UNITED STATES DEPARTMENT OF ENERGY

IN RE:

YUCCA MOUNTAIN SITE PROJECT RESPONSE
TO QUESTIONS OF THE NUCLEAR WASTE
TECHNICAL REVIEW BOARD

REPORTERS' TRANSCRIPT
OF
PROCEEDINGS

Taken on Tuesday, April 11, 1989
At nine o'clock a.m.
101 Convention Center Drive, Ste. 450
Las Vegas, Nevada

Reported by: Anna Maria Ciarrocchi, CSR #188

Pamela A. Manning, CSR #226

APPEARANCES:

For the Technical Review Board:	DON DEERE EDWARD CORDING CLARENCE ALLEN WARNER NORTH
For the United States Department of Energy:	MAX BLANCHARD L.J. OWENS JOHN ROBSON DON SCHLICK CARL GERTZ JAMES CARLSON ARCH GIRDLEY
For SAIC (Science Applications International Corp.):	KEN BEALL MIKE GLORA MICHAEL VOEGELE MARYLOU BROWN
For the United States Geological Survey:	LARRY HAYES BILL WILSON
For Los Alamos Laboratories:	TOM MERSON
For the Office of	RALPH STEIN

Civilian Radioactive Waste Management:
TOM ISAACS
JEROME SALTZMAN

For the Nuclear Regulatory Commission:
MYSORE NATARAJA

I N D E X

MR. ISAACS: Good morning to all of you. I want to particularly welcome the members of I guess it's the structural geology and geoengineering panel. I want to welcome you, and also welcome Professor Cording. We are delighted to have the opportunity.

I am Tom Isaacs, you saw my name on the chart. I'm the associate director for external relations and policy within the Department of Energy's civilian radioactive waste program and headquarters. Among my responsibilities is the personal liaison and direct liaison with Nuclear Waste Technical Review Board. So I consider it to be one of my most important assignments to make sure that the Department of Energy, as an organization, works very well with the review board and panels that you've already established.

As those of you who were there are aware, we already have what I thought was a very good two-day opening session with the board as a whole to give them an overview of the program, and we're really looking forward to the opportunity to working with all the panels that have been established.

I want to echo what Carl said about cooperation, and I want to say this not just to the board and to this panel, but to all the people working on behalf of this program, that both by design and by law, this technical review board has a very important responsibility with regard to this program.

It's important to recognize the fact that we want to be cooperative, we need to be cooperative, and we should be cooperative in all aspects of this program. I think it's essential, for the good conduct of this program to meet both the letter and spirit of the Nuclear Waste Policy Act as amended, that we run ourselves in a very professional manner and very cooperative manner, both with the board when it meets and with all the individual panels.

I want to make sure that we all recognize the obligation that we have. And I believe personally that it can get tremendous benefit for the program. First and foremost, because of the tremendous expertise and insight that exists on the members of this board. And secondly, because if we listen with and work well with the board and take advantage of the board, it can certainly strengthen our program.

And lastly and not least, because it can certainly add to the overall integrity and confidence people will have in this program if they recognize that we are working in a cooperative and positive way with the board. I think it's important to recognize that with this board and it's obvious to me this is a can-do group. It's obvious that you're getting off to a start in that way, that with five panels and the board meeting it's going to be a lot of activity.

One of the reasons why I wanted to make sure that this meeting, that I attended personally -- and I will try to make as many of these as possible -- is to make sure the right kind of rapport is established between people who are working on this program and the board. It's very important that we give to the panel all of the information that they need in order to do this job well. So I think that's very important.

On the other hand, I think it's also important to recognize that with a program which is quite broad in nature and Carl Gertz' responsibilities, while they are quite broad, is not the entire program. The program is even broader than that, of course, and the board will ultimately have to involve itself in such things as worrying about monitor of storage and transportation and other kinds of activities that this program is associated with, that we work together in a very disciplined manner.

So I want to make sure that we take down any kinds of commitments that come out of this meeting or any kinds of insights that come out of this meeting in a rather rigorous fashion, and that this meeting should not be the process by which we make ad hoc decisions in this program, but the process by which we exchange information with the board, receive their comments back, and then provide all kinds of opportunities to the board so that the program responds in a very timely way and in a considerate way to whatever kinds of comments come from the board. So I think that's a very important thing to say, as well.

I want to also mention that from a logistics point of view, I want to continue to encourage the good working relationship that has started in terms of logistics in setting up meetings and reacting that we work through Jim Carlson of my staff and Bill Coons, who is executive director of the board. I want to continue to encourage that we work together in that way.

The only other thing I want to say is to the board and to this panel, we welcome you, and we hope that the next couple of days will provide you with the kind of information that you need. If they don't, I don't think you should be bashful, and I'm sure you won't, in telling us what additional information you need. Our materials are available to you, our documents are available to you, and most importantly, our people are available to you. We tried to assemble the right kind of people for this meeting.

Let me just say welcome, we're looking forward to this. I personally think it's a great thing, and I want to thank you for both our own people for their participation and particularly members of the board and consultants, for their participation, as well.

With that I'll turn it over to you, Don.

MR. DEERE: Thank you very much, Tom.

Good morning. I am Don Deere, chairman of the Technical Review Board. We are looking forward to cooperation in receiving and discussing the information with you regarding the two questions which we have raised about the exploratory shaft program.

First, I should say that this is not a meeting of the full board, but rather a meeting with the board's panel on structural geology and geoengineering, as you have stated. Another panel, the one on risk and performance analysis, will have its first meeting in Washington on May 16 and 17th. The second meeting of the full board will be here in Las Vegas, a three-day meeting, June 26, 27 and 28.

I would like to introduce the members of the board who are attending this, and our consultant. Chairman of the panel on structural geology and geoengineering and professor at the seismological lab at Cal-Tech and former president of the Geological Society of America is Dr. Clarence Allen.

Clarence, would you stand, please?

He and I, at the moment, constitute the panel on structural geology and geoengineering.

Also attending, as the chairman of the panel on risk and performance analysis is a principal of the firm Decision Focus, and is consulting professor at Stanford University. Dr. Warner North.

He essentially will be an ad hoc member

of each of our five panels, as will I.

Also present is a professor of civil engineering in the specialties of applied rock mechanics and underground construction from the

University of Illinois at Champaign-Urbana, who will serve as consultant to our panel. Dr. Edward Cording.

Dr. Cording did his Ph.D. thesis 24 years ago, if I'm not mistaken, more or less, at the Nevada Test Site in the design and construction of tunnel shafts and large underground openings in tuff. He was attached to the design firm of Fenix & Scisson.

Since then Dr. Cording has conducted research and consulting work on tunnels, shafts and underground caverns throughout the United States and several foreign countries. We feel that he will be a strong member to advise our panel, and we are trying to commit him to as much time as he can give us, and to attend essentially all of our panel meetings and a great number of our board meetings to represent us in this specialty field.

Now, to return to the purpose of this meeting, which is to raise two questions for D.O.E. and their contractors to brief us on: To allow us to have a better basis for understanding, and for discussing some potential concerns. The two questions that we raised at the last meeting: One, would it not be possible to use raise boring or some other modern method to excavate the shafts -- that is the exploratory shafts; at least the second shaft --

in order to enjoy its benefits with respect to less disturbance of the walls of the shaft to greater rates of construction, and perhaps to allow greater flexibility within the test program.

These are things that we will be informed on today, and it may not be as easy as it appears on the outside.

The second question: Wouldn't it be advisable to excavate the perimeter drift as soon as possible, rather than wait until the construction stage five or six years from now? Preferably, excavated by means of a tunnel boring machine.

I would also like to add that we are soon to have the appointment of our ninth member to the Technical Review Board; hopefully this will be in time for the June meeting here. And the other two appointments, the 10th and 11th, are in progress.

Thank you very much. We await with interest your presentations.

MR. ISAACS: Thank you. And I invite people who would like to take off their jackets, to do so.

MR. BLANCHARD: I am Max Blanchard, the project officer working with Carl. What I'd like to do is discuss the agenda with you in a minute. But before we do that, I think, after your introductions of the staff members, you of course know Tom and Ralph because you met with him, and Jim Carlson before.

But there's a lot of people in the room that you don't know, so I thought what might be appropriate now is for those of us at the front table and staff that we have brought in who are some technical experts, we may want to have conversations with or you may want to have conversations with, is that we go through some introductions so that you recognize the name and face of the person.

For today's talks we have the speakers here at the front table. For tomorrow's talks we'll do the same. But with respect to the first subject, construction method for the exploratory shaft, we have a group of experts we've brought in who have been working with us for more or less ten years on this particular topic. So if you want to pursue some in-depth questions, please do so.

Also, as you know, we have some other

people in the audience with the State, NRC and EEI. So I thought maybe we'd start here with Bill Wilson with the USGS.

Could you kind of tell us where you're

from, and what role?

MR. WILSON: I'm Bill Wilson. I'm with the USGS in Denver. I'm a hydrologist. My role currently is to advise the technical project officer for the survey, Larry Hayes who is in the back of the room, on the various technical aspects of the Survey's program in this project. Before that, I served for about eight years or so as manager of the hydrologic program that the Survey participates in, in this project.

MR. BLANCHARD: Thank you. Ken?

MR. BEALL: Ken Beall with the SAIC, and I'm the engineering integration department manager. I basically provide technical support to the project office. This is the third repository program I've worked on in the last ten years, and prior to that I was involved in commercial mining design.

MR. CARLSON: Jim Carlson. I work with Tom Isaacs in Civilian Radioactive Waste Management Office in Washington. I'm responsible for liaison with the external board and commissions.

MR. STEIN: Ralph Stein. I'm an associate director of assistant integration and regulation at D.O.E. headquarters. My office is responsible for let's say licensing of the repository and MRS and other activities associated with the regulatory site of the house.

In addition to that, Systems Integration Activities are in my office, and we do just what the name implies, and that is integrate the three elements of the program: the systems, the repository transportation and MRS program. In addition to that, it's my office that will present to Dr. North the activities that we have currently underway on performance assessment in the middle of May.

MR. ISAACS: I'm still Tom Isaacs.

MR. BLANCHARD: And that's still Carl Gertz.

MR. GERTZ: You bet.

MR. SALTZMAN: Jerry Saltzman. I'm the acting associate director for the D.O.E. headquarters office of facility siting and development. We have the geosciences and engineering part of the program under us, and we work very closely with the project office on this.

MR. VOEGELE: Mike Voegele. I'm with Science Applications here in Las Vegas. I'm the assistant project manager for site evaluation, and that's the group at SAI that supports the Yucca Mountain project office in the areas of regulatory compliance. For example, our group is the group that helped prepare the Site Characterization Plan.

MR. BLANCHARD: Thank you. Let's go back there.

MR. LITTLE: Leo Little, director of engineering development division. We work directly for Carl.

MR. GLORA: Mike Glora. I'm with the SAIC. I work for Mike Voegele. I am manager of Technical Evaluation division, and I've been here about six years. Before that I was with the SALT project for four or five years. Before that I was a licensing manager with Babcock & Wilcox.

MR. WEST: I'm Chris West, director of the Office of External Affairs for the Nevada Operations Office of D.O.E.. I'm basically here to help run an interference should the news media catch up with you.

MR. HAYES: Larry Hayes, technical

project officer for USGS activities in the project.

MR. PRITCHETT: My name is Bob Pritchett with Reynolds Electrical & Engineering Company. We will be supporting the program for the underground construction and surface facility construction and the surface base drilling program.

MR. JOHNSON: Carl Johnson. I'm with the Nevada Agency for Nuclear Projects. Our agency has been designated by the state as the oversight group for the D.O.E. projects. My responsibility is the technical review activities; therefore, I'm responsible for not only overseeing D.O.E.'s technical activities, but also conducting independent studies of our own of the site.

MR. TILLERSON: David Tillerson. I'm an earth science advisor for the State of Nevada.

MR. GRUBB: I'm Jim Grubb. I'm a mining engineer for the State of Nevada.

MR. GIRDLEY: I'm Arch Girdley. I work for Max on site investigations.

