoves that are deferred on the north ramp. There's something like four on the north-south main and there's quite a number that are deferred on the south ramp. But, to me, we've got to recognize what the objectives of the exercise are. That is testing. There's some tests that we will feel very uncomfortable with on deferring. These are the tests that we've identified, the seven alcoves, the timing in there to do those alcoves.

MR. MCFARLAND: You're going to identify the tests and the non-recoverable data that has led to these conclusions?

MR. WILLIAMS: We're going to identify that. In the ESF presentation, we've got a crosswalk there that shows you some of the tests that we are fielding and the reasons why we're doing that in these alcoves.

MR. CRAUN: Maybe I can answer the question. Is the question as to why don't we go ahead and tunnel beyond the alcove and then build the alcove path after we've gotten the machine beyond the alcove?

MR. MCFARLAND: The real question, Dennis, is getting at what is the rationale, whether it be to excavate across the location or to stop the machine? What is the basis for the decision that you have made to develop the schedule?

MR. WILLIAMS: Okay. I don't know whether we can really satisfy you on the basis for the decision process that we've gone through. I think the way we laid out in sequence, we said, okay, we would--okay, for the best characterization, we would have these alcoves at these locations to do these tests. Can you build these out--you know, I don't care. You know, if we can build those alcoves concurrently with excavation with the main tunnel excavation, I have no problem with that. If it boils down to a matter that we can excavate those alcoves in a matter of a week, you know, then we're closing in on the issue. If it's starting to take, you know, three months to excavate those alcoves, then I think we may have to rethink the situation.

MR. CRAUN: And, we are looking at concurrent alcove tunneling operations.

DR. CORDING: I think the one thing to look at--it seems to me some of the concerns about doing testing at upper levels has been the fact that the schedule is such that you felt that you weren't getting down far enough in time and, if that changes and you can improve that, then there might be some more possibility of saying we know we can start certain of the tests down at the repository level, for example, the thermal tests, and that then becomes a higher priority objective than having to do it at other levels. So, to me, it seems that we're talking about a real synergism here among the various alternatives and the construction and the testing.

MR. WILLIAMS: Yeah, and one of the reasons why we have proposed and we've talked quite a bit about the TSW-1 as being a possible test bed for some of our early thermal tests, is because we have concerns about how fast this TBM is going to excavate, but it doesn't get down to the levels that we really want to get to. What are the alternatives that we can use, and in that case, if it's going slow, excavate another alcove. We'll negotiate that with the--

DR. CORDING: And, it could be a Catch-22 if you aren't being flexible because you say it's going slow and so we have to put an alcove and we put an alcove and it goes slow. And, you know, so if you're working together on this and it seems that you are, there's other options to still be considered here.

MR. CRAUN: I think from both the testing community and the quality assurance organization and all of those that are participating in some of the discussions to allow us to resolve the issues, there's been a great deal of flexibility demonstrated, a lot of willingness to try to step back and look at what we've done, how can we change it to improve our performance? So, it's been good, so far, from just an outsider coming in.

DR. LANGMUIR: A question maybe for Dennis. I'm just wondering if we have in our materials or if he's gotten this so he can provide us today a list of what you view as the non-deferable tests that would need to be done early-on? I'd like to know what they are, but it may not be--

DR. CORDING: Dennis, you have more presentations to make and maybe this would be better to come up as a question in your presentation.

MR. WILLIAMS: It's in some of the crosswalk material that are on the ESF portion of my later presentation.

DR. LANGMUIR: Okay, fine.

MR. WILLIAMS: We'll hit it briefly as time permits.

DR. CORDING: Thank you very much, Richard Craun.

MR. CRAUN: Okay, thank you.

DR. CORDING: Let's bring up our other panel participants and we can continue with that discussion on the strategy and exploratory program.

DR. YOUNKER: Yeah. let me remind you of where we are. We're down here in our strategy element or barrier #5 which is the migration through the geosphere. We were in the midst of discussing the types of testing in surface and underground that map to the key uncertainties in the migration through the geosphere.

MS. JONES: I just had just a quick question about the rest of the time we have here. One of the biggest areas that we have to talk about obviously is the ESF testing program and we also had a little bit more of the hydrology and went on then to the things like the tectonics program. Is there any particular emphasis you'd like to have because we really are on a pretty short time frame here to try to get to the rest of this.

DR. CORDING: I think we had originally had a schedule that called for a public comment session at 3:00 o'clock and I'd like to try to be close to that. I'm not sure how to prioritize what you want to present. You perhaps could help us with that.

MS. JONES: Well, it sounds like clearly there's going to be a discussion and interest on the ESF and so let's blast through fairly quickly some of the programs that you had numerous briefings on. For the model for fracture-matrix coupling then, is that the one we're--

DR. LANGMUIR: I'd like to also remind you that we didn't finish the chlorine-36 discussion. If there's a chance to do that for just a short question and answer before the open discussion, I'd like to do that, too. Bring back chlorine-36. It wasn't quite completed, that discussion.

DR. CORDING: Yes, all right.

MS. JONES: Okay. Let me just quickly then go through the surface-based activities here because we've already talked about the pneumatic testing and I showed you a map of that earlier. The only additional piece of information from the surface-based testing program that I would present here would be the cross-hole tests that are being started right now at the C-hole complex. This shows the location of that to the south and east of the repository block. And, the 5-year plan right now does include a southern tracer complex to give us a second testing location related to this particular program.

DR. LANGMUIR: This is cross-hole testing when you push fluid in one hole and sample at another hole?

MS. JONES: Yeah, the C-well has--yes.

DR. LANGMUIR: And, you put tracers in it so you can evaluate--

MS. JONES: Yeah, C-wells has several different components, actually. Its participating organizations are the U.S. Geological Survey which is looking at the conservative tracers and doing pump testing. Then, Los Alamos is looking at reactive tracers within this multiple hole complex. And, earlier, we went very quickly past the colloid issue when we were talking about the engineered barrier system, but from the transport perspective, the C-wells test is using microspheres to simulate colloids and that would be a Los Alamos test in conjunction with the rest of the C-wells testing.

DR. LANGMUIR: But, you have not consciously sought out fracture zones that are known to be fracture zones here. You're simply putting it in the rock and whatever happens to be there in the way of fractures is what you're studying--

MS. JONES: Yeah, I was going to ask Russ to describe the test in a little more detail.

MR. PATTERSON: These tests are--these holes have been mapped and it is in a fractured area. We're putting packers in different areas within the hole based on the fracture maps and the TB logs and that sort of thing. So, yeah, we're looking at trying to define how water flows through fractured media. That's exactly what C-hole test is for; using tracers, conservative and reactive tracers, and the microspheres.

MS. JONES: I was going to say the timing on this particular set of tests is the--like I said, the C-wells testing has started. That's FY-95 and '96 time frame, possibly a little bit longer than that. And then, the earliest for the second southern tracer complex would be roughly the '98/99 time frame. So, basically, for suitability, we'd have only the C-wells information.

DR. DOMENICO: Just one quick question. What's the spacing between the wells in the C tests, approximately?

MR. PATTERSON: I'm sorry, I'm going to have to say about 200 feet and they're in an L shape. We discussed this quite a bit, I think, last April at the full Board meeting. If you go back and pull out those, I think there's a discussion.

MR. WILLIAMS: About the only thing I would say on the ESF portion of this key uncertainty is basically speak to the tests that we've been talking about before; the radial borehole, fracture mapping, monitoring mapping of the seeps for the perched water, and the major fault tests. Just in your hard copy book, this is somewhat the layout of a typical hydrologic properties of major faults. This would be what we would be feeling in an alcove again, basically, to get boreholes across the fault, perpendicular and parallel. In some cases like at the Bow Ridge, we may not be able to do those perpendicular holes because of the ground conditions and the support, but that's one of those things we work out with the design folks.

MS. JONES: And, for here again, we've just talked about this C-wells using the microspheres to simulate the colloid transport and the same types of tests being conducted at the southern tracer complex. So, this is where we really start introducing some of the Calico hills testing and/or the surrogate here which would be P-Tunnel.

MR. WILLIAMS: Right. And, with regard to P-Tunnel, just a little bit of a location map on that. It's not a great drawing, but I'd point out that we are here at the crossroads of the west in Beatty. We've got Yucca Mountain over here to the east of us and, about 30 miles to the northeast up on the forward areas of the test site, we do have P-Tunnel.

DR. LANGMUIR: By the way, your C test colloid thing, I find it bothersome because it's a continuation of a logic of testing and of thinking about issues that is a series logic rather than a parallel logic. You could be asking questions which would determine whether colloids are relevant, at all, and answering those questions rather quickly instead of continuing on with things. Well, sure, you're going to have colloids going in fractures. I can tell you it's going to happen. But, will they ever make it from the waste package out through a backfill? The answer probably is no. And, if that's the case--

MS. JONES: Then, we don't do this.

DR. LANGMUIR: If you're going to have a backfill, this is a waste of money.

MS. JONES: Then, we don't do it.

DR. LANGMUIR: Yeah.

MS. JONES: Right.

DR. LANGMUIR: I think where we are right now in the program, we need to ask questions like this. Questions which in themselves by answering single questions, you eliminate issues as needing to be continued.

MS. JONES: Yeah, actually, I should just point out just as an aside here that in looking at the colloid question, that was actually deferred out of this year's program just because of that reason. Until we get some better feel from the engineering perspective like we talked about earlier this morning, we really haven't got this in our near-term testing program. But, in terms of a 5 year plan, it is in there if you want to think of it as a place holder pending some of the earlier answers. And, I do believe--and, I'd look for a nod here, but I believe the colloid part of this is one of the last pieces in this multiple year testing. We'd be doing other tracer testing first.

MR. PATTERSON: Yeah, it's the last.

MS. JONES: Yeah, that's what I thought.

MR. PATTERSON: This year, all we're going to be doing --right now, we're doing barometric pressure testing. We're not doing any pump tests yet. Pump tests will be done this year and maybe start some conservative tracer tests. I don't even know if we're going to get that point this year. Then, next year, will actually be more of conservative tracers and reactive tracers and then it would be colloids after that if we find out. So, we actually have about a year and a half to make that decision really if we're going to do colloid testing.

MS. JONES: Yeah. In some respects, in trying to collapse the information to a real small piece, you aren't seeing a lot of the time phasing on some of these smaller pieces.

MR. WILLIAMS: Okay. With regard to the field-scale transport experiment at P-Tunnel, this is a listing of the objectives. Basically, we're talking about a bedded unit below the Rainier Mesa welded unit. It's vitric and zeolitic tuffs. We have noted that it is similar to Calico Hills. It's not an equivalent to Calico Hills, but we hope to be able to investigate the processes associated with transport in this type of unit, work on our scaling effects, characterize potential fast paths, and really start working on doing some model work to see if we can simulate those conditions.

MS. JONES: I just wanted to make one comment about the Calico Hills. Earlier this morning, a question was asked about whether we were tying the decision to go or not go to the Calico Hills or how to get there to other schedules, how it fit in. And, the systems engineers can correct me if I'm wrong, but I believe the sequence of events is we were looking at having to have a decision this spring, in a very short time frame here, because we were tied in then to a design of the access, whatever that turned out to be, procurement of equipment or whatever had to happen beyond that, and then tying to the TBM advance, that particular schedule. So that when we reached the point where we would take off for access to the Calico Hills, everything else was backed up and in place to do that.

DR. LANGMUIR: Why is that necessary? I mean, we heard earlier, a year or so ago, from one of your employees, the DOE folks, about coming in around the other side of the mountain using an outside contractor totally independent of the TBM system. It wouldn't be tied to it at any time and it would be cheaper, as well. Whatever happened to that recommendation?

MS. JONES: I'm not sure. If the systems engineering group was looking at that as an option, it was considered, but there were also some land access and logistical issues that had not been considered completely at that time. Tom

Geer is going to bring us up to date on that study right now.

MR. GEER: That is one of the options that we're looking at or will be looking at for access mode since we have the data needs clearly identified and articulated. The analysis or the idea that was put forth in the past didn't have a complete analysis behind it and hadn't considered any alternatives in addition to the external access. So, we don't know that that would be the right answer for the project. It's certainly, you know, a feasible option and it's going to be one of the ones that we evaluate.

DR. CORDING: One question on that. Do you have a time frame at which if you were to proceed on that that you would be able to start tunneling, for example?

MR. GEER: When we would be able to start tunneling would depend mostly on when we need to. We expect by the end of this month to have put together the list of the data needs that we would expect or require from Calico Hills and identify the initial suite of these excavation options to get there. And, I believe, it's by May of this year, we expect to have the study completed. I may be off a few months on that date. One of the things that the results of the study will establish is what the schedule for access would be, what it would take to--when, number one, the data is needed and then backing up from that when the accesses would have to begin and when the procurement cycles would have to begin to do that. So, later or mid this calendar year is when I expect to see the schedules for that detailed out.

Does that take care of your question?

DR. CORDING: Well, you didn't give me a date, but your terms of when you would actually be able to start the tunneling, but I don't--

MR. GEER: Well, we don't have that date right now.

DR. CORDING: Yeah, but you'd be working on it this next few months to--

MR. GEER: Right, we should know that date mid this year.

MS. JONES: This was conducted in two parts. First, whatever the data needs, they just finished that and you're almost presupposing the answer is tunnel from--as the answer to the proper mode of access. And, I'm not sure that the study has reached the point of saying that the data needs must have a tunnel to get you there. Although, I don't think too many of us would be surprised if that were the answer, but basically we're doing it from the front end looking at the data needs first.

MR. GEER: We're conducting the study with a sense of urgency that that is the answer because that will put the greatest pressure on us. So, we're scheduling the completion of the study in what we believe will be enough time to get that fully planned and implemented. But, again, we don't have the actual date that we would need to start excavating.

MR. WILLIAMS: But, with regard to P-Tunnel, the opportunity came up last year to take advantage of the situation up at P-Tunnel and, because we were really scrambling to get as much information as we possibly could for especially TSS, we embarked on this particular effort. This is a schedule of some of the activities associated with that. We're in the process right now of trying to accelerate some of the early '96 back into some of the late '95 time frame and then, hopefully, have some useful information that we can use in TSS. This is regardless of the outcome of the system study on the Calico Hills.

MS. JONES: Steep hydrolic gradient is fairly straightforward. And, towards the end of fiscal '95, we start drilling WT-24 which is up there at the north end. Then, depending on the results of that, as well as the results of geophysics that we ran up along Yucca Wash in '94 looking at possible structural controls, we'll have the one hole in, WT-24, in '95. If necessary, we have in the schedule WT-23 in '97. Specifically, looking at that steep hydrologic gradient. There's also a possibility that, I think, we have G-5 scheduled later in the sequence here and that would be available for LA, license application time, if we needed it if WT-24 didn't do the job.

We talked about C-wells. The thing here to bring out would be the WT or water table program. I've laid this one out just in the interest of time here. I've laid this out, the way we did the earlier ones. First, we're showing the existing holes from the WT program. There actually haven't been any new WT holes drilled since we restarted site characterization. So, these are the older holes. But, they're available for testing. At site suitability, actually, you have this suite of holes available. Seven of them will have had their testing completed. And then. for license application, I show you a complete suite of holes that we have and at that point there are 20 available and 17 would have been tested by the time of license application.

And then, the geologic boreholes which would be the fourth type of the deep drilling program that we have. Right now, P-1 is the only hole that reaches the top of the paleozoics and it only goes down a couple hundred feet, maybe a couple hundred feet into them. So, we have two holes in our current five year plan. The first one is G-6, down to the south and west. It goes down into the paleozoics. And, it's been cited to help with the interpretation of the regional seismic reflection line and I'll show you that when we get to the tectonics program. But, that's what this line is showing; is the trace of the deep reflection line and we put G-6 right there to help with the control on that. Then, up to the north, we have G-5 in the later time frame also going down to the paleozoics and, as I said earlier, if needed, it could assist with the interpretation of the steep hydrolic gradient.

DR. YOUNKER: Leon wants to ask the question, "What within the geosphere barriers could we find that would lead us to a decision that the site had a potential disqualifying feature present?" He raises this question on each one and I'm obligated to just ask you that question or ask ourselves that question.