MR. PESHEL: John Peshel. I am geotechnical engineer with the NRC.

MR. NATARAJA: Mysore Nataraja. I am also at geotechnical engineering.

MR. BLANCHARD: You need to spell your

names.

MR. NATARAJA: N-a-t-a-r-a-j-a is the last name. M-y-s-o-r-e is the first name.

MR. BLANCHARD: We have some people, I

don't know whether they are EEI or --

MR. WILLIAMS: I'm Bob Williams with the Electric Power Research Institute. The utilities have reorganized recently their oversight activity and have put together a stronger team to monitor the progress of this program. EPRI's role will be the technical activity. EEI's role will be the problematic cost and schedule activity. Nevertheless, my colleague is here under EEI auspices because that's where the contract apparently resides.

MR. SMITH: My name is Jay Smith. I'm a consultant with the Edison Electric Institute. I'm an engineering geologist. The objective of EEI is to provide a combination of technical licensing and programmatic oversight to the program, in the hopes that we can facilitate both the program, and the exchange of technical experience realized by the utilities of construction of engineer facilities.

MR. BLANCHARD: You, sir?

MR. GOESER: Dave Goeser with Weston, I am an observer.

MR. BLANCHARD: Okay. We'll go over to Mike?

MR. CLINE: Mike Cline with Weston. I'm a structural geologist and department manager for the engineering geoscience department providing support to the D.O.E. headquarters.

MR. DOBSON: I'm David Dobson. I'm a geologist working for Max Blanchard on the regulatory site evaluation of the D.O.E./Yucca Mountain project.

MR. SIEFKEN: Dave Siefken. I'm the program manager for Weston, who operate D.O.E. headquarters for this program.

MS. BROWN: Mary Lou Brown. I work with Science Applications, and I work for Mike Glora, Mike Voegele and the licensing group. It's my responsibility to integrate technical presentations and responses to the NRC.

MR. KALIA: Hemendra Kalia. I'm with Los Alamos National Labs involved with the exploratory testing here. I'm involved in activations for 15 years. I work projects and the last assignment I had was activating the SALT project.

MR. BLANCHARD: John?

MR. ROBSON: John Robson, exploratory

shaft branch chief. I work for Leo Little in the engineering development division. We in general utilizing the AE's provide ES design. Given a multitude a myriad of requirements.

MR. SCHLICK: Don Schlick, general engineer exploratory shaft.

MR. OWENS: My name is Jim Owens. I'm a mining engineer, also on the exploratory shaft.

MR. TILLERSON: Joe Tillerson with Sandia National Laboratories. I'm heading the division responsible for the underground mine design repository -- not the exploratory shaft -- and hence, work with the integration of the exploratory shaft with that. My group is also responsible for the underground rock mechanics analysis work.

MR. MERSON: Tom Merson, Los Alamos. My function is to integrate the testing activities in the design of ESF.

MR. BLANCHARD: Scott?

MR. SINNOCK: Scott Sinnock. I'm also with Sandia National Laboratories. Supervisor of the project interface division and an officer in Las Vegas. Spent ten years on site selection, performance assessment data base activities and geologist training.

MR. BLANCHARD: Thanks, Scott.

Everyone has introduced themselves but you came in late, so we missed you.

MR. BRADHURST: I'm Steve Bradhurst. I

represent Nye County, and I've been directing the county repository program for the last six years.

MR. BLANCHARD: Okay. What I'd like to do now is discuss the agenda with you and see how close we are in terms of accomplishing our goals. We have been through the welcoming and the introductory remarks. After I finish discussing the agenda, Ralph will describe the key regulatory concerns.

There's about four particular provisions in 10 CFR 60 that have been a guiding policy throughout the time we developed the strategy for site characterization, and developed the SCP. Given those four guiding principles, they can be focused down into three particular concerns. I won't say what they are right at the moment, because that will steal some of Ralph's thunder.

For this afternoon, we'd like to discuss with you the approach we've taken to constructing the exploratory shaft from a design standpoint, and the five alternatives that we have considered during the time we zeroed in on the conventional drill-and-blast method. In order to do that, for -- nearly for the last ten years we have been looking at how to best characterize the site.

There are three things that bear very

heavily on the selection of the exploratory shaft construction technique. One are constraints that come from the regulations. You'll see that there is somewhere like ten different sections in 10 CFR 60 that we've had to use as constraints, in addition to the number of reg guides, GTP's and comments that we have received from the NRC technical staff.

So in addition to the four that Ralph will talk about, which are overall policy guiding portions of 10 CFR 60, there are a number of specific provisions that we have had to zero in on 10 CFR 60. From a scientific standpoint, Bill will talk about the geohydrology of the site and how the need to characterize the site requires very careful consideration in the process of constructing the exploratory shaft. We want to make sure that we don't have an adverse impact on the waste isolation potential of the site.

Also, at the same time we want to make sure we don't have an adverse impact on our ability to characterize the site. We don't want one experiment making a spurious measurement as a consequence of influence from interference from another experiment, or from the construction method in general. In the process of doing that, Bill will discuss the things that turn out to be scientific goals or constraints that are placed on engineering.

Bill has been with the project for a long time; ten years. Bill. During that time he was a member of a committee that we had called the Exploratory Test Shaft Committee. That committee was formed before I came to the project in 1983. I think it was formed in '82. It's a group of about 25 or 30 scientists and engineers who have met almost monthly in the early eighties, and more recently quarterly,; where they have scoped out those two things: What effect the exploratory shaft might have on waste isolation, and how to conduct meaningful experiments and to make sure that they are not interfering with one another. The analysis you will find of those evaluations is in 8.4 of the SCP.

Ken Beall, who has been on the project for quite some time, has looked at the exploratory shaft design from the WIPP, SALT and tuff site viewpoint. He will discuss how the engineers have tried to take the constraints coming from here and here, and fold them into design requirements to accomplish the design and operational system that won't have negative impacts on either one of these. And I promise I'll be brief when I discuss conclusions; I only have one viewgraph.

Each of the speakers here today has approximately a 25 percent time allocated for discussion as he's giving you the presentation. If the discussion gets very lengthy, we'll have to decide whether to slip the talks -- there may not be any reason to keep them on schedule, but we do have another half hour or so allocated to further discussion.

And of course, as Carl has mentioned, we'll stay as late as you'd like to stay today and tomorrow. And for tomorrow, we'll be discussing the considerations for using the perimeter drifting as part of the site characterization.

Again, I'll be discussing the regulatory constraints, and they come from both the law, the Waste Policy Act, as well as 10 CFR 60, and comments we've received from NRC.

Then Mike Voegele will discuss the aspects of scientific and testing considerations that are particularly amenable to perimeter drifting. Our goal, as you know when we get under ground -- or when we start conducting site characterization in general -- is to develop a three-dimensional understanding of the site. To do that, we also need to understand the processes or acting on the site to change the site because the long-term goal is to predict the impact on waste isolation for 10,000 years. So we need an understanding of how process will change those characteristics. In order to be successful with that, we must have representative data.

So the key to this is gaining the representative data, and in order to do that, Mike will be discussing the strategy we have for site characterization. You'll find that that includes underground testing, and surface base testing.

The surface base testing is divided into two different techniques: One which is study the anomalies. Find out what those anomalies might be on waste isolation.

But of course, it would not be appropriate to take the properties and characteristics we learn about the anomalies and extrapolate them to the whole site. So we have a systematic drilling program, which is geared towards acquiring geostatistically useful or meaningful information so that we can take the meaning and the various consideration as we begin looking at predicting waste isolation potential.

So there are these two aspects: The underground and surface, and the surface is divided into two aspects: Features program and surface base, the systematic.

Then Joe Tillerson will talk about the engineering considerations, given the regulatory and scientific testing needs for site characterization. And in the process of doing that, he'll discuss the very nature of what a perimeter drift is in our program as we see it, and how we need to understand vertical characteristics, as well as the lateral characteristics of the Topopah Spring before we can really fix a perimeter drift.

Of course, it goes without saying that the waste isolation potential of the site depends not just on our knowledge and understanding of Topopah Spring, but also the waste isolation barrier that's below that rock unit, which is the Calico Hills. That's the unit that has approximately 1,000 feet of rock from below the repository down to the water table, and that's our natural barrier. Of course, the waste is moved by water, and the next rock unit or the several rock units above the Topopah Spring retard the migration of water to reaching the points.

So to really understand the waste

isolation potential of the site, we need about as much information from the Calico Hills and the overlying rock units that constrain the amount of water to reach the waste, as we do from the Topopah Spring.

Okay. With that as an agenda introduction, unless you would suggest we modify that or make some changes and you are perfectly pleased to do so now, I think we could go ahead and start.

MR. DEERE: That's fine, I think.

MR. STEIN: Again, I appreciate the opportunity of presenting the information today, and I'm looking forward to meeting again with Dr. North next month to continue our briefing of the Technical Review Board.

I think that the first thing I would like to say is that I believe that the Key Regulatory Concerns is really a misnomer for this talk. I think it would be better if I had entitled it Key Regulatory Factors Associated With Site Characterization because they're not concerns. We have regulations we have to abide by, and they can't be classified as concerns; they are regulations, and we need to meet those regulations. So what I would like to do, as I go through my talk, is to cover the following material that is shown in this outline.

This outline I think will give you a good foundation for the subsequent talks that you will be hearing today and tomorrow, and I also recognize that your interest is in the technical part of the presentation; you want to get to the topics at hand. And so, I will try to make up a considerable amount of time by going through these regulatory foundation, if you will, before we proceed.

Again, the purpose of the regulatory foundation is to be sure that you understand in what framework our program is developed.

MR. DEERE: If I may interrupt, I think this is very good because this is precisely the kind of information that we have not been able to get all familiarity with it, as desired. So this would be very helpful to us.

MR. STEIN: I'm pleased. And I think that between myself and Max, a little bit later on today -- in fact, Max has two presentations where he talks about continuation of regulatory areas -- we'll be able to give you I think a pretty good foundation. Of course, we do have the NRC experts here. If we have some questions that I am not able to answer on the the regulations, I'm sure they'll be pleased to discuss it.

MR. ISAACS: Let me just mention that although the room is laid out in a way that makes this seem somewhat formal, I'd suggest we try to keep this informal. If you have any questions or comments as we proceed, feel free to ask them.

MR. STEIN: The two questions that you had asked at the last meeting that we were together, were the questions on methods of exploratory shaft construction, and early perimeter drifting. So what we have tried to do today is not only in the regulatory area, but also in a technical area, is focus in specifically on those two questions. It has been noted that the proper people are here to discuss those two areas with you.

Now, this is basically what it is that hopefully we'll be able to talk about today, in an overview of the key statutory and regulatory requirements governing the high-level waste program.

If we look at the D.O.E. programmatic goal, this is our objective. Our objective is to develop and operate the nation's first licensed facility for the safe disposal of high-level nuclear waste. Within the framework of that objective, we need to assure, and we are regulated to assure, that the environment and the health and safety of the public are properly protected. We have a number of legislative and regulatory areas that we have to deal with, and we will talk to you more about that later.

The principal law under which we operate is the Nuclear Waste Policy Act of 1982, and the Nuclear Waste Policy Amendments Act of 1987, which amended the 1982 act.

And of course, the Nuclear Regulatory Commission is our regulator, and I would like to say that the Nuclear Regulatory Commission has taken a view -- and this is factual statement, I believe. I tried to confirm it yesterday with some of the people I interface with at the NRC -- is that the work that the department is currently performing on the exploratory shaft facility is regulatory driven because the ESF facility may become part of the repository.

Therefore, the data related to the exploratory shaft will be considered not only as a need for site characterization and site suitability, but also as part of the license application. And accordingly, will be subject to those regulatory requirements specified for the application.

Two things that I need to broaden on

that statement. We are not subject at this point, because we have not submitted a license application to enforcement. And second, we are not fined at this point. We cannot be fined. So if we were to create a willfully false statement, at the present time because we're not an applicant, we are not subject to enforcement to the fines.