DR. ALLEN: That might be a question that Leon might well have asked.

DR. YOUNKER: Oh, he already did. He gives me the signal on each of the--

DR. ALLEN: Oh, I see. I see what you're saying.

DR. YOUNKER: Do you guys want to respond to that or do you want to think about it?

MS. JONES: Think about it because again we're just really into the hydrology program and we pretty well talked about that. You know, this is all geared again towards water movement--

DR. YOUNKER: Talk to the microphone.

MS. JONES: I'm sorry. Again, this is all part of the earlier discussions on how water is moving through the--in particular, this one is how water is moving through the mountain. So, we're looking again for the fast flow paths or something anomalous that we can't model like we talked about earlier. I don't see anything else coming in here.

DR. REITER: I want to ask a couple of specific questions. To what extent are you relying upon--let's say, the Calico Hills is extensively fractured, we had very little retardation. What would that mean? What happens if you find there's very little dilution, very little vertical mixing, a very thin layer--is that an indication that--

DR. YOUNKER: Really getting--those are more performance assessment oriented consequences type questions. But, I think from the standpoint of how much we rely on the natural barriers to retard when there's actually been releases, you know, I suppose it would be of concern to us if we found out that the Calico Hills really wasn't going to perform in any manner and that as a natural barrier for retardation, rather it's a--I have trouble looking at that all by itself and saying that would be a disqualifying feature for the site. But, it would certainly raise our concern that whether or not part of the system that we had always figured was a backup barrier or part of a multiple barrier system was really going to function. I guess, the same thing for any aspect. I keep coming back to that same answer.

DR. BROCOUM: Also, again, disqualifying a site is a very major decision because to some degree you might be saying the geologic disposal will not work. So, that is a decision. That's an important decision to say qualifying or, even in a sense, more important. So, I think that would be very hard, at least in my mind, to come up with a specific feature that all by itself would disqualify the site. And, I think the way the questions are coming from, you say, well, this is qualified, would that--I think those questions cannot be answered simply yes or no. It's how it fits in the whole picture, what we know about the site at the time, and what the performance assessments are telling us. So, I think that's why they're very difficult questions to answer.

DR. ALLEN: Could I ask Susan or perhaps give you a chance to modify what I thought you said this morning and under argument from Leon about disqualifiers. You made the statement that a disqualifier might well be if there are too many faults on the site. If you're on record as saying that, I'd like to give you a chance to expand that.

MS. JONES: Yeah, I tied it to the design and the fact that there is a condition that we have to deal with which is do you have enough space in which to put this repository? So, if you suddenly find yourself with a number of fracture zones and for whatever reason you chose to have a standoff distance, you're suddenly shrinking. It's the lateral extent of the suitable ground for emplacing waste.

DR. ALLEN: Well, let's assume we have a site with a fault every five meters with very minor displacement, with no evidence of any water flow, does that--why should that disqualify this site?

MS. JONES: It might not. It might; it might not. It probably wouldn't. But, what I'm saying is, you know, that's--you're speculating on what might lead us to a disqualifier and we do have to worry about the lateral extent, the availability of space to put it. And, if you chose some sort of a very conservative design that let us stand off from these types of fracture zones, every time you found one, you would be removing emplacement area. So, you know, it's a real tortuous path and logic that you have to go through to find that. But, that's the only thing I can think of.

MR. WILLIAMS: I think that one of the things that we're dealing with here whenever we talk about the field program is collecting the right data, making the right analysis, being able to describe the phenomena, and understand those processes and with some sense of reliability, predict what's going on. Now, whenever we start approaching some of Leon's questions, I think that the people sitting over on this end of the table, that's not really what we're charging forward at with this part of the field testing program.

DR. PALCIAUSKAS: Rather than a disqualifier, I'll just give probably a very real situation that in the next year will come up. Suppose we find more tritium at the Calico

Hills/Topopah Spring interface and yet we can't really determine what amount of water is coming out? We know it's there, but we really can't tell what the total flux is. How are you going to approach that problem?

DR. YOUNKER: I think that gets back to the kind of question of the uncertainties in the overall way that we've set up the strategy. And, you know, if you--I think, Dennis answered one of the questions about the--if you end up with a lot of fractures, kind of distributed fracture-flow, and the fracture spacing was fairly high or I mean it was fairly narrow so that there was a lot of--it looked as if it would be difficult to put a repository in where you didn't have a preponderance of the waste packages contacted by dripping water, you know, we'd have to think about the whole concept because that's not how we thought this site was going to behave.

So, I don't know whether that means then that DOE--I mean, DOE would look at that and say, you know, here we are down this far thinking the site had certain properties and characteristics. We've designed the system for that. You know, it would have to be a major decision point in the program, I would think. But, whether that alone automatically throws you to a disqualifying condition in Part 960 is where we all go, yeah, but it isn't that easy. It isn't just the instant step.

DR. REITER: And, again, the question we have framed in the beginning was we realize these aren't necessarily disqualifiers. But, what we're looking for are what are those kinds of things that would seriously challenge the site, could possibly be disqualifiers, not that they are. And, I think I might not agree with Dennis that that is something separate from the field testing program. I would maintain that searching out those kinds of features and knowledge of the performance should help you drive the testing program to make sure that you're looking to the right kinds of things. And, that's the purpose of this whole exercise. That's why I keep asking these questions.

MR. WILLIAMS: Yeah, and I didn't mean to abdicate our responsibility in being involved in that, Leon.

DR. YOUNKER: It's a perfect time. I'm not done yet, but I'll jump to my last viewgraph because the point that you're making is the one that I was going to close with and let me just make it now and reiterate it later.

Basically, the idea that what we've been talking about a lot and will continue in the little bit that we have left is getting at what are the features and conditions in characterizing them adequately to support the characterization we need, looking at alternative hypothesis, reviewing the assumptions that underlie all this, and that's certainly one big piece of what we do. But, like Dennis said, then you've got to look at it over from the perspective of performance assessment and the application of the information. What's the significance with regard to safety of the site, whether it's pre-closure or post-closure like we're talking about today. And, that's where I think getting at a realistic representation of the effects of that, whatever that feature or condition, whether it's distributed fracture flow through performance assessment and through taking it through the consequences, is where you get the answer to the question that you're asking. Or, at least, I think that's where we believe we find those answers. It's in what difference does it make in terms of consequences to the safety of the site.

DR. REITER: And, again, this is not something done after you do your field investigations.

DR. YOUNKER: No, it's ongoing; iterative.

DR. REITER: Don Langmuir pointed out the colloids may not be an important thing to look at depending what you're doing. I would call this the systematic exploration of failure space. You want to try and find out somehow what are the ways a system can fail? You know your knowledge if not going to be complete, but that kind of information done in an iterative manner through performance assessment, through your scientists is going to help you focus in on things that really count. Otherwise, you might be spending an awful lot of time and energy on things that are maybe very interesting to certain people, but they may not be very important.

DR. YOUNKER: That's very true. We agree completely.

We have two pieces left to this presentation of the strategy and the interface to the testing program. One part is to look at thermal effects. Remember, we said we were going to do that separate. So, we have a couple of--we'll look at the key uncertainties and the plans to address them on thermal effects and then we go to the external features, events, and processes and quickly walk through the list of those. So, I think, we can finish that probably by your 3:00 o'clock cutoff and then we'll have to decide how you want to handle the little updates.

DR. CORDING: Yeah, fine.

DR. YOUNKER: Okay. For thermal effects, the key uncertainties are the effects of temperature on everything, as you might guess. And, temperature on engineered barrier, temperature on rock mass stability, thermal load on near-field humidity, waste package material corrosion rates, mobilization rates, mobilization of radionuclides from the EBS, and then thermal load on moisture distribution, and any effect on minerals along flow paths. I think my little note to myself is probably the best I can do for the bottom line. Lots of modeling results, what we need is some data. That's what my note says.

DR. CANTLON: Before you take that off, Jean, wouldn't you add also movement of water from the water table up?

DR. YOUNKER: Sure, I guess it probably fits there somewhere. I think any question of redistribution of flux whether you're pulling it up or whether you're moving it around, yes.