But in all other regards, all other aspects of the regulatory program, the NRC regulates us as if we are indeed an applicant. Whether or not you consider that correct or not, that is the NRC's view.

The umbrella regulations and requirements to which the Department must conform imposes certain conditions for achieving the objective, which may be different. And I think perhaps it is -- forgive me if I'm speaking out of turn -- for approaches that are applied to more conventional underground projects.

Now, I guess there's one other area that I would like to note to you. I'm going to describe a series of regulations today. Among them are the regulations that are on this viewgraph. In describing these regulations, we must abide by these regulations. But it's important to understand that the program that we have put into place, in the Department's view, meets all the requirements of the regulations. But does not necessarily imply that the regulations drove our program to this specific program that we currently have.

In other words, you could construct a different set of site characterization activities and plans, and still abide by the regulations. But that would have to be analyzed. What we have done is we have analyzed our program that you have had described, and will have described to you, and know that that program does comply, in our view, with the existing regulations.

Now, this is a synopsis of the key NRC regulations. The Department is governed by the Nuclear Waste Policy Act, and by several of these particular regulations in this viewgraph; notably, those in part 60. These particular ones are the ones that bear on site characterization, and I'd like to discuss them and just talk to you.

Part 60.2 defines site

characterization -- and I'll come back to all of these. Part 60.15 requires that a site characterization program be conducted and establishes constraints on the program. Part 60.140 requires that a performance confirmation program be conducted which begins during site characterization. Part 60.151 requires that the activities of the Site Characterization Program be conducted under a quantified, quality assurance program. Let me cover these one at a time.

First, 60.2, definition. If you will, I apologize for the viewgraph. I don't expect you to read it now, but this is right out of the regulations. We quoted it verbatim. As we go through these, I took the opportunity of underlining certain of the key provisions in the regulations. They are not underlined in the regulations themselves, but I went ahead and underlined so that it would be highlighted to you.

This definition constrains to scope the site characterization activities, allowing only those subsurface lateral excavations and borings which are needed to determine the suitability of the site for the repositories. Activities for obtaining additional data beyond that which is needed for site characterization are not included, and accordingly, are restricted.

I want to quickly add that this is what the definition says. But the word, for example, "limited" is not defined. So that I can't say to you that when it says limited, that the excavation means 100 lateral feet of excavation, or 1,000 or whatever. It just says limited. And I think, though, sort of as an aside, that if I were to put in enough excavation to have a good start on the repository, I think that there might be some objection to that, and I might be --

MR. DEERE: Yes. I would bring in, however, if you go five or six words farther along, it says "needed".

MR. STEIN: Right.

MR. DEERE: So we can play those two words together, or against each other.

MR. STEIN: Exactly, Don. You're absolutely right. That's what I was trying to say when I said limited is not defined; it's whatever is needed.

MR. DEERE: Yes.

MR. STEIN: It was just a concept that the definition is trying to convey. Don't do more than what you need to do in order to do a decent site characterization.

MR. ISAACS: I think it's important to recognize that there was a concern, particularly when we had more than one site characterization plan, that the department not use the site characterization phase as a subterfuge to go ahead and actually start building a repository. We were to do whatever we needed in order to characterize the site, and not more than that.

MR. STEIN: This is the 60.15 on-site characterization, and also, it continues to give us certain rules and regulations that we need to follow. It tells us, for example, that we need to limit the adverse effects on long-term performance of the repository. Limit the number of exploratory boreholes and shafts. Locate shafts, boreholes and unexcavated pillars and coordinate the exploratory shaft facility and drilling with the repository design.

This is just a continuation, and you have all of these in your book. And again, I would not ask you to take your time now to read it. I just wanted to make note to you that there are certain provisions and certain limitations that appear in the regulations that we need to be able to deal with.

Now, in terms of performance confirmation, the Site Characterization Program is one that continues beyond the time when we submit a license application. In other words, there are a whole series of activities which we have defined in our Site Characterization Plan that are specifically designed to address this provision called Performance Confirmation. And that continues on for a long period of time, and may continue on throughout the period of time that we're even loading into the repository in order to gain enough information to confirm that the site is suitable before we go to the NRC 50 years or so after the repository is started to be loaded for an amendment to license to close the repository.

So performance confirmation starts early, it continues on through site characterization, it continues on through construction, and will continue on beyond the construction period. But it does start early, and again, it must be designed not to adversely affect the natural and engineering features of the repository, and we need to be able to identify any changes to the geology which may be caused by site characterization.

So that's an important factor, and one that the technical people will be returning to. Whatever it is that we do, we must be able to focus in on what impact that may have on the geology. And therefore, what impact that might have on the changes that will occur to the geology, if there is an impact associated with site characterization.

This continues on performance confirmation, and continues on. Again, I would not ask you to read it at this point because it is in your handout. But these are all the applicability of the various parts of the Site Characterization Program.

Now, one area that I went through, in terms of requirements, is the quality assurance. Our program is governed by a quality assurance program. It's part of the regulations. 10 CFR 60 refers us to 10 CFR 50 Appendix B, as the quality assurance program which we have to comply with. And we use, as an expansion of 10 CFR 50 Appendix B, we use NQ A-1, which has 18 criteria.

There's 18 criteria that are called out in the regulations in 10 CFR 50 Appendix B that we must abide by in order to implement a program. So that data that we collect, for example, must be done in a way that satisfies the quality assurance requirements. Designs that we accomplish must be done in a way that satisfies the quality assurance requirements.

Our program is subject to surveillance by both our internal quality assurance offices, and also it's subject to the review of the NRC quality assurance. They periodically, during the course of the program, will come in and surveil our program to make sure that we are complying with the quality assurance activities, as well as perform audits.

Now, let me hasten to say that when we talk about quality assurance, and talk about the program, we're talking about all the elements of the program. Not just D.O.E., but the laboratories, the engineering contractors, the scientists, all of them must have a quality assurance program that meets the requirements of 10 CFR part 50 Appendix B.

Now, what these are, this particular viewgraph, is a chart that essentially goes to the staff's interpretation, the NRC staff's interpretation, of the regulation regarding site characterization. Very simply put, these statements that are shown in this chart are the statements that we, in working with the staff, have agreed to represent, if you will, a solution to how to interpret the regulation.

First, "Site characterization activities must not adversely affect the ability of the site to isolate radioactive waste."

Second, "Site characterization activities must not compromise the ability to characterize the site."

And third, "Site characterization activities must provide data which is representative of the site." The last one, we'll get back to that in a moment. We have an exploratory shaft, and in one corner of the site is and underground facility is representative of the parent site. And I think that goes to one of the areas that the panel is concerned about, as to whether or not we actually will acquire the needed data by doing site characterization work as we currently plan, or whether we need to do something more.

I'd like to expand on each one of these regulatory concerns. Basically, the way I like to expand on it is that I would like to say what they are again, and then note to you how we address them in our Site Characterization Plan program.

In regard to the first concern, we

concluded in 8.4 of the Site Characterization Plan, as we went through an analysis, that none -- that there would be no adverse effects for the creation of preferential pathways in the unsaturated zone, significant increases in groundwater flux, significant changes to the hydrologic properties of the unsaturated zone; and significant decrease in radionuclide retardation properties. That was addressed technically, analyzed in the Site Characterization Plan, and it can be found, as I said, in Section 8.4.

In this second regulatory concern, we need to be able to show that the interferences between site activities cannot occur. These --

MR. DEERE: Excuse me. Could I ask you to go back to the number one concern?

MR. STEIN: Sure.

MR. DEERE: I think number three that you have there, no significant changes to the hydrologic properties, principally hydraulic conductivity, is one of the concerns that have led us to the suggestion of consideration of the raise bore shaft.

MR. STEIN: Yes. That's right, and that is one that --

MR. DEERE: That's a driving factor?

MR. STEIN: It's a driving factor.

MR. DEERE: That was the number one driving factor of our recommendation.

MR. STEIN: And we're prepared to talk about it in more detail later, just as we are prepared to talk about perimeter drifting.

MR. DEERE: Sure.

MR. WILSON: I put a star by it.

MR. DEERE: I'm sure you already have the answer.

MR. STEIN: Not necessarily. Again, this is the key regulatory concern number two.

Let me just say that in the Site Characterization Plan, in Section 8.4, we again address this particular regulatory concern, in terms of just what kind of impact might there be, in terms of interferences, both interferences from shaft to shaft as we construct each shaft, between shaft and underground as we construct the underground and are constructing another shaft.

Test-to-construction interferences. Test-to-test interferences. All this has to be considered because of the concern that data could be lost or data could be compromised or data could be massed if you don't analyze, if you don't make some judgment as to whether or not these interferences exist, or what are you doing to mitigate these interferences?

MR. DEERE: Could you slide that over just a little bit so I could see?

MR. STEIN: Excuse me.

MR. DEERE: Again, I would say that number one has had some impact into our thinking. That is no construction-to-test interference because of water control. Raise boring does not introduce water into the site.

MR. STEIN: Right.

MR. DEERE: Another driving factor for the raise boring.

MR. STEIN: Okay. Regulatory Concern No. 3, and as I said, I sort of went to that a little bit ago. That's relative to representativeness, and the program that we have will result in gathering data from the Site Characterization Program. That, in and of itself, will be representative of the entire site, as opposed to being just locally representing a part of the site. And that is an area that we need to ensure that we are able to deal with in an appropriate way, and again, we will be coming back to that in the technical discussions. I know that that is an area of keen interest to you.

MR. DEERE: And if I may interrupt once more. You have such a good diagram that it keeps ticking one's memory. Number three and number four should be starred for our concerns about tomorrow's discussion.

MR. STEIN: Okay.

MR. NORTH: Perhaps number two, as well.

MR. DEERE: We think you have a good list there.

MR. STEIN: I know what certain people will be doing this evening. I think that --

MR. ALLEN: On number four, what is the reason for stating "particularly in the southern part of the repository block"?

MR. STEIN: That's the part --

MR. VOEGELE: Would you like me to answer that question?

MR. STEIN: Yes.

MR. VOEGELE: We have some evidence from geologic mapping that's taking place to date that there's probably a higher density of faulting in the southern block. In fact, we have had some recommendations on the part of the NRC staff, when they reviewed our Site Characterization Plan draft, that they suggest modifying our program to try to get more information in that part of the block.

MR. STEIN: Thank you. This is again,

a section out of the Nuclear Waste Policy Act. The reason that I'm showing you that is that again, we have to deal not only with the requirements that are listed by the NRC in their regulations, but we also have to deal with those requirements that are specified in the Act. And again, this is not -- this is not as prescriptive as some sections of the Act. But nevertheless, it does provide us with general guidance to thinking of Congress when they created the Act and voted it into law. Principally, the restrictions delineated within the Act are that site characterization may include only those activities which are necessary for evaluation and suitability of the site, and for compliance with the National Environmental Policy Act of 1969. And though these activities must be conducted in a manner that minimizes any significant adverse environmental impacts.

And again, I emphasize and underline these for ease of reading.

MR. DEERE: And again, we should have

the underlining on "necessary".

MR. STEIN: Absolutely. Without a doubt. We need to be able to do whatever is necessary in order to evaluate the suitability of the site.

And again, this is just a continuation of the restrictions that are noted in the Nuclear Waste Policy Act, and just for your benefit, I had them printed up in its entirety.

I would just like to summarize. I have two viewgraphs that summarize, and I'm not sure that I'm going to be able to get them both on -- well, I can't so I'll just put them on one at a time. In summary, both the Nuclear Waste Policy Act and the regulations require that our Site Characterization Program be conducted within the framework of the constraints that are noted up in this viewgraph.

This framework results in requirements that site characterization is limited to testing needed to determine the suitability of the site. The number of subsurface penetrations above and around the underground facilities shall be limited. Site characterization is to include limited subsurface excavations and borings. Subsurface exploratory drilling, excavation and in-situ testing shall be planned and coordinated with the repository design and construction --

MR. ALLEN: Oh, 1 and 4 really are a little bit in conflict with one another. One says you won't pay any attention to later plans, and number 4 says you will.