Okay. And then, approaches to address those uncertainties and I will just slide back through these very quickly because I think Dennis is going to jump in here with a little bit on the in situ test program. Short-term heater tests, longer duration to get at the coupled processes, laboratory tests for corrosion rates under various conditions, lab tests of our waste form dissolution and solubility under a range of temperature conditions, and then rock properties testing.

And, I'll quickly hand off to the site people again.

MS. JONES: The surface-based activity that deals with this is primarily the systematic drilling program providing core for the rock properties testing. Most of this discussion deals with the heater tests in the ESF and the attendant pre-cursor activities. The main customer actually for our systematic drilling program is the design organization, repository design. And, what I've included in your package is, first of all, a legible plan that shows the boreholes that are available for the systematic drilling program. It's not just SD holes is the only point I want to make, but anything that is in a position where the rock properties are relevant to input to design such as the NRG holes, the north ramp geologic holes, and so on. And, basically, these are the holes that are available right now for TSS showing sort of the sphere of influence of each of the holes there.

And then, for technical site suitability which also correlates with the advanced conceptual design we have about 65% of the area covered. This is additive, by the way. You take the existing plus these additional holes.

And then, the next one flipping through shows for a license application. We add an additional series of holes here. We'll have pretty well the coverage that was expected or planned out in the SCP by the time we're finished with this. That last diagram shows the total coverage by the time you put all of the various holes that have been available, this is the kind of systematic coverage we have for these types of rock properties. And, this information also feeds our 3-D framework model, as well as the rock properties model.

DR. LANGMUIR: Susan, I missed it. What does SD stand for?

MS. JONES: Systematic drilling.

DR. LANGMUIR: Okay.

MS. JONES: This is Chris Routman's geostatistically based drilling program as opposed to things like the UZ or WT programs that are feature based.

MR. WILLIAMS: In the ESF activity part of it, the thermal tests that we're looking at, we also have the Fran Ridge which is basically the fielding of an underground test near the surface. I'll talk about that very briefly. But, the main thing I want to convey here is that due to the TBM progress--I'll just put it in those flat terms--and the need to really get into the coupled processes on the thermal test of confining the mechanical, the hydrological, and the chemical, all coupled together, we are rethinking our entire thermal testing strategy program. Now, this is different, of course, from the repository loading strategy that you've had a lot of briefings on. But, hopefully, what we'll see is a compatibility here that we are testing in the ranges, even from some of our initial tests that will cover the full range of thermal loading strategies.

Just a couple of colored ones here. We have the Fran Ridge large block. It is isolated. It's a 3 meter by 3 meter by 5 meter block. We originally had quite a plan associated with the testing at the Fran Ridge block basically in the areas of the thermal hydrologic. We are going forward with that. The thing that we may not do as extensively as we had planned in the past is the loading component. However, we will still be looking at the instrumentation. We will be heating the block up. We will be looking at the processes that are ongoing in that. We'll be attempting to validate some of the models that we will use on this and also for thermal tests in the ESF as we get down there later.

DR. LANGMUIR: You're also doing P-Tunnel testing of thermal--you've got a thermal P-Tunnel effort or am I wrong on that?

MR. WILLIAMS: No, P-Tunnel doesn't have a thermal component.

DR. LANGMUIR: Nothing thermal on P?

MR. WILLIAMS: No.

DR. LANGMUIR: Okay.

MR. WILLIAMS: And, another little pretty, I think, in the last meeting in Washington, you saw a 3-dimensional block fracture map that Livermore had done on this block. So, this is just a little visual representation of that. I would like to leave Fran Ridge right now and go on to some of the things that we're doing with regard to the white paper that we have Sandia basically coordinating. They're coordinating all the people that are involved in the thermal, again for some fully coupled tests. It's largely Sandia who has traditionally been in the mechanical arena and Livermore, of course, who has traditionally been in the hydrologic and chemical area.

I'll do this showing some diagrams of basically a test layout, a test schematic, and then probably, more importantly, the information needs that are associated with fielding this test. In this case, we have a diagram of the axisymmetrical test. This was one of the very early tests in the system. It was to simulate the borehole emplacement in the floor. Basically, it's been modified. We're considering modifying it to accommodate some of the more hydrologic and chemical aspects. One thing that came out of looking at this test when it was in the floor boreholes, was a matter of the water would drain off, but where would the water go? There was no way of capturing that. We're probably going to reconfigure that test and put it in the roof so that the water will drain down into the opening and we'll see how the actual thermal--how the water sheds in regard to that--or in response to that thermal stress.

The information needs associated with that, I think you can start seeing on this particular overhead some of the more mechanical aspects that were originally associated with this test and then we're starting to see some of the hydrological and chemical. What are we doing with regard to drying fronts, residual water saturations in the dry zone, refluxes, and the conductive/convective. Hopefully, this will start providing some information for Tom Buscheck and his thoughts on this.

A second one under consideration, the old horizontal heater test. This is where the axisymmetrical was more of a symmetrical test. This is a non-symmetrical test. Again, it's got the heaters and the instrumentation associated with it that would give us information with regard to the mechanical, hydrologic, and chemical coupling.

DR. LANGMUIR: Let me ask you, Dennis, even your diagram suggests what I'm suspecting. That you're going to be looking at the flow in conceivably very limited length, limited permeability zones which are connected anywhere beyond where you look at them. I mean, they may be a few feet in dimension. And, this does not tell you anything about the mountain behavior as a whole and it doesn't characterize effects which would include fracture zones where you might have major movement of fluids on a total different scale than the tests themselves that you're looking at. And, you'll never see that with these tests.

MR. WILLIAMS: Right. And, you won't see that with these tests because these are the first, these are the simple initial tests. When I get to the fourth test, I think you'll start seeing that it has a broader scope and, under some different geometries, may start to simulate repository conditions.

Heated block is purely the old mechanical test and you'll see that the information needs associated with that are purely mechanical. Again, this tells us a lot about the mechanical response of the rock under thermal loading. It's an easy test to do. We can field it in a lot of locations. We can get a lot of information very quickly by doing this.

I think, here, we're starting to approach the larger test that you may be thinking about. This probably is getting in the range of what Livermore has called their engineered barrier systems thermal test. I'd like to go quickly first to the information needs on that and run through those because that, to me, is the most important part of it, especially when we're starting to get down here into some statements on the thermal mechanical properties of backfill. We're putting our coupons in this test for the corrosion and we see those key items of the residual saturation of the drying front, the refluxing, and the conductive and convective.

Now, the exact geometries of this hasn't been--or we haven't worked that out to completion yet. And, I think the geometries and how many places we insert heaters along a set of alcoves or along a drift may start to approach the simulation that you perhaps are referring to where we can see possibly the thermal influence, say, of two different heaters starting to converge and then starting to simulate those convective and condensing characteristics.

DR. LANGMUIR: Yeah, the time scale that you're going to learn things on would be presumably within very, very quickly on the thermal mechanical effects, right?

MR. WILLIAMS: That's right.

DR. LANGMUIR: You'll know those within a year or less?

MR. WILLIAMS: That's right.

DR. LANGMUIR: Whereas as you start talking about transport of fluids, those processes are going to take some years?

MR. WILLIAMS: You're talking in the case of this test of running it to completion, these are the eight to 10 year time frames that we've been talking about. The other three tests, the simple tests, we can probably heat those us and run them to completion in a matter of months to a year. This is the larger scale test. This is a test that's going to have to run over longer durations and into performance--

DR. LANGMUIR: Are you only going to be looking at redistribution of fluids, water, that's already in the blocks or are you going to consider putting water into these systems when you cook them?

MR. WILLIAMS: There is a consideration on one of the smaller tests to rewetting, to putting water back into the system.

Again, this is what we're working at, but our major objective in this case has been trying to collapse all of our thermal testing down. I don't know whether you've read a lot of our old documents, but I get very confused by it. I mean, we have heater scale tests, we have room tests, we have canister heater tests, we've got mechanical components. Hopefully, we will be able to collapse that all into a consolidated set of tests, some that we can field early, some that we have to run for longer durations, but they will provide us the information needs in all the areas where we need it; the hydrologic, the mechanical, and the chemical.

DR. LANGMUIR: To what extent is total system performance analysis provided you guidance as to how to collapse?

MR. WILLIAMS: I really couldn't tell you for sure. We've put this in the hands of Sandia. We basically have told them to develop a white paper on this. I don't know for sure who is on that--I know Jim is on the team. He's walking up. He can tell us some more maybe about the inner workings of that group.

DR. BLINK: Larry Costin at Sandia has been working on this for some time now and this was an effort that was started last year under the engineering side and it's continued on into the scientific program side. We're using a customer supplier approach to it and Sandia started out by taking all of the requirements from the various customers including pre-closure and post-closure PA and boiling that down into a set of requirements that the testing program has to satisfy. One of the things that we're doing in the next phase of this which will last the next few weeks is to boil down our experience from previous thermal and hydrological testing and try to capitalize on the lessons learned from that testing.

DR. LANGMUIR: Now, that's G-Tunnel and everything else that you've--

DR. BLINK: G-Tunnel, Climax, the Canadian experience, even Stripa for the hydrological experiments. WIPP has learned some interesting things. And, we're going to try to boil that down and bring that into a set of constraints on test geometries. That report is due to Susan by around the end of the month, I believe. So, we're getting close to the line on that one.

The geometries that Dennis showed you were Sandia's first cut; actually, it was their second cut at a set of geometries, but that's not yet agreed to by this team. The team also includes Bo Bodvarsson from LBL and the Los Alamos test coordination office people. So, we've got a pretty good team working on this.

MR. WILLIAMS: I think some of the early things that are coming out of this and this in some part relates to our excavation technologies out there, but the first three tests that I mentioned have no real requirement for machine excavation. As long as we have controlled blasting to develop the openings, that will work. I think you can see in the--if we end up with something along the lines of this room-scale thermal test, the only place that we're looking at something that may necessitate machine excavation is the main room for the heater test, but those are not hard requirements for that machine excavation. Controlled blasting may do the trick for us.

And, likewise, this test here is probably the only one that's going to absolutely require it to be fielded in TSW-2. We may be able to start fielding some of those other tests in a non-lithophysal unit of TSW-1 which gives us a little bit of advantage on the schedule and the amount of information we'll have for TSS.

DR. CORDING: Just one comment. I am pleased to see that integration of the thermal hydrologic and the thermal mechanical because I think the hydrologic are the key to the site suitability decision. Mechanical testing is important, but I think more as something that can be tied in with the thermal hydrologic and it's not so much a site suitability issue as I've seen it as it is more a design--some of the design issues. But, in the decisions to go to alcoves and things, I think it's the hydrologic that ought to be driving those decisions on the testing. And, I'm pleased that we're finally bringing together, as it appears, the work that's being conducted and thermal mechanical and thermal hydrologic and not a lot of duplication that I think we've seen in the past years on those sorts of tests.

One other comment I'd like to make, a procedural matter here. I'd like to complete our discussion on the thermal portion. There may be a few more comments there. Then, we're going to take a short break of 10 minutes and we have advertised that we would have a public comment session at 3:00 p.m. We're going to do that and then, if there is time before approximately 4:00 o'clock, our time for closure, we will then continue with some of our other parts of this program. So, we'll allow the public comment to be made. We have a signup sheet that we have here and there will be some public comment and we'll accommodate that. Certainly, we're very interested in that. If there is additional time, then we'll continue with our other portions of our presentations.

So, Susan and Dennis and Jean, if there are more comments here to be made or more that you want to state or summarize on the thermal portion of this, then perhaps we should complete that in the next few minutes and then have our break.

MR. WILLIAMS: That concluded our prepared remarks on the thermal.

DR. CORDING: Okay. Susan?

MS. JONES: No, he said he was finished. He's finished and I'm finished.

DR. CORDING: All right. We'll take then a 10 minute break and go to our public comment session.

(Whereupon, a brief recess was taken.)

DR. CORDING: I'd like to invite our public comment at this time. I have several individuals that have asked to speak and I'd like to have them speak first. If there are others in the audience that want to make public comment at this time, then we will also allow that to take place.

So, the first individual is Ms. Victoria McGhee to make a public comment.

MS. MCGHEE: My name is Victoria McGhee. I live in Amargosa Valley. It has been my observation that the fact of the nuclear repository at Yucca Mountain study has had a profound effect on the Amargosa Valley. This profound effect is both social and economical. For instance, the master plan for Nye County shows no growth for Amargosa Valley. New roads recently completed completely skirt the Amargosa Valley. The attempts to deny water rights to the citizens of Amargosa Valley, county imposed obstacles and regulations to discourage development; this is just to cite a few.

The reading material supplied by the developers of Yucca Mountain, I discover that Amargosa Valley is in what is called the critical hazard area of the Yucca Mountain development. This being the case, the developers of Yucca

Mountain are derelict in its responsibility to the Amargosa Valley. Right now at this moment, there is a whole generation of children in our schools. With no growth or development in Amargosa Valley, what are they to prepare for? They will have to leave this valley for employment and we are not preparing for that eventuality. The Amargosa schools should be enriched with all the programs and enrichment possible. The high school should be brought up to the standard of a magnet school with college preparation in the forefront. Grants should be provided for all those wishing to continue their education in universities or technical schools. To do less would deny the opportunity to lead useful, fulfilling lives in the outside world to this generation of students. PET payments to Nye County for politicians to build monuments to themselves in Pahrump and Tonopah does not relieve the developers of Yucca Mountain of their responsibility to the children of Amargosa Valley nor will vast sums of money paid to Clark County for studies that have any effect on the local people.

The true victims of Amargosa Valley are the children who are in school today. When they did the Alaska Pipeline, they provided all the natives in the area with paid for college educations. To do less for the children of Amargosa Valley would be a real crime. I thank you.

DR. CORDING: Thank you. Is there--your comments are on our official record and transcript and, if there are any responses that DOE wishes to make on that or anyone else in the group, we are willing to have that at this time.

(No response.)

DR. CORDING: Thank you. Our next individual that we have, Marty Mifflin, had asked to make a statement or a comment.

MR. MIFFLIN: Thank you. I'd like to refer back to some of the presentation and one of the key observations that I made listening to the approach that DOE has outlined is that from a licensing perspective, I find it a little hard to understand exactly what the strategy is with respect to characterizing the site and making a license application without somehow indicating the thermal load with respect to that application. There's a lot of different ramifications, but the most obvious one is that it sounded to me like the approach will be at a relatively cold thermal load. Yet, the databases and the scope of the characterization program, all of the location and design and the effort to resolve issues, are all focused in on the repository block. And, yet, with the cold thermal load scenario, the rough back of the envelope type of calculation suggests you would need, rather than say 2,000 acres, you need something like 4,000 to 6,000 acres of repository. Well, you don't have that type of program with respect to the measuring of site characterization. You haven't focused in on more than the 2,000 area. Now, if you go to the dryout or hot thermal load, you're fine. If you stick with the referenced thermal load, you're okay. But, I think you have to somehow make a decision as to what--and, I'm saying this from a perspective if I was NRC--of what the thermal load would be because, otherwise, you don't have a program that's necessarily focused on the requirements of licensing and that's with respect to the repository characterization. So, that's one aspect that I'm having a real hard time understanding the reality of the strategy in the five or six year program that you have.

The other key point that I really believe that I want to make a comment both to the Board and DOE is with respect to the tunneling and the databases that will come from it. I hope I misunderstand the information that was handed out on the cost of this. If that cost is for just FY-95, that's the most expensive database that we don't know what it is that will be ever be developed in the history of mankind. And, I think a very serious question should be reviewed and that is what are the databases that are critical that come from the ESF and the timing of these? I have never truly believed that the surface-based program could not produce the majority of the hydrologic databases. And, the practicalities of when you create your alcoves and what do you really get out of them is a really important question to deal with with respect to the costs that have become real at this point in time, both in time and in monetary costs.

Thank you.

DR. CORDING: Thank you. Any comment specifically on Marty's question and comment?

DR. BROCOUM: We will have a position on thermal loading when we submit a license application. It may not be the high thermal load either considered recently or the thermal load in the SCP. We will have the highest load that we can support at that time within the range we're looking at. We think it will be in the lower end of the range. We will make a license application for the amount of waste that we can support in the repository block for that thermal loading. We are putting together--Russ mentioned this paper this morning --but we will be putting together contingency plans for looking at the expansion areas. The license application we make will be a complete license application for the amount of waste which may be less than 70,000 metric tons and we intend to at that time be able to make the case for. So, it's just a strategy if we get into a license application in the year 2001, as opposed to some later year.