MR. STEIN: You're saying Nos. 1 and 4 have a conflict?

MR. ALLEN: Number 1 says the site characterization shall be limited to what's necessary for the characterization; nothing to do with startup construction. Four says you have to do this in such a way that it's coordinated with possible design construction. So to some degree they're a little bit tugging in opposite directions there.

MR. STEIN: There's a certain amount of tugging there. The repository design will be initiated while site characterization activities are underway. So there will be an opportunity for input -- in fact, there needs to be an opportunity for site characterization input to be factored into the design.

But obviously you're not going to be able to do any construction until such time as the Site Characterization Program, not the performance confirmation, is complete. So there is a little bit of that pulling and tugging, as you said. But sometimes there is that conflict as we've seen in the regulations, and sometimes we've seen the conflict in the Nuclear Waste Policy Act.

Just to digress for a moment, I was up on the Hill during the development of the Nuclear Waste Policy Act, and the fact is that some of the language in the Act -- none that we are currently dealing with -- is specific language not put in. So there's language that I have in there from the committee that I work on.

There are seven committees that have jurisdiction under the Nuclear Waste Policy Act. Each of the committees, to more or less extent -- you all actually have the major responsibility, but each of the committees put in certain language in the Act that was their own particular needs and desires to represent their groups.

So sometimes you do see conflicting statements in the Act, and the NRC, in developing their regulations, tries to reflect the Act as much as possible. So perhaps you see some of that carrying over.

MR. DEERE: But we can almost summarize

that by saying you could have final statement. The amount of testing shall be limited to that necessary to develop. And I don't think that either word should be necessary in overriding the other. Because if it is not considered to be quite characterized, you have to get more data to do it, and you're not limited from doing that.

MR. STEIN: Absolutely not.

MR. DEERE: So I really see "limited" as not being there. You have to do that that is necessary to characterize.

MR. ISAACS: I think that's exactly right, and we are not limited from doing anything that we can justify as being necessary. I think Clarence's point is a good one. Necessary either to determine the suitability of the site or to be prepared to go forward with construction, should the site be acceptable. That's a very good point.

The point Ralph is bringing out and emphasizing is what's important also is the justified part. There was a concern, as this parenthetical statement says in the first bullet, that during the characterization period we would start to conduct more and more activities that were less and less associated with characterizing the site and more and more associated with building the site. And we are limited, precluded from doing those kinds.

So the point Ralph is making is there is an obligation on our part to justify those activities that we conducted during site characterization as necessary activities. So that's the balance I think Ralph is trying to bring to you.

MR. STEIN: I think Tom said it very well. If we want to do something, we need to be able to justify that what it is we want to do is necessary for site characterization. And limited, as I said earlier, is not descriptive in --

MR. BLANCHARD: Ralph, could we hold a minute? We notice perhaps a logistics problem here.

MR. DEERE: Let's pause for the reporter.

MR. STEIN: Dr. Deere, are we ready?

MR. DEERE: We are ready.

But I guess one could also say that if some testing or exploration is deemed to be necessary for your full characterization, that as good engineers, we would see if it could fit into the final layout of the facility.

MR. STEIN: You're helping me actually in bringing my summary to a close.

MR. DEERE: I'm sorry.

MR. STEIN: This is basically what I
was going to conclude, and it really picks up on the
comments that the board/panel has been making, as we

go along.

We have a prescriptive program, in a sense. There are places in there that it gives us actual numbers that we have to deal with. Not only in the regulations, but within the Nuclear Waste Policy Act. There are other places that talk in terms of generalities. It doesn't quantify; it's a qualified statement, like "limited", for example. But it doesn't quantify the statement.

Your use of the word "necessary" for site characterization I think is completely appropriate. We need to do whatever it is to demonstrate that the site is suitable or not suitable; whatever the case may be. To do that, we might have to make changes into a program, adjust the program, whatever is appropriate.

But what I have been trying to convey is that we do live within a regulatory framework. And if we decide that changes are appropriate and needed, we have to analyze it within the framework of those regulations that we operate under. That's basically what it is that I'm trying to convey as we go along here.

And furthermore, I was going to conclude, and will conclude, by noting that we have a program that we believe will address the regulatory requirements, and we believe is a program that will address the suitability of the site. In other words, our Site Characterization Program not only we believe is adequate for us to proceed to making a judgment on the suitability, but it's also, we believe, appropriate within the regulatory framework.

Having said that, I'd like to repeat what I said again, and that is that other programs within the framework of the regulation could be constructed and developed that would also meet the regulatory requirements.

That concludes what I was going to say, and did say.

MR. ALLEN: The final statement here is sort of an odd one. Presumably you want to try to design a program that will not only minimize any significant environmental impact; it will simply minimize any environmental impacts at all. Using both "minimize" and "significant" further confuses things. You want to minimize environmental impact, period.

MR. STEIN: I'm trying to use, to the extent that I could, words that were directly out of either the regulation, or the Act. That's in 113 of the Act, those words.

MR. ISAACS: Ralph's point is a good one. Those are derived from the words that are in the Nuclear Waste Policy Act. There's a threshold -- we claim that they were very insightful in their structuring of that provision, and we intend to follow it carefully.

MR. BLANCHARD: But in the environmental world, there is a flight that goes up that differentiates between insignificant and significant. And sometimes from a permitting standpoint, it isn't all that significant. It makes it become an environmental significant issue. And that's why the words turned out to be written that way in the regulation.

MR. STEIN: There's another aspect of it too, that oftentimes you're faced with who decides what is right, who decides what limited means. Frequently, the courts decide what limited means. And this is something that the Department has lots of experience in. Relative to this program and other programs, of course, but relative to this program. Frequently the courts decide.

Max?

MR. GERTZ: Max, before you start, do

you want to take a break? Is this an appropriate time?

MR. BLANCHARD: It's your pleasure.

MR. DEERE: Five, ten minutes would be great.

(Thereupon a brief recess was taken, after which the following proceedings were had:)

MR. BLANCHARD: Before we begin our next session, Ralph has a couple of points he'd like to make.

MR. STEIN: I just wanted to follow up on Dr. Deere, your comment about need and limited, those words and the quantification of the words. It pointed out to me, which is something that I should have remembered, is the way this program has changed over the years. In 1979, for example, NRC indicated in their supplemental information that accompany 10 CFR Part 60, which I think was first issued in 1979. Their thinking in terms of a shaft was that we might consider one exploratory shaft with a small mound, few tens of feet, of drifting for an underground testing road.

Then in early 1980 NRC indicated in their supplemental information updating the revisions to 10 CFR 50, that they were now thinking of two exploratory shafts with as much as 1,000 feet of drifts.

Then we currently, our current program has two exploratory shafts which are, by the way, much larger than what the exploratory shaft sizes were in the earlier years of our designs, with approximately 9600 feet of drifts. So there is some run that has occurred. Now we have a Technical Review Board.

MR. DEERE: They're all in favor, they just say go circular.

MR. ISAACS: Just keep in mind, if you will --

MR. CORDING: Is this a smooth curve or --

MR. ISAACS: It better be S shaped at some point.

MR. DEERE: When was the second one that had the 1,000 foot of drifting?

MR. STEIN: That was in 1980.

MR. ISAACS: I think it's interesting to note that in some other countries they are slow to coming to closure on the fact that they will need to do exploratory shafts in order to characterize their sites. There were nations that have the historic surface-based testing as the basis upon which they characterize their sites.

So the notion of how much testing is enough is clearly an evolving discipline, and I think it's fair to say in that sense the U.S. has been a leader in terms of identifying the extent we need to do tests.

MR. BLANCHARD: Before I start, there are a couple of things I'd like to make sure you're all aware of. First, we have telephones available. There are some in the lobby, they're on the fourth floor with the receptionist desk. There's also one in here. Just to reiterate, any time you all feel the need to use a caucus room, it's room 437. And for other people who are here who have not signed in, please see Andrea Jennetta right over here -- raise your hand, Andrea -- so that you can fill out the sign-in forms.

MR. WILSON: Max, there's been some new people come in too.

MR. BLANCHARD: Okay. Where are you? All right. Now we're into our first session.

Of course, we will need to describe our approach to the construction and the alternatives considered. What I'd like to do now is spend 15 or 20 minutes talking about the regulatory considerations. It's different -- I want you to understand it's going to be a little different than Ralph's. Ralph's is talking about a policy for site characterization. It's been an evolving policy, and as you know, it's built on the comments from the NRC and not changing the understanding of the regulations.

Now what we want to do at the project level is talk about how we've looked at the regulations from about 1980 on, and how that has shaped constraints on scientific and engineering considerations that went into developing what we think is the appropriate construction method. So I will have -- we considered fair number of more constraints than Ralph talked about. At the time.

Now Ralph, the theme is there, limit impacts to the site, and support the acquisition of information that's called for either by performance assessment, or that's called for by the design. And so, basically our program is driven by the needs in performance assessment, and by the needs in the design. But it requires fundamental understanding of the block because we're not engineering a mountain; we're understanding what the mountain can do for us in terms of waste isolation.

Our constraints and guidance that come from the regulations, of course, impact how we conduct characterization, and they impact how the design is done. During the course of the day, Ken Beall and Bill Wilson will talk to you about those constraints.

We've seen, over the last several years -- well, starting from 1981, I guess, and '82 -- we've seen an influence in three things: 10 CFR 60, 10 CFR 960. This one is the NRC's regulations, but that's the DOE's own siting guidelines. And the guidance from the NRC. Both the regulation itself in 10 CFR 60, but comments that go with that and other documents that were not from the NRC.

MR. DEERE: Now the 10 CFR 60 is NRC; right?

MR. BLANCHARD: Yes. And this one is the DOE --

MR. DEERE: And the 960 is the D.O.E.'s

that incorporate a number of them and add some additional, am I correct?

MR. BLANCHARD: Yes. It was the basis for the Department to screen from nine to five to three sites, and it had disqualifying conditions and qualifying conditions.

MR. ISAACS: It was also used in the screening for the second repository program. Where we were in more generalized area.

MR. BLANCHARD: There are other things in the program where we get advice or guidance from the NRC technical staff. Reg guides, generic technical position papers, branch technical position papers which tell us what their views are, as well as direct comments that they make about things we've prepared.

What I would like to do is to run through a series of things that we considered as we evolved our exploratory shaft design that were 10 CFR 60. If I get in your way, please tell me to move because sometimes I block the screen.

60.15. This requires, in our view, testing at depth, limiting adverse effects on performance, limiting the number of shafts and boreholes.

Now, we talked about that just for a minute, but obviously there can be too many shafts, and there can be too many boreholes. At some point in-depth -- your quest for information produces Swiss cheese. The trick, as Ralph was trying to point out, is that if you can coordinate or integrate your conceptual design for the repository along with your quest for information about the site, you can end up with boreholes and shafts in places where they're easy to accommodate instead of ten years from now, saying well, I wish we hadn't put that hole there. That's part of the finesse' that we're trying to include.

And then that in effect puts an exploratory shaft in a convenient location so that sometime later we can incorporate it in a repository with a minimum degree of difficulty, with respect to the regulatory and licensing concerns we have to show.

MR. ALLEN: What is GROA?

MR. BLANCHARD: Geologic Repository Operations Area. When you look at the definitions in 10 CFR 60, it's different than the repository. The repository is the underground system and the rock that becomes a barrier for waste isolation. Out to five kilometers, as well as the surface facilities.

That's the repository.

This, though the Geologic Repository Operations Area, doesn't include the barrier; it's the surface facilities and development for where you handle the waste. And like it or not, the regulations make a distinction between those, and so we have to treat those differently.

In 60.17, the content of the Site Characterization Plan is discussed. The first one, plan for investigations we've done. That's our 6,000-page Site Characterization Plan we now have on the street, which is eight chapters long. It also calls for plans to control adverse impacts.

We have a section in Chapter 8.4 that describes an evaluation, and our general plans to control adverse impacts. But we're also preparing a more detailed document which will explain how we're going to control adverse impacts in the process of conducting site characterization.

In 60.21, even at the time we're starting site characterization we have to be cognizant of the content of a license application because it calls for the detailed site description and classical types of information -- geology, hydrology and geochemistry.

If we're going to construct something now or do something now that turns out to become part of the license application, we have to make sure that we do it the right way and document it the right way.

The information that's going into the site description provides the data to make the assessments of both the natural and engineered barriers, and the long-term performance.

So these two are linked, and the SCP is the linkage between site characterization and the license application. We want to make sure that the 106 study plans and the 308 activities you've got identified in Chapter 8 have a direct flow of information into design and performance, so that we can prepare the license application. And the construction method must not interfere with the acquisition of the scientific information needed to do that.

In 60.72, the section on construction records. Well, it requires that we maintain a set of records that describe the conditions encountered during characterization. It goes on to explain geologic maps, cross sections, nature of the materials.

MR. ALLEN: During characterization, or

during construction?

MR. BLANCHARD: During construction.
If it turns out later on, we think it would be nice
to incorporate the exploratory shaft in the

underground facilities that go with the exploratory shaft into the repository. Then the burden is on us now to make sure that we keep the records that describe the conditions encountered because in effect, if we incorporate the exploratory shaft in the repository, we could be doing that construction right now.

So we have to have a record system and design control system set up which would allow us to do that.

MR. STEIN: Max, it might be worthwhile to note that the exploratory shaft facility is within the repository block, even at the present time. So it isn't as if it is somewhat distanced from the repository. So if we -- whether or not we include it in the repository, we're only talking about including it in the sense of ventilation and factors like that. But nevertheless, from a construction standpoint, it is being constructed within the repository block.

MR. GERTZ: Even more specifically, our exploratory shafts will eventually become ventilation shafts in the repository. So it's an integral part of the repository design right now. Even though the repository design won't start or be built for many years to come.

MR. BLANCHARD: However, the point Ralph made, quite well, was that we could put together the program and do it differently and still comply with the regulations. Such as the possibility of having the exploratory shafts (inaudible). That's not in our current plans.

In 60.122, the siting criteria. This requires an assessment and an evaluation of things called favorable and potentially adverse conditions. It also requires that -- that are present at the site. So we have to determine that at site characterization. But we have to go one step farther. We have to recognize conditions that may be present, but undetected.

So we have to know the uncertainty. And that has -- that little phrase has caused much debate in the time we were preparing and laying out Chapter 8 and identifying the 106 study plans. That's not easy to do. You really have to understand that certainly in order to be able to do that.

MR. DEERE: That's where you start

getting into the limited versus necessary.

MR. BLANCHARD: Yes.

MR. NORTH: Let's flag that as an item for the meeting in May.

MR. DEERE: It's a risk analysis item.

MR. ALLEN: I'm sure you have to know the uncertainties.

MR. BLANCHARD: You have to know the uncertainties about the uncertainties. Okay.

Of course, in order to do this it requires a knowledge about things like hydrology and the tectonic processes that are apt to change the structure of the mountain. Of course, the intent is to provide reasonable assurance that the performance objectives can be met, so that when you look at the performance assessment done by those who are doing radionuclide release and retardation calculations, you can combine that with favorable and potentially adverse conditions and look at the conditions that may be present and could be undetected. And you build something called reasonable assurance so that you're not just relying on the models and calculations that go with that on radionuclide release and retardation.

There's one other thing, we have to

determine if the site conditions require complex engineering solutions. As you'll find out later on, if it turns out it's a potentially adverse condition to have complex engineering solutions, if you end up with a very complicated structural feature in the repository or at the location of the site.

MR. NORTH: Could you give us an example of the degree to which such contingency plans for complex engineering solutions have actually been formulated, given the evaluation of favorable potentially adverse conditions which may be present but have not yet been detected?

MR. BLANCHARD: Well, yeah. Let's try to make it very relevant to the ESF construction method.

If it turns out that, in the process of constructing the exploratory shaft, we discovered a linear feature that, although it wasn't a fault, it wasn't recognized by (inaudible) surface, it was a very through-going structure and it changed the hydraulic conductivity by orders of magnitude -- maybe say 10,000; that's possible -- then it would affect the entire repository layout.

In fact, we may have tremendous setback distances, and end up with a bifurcated repository or repository that would be partly two levels, or something like that. That would increase the degree of complexity on the approach.

MR. NORTH: My question is to what

extent do plans exist for these contingencies? Or to what extent is this simply a concern that you have for the future that as you learn new things, you may have to develop such plans?

MR. VOEGELE: Max? Could I help you?

MR. BLANCHARD: Yes?

MR. VOEGELE: Within the context of the post-closure impacts on site performance and the repository design features developed to address those post-closure impacts, there actually have been -- excuse me?

MR. CORDING: You said post-closure?

MR. VOEGELE: Yes. I'm focusing on the post-closure performance of the repository after closure when we've sealed it up. With respect to that performance there have been some contingency plans developed in the existing SCP -- or the conceptual design report that supported the Site Characterization Plan for the repository.

Basically they looked at the area available for emplacement of wastes, tried to look at a probablistic distribution of uncertainty in that area as a function of uncertainties in the orientation of the known faults.

They also looked at trying to develop

some particular criteria for accepting ground as being acceptable for emplacing waste on the basis of the post-closure impact.

So there have been, and there is in place currently, an exercise to flush out those particular types of plans. They're rather at the conceptual stage right now, and they primarily deal with avoiding ground that would not be as good from some perspectives as other ground.

That information is written up in the conceptual design report for the repository, as well as in the Site Characterization Plan. We can point that out to you if you'd like to pursue it.

MR. NORTH: Yes.

MR. BLANCHARD: Any other questions? Okay. There's a series of sections under the scope of the design criteria 60.130. It's really 131 through -- well, including 131 through 134. And here are some of the constraints that we've pulled out of these sections. There must be flexibility to accommodate site conditions as you conduct site characterization. You must control water and gas.

Construction method must limit preferential pathways for water flow from the surface down to the water table, or the accessible environment. The engineered barrier contribution to isolation and containment must not have an adverse impact. The stability of the underground openings. And finally, compliance with MSHA, for mining regulations.

So those are some more constraints that the engineers and scientists have had to deal with. 130 mostly focuses on the engineering design aspect.

Moving to the DOE regulation, siting guidelines 10 CFR 960, when we screened from nine to five to three, we did that in the process of looking at possible sites and examining whether or not they had what seemed to be disqualifying conditions. If they didn't we looked at potentially favorable adverse conditions with a goal towards demonstrating, for each one of the technical criteria, that the qualifying condition was met.

In particular, this one, 960.5-1 talks about using reasonably available technology. For siting, construction and operation and closure, it has to be demonstrated to meet this qualifying condition that it's technically feasible and the criteria is, is the technology available to do it.

MR. ALLEN: What's the meaning of the word "reasonably"?

MR. BLANCHARD: Well, I think it was meant to allow people to get a little bit farther beyond than what's simply available off the shelf. But not get so far ahead --

MR. ALLEN: Future available technology?

MR. BLANCHARD: I don't think it goes that far.

MR. ISAACS: Adaptations of existing.

MR. BLANCHARD: Yes. In other words, if we were trying to -- let me go back to my many years from NASA. If we were trying to build a shuttle and we knew we had to deal with thousand-degree skin temperatures and there wasn't a way to do that very well except use some metals which didn't have the right properties, it wouldn't be the right thing in this program to develop ceramics which can be red hot, but yet you can hold it in your hand and your hand not get hot.

That's the way we've interpreted that. It has to be available technology. We don't want to go into a ten-year development program to determine whether or not we'll still have aerodynamic characteristics on the wings after we've put the tiles on.

MR. DEERE: Perhaps another way to look

at it to be reasonably available, is to be available in this country. We wouldn't necessarily want to have to go to a Japanese contractor to get something, or to a German contractor that may be doing this in their country.

MR. ALLEN: The addition of the word "reasonably" means it doesn't have to be based on available technology. It has to be based on what you think in the future might be coming out of available technology.

MR. BLANCHARD: I don't think we viewed it that way. During the ten years we wrote the SCP and the EA's, our policy within the Department has been that it's one step -- could be one step beyond what's available off the shelf, but it had to be demonstrated in scientific literature and in the laboratory. There had to be confirmation empirically, and there had to be appropriate theoretical stuff behind it; a model to show that you could do it when you went out there to do it. It was not to be predicated upon things that you think might be breaking in science.

MR. WILSON: It does allow us to do
some prototype testing, for example.

MR. BLANCHARD: And as a consequence of

that, Clarence, we have developed something we call prototype test programs. We have some prototype testing going on in order to demonstrate for the record that it is reasonably available, and we can count on that. And we can discuss that later, if you'd like. In fact, we're preparing a report now to describe the nature of the prototype tests appropriate.

You all may not take that view, but that is what I'm trying to explain again is, the view we've had and the things we saw that impacted what we were doing from about 1980 until now, 1989. And how we have moved that into the program as a constraint. Right or wrong, that's how we did it.

Then there are other things. As I said, guidance and comments. Talk about reg guide 417 and the generic technical position paper, and then some comments that the NRC has made on our consultation draft which were very explicit about the way we should construct.

First, reg guide 417, this identifies

the types of data and the sciences that had to be included in the Site Characterization Plan, and it went so far as to give us a rather thick annotated outline of what had to be in each section. In order to get the SCP accepted by the NRC for review, they have a review plan where they do an analysis on the document to decide whether or not they'll accept it for review.

So there's kind of a door that you have to get, and given the information that we had in the consultation draft, I think it would probably be fair to say that that consultation draft, had it been statutory, probably wouldn't have gotten through that door for the acceptance review because there were sections that were not quite mature enough for the final version.

In terms of the NRC guidance --

MR. ISAACS: Excuse me. They have now accepted our site characterization.

MR. BLANCHARD: Yes. And they have also accepted the five study plans that we sent to them along with the SCP, or shortly thereafter, for review. They had seen the study plans earlier, and decided that they didn't quite match what they were looking for and they wouldn't review them. So there's got to be dialogue with the Department and the NRC to make sure we both understand, and that we don't have unrealistic expectations.

MR. STEIN: Max, on that latter item,

they have accepted the five study plans for review, if you will, but in codes. There's a document that needs to accompany those five study plans which have not gone yet, and that's the site characterization SPA, SPA.

MR. BLANCHARD: Study Plan Analysis document. Dave Dobson has authored it, and it's currently in review.

MR. STEIN: Which has not yet gone to the NRC. NRC believes that they need that document before they can officially start to review the study plan. But in regard to the SCP, that document has been accepted by them for official review, and they're scheduled to complete their review and issue a report called a Site Characterization Analysis in July of this year.

MR. BLANCHARD: Suffice it to say that getting the key documents in the program accepted by the NRC is no small task. That may be the subject of other discussion, but believe me, it has not been a small task on the part of the project or the reporters. We've had to do a lot of work, a lot of man-hours and prepare special documents to do that, in addition to the product produced.

Now, their generic technical position

paper on in-situ testing includes certain things pertinent to the construction method. It calls for an in-situ test program to be developed with two major objectives: One, to characterize the host rock and make in-situ measurements of its properties. And another one, to determine the response characteristics of the host rock and engineered components, both prior to construction. We have that reflected in the SCP.

Relative to the shaft construction method for those things, they perceive the shaft construction method could possibly affect the ability to actually conduct the test; not necessarily waste isolation, although it could affect waste isolation. It could interfere with your tests.

So they've identified things, like inspection, examination and mapping. Explicitly, an evaluation of groundwater influx and measurement of in-situ stresses and other geological information that they believe needs to be acquired in the in-situ test program.

Also comments. Now, over a year ago, year and a half ago, we issued a consultation draft SCP to the NRC, the state and the public, as you know. What I have here is about five comments that I wanted to talk to you. These are comments that have come officially from the NRC technical staff in a published document to the Department, and we have dealt with these comments and answered them in the process of converting the consultation draft to the statutory draft.