DR. CORDING: All right. Steve Frishman has a comment.

MR. FRISHMAN: Steve Frishman with the State of Nevada. I have a couple of different comments. The state of Nevada, it's feeling--after listening today, it's feeling like Texas again because I see the same problems over and over.

First of all, I'm glad to hear Leon and others beginning to ask the perpetual question. I think one of the observations I made--I'm not going to go into once again why I think it's not very responsive to the law or to the people who are having to try to understand how you're going to get to site suitability. I don't think it's very responsive to say the equivalent of what Steve really said to us and that's that the only thing that's harder to do than qualify the site is disqualify the site. And, that's pretty much the way it came out in the last discussion on that. But, I hope the question continues to get asked because I think it's a critical one at this point in the program.

Just to reflect a little bit on this question of disqualification, in 1989, the Secretary laid out then the new program. If you will recall at that time and if you recall the Board's own warnings and admonitions and desires, the idea was to design a testing program that would identify as quickly as possible whether there were factors which disqualified the site. And, now, here we are five years later and we're hearing that there really aren't any factors that would disqualify the site. We have to go all the way through an elaborate performance assessment and even then, do some knob twisting. So, I guess, the question sort of institutionally is what you have been doing for the last five years when you were under the last direction? And, now, we have a new direction that says it couldn't have been done. So, for five years, we operated under advice from everybody and orders from the Secretary to do something which you now say couldn't be done. Why did it take five years to figure that out?

Now, in the site suitability area, I just sort of heard a different emphasis today mostly again from Steve. I always pick on him in front of you. Maybe, he'll quit coming to these meetings. It seems as if the standard for site suitability now is to come up with information where it's unlikely--or information about suitability where it's unlikely that they would change their mind. And, this is the higher level finding. In 1998 for technical site suitability, after experience in going through everything that I can get on the program approach, especially after hearing things today, it seems to me very difficult to get to a point in 1998 based on the work that has been discussed where you can make decisions where it is unlikely that you would find something that would change your mind. And, the place where I think that's probably most important is right back to the factor that I think we all consider to be most important in site suitability and that has to do with flux.

The flux question itself is probably one that will never be answered totally to everyone's satisfaction in the undisturbed site. But, with the type of disturbance that is being planned in terms of what Marty was talking about and that we all are beginning to look at more carefully, starting out with a low thermal loading and then seeing if you can find a basis for upping that thermal loading. Well, it seems to me that thermal loading is one of those areas where, as admitted, there are extremely high uncertainties in terms of how the system operates at different thermal loads.

So, it's going to be very difficult to come in in 1998 with a low thermal load--the low thermal load scenario right now is roughly like a 24 to 27 kilowatt per acre load --and make predictions about performance that are unlikely to change at on the order of a 57 kilowatt per acre load because we've heard lots of discussion over the last few months even that factors are very, very different at 57 versus 24 or 27 and 57 may, in fact, even be more damaging to waste packages than the low thermal load or the high thermal load. This is discussed fairly commonly. So, I think right there, if you come in with a thermal load that is low, then you're very likely--or it's difficult to say that on the basis of flux-- and, I want to go into a discussion of flux in just a minute --but it's very likely to say in 1998 at a low thermal load that the hydrologic condition and the suitability of the site you feel is unlikely to change with new information and it's new information that is largely under your own control.

Now, on just the subject of flux, there is discussion about perched water, discussion about starting with a low thermal load, and if you look at some of the modeling that's been done--and, I think it's showed up in some of Hugh's work and some other places--you see at 27 kilowatts per acre, you see that there is a zone around an MPC that goes above the boiling point of water, would go above 100 degrees C. So, you're going to start having the system of driving water away from the location in the drift where the MPC is. But, what you're going to have is a boiling front and a condensation front that actually surrounds that MPC, but intersects the drift. So, it's very likely that you're always going to have a condition equivalent to perched water, but in this case it's going to be reflux. And, the reflux is going to operate very differently from perched water. One, chemically, it's going to be very different and also it's going to flow differently. It's going to look for the easiest fracture and you're going to have water returning to the drift all the time. And, you're probably going to have an air temperature above 100 degrees. So, this is a condition I haven't heard discussed, but it sounds to me like it's going to be the condition at the lowest thermal load that's even being discussed in the program.

So, you're always going to have a perched water equivalent situation, but also one that it extremely unpredictable. One, it's going to be very difficult to understand the chemistry in that system and the other, as I think has been shown already in G-Tunnel, it's very difficult to understand the return flow fractures; which ones are going to move the water and which ones aren't just because you can't examine it at that scale. So, if you're going to try to characterize this, what you're going to literally have to do is try to--is do a research program at the location of every MPC or where you think the reflux area is going to be. And, I think that's essentially an impossible task and, even if you tried to do it, you don't have enough money, time, or probably there's not enough certainty in it to do it anyway.

So, the low thermal load scenario is one that is really--it's a boiling scenario anyway; maybe even more complicated than looking at the entire block at some thermal load because you have to look at each individual MPC being like a 14 kilowatt source. The other thing about this and just sort of tying this together with suitability in another direction, to get a 27 kilowatt per acre load, you're looking at about two MPCs per acre. And, that takes care of roughly with the area you have, if you can use as much of it as you think you can, you're looking at about maybe 25,000 metric tons total. Now, at your last meeting, some of us were talking outside when we started thinking about it at this scale and the conclusion is it's likely that given the course that you're following, you can make a decision in 1998 that the Yucca Mountain repository block is suitable for a repository, but it is not suitable--or you don't know that it's suitable for a repository that you would build. Because I doubt very much you would build a 25,000 ton repository or one even close to that; I doubt if you'd even ask for a license for one because who is going to spend the next $50 billion for another one? I think it's totally infeasible that you would come into NRC asking for a license for a repository that you would not build because it is just literally not worth the money or the time and it doesn't solve the problem for anybody.

So, I think you're going to have to get real about how you're going to deal with thermal load and you're going to have to get real about whether you think in 1998 you can make a decision that is an investment decision that is taking you to an investment that nobody would be willing to pay for and you'd probably even be ashamed to ask for.

So, that's it for today.

DR. CORDING: Thank you. Any comments?

DR. BROCOUM: I'll make a couple of comments since Steve said he was picking on me. I'm not going to pick on Steve though. This almost sounds like a continuation of the meeting we had in Washington, some of the comments.

I just want to make a comment. This first thing you said that Leon is asking questions about disqualifiers, what have we done for the last five years, what did we do in 1989. We basically have a concept of how this will operate, the various processes of a site operate. There are a series of hypotheses. As we collect more information, we either confirm these hypotheses or we replace them with new ones. To the extent we are confirming a hypotheses, they will eventually roll up into how the site performs through the performance assessment. So, I think collecting the information this last five years has allowed us to get a better understanding on how the site operates. I, personally, think it's unlikely that it will be easy to disqualify the site on the discovery of a single feature. Also, the comment I made earlier is about how difficult it would be to disqualify. I'm just saying it's just a very important decision. I can imagine, for example--I'll take my DOE hat off for a second. I could imagine if we came up with a position saying, oh, we think the site ought to be disqualified, we'd probably be in front of TRB in numerous meetings justifying why we think that is the case. I mean, I think we all realize it's a very important decision because we may be precluding a geologic disposal.

On the suitability, Steve made a comment that the definition of suitability has changed. I don't think we've changed it. We've said that we have to make high level findings, and before we can make a technical site suitability evaluation, we have to make a finding on each of the guideline qualifying and disqualifying conditions in the 960 guidelines and we have to make them to a degree of confidence that we don't think additional information will change our mind.

The last point I wanted to talk about is the license application and the thermal loading we have in that license application. Whatever thermal loading we come in with, if additional information indicates that the site may not perform at a higher thermal loading, then obviously we will not go in and ask for that higher thermal loading. The application we submit to the NRC will be one, if necessary, we'll be prepared to defend through the construction.

Those are my comments.