Infiltration of drilling fluids from past holes -- and here they're considering geological core holes like G-4, which is 300 feet away from the exploratory shaft site. -- could or may compromise hydrologic and geochemical tests that are planned to be made along the shaft during its construction or underground when you do the in-situ test.

Also, we should consider mapping or photographing the floor and faces of the shafts in order to get information about the fracture networks. As we had this debate, as Bill will talk about, how do we understand water flow in the unsaturated zone is so key to understand the fractures.

MR. ALLEN: Well, presumably you would plan that anyway.

MR. BLANCHARD: Sure. Our science program, with or without regulations, focuses in on that.

Plans should be made to correlate

structures that may curb, that connect ES-1 to ES-2 and keep a photo log of that for posterity.

Adverse effects that could be caused by drilling and blasting in the construction of ES-2.

And finally, some comments about the proposed strategy for minimizing shaft damage, they think is reasonable; however, they reserve their comment to later review of the actual detailed procedures for the drill and blast method. It appears that they plan on reviewing those procedures.

In conclusion then, with respect to the regulatory constraints and how they influence the science and engineering, the selection of the shaft construction method does have a number of regulatory constraints. And to reiterate the points that Ralph had, we think those regulatory constraints can be put into the three concerns.

One is that they must not adversely affect the ability of the site to isolate waste. They must not interfere with the acquisition of information needed to make that assessment -- Ralph used the phrase "ability to characterize" the site. And finally, we must use reasonably available technology.

Now, if you have questions I would be

glad to try to answer them, and use some of the staff
that's here to help me answer.

MR. NORTH: Let's go back a couple of
slides to the NRC comments on the consultation draft,
particularly the second and third bullet, the adverse
effects of drill and blast construction and had a
proposed strategy for minimizing shaft wall damage.

I think we'd be interested in learning
a little bit more about this interchange. Perhaps
you could make copies of the comments available to us.
Perhaps either you or some of the NRC staff here
could explain to us in more detail just what was said
on these two points.

MR. BLANCHARD: Well, first we can give
you a package of their comments. We can also give
you a package with our response to those comments,
which was above and beyond what's in the SCP.
Prepared a one-page written response for every item
that was in their comment package. And it also
includes a road map for where to go in the SCP to
find the answers, and then we wrote a paragraph to

describe what the answer was.

So we'd be glad to get that. We'll have to do some -- do you want four copies, or just one?

MR. DEERE: Four.

MR. BLANCHARD: Mike, would you start getting those Xeroxed?

MR. GLORA: Maybe late this afternoon or tomorrow morning.

MR. BLANCHARD: Is that all right? All right. Did you want to pick any one of these and talk about it a little bit more? I think what you're going to find is, in some ways if we go into it too early it will be covered --

MR. NORTH: If it's covered later, fine.

MR. BLANCHARD: And then maybe what we'll do is come back to these if they don't cover it well enough. Would that be all right?

MR. NORTH: Yeah.

MR. BLANCHARD: If there are no other questions, then what I would suggest we do now is that, because Bill Wilson has an hour to hour and 15-minute presentation and it ties the regulations together and forms a basis for the engineering talk, I would suggest we take a lunch break here.

There's another reason for suggesting that, and that is unless you go to a sandwich shop, you may not get back in an hour. With the Convention Center, things going on this week, I found myself waiting in line to place an order for a sandwich at the drug store across the street for 20 minutes. So I would suggest that maybe we break here, and reassemble on schedule, like 12:30? Is that what was there? It might be better if we did it at 1:00.

(Thereupon a lunch recess was taken, after which the following proceedings were had:)

AFTER RECESS

(The proceedings reconvened at one o'clock p.m., pursuant to recess for lunch.)

MR. BLANCHARD: So we have a new court recorder, Pam Manning is going to be taking the recording this afternoon. Remind you to please speak up. For those of you who are talking in the back of the room, please state your name and speak up loud enough so that she can hear.

According to our plan, we're going to begin talking about scientific considerations that in one way or another drove the exploratory shaft construction. And Bill Wilson from the USGS is prepared to talk about that.

Bill, are you ready?

MR. WILSON: Yeah.

First of all, you should have, all of you should have a substitute packet of my view graph handouts. Those at the head table, the substitution has already been made, so you don't have to worry about it, but those of you in the back I just gave a -- just pull out the old set and substitute wholesale the new set.

Does anybody not have? There's some in

that box, as I recall. I tried to put one wherever there was a book.

All right. I will be discussing, as Max said, the scientific considerations that we feel should go into any decision about an exploratory shaft construction method. And this is appropriate, of course, because the principal reason for constructing an ESF in the first place is to obtain site characterization data.

Thank you.

And, therefore, whatever method is chosen or utilized should optimize the ability to make observations of ambient in situ conditions, the processes, and relationships. And, of course, we're dealing at Yucca Mountain in the unsaturated zone and so all three of these factors, conditions, processes, and relationships, are important to the overall characterization. And as part of that, of course, we want to be able to obtain reliable rock and water samples for analysis. So these are really the overall scientific objectives of any kind of shaft characterization operation.

So in order to help meet these objectives -- can this go up higher somehow? How is that?

In order to help meet these objectives there are certain features of a construction method that would be highly desirable from a scientific standpoint. And these include direct access to the shaft during construction, certainly minimal disturbance of the ambient site conditions, and finally the ability to monitor both the magnitude and the extent of the disturbance that does occur.

So in my talk today I will be covering these major aspects, the observations and samples, the access, the disturbance, and the monitoring of the disturbance.

But before getting to each of those topics, I would like to give you a brief overview of the hydrogeologic framework at Yucca Mountain. This is important because in many ways the unsaturated zone that we're dealing with is a unique environment, and it is that environment that determines to a great extent the kinds of information we feel we need in order to characterize this site. And so having that kind of understanding, I think, will help assess the scientific considerations that we'll be discussing.

This is an oblique view of Yucca Mountain, looking to the north, along Yucca Crest, with Solitario Canyon off to the west. You can see here the eastward-dipping units off to the right, the outcrops along this scarp that faces Solitario Canyon. This marks the approximate position of the Solitario Canyon Fault.

MR. ALLEN: The repository is all off to the right?

MR. WILSON: The repository, we look down, it was, yes, off to the right, yes.

That view we had before was looking up this canyon, Solitario Canyon, with the dipping units off to the east, and this shows the design perimeter of the repository as we now conceive it. It also shows the exploratory shaft locations, ES-1 and 2, and the location of the surface facilities, just to kind of get you oriented.

Now, I will be showing next two cross sections. The first one is more or less at the northern part of the repository area, where it's at the widest, and then the second one will be right at the southern -- very southern tip, near the southern end of the repository area.

This east-west geologic section at the northern part of the repository shows many features that are -- provide the geologic framework that we're dealing with. It also shows in a very schematic way, not to scale at all, the possible location of the exploratory shaft -- of the repository itself, just to indicate that it would be within this unit called Topopah Spring welded unit.

These units shown here are hydrogeologic units that have been distinguished on the basis of the degree of welding of the tuff units that occur there. Basically two types, densely welded tuff and a nonwelded tuff. These have very distinctive hydrogeologic properties.

The densely welded tuff has a high fracture density, ten to 40 fractures per cubic meter is the way it's been expressed in the SCP, whereas the nonwelded units have maybe one to three fractures per cubic meter.

There's a substantial difference in the matrix permeability. The welded units have a saturated matrix permeability that can be expressed in terms of about one millimeter per day -- per year, one millimeter per year. Whereas in the nonwelded units the matrix permeability is several orders of magnitude greater than that.

Porosity is different. In the welded units it's about 10 to 15 percent matrix porosity, in the nonwelded units it's about 40 percent. Also in the welded units saturation is about 65 percent.

So we have alternating welded and nonwelded units. The Tiva Canyon is the cap rock, it's a welded unit, underlain by the Paintbrush nonwelded unit. The host rock, the proposed host rock, is the Topopah Spring, which is a welded unit, and that's underlain by the Calico Hills nonwelded unit.

The water table at this part of the repository area is within the Calico Hills. The thickness of the unsaturated zone here is 500 to 750 meters, depending on where you are in the land surface.

MR. ALLEN: Would then units like the Calico Hills, are there also beds occasionally of welded units, and within the Topopah Springs are there occasional thin beds of nonwelded, or are they really completely distinct throughout?

MR. WILSON: There are gradations for one thing. Not all -- there's moderately welded as well as densely welded and nonwelded. There are other differences in lithology within the units.

For example, in the Calico Hills there's the zeolitic faces and the vitric faces. In Topopah Springs there are zones that have more of the lithophysae or the big pores, gas bubbles in them.

So they're not completely uniform units but from an overall standpoint, from a gross standpoint, they're fairly distinct and uniform.

MR. ALLEN: I guess my question is to what degree does one sample of the Topopah Springs characterize the entire thickness of the unit?

MR. WILSON: We feel it's important to be able to sample the full section because there are differences, but they are pretty much all a welded tuff. But there are going to be ranges in the properties within that welded tuff.

MR. DEERE: Over there by the Solitario Canyon Fault, you showed a photo, the first photo you showed, there was a noticeable break in the slope on the right. Would that be the contact --

MR. WILSON: That is this slope.

MR. DEERE: There was some break in that slope with some additional --

MR. WILSON: That's probably the contact between the Tiva Canyon and the Paintbrush.

The Paintbrush is a softer unit.

MR. DEERE: Could you maybe show that again so we can look once more.

MR. WILSON: Okay. You're talking

about in here?

MR. DEERE: Yes.

MR. WILSON: Let's see if I -- there's somebody in here that has a better feel for this. I believe a good bit of this is the Tiva Canyon and then we have the Paintbrush and then the Topopah Spring does outcrop in Solitario Canyon, the Topopah Spring welded unit is outcropping in the canyon. Does that -- is that correct, on that?

MR. DEERE: Will this be an area that we'll go on the field trip in June, do you know?

MR. BLANCHARD: Yes. We're currently organizing the field trip.

MR. WILSON: I assume so, Don.

The field trip always goes to the top of the ridge here. That's the standard field trip.

MR. DEERE: I see.

MR. WILSON: You'll get a good chance to view that and the geologist will be able to point out specifically what units you're looking at.

MR. ALLEN: You'll be invited to walk

down the hill.

MR. WILSON: Certainly.

Let me return, though, to the faults because that's an important point.

On the west, as I mentioned, there is the Solitario Canyon Fault. That is a highly brecciated zone. There's a series of faults and units are jumbled there.

To the east is a series of normal faults which has been used to help bound the repository area, at least under present plans. Within the block itself there's only been one fault identified, major fault identified, called the Ghost Dance Fault, within the repository block itself.

There may be additional faults encountered underground as we get underground, but as far as the surface expression, that's the only one that's been identified.

Going now --

MR. ALLEN: Pardon me. Is it sufficiently distinctive, the surface outcrop --

MR. WILSON: Is what?

MR. ALLEN: -- so that you are very confident of saying there are not other features similar to it in the area? It is really distinctive?

MR. WILSON: The fault, you mean?

MR. ALLEN: The Ghost Dance Fault.

MR. WILSON: Yes. You'll see that the rocks are generally quite well exposed and it's been mapped in great detail by the geologists. So we're fairly confident that there are no other major faults within the block. There are very numerous minor faults but no major ones. And by major the displacement on that is about 38 meters and --

MR. ALLEN: The vertical separation?

MR. WILSON: Right.

MR. ALLEN: Do we have any idea of what strikes of component it might have, if anything?

MR. WILSON: Very little on that one. There are strike slip faults in the area. Some of these northwest-trending washes are believed to be underlain by strike slip faults.

UNIDENTIFIED SPEAKER: Would you lay your pointer on the section line again.

MR. WILSON: Section line I believe is about here. These cross sections are from Scott and Bonk, who did the geologic mapping and have produced the geologic map and sections that I'm showing here.

Now we move toward the southern tip of the block, and there are several differences here.

One is that the -- as you may have noticed, the shape of the repository block comes to a narrower point at the southern end, and this is reflected in the width of the general repository area.

There has been -- again, we have the Solitario Canyon Fault with the brecciated zone. The water table now is down below the Calico Hills into the Crater Flat unit, which is a mixture of welded and nonwelded units. But the main difference I think you can see is the mapping here or the showing of multiple what's been called imbricate fault zone.

This is partly conceptual, I guess, because Scott and Bonk when they were doing their mapping postulated that these probably occur on the basis of the stratigraphic relationships that they observe. They were not able to map each one individually. And so they're -- most of them are dashed to one degree or another and are hypothesized to be there to account for the stratigraphic relationships.

There are other conceptual models being considered as part of our characterization effort that do not require this large number of intricate fault structures at this --

MR. ALLEN: Is the Ghost Dance Fault

still present at this latitude?

MR. WILSON: If it is it's now lost in -- I can't remember whether it extends -- I believe it does, but it will be one of these in here at this point.

Now, what I would like to do is superpose the hydrology in a very conceptual way onto this generalized geologic framework. And I stress that these are -- this is really a conceptual model of the flow in the unsaturated zone, in which we have indicated by the straight-line arrows liquid water flow and by the wiggly arrows potential water vapor flow.

And what I'm trying to illustrate here is the -- are the alternative flow paths that might be occurring at Yucca Mountain in the unsaturated zone. And I'll just quickly kind of run down the section.

We start with precipitation which at Yucca Mountain is about 150 millimeters per year, a little over six inches. Most of this evapotranspires and runs off and is lost to the site itself. But some small amount we believe does infiltrate beneath the land surface.

MR. ALLEN: Within the historic record

what can we say about the variability or the variance
of that rainfall?

MR. WILSON: From year to year?

MR. ALLEN: From year to year. What's

the maximum, minimum, do you know?

MR. WILSON: Well, I would say a half to twice or more. I mean from year to year it's quite variable. We don't have -- at this site we don't have records. There are records at Beatty and other nearby areas.

Does anybody have a feel for the range of precip from year to year here in Las Vegas, for example?

MR. ALLEN: I suspect it would be a lot more than twice at the maximum.

MR. WILSON: It might well be.

And, of course, the intensity varies from storm to storm. There's snow that occurs on Yucca Mountain periodically in the wintertime. So we do get a snow melt. Some infiltration as a result of that.

Remember that the Tiva Canyon is a welded -- indicated by the orange color is a welded unit. It's conceivable that under some conditions we may get flow in the fractures in the Tiva Canyon infiltrating downward.

It encounters this dipping nonwelded unit and there's the potential then for -- because of the contrast of these properties, for some lateral flow to occur downdip toward the east.

This, in turn, may result in the development of temporary perched water bodies, shown by this symbol right here, where the structural conditions may favor such a development.

This, in turn, may lead to flow down a fault, such as the Ghost Dance Fault, and it may be that you'll get a short-circuiting flow directly down the fault. The fault may be a preferred pathway.

But probably some amount of water does infiltrate on through and into the Topopah Spring welded unit. Again, a densely-welded unit. And the question is -- one of the main questions that we're dealing with is: Does that flow occur in fractures or does it occur in the matrix?

Our present expectation is that it is predominantly in the matrix. But many of our tests and many of our sampling programs are designed to define just under what conditions flow in fractures does occur or could occur and is it likely that those conditions exist or could exist under future situations.

MR. ALLEN: Why are the welded units more permeable than the unwelded units?

MR. WILSON: The matrix of the welded

units are less permeable, the matrix I'm talking about, from the saturated permeability standpoint.

MR. DEERE: But it's so fractured that the mass permeability is many times greater.

MR. WILSON: That's true, if we're talking about saturated conditions. And what I'm going to do in a few minutes is talk a little bit more about what controls flow in fractures and what controls flow in matrix in the next few view graphs.

MR. DEERE: Bill, I would like to -- I wanted to introduce this at some point in time and you just mentioned it there about the fracture versus the matrix, because in reading through the various reports this is a question, apparently, that has been looked at carefully and is still being looked at carefully.

And the experience I had is in the last three or four years, happens to be in red beds, deposited under a desert environment, which seem to be moderately impermeable, really the fine-grain sandstones.

And when the reservoir was built the wedding front started to move around the abutments and down -- down the abutment area, and piezometers were installed downstream so we could see this advance. But there also was a major cliff along which you could watch the movement.

And using the piezometers and using the outcrop information that you could see in the cliff, there was absolutely no doubt that the fractures led the way but they could not get very far. They had to pull and saturate the matrix.

MR. WILSON: Right.

MR. DEERE: So we have a great number of perched water tables, because it depends on the relative -- we have some interbeds of fine sandstones versus a little bit coarser sandstone and even some shale units. So you have a whole series of perched water tables because one led it a little faster and then it comes back in again. So you could see the wedded fronts. But in every case you don't get the water to contact moving too much farther, it just simply doesn't get that far before it's sucked up.

MR. WILSON: Sucked back into the matrix.

MR. DEERE: But every single, every

single time the water in the fractures is out ahead by anything from two or three meters to 10 or 15 meters. And the whole mass is moving downstream and since it's slightly inclined it's also moving up, so the piezometers in the last five years that I've been observing it have shown a raise of about a half a meter per year, and now in the total of 20 years it has moved about a hundred meters.

But now we've put the drains in to lower the water and you don't get a drop from the matrix. I mean not a drop comes out. It's held --

MR. WILSON: From the matrix.

MR. DEERE: From the matrix. It's held in by the capillarity. And if you don't intercept a fracture, we don't pull down the water level.

So it's a very close interrelationship, and I get the impression that your theoretical studies here are showing something like this.

MR. WILSON: In fact, I'll address some of those points that you made.

MR. DEERE: Okay.

MR. WILSON: One difference that I think at that site you're describing, you have a constant source of head of water.

MR. DEERE: Absolutely. Yes, that's

the difference.

MR. WILSON: Which we, of course, don't have.

MR. DEERE: Right.

MR. WILSON: And I think another important difference may be that we have -- may get, as I said, some flow in the fractures here where you get an intense rainfall event and it just overwhelms the matrix system. But when you get to these nonwelded units, which have many fewer fractures and which the fractures may be not even very distinct, in the welded you get kind of a damping effect. That may lead to a more constant condition for flow beneath that nonwelded unit.

MR. DEERE: Okay.

MR. WILSON: Okay. So we'll return to the question of fractures in the matrix here shortly, but in the meantime we've got water moving down through the Topopah Spring, the potential, again, for perched water development at the contact with the Calico Hills, and probably some water does eventually reach the water table and becomes recharged to the saturated zone beneath.

An offsetting factor, though, that we need to take into account, is the potential for vapor flow moving vertically upward through the fractured network in the densely-welded units. This have been observed -- this phenomenon has been observed in boreholes where we are aware of upward vapor flow occurring and discharging outcrops to boreholes.

When you go up to the top of Yucca Mountain there is one borehole there that is a blowing well, so to speak. At certain times of the year it's discharging, at other times of the year it's recharging. That's partly because of this outcrop here where you have heavier in the wintertime, you have heavier colder air settling in here and moving inward, and in the summertime it reverses and goes back out. So, in any event, the air circulation within the Topopah Spring unit probably impacts the moisture distribution in that unit.

But one of the key points I want to make with this diagram is that we have a variety of types of phenomena occurring above the repository horizon, which is somewhere in here, as well as below it, that we need to understand in order to assess the potential for the moisture contacting the repository itself.

Now, let's look at some idealized what we term moisture characteristic curves, which show the relationship between saturation, increasing to your left, and increasing hydraulic conductivity toward the top of the curve.

And we have basically three curves here.

One reflects the relationship for the matrix alone. This is the solid line. Another one reflects the relationship for a fracture, shown by this solid line. And then a dashed line represents the relationship for the combined fracture/matrix system. And there are no numbers on here because we really don't know what the exact relationships are, that's one of the things we feel we need to find out. But this is just showing some of the principles involved.

You can see at low saturations, then, the permeability of the matrix is higher than that of the fracture. And flow will be predominantly within the matrix. As saturation increases, though, the hydraulic conductivity increases also, and we reach a point which we could term the critical saturation, where the two curves cross and then at higher saturations we now have the condition where the permeability of the fracture is higher than that of the matrix, and under these conditions flow in the fractures is likely to predominate.

So it's important, first of all, to be

able to understand what the water saturation amounts are in the units and to know what this relationship is so that if that were to change, if there were to be water moving through the fractures, we'll know what -- water moving through the system, we'll know what the likelihood is of developing a fracture flow component.

This is further illustrated, then, in the next diagram, and then I'll stop a minute, see if you have questions or comments.

Here we have kind of a highly-schematic diagram of two fracture planes intersecting a matrix that has some matrix porosity and permeability to it. And you can see that we have two components in here, two phases. We have liquid water shown in the blue and we have air that's shown here in the green. And where the fracture is narrow or where there are asperities or contact points on the fracture plane, then water flowing through the matrix can cross the fracture, and it doesn't necessarily move down the fracture plane. It's not until you get either a very large flux or a substantially increased amount of saturation within the matrix that this air then is replaced by water and you could get flow down the fractures.

And what we need to know, then, is what are the characteristics of the fractures, what's their interconnectivity, a whole set of properties of the fractures and the matrix in order to be able to understand the conditions where this air flow is replaced by water.

MR. DEERE: While you have that one on, this rather unique point that you mention of air flowing out of the borehole, and I'm sure that's impressive to anybody who has an opportunity to see it, six months ago we observed the same thing in another welded tuff in the mountains of Peru. The pressure tunnel in welded tuff was just completed after about four or five years construction and it was pressurized up the first time. The only thing was they couldn't fill it. There was water leaking through the concrete. And in repair they had to repair some of the cracks, a thousand, to be exact, and to do some grouting.

And in one of the grout holes, which is about 300 meters from the outcrop of the welded tuff, air was blowing in. And that was quite a surprise to everyone. Later that evening they found out it was blowing out. And the next morning it was blowing in. So it was a balance.

Now, what were the things that are common with your site and with that site?

Number one, they have to be covered with an impermeable layer. Otherwise you get rapid equalization.

MR. WILSON: Right, right.

MR. DEERE: And having your -- which canyon formation is it?

MR. WILSON: Tiva Canyon.

MR. DEERE: Yeah, the Tiva Canyon nonwelded unit.

MR. WILSON: No, the Tiva Canyon is a welded. The Paintbrush is the one in between.

MR. DEERE: Right. So the boring you're speaking of must have penetrated the Paintbrush and be down into the welded tuff; is that correct?

MR. WILSON: The principle is correct. The conclusion is not quite right because the boring, the air circulation is actually within the Tiva. There are sufficient differences because the Tiva is made up of -- well, all of these units are made up of several layers.

There's a sufficient difference in the fracture permeability within the Tiva that it is actually -- but you're right, there's sort of a confining layer above to serve the same purpose.

MR. DEERE: I only mention this because to many people it may be unique that you had it here, but it has happened in other areas.

MR. WILSON: Right. In fact, we started observing -- looking for this here based on the experience from other areas where we had heard about it.

Well, I've indicated some of the aspects of this flow system that we feel we need to understand and develop information about, and so we have, as you know, developed a site characterization plan that is relatively comprehensive, deals with both a broad surface-base program at the site scale and at a broad regional scale for hydrology and climate, tectonics. At the site scale we're looking at both the unsaturated zone and the saturated zone underneath it.

But in addition to the surface-base program, we have what's been -- we've been talking about today, the exploratory shaft program, and even there we have two components of that. One is the construction phase tests that are designed to obtain information in the shaft itself, and secondly we have what we call the in situ phase tests, which are at the main test level and are being done in drifts that are constructed for that purpose.

What I would like to do, then, is to

concentrate on the construction phase aspects because I think those are the ones that are influenced most by the shaft construction methodology, and so I would like to return to my outline, which one of the principal objectives of the scientific program, if you will, is to make observations and obtain samples.

And we feel because of these kinds of differences that I've described that it's important to make these observations and get samples throughout the entire section that's penetrated by the shaft. Resulting, we hope, in an understanding of the conditions and the processes and the relationships both above and below the repository horizon.

And we also want to have the flexibility -- we have a planned program to test in the exploratory shaft. We want to have the flexibility to be able to deal with contingencies or surprises that might come about as we -- as the shaft is constructed.

So I've listed here in the three major disciplines that we're concerned about, the geologic, hydrologic, and geochemical, many of the aspects that we're hoping to be able to test and observe and as part of that get samples. Most of them, I think, are fairly straightforward and obvious to you.

In the geologic the lithology, the contacts, here we emphasize the fracture characteristics, any faults that might be encountered, in situ stress conditions.

The hydrologic aspects are associated now with an unsaturated zone environment, talking about matrix and fracture hydraulic properties, the bulk hydraulic and pneumatic gas flow properties, air flow properties.

One thing we would like -- we feel we need to do is to determine what the effects of construction are on these properties. And I'll discuss those in more detail shortly.

There's the question of perched water, conceptual model you saw the potential there for the development of perched water. We would like to be able to determine if it's encountered the hydraulic properties and the chemistry of that perched water zone. And, of course, the chemistry of unsaturated water in both the fractures and the matrix pores.

In the geochemical arena, mineralogy of

fracture coatings is one of the tests that's been carried out. As well as a chloride and chlorine-36 sampling program for helping to date the water.

Now, I said that there were three

desirable features of a construction method that would help to meet these goals, these objectives of the scientific program. The first of these that I listed in the very first view graph is the access to the shaft during construction.

We feel that it's important to have direct access, have it be frequent, and be there quickly, because some of the things that we want to observe or measure are time dependent. For example, we want to evaluate possible presence of perched water, and we don't want to wait until it's either drained or its character has been changed or it's been masked by the construction -- continuing construction activities.

We expect to have a preview of whether or not perched water is likely to be there by drilling a multiple-purpose borehole ahead of the -- prior to start of shaft construction. In that borehole we will be doing tests and sampling and taking core, so that we'll have, we hope, a fairly good indication of what kinds of conditions to expect in the shaft itself.

MR. DEERE: Will that be a boring right in the shaft?

MR. WILSON: No, it will be adjoining,

nearby. We'll discuss that more shortly.

Obtaining rock samples is important, of course, for accomplishing the scientific objectives. One aspect of that is to obtain as we penetrate a new hydrogeologic unit. We plan to obtain a fairly large sweep of samples early on in that penetration and use the results of the tests that we'll do on those samples for matrix properties and water content to direct our sampling design, our sampling program for the rest of that unit, so we will hope to have a statistically-representative sample and we won't oversample or undersample as we go. So that would mean we would like to get the samples early in the penetration of each of these units.

Shaft wall mapping, of course, is an aspect that we'll be doing. We're using two -- plan to use two techniques. One will be a photogrammetric technique, where we'll be taking stereoscopic photographs of all the exposed walls of the shaft, and then we'll be doing a detailed line survey around the circumference of the shaft at two-meter intervals.

We feel it's -- it would be helpful to be able to map as we go so that we can see as things -- as the conditions are changing and also to help us determine the exact depths of the break-out zones.

There will be an upper demonstration break-out zone and then, of course, the main test level.

And the exact depths of those have not been established. We have a fairly good idea, but we would rather use the actual conditions as a basis for making that selection.

MR. DEERE: Will we have a chance to question a little later the shaft wall mapping or is this the appropriate place to ask a question?

MR. WILSON: Either time is fine. I hadn't planned to go into any more detail, so you may want to ask now.

MR. DEERE: Will this be like a statistical data that you'll be accumulating from that or will you be trying to connect what you see in the upper survey with the one that you get two meters down? In other words, to me mapping is better than line mapping.

MR. WILSON: Yes. Well, the photography will be used and will overlap the whole -- everything will be overlapped, so we'll have a continuous record from the photography. That will all be digitized and available in whatever detail and format that people would want to use it. The detailed line mapping around the circumference in mapping every feature that crosses that line that's 30 centimeters or longer that can be mapped, that's the extent of the detailed mapping of that wall. With a two-meter separation, probably we'll be able to connect the features that are observed.

MR. DEERE: But shouldn't they do it?

MR. WILSON: It would be nice.

MR. DEERE: To me one is a statistical study and it's good statistics and poor geology. But while the man is there and he has his point where it crosses the upper line and he has the same structure crossing the lower line, all he has to do is just put a pencil mark and he doesn't have to go to a photograph then.

MR. WILSON: Let me ask Mark McKeown, who is our mapper, to address that question.

Come on up here, Mark, it's hard to hear with this machine. Turn the machine off.

MR. McKEOWN: They will be connected together. The process consists of the photogrammetric phase, which is the photography, which then there's also the specific detail line survey data, which gives us some information that we can obtain photogrammetrically. But in the photogrammetric lab when we do the mapping from the photographs, the data we obtain from the detailed line surveys will be integrated into the maps, so you will see a continuity between the detail line survey.

MR. WILSON: I think what Don is asking is why don't you do that in the field while you're there.

MR. McKEOWN: The reason we're not doing it in the field while we're there, we're trying to optimize the time we spend mapping. We don't feel it's really necessary to draw it on a piece of paper in the field because we can do it in a much better environment in the laboratory and it will take less time away from the construction process. We don't see any real advantage to connecting the detail line surveys in the field. We feel we can do just as good a job in the lab.

MR. BLANCHARD: Haven't you done a prototype test out there in this kind of rock?

MR. McKEOWN: We've done some prototype testing in the drifts and we do have some test pits in the same formation, and our prototype testing indicates that we will be able to do this.

MR. BLANCHARD: When you go on your field trip we'll stop by the prototype test areas in that rock so you can take a look at it.

MR. DEERE: Because the alternative way is you put a thumbtack in at the point on the same structure and then you locate the thumbtack by any kind of method you want to, and that has got your structure tied down and your structure has a strike and a dip and a character and a fault, and you can't get that off a photograph.

MR. McKEOWN: That's right. That's why we're doing a detailed line survey. We can't get strike and dip off the photograph.

MR. DEERE: Every structure that goes across your line survey will be mapped with strike, dip, and (inaudible).

MR. McKEOWN: You bet.

(Thereupon a brief recess was
taken, after which the following
proceedings were had:)

MR. NORTH: Before you go further I've got a generic question I would like to pose. On the agenda here we have listed how are other methods and alternatives, particularly raise boring of the second shaft, considered? As you go through these various slides, I've thumbed ahead in your presentation, I would like to hear your response to that specific question.

MR. WILSON: Actually that specific question is dealt with by the engineering discussion that comes -- that follows mine, because what they do is take the requirements and the desires of the scientists and then deal with alternative ways of getting at that information.

MR. NORTH: What would help me as a nonspecialist in this area is a comparison in terms of desirability from these two methods or can you do that? Are you simply just saying these are desirable features and the rest of it will be picked up in subsequent presentations? In other words, how desirable do they turn out to be looking at one alternative versus the other?

MR. WILSON: I understand what you're saying. There's trade-offs and priorities. I think in Ken's -- you have a view graph which compares the various alternatives versus the objectives; is that correct?

MR. BEALL: I have a set of summary ones that make comparison.

MR. WILSON: If that doesn't do it for you, why, we'll try to get back to it. But I sense what you're saying.

Another reason for having direct access

to the shaft during construction is to be able to monitor the disturbance that is caused by the shaft construction, whatever that disturbance is.

And, of course, this is important because it could have potentially adverse effects on the site conditions themselves and that would affect our testing, affect performance. And there is expected to be a mechanical response of the rock mass regardless of the kind of construction method, but just by the presence of an opening, and we need to know that, what that effect is for both design and performance evaluations.

So I'll discuss these -- this disturbance component here in a few minutes.

The second desirable feature that I listed at the beginning was to minimize construction-related disturbance of site conditions. And what I have here really is an outline of the next few minutes of the talk.

I'm going to first discuss how hydrogeologic conditions might be affected, the potential effects, the response of the rock mass, what kinds of analyses have been done to assess the impact of these potential effects, and some conclusions that were drawn from those analyses. And then I'll discuss the disturbance of the geochemical conditions by fluids and materials being introduced to the system, what are the potential effects on the geochemical conditions, and some analyses and conclusions.

So turning now to the hydrogeologic conditions and the potential effects on these conditions.

There seem to be two principal ways in which the hydrogeologic conditions could be affected by shaft construction. One would be the introduction of fluids, and this is our most significant concern, because of the modification and the sensitive relationships that I showed you of the hydrologic conditions in the -- at the site.

Fluids would have -- could have the impact of increasing matrix saturation and thereby permeability. The introduction of fluids could result in the initiation or the enhancement of flow in fractures. It could modify the amount and distribution of flux in the rocks surrounding the shaft. And it could have the effect of biasing the results of our hydrologic tests if we're -- modify those conditions.

Examples would be the matrix properties

test, where we are trying to obtain samples to learn the in situ, ambient, saturation conditions, and moisture content and matrix potential. Another way it could bias the results would be to mask perched water bodies that might be naturally occurring but could be masked by this feature.

The second area of modification could be through the creation of new fractures or the modification of existing fractures. This would result in the change in the rock-mass permeability, could create preferential pathways for water and gas, and could bias the results of the shaft wall mapping.

So to evaluate these potential effects a whole host of analyses, calculations have been made, and what I'm going to do is hit a few of the highlights of these.

I've indicated in the next view graph and one a couple later some of the references that -- from which these results are taken. And you can use those references for more details if you wish.

In the normal, so-called normal drill

and blast method, as much as three cubic meters or about 800 gallons of water per meter of shaft depth could be used in the construction.

MR. DEERE: Excuse me, do you mean it

is permitted to use that?

MR. WILSON: No, that's not what's permitted, that's what --

MR. DEERE: Normal.

MR. WILSON: Normal means if they're to go about doing it in their normal drill and blast approach.

MR. DEERE: You're not permitting that, you're not happy with that?

MR. WILSON: We're not happy with that.

MR. DEERE: We agree. Good reason.

MR. WILSON: Eight hundred gallons to me seems like a lot of water for a meter of shaft depth extrusion. However, out of that 800 gallons, if that's the amount that would be used, only about 10 percent of it is retained in the rock. Most of it is recovered through mucking or ventilation or whatever.

There have been analyses made to evaluate what the modified permeability zone or MPZ would be surrounding the shaft wall. And it's thought -- it's expected that it would be about two to three meters beyond the shaft wall. This is where the principal changes in permeability would occur. And I'll discuss this in the next view graph in a minute.

By introducing this water -- this water, by the way, is used primarily for the drilling of the blast holes. It's used for some dust control. And would be used for some shaft wall cleaning for mapping purposes. Most of it, though, is in the drilling premises.

The calculations that have been made indicate that within this MPZ, modified permeability zone, the saturation of the matrix if averaged out would be increased by about three and a half percent. The ambient saturation in the Topopah Spring, that I indicated earlier, is about 65 percent now. Beyond ten meters the change in saturation is expected to be less than one percent.

Now, the expected change in rock-mass permeability was analyzed, and here we're dealing with the equivalent saturated permeability averaged over an annulus one radius wide around the shaft wall. Of course, this change is the combined effect of both blasting on the proposed scheme and the stress redistribution which occurs by the creation of an opening.

The increase in permeability averaged over this distance in the MPZ is about 20 to 80 times.

The blasting effects occur only within the first half meter to one meter, depending on some of the assumptions made. It was a very small -- using a controlled blasting technique. Beyond the permeability then decreases and beyond eight meters it's less than two times the ambient permeability.

So based on these analyses, some conclusions have been drawn.

Regarding the introduction of fluids, the project has always taken the stance that it is highly prudent to minimize the introduction of fluids, regardless of what the analyses show, and so the project intends to control and monitor all the fluids that are used, to minimize the amounts to the extent practical. In the drill and blast method there will be low heads imposed upon the fluids and tracers will be included in any fluids that are used, so that if they are encountered at some later testing period they can be identified and recognized.

As a result, then, of these kinds of controls, we do anticipate