DR. CORDING: Thank you. Other comments from the public, the audience, anyone in the room?

MR. BLANCHARD: I'm Max Blanchard, citizen of Clark County. I'd like to pursue a question. Perhaps, it would be better for either Russ or Lake to answer it, but I think the people up there at the table could get it started.

One of the reality tests of any exploration program like this, that goes a long time is, how much money can you really get to conduct the operation? And, in the past constructs for site characterization, there's been repeated efforts to define a longer term test program where the reality didn't quite match the expectations. And that there was inability to get enough money to field the test program the way it was designed. And there was always a situation where people had to refer to a bow/wave of funding that was yet to come, and, which never showed up. I know that the current program that's been put together by Dan Dreyfus and Lake and others, some of which are in this room, have tried to address that. But, to what extent has this finally tuned and distilled the program now, where you've associated uncertainty and goals to the test program and some specific answers? It looks to me like you've got it quite well-distilled down and connected. From that standpoint, I applaud you on making the picture ever increasingly more clear. But, my question is still to what extent is this at-risk from not being reality because of inability to secure funds to carry it out?

MR. BARRETT: It is very simple and the declining Federal budgets with the caps--you know, under the Budget Act of 1990, we have got to have a change in the budget statutes that basically allow the rate payers money, the nominal $600 million a year that they pay into the fund, to be used for this program. If we don't get this out from under the caps, there will not be the money to do the things that we've laid out in the program plan. It very explicitly states it up front. The administration has proposed last year legislation. I expect the administration will propose legislation again this year to allow that money to be used for its intended purpose. If that does not occur, this is not going to happen. Simple as that.

DR. CORDING: Thank you. Yes?

MS. TREICHEL: Judy Treichel, Nevada Nuclear Waste Task Force. I wrote a letter to the Board a while ago that sort of expressed some of the frustrations that I was feeling and that I felt on behalf of people who contact my office quite often. The reason I'm making a statement now is not to repeat anything that was in the letter, but because this meeting has in a way amplified or illustrated what was in that letter.

And, it goes back to, as Steve had talked about, the idea that it's terribly hard to disqualify this site. And, people had an expectation that that's what DOE was coming here to do; to look for disqualifiers and to give guarantees or certainties that this was a safe thing to do and that people could feel absolutely confident that nothing would happen if it wasn't safe. There were a lot of assurances and almost promises that were given. You've heard now from people who live in the "critical area", live right near here, and would be neighbors to that facility and they're being asked to rely on trust as far as their health, their safety, their economic well-being is concerned. Then, you've got an entire population of this country that's got to count on the idea that everything will be done right the first time and that it will be error free when you come to a national shipping campaign to get waste here. What we're hearing is that in your determinations for suitability, for license ability, for post-closure, for pre-closure performance, for everything that's involved in this program, you are relying a great deal on a belief, on a good guess.

And, I guess my bottom line would just be to say that I think in a case where a facility like this is being forced on an unwilling population, not a bunch of people who are playing ball and who are in the game with you and working in league with this thing, but are entirely and very, very opposed to this thing, that it's atrocious to require that they go along with this thing on trust because I just don't think it can happen. I don't think it's realistic or that it's good business.

Thank you.

DR. CORDING: Thank you very much. Other public comments; comments from Board, staff?

(No response.)

DR. CORDING: We had discussed the potential for wrapping up some comments on our presentations and then, if there were at the end additional public comment, we could entertain that. We're going to try to complete in the next 15 minutes.

Jean, perhaps, you could give me some guidance as to what you might want to do in terms of summaries from your group? I think that's really the point we're at at this time.

DR. YOUNKER: Well, what we have left is basically the disruptive--the features, events, and processes that could cause disruption and NRC's job and the unanticipated events, the extreme events to talk about that would impact the way the basic elements of the strategy work and the maps to the site program for volcanism--well, let me just put this up. What we have left is this. Within the part that I've been doing is climate, tectonics, igneous activity, focus on volcanism, and then human interference and the map to the site program. Then, the other piece that we have left that we haven't covered is a quick update of what the ESF testing program, where it is now, and the status and the status on surface-based. Maybe, some of that has come out through the discussion, but I don't really know what your priorities are in terms of would you rather hear the rest of this so you get the complete picture of the strategy elements and the map to the priorities; or would you rather just close this out and go to the quick updates? Because I think you can do one or the other by 4:00.

DR. CORDING: Jean, if you could just give us what the topics are there in a moment and then just summaries perhaps from other participants.

DR. YOUNKER: You want me to finish this one, then?

DR. CORDING: Just finish that in a summary fashion so we know what the topics are.

DR. YOUNKER: Okay.

DR. CORDING: Because I think we have discussed much of the other.

DR. YOUNKER: Okay. The key uncertainties then for climate are, as you might guess, the potential for increased infiltration and wetting of the engineered barriers; changes in saturation in the unsaturated zone rocks; and then, the potential increased recharge to the regional groundwater system causing either changes in the water table elevation or changes in velocities in the saturated zone. The way to get at that is, of course, with both a modeling approach, as well as any of the field paleohydrologic/paleoclimatologic studies and that's where we were going to map to quickly.

MS. JONES: We weren't really going to spend too much time here at this particular meeting on the climate program, but basically all I have listed here are the parts of the program where we are doing our infiltration studies. We're doing our paleoclimate program, looking at past and then present climate conditions in order to head towards our climate models which would be used then to predict future climate, as we discussed earlier, as one of the drivers of the groundwater system. This is also a place where we've been doing some detailed mapping of Quaternary sediments; not just Holocene, but Quaternary. And, that is also tied to the next topic which is the tectonics program because this is part of our geochronology program where we're looking at dating offsets on the particular faults.

DR. YOUNKER: All right. For the key uncertainties for the effects of tectonics, now we've separated volcanism and the rest of tectonics for those of you who know that we normally--sorry, that didn't help to hold it up there. We've separated tectonics and volcanism given that volcanism we kind of look at specifically in the next viewgraph. So, here, we're just talking about potential effects of faulting and ground motion on engineered barriers, direct effects, and then any kind of changes in your overall conductivity of the system due to renewal of flow paths or due to faulting activity causing opening up of flow paths that have previously been cemented, and then the potential for water table rise related to tectonic events.

MS. JONES: In the interest of time here, let's go straight to the map because what we're talking about here in our tectonics program is the trenching and mapping of Quaternary faults and this particular cartoon here just shows the major faults in the region. This, for your information, is the SCP program and it's nearing completion. It also shows the trenching along the Ghost Dance Fault which was not necessarily called out. Most of these are Quaternary faults, although we're still not sure about the Ghost Dance Fault. These are still being mapped. Generally, the trenching which are the--you see the icons here for the various trenches. Generally, these are addressing the late Quaternary faults. And, there are two other things shown here though; Stage coach Road Fault shallow boreholes. These were put in recently on the down thown side to determine the early and mid-Quaternary displacement of this Stage Coach Road Fault and we've also used a little bit of some refraction work here over on the Windy Wash area looking at total displacement on an older basalt. But, basically, this program is almost finished; that's the bottom line. We're at the point now where we're developing the seismic hazard methodology and the design input over the next couple of years. But, the field portion of this is wrapping up.

A quick summary here of the bedrock mapping. Through FY-95, we have been looking primarily at the repository area and then the plan is to expand slightly beyond that. This just summarizes the types of mapping that have occurred and are planned. So, we're getting a little bit into the planning stage here. Mapping along the Ghost Dance Fault raised the question of the previously unrecognized faults, such as the Sun Dance structure. So, this year, we're going to be issuing the structural map of the central repository block. Basically, that's addressed at looking elsewhere to see if we have any of these other unrecognized structures on the surface; plus, we're also integrating other types of data into our tectonics model.

Then, future plans here is to move outside the immediate repository block to enhance Scott & Bonk, update that information, look from Bear Mountain to Jackass Flats by compiling the surface geology for this broader area. Then, all of this updated information goes into our integrated 3-D model.

I just wanted to very quickly show the surface geophysics here because, as people here are well aware, we've had a tough time getting this program pulled together and fielded. What you're seeing here is the program that is in operation right now. This is a shallow to intermediate depth. We're talking down to maybe 5 kilometers. We ran a small program in '94 looking at the Ghost Dance Fault and the initial indicators there is that this would be a--we'd be getting useful results out of this. So, we've laid out the program that you see covering primarily the repository block itself. The lines you see to the north there are addressing the steep hydrolic gradient and then the central block is shown there. As I said, this is in progress. It started right after Thanks--last month. Yeah, right after--early in December and is ongoing. This is primarily under Lawrence Berkeley Lab.

DR. ALLEN: Before we move that slide, could I just make two brief statements? I wanted to talk to you about these, Susan. If it becomes necessary to go into application without an actual drift through the block itself over the Solitario Canyon Fault, at the very least, Line RGME should be extended along the line of the north portal of--

MS. JONES: The north ramp extension, right.

DR. ALLEN: Well, what do you call it, portal or continuation--

MS. JONES: Yeah, north ramp extension, right.

DR. ALLEN: So, in that case, we'll have both the ground crews and the geophysical data along that line to give us some idea whether we can believe the geophysical work anywhere else.

MS. JONES: Right.

DR. ALLEN: And, I would just remind you that both Leon and I have been involved for many years in NRC presentations on nuclear power plants involving geophysical data, some of which costs tens of millions of dollars literally. It's almost inevitable that the applicant will come in with one interpretation, the intervenors will come in with a different one, and the ultimate truth is not, at all, clear.

MS. JONES: And then, the second part of the program was a deep seismic refluxion line. This was done by the USGS or under the USGS. It was completed in November. This one is looking down to approximately 20 kilometers depth. Again, the initial data is looking pretty good. The provisional interpretation is due out in May.

DR. YOUNKER: Okay. Back to the volcanism key uncertainties. Direct effects of igneous activity on the repository; effects of igneous activity on water table; any kind of gaseous material associated with volcanism intrusive activity; and then, any kind of fluid movement along faults or fractures. I think this is another area where you'll hear from the site people that we have made a fair amount of advance in our understanding and I think we're in pretty decent shape, at least, from a performance assessment perspective on our dealing with the consequences of volcanism.

MS. JONES: Actually, in the interest of time, I think I--because I'd rather get to a couple of viewgraphs in my closing presentation, but you've all heard the volcanism discussed at length. Basically, this is another program that's winding down. It will be finished in a couple of years. We've actually finished all the geochronology work at Lathrop Wells which is the last piece of that. We do in the plan currently show the three holes to look at the magnetic anomalies. But, again, this is another program that's rapidly winding down.

DR. YOUNKER: Then, for the effects of human interference. Once again the concern here, direct intrusion from exploratory drilling or introduction of fluids associated with that exploratory drilling. And, the way we approach this mostly is just to get probability of drilling and get at the consequences of any kind of intrusion. So, this tends to be more of a modeling approach to understanding. But, understanding the drivers on exploration, i.e. the potential for any kind of natural resources that would be of significant value is something that we rely on the site program for.

MS. JONES: And, here, the surface-based activity is somewhat of a misnomer. Basically, Item 1 is again a compilation of existing information. This is primarily the University of Nevada system operating under the M&O's QA system that will be doing this work for us and that's kicking off. Actually, this month, it should be starting.

In terms of assessing metallic resources and evaluating core, we've had a program in place where the core as it's initially logged is examined from the perspective of natural resources and then the U.S. Geological Survey would be picking up from there. Likewise, if we see anything in the underground.

I would just like to show you three viewgraphs really out of the--or do you want to--

DR. YOUNKER: Yeah, all I was going to say was just I already covered my last one for those of you who are following along. The basic important thing to remember is that we're getting at a lot of discussion about characterizing features and conditions. The importance of understanding what consequences any of the uncertainties have that we're chasing here, we have to get at through the significance with respect to either post-closure or pre-closure performance since that's where you get a handle on what's really important. And, we are certainly attempting to get that iterative performance from both the pre-closure and post-closure pinned down and working very effectively.

That was really my final comments and then you guys can go to your final comments.

DR. CORDING: One question, I think, for Jean. Bill Barnard?

DR. BARNARD: Jean, last month on December 19 when DOE met with the Nuclear Regulatory Commission, NRC Chairman Sellon mentioned how useful it would be to have a short, clearly articulated description of the waste isolation strategy. Are there any plans to write up a simplified version of your presentation this afternoon?

DR. YOUNKER: Yeah. The approach that I think we're taking, and Steve can verify this or tell me I'm off base, but I believe in the license application annotated outline that will be delivered by the DOE to the NRC in the spring, March, time frame, the chapter that talks about the licensing strategy will hopefully be as up to date as we can make it given where we are in the production process for that document describing this approach that we've been talking with you about both in October and today.

DR. BROCOUM: In response to the Commission's request, Dan has asked for a white paper. We're going to take a part and put it in the annotated outline and also turn it into a white paper for Dan which will be available which, you know, will just be that part of the annotated outline put in a white paper format. And so, we are working on that now.

DR. CORDING: Okay. Thank you. Some summary comments or some of the key points that you wanted to make if we can do that briefly. Thank you.

MS. JONES: Right. I'm not going to go through the key deliverables and so on and so forth. You can read that yourself. But, I just wanted to summarize that the focus of this was to address the TRB concern that you had in your December letter that we had sharply reduced the scope of our surface-based drilling. We went through it very, very quickly. This is the table that I referred to repeatedly throughout the day that shows right now we really do have 33 deep holes in place and by the time we reach license application, there will be 54 deep holes available to produce either testing or samples.

And, the second thing I wanted to--the point I made was that we understand that it's easy to look at a drilling schedule and think that that was the only--those are the only facilities that would be available and I hope I've allayed that concern because this very quickly summarizes some of the key testing programs; not all of them, but the key ones. And, shows that we do, indeed, have a large number of holes that are available and that will have their testing or their samples analyzed at the various points of our program.

And then, for your information, this, as I said, was our preliminary field work plan for the next five years. This is literally as of just January 10. We put this together right before Christmas and took one quick look at it, but this will be the basis for the rebaselining effort that's underway right now and forms the surface-based testing program for the next five years.

We'd welcome an opportunity to talk about our program. It shouldn't be three years until the next briefing on our surface-based program. Thank you.

DR. CORDING: Thank you very much, Susan; appreciate it.

All right. Thank you very much, all, for a session where we've delved into many issues and been able to, I think, go further with our understandings of the program. Thank you very much for that. And, also, those in the audience who have participated.

I'm going to turn it immediately over to our chairman, John Cantlon.

DR. CANTLON: Let me first follow on. If there are public comments to close off since we did cut off 15 minutes of public comments--anyone have a burning comment that needs to be made at this juncture? Yes?

MR. TIESENHAUSEN: I'd just like to thank Nye County for its hospitality here and, most of all, the ladies in the back who slaved away and kept us supplied with coffee and goodies.

DR. CANTLON: Well, thank you. I was going to do that, as well. I appreciate the stand in. We certainly do appreciate that and let me add, would each of you please police up the environs where you are? Recall, they don't have a work force here to clean up. So, if we don't clean up as we leave, we leave somebody else with an enormous task that isn't necessary.

I would like to again, as Ed did, personally thank all of the contributors to this program. I think that, you know, as you look at these interactions between the Board and

DOE, certain of these things get to somewhat more critical, somewhat more tense sets of issues. This is one of those kinds of issues. The rhetoric hasn't been very high here. We've had some exchanges in which the rhetoric was a little bit stronger. On the other hand, I think this is an extremely sharply focused and critical set of issues that we are addressing. This is a prototype process that we're in. So, people shouldn't be too surprised that all of the solid answers aren't there. All of the solid answers aren't going to be there immediately tomorrow or the next day, but we are, I think, seeing the kind of convergence that DOE hoped for five years ago. It's beginning to appear. Things are getting clearer, but there is a great deal of work yet to be done in a very short time and not very many dollars to get it done. So, thank you all for moving us in that direction. The Board really appreciates it and we look forward to continuing this process. Clearly, neither you nor we are done with this topic.

So, thanks very much.

I need to have the Board in the back room to get our final close-off as to what we're going to do at the next. So, would the Board members and the staff appear in the back room?

(Whereupon, at 4:00 p.m., the meeting was concluded.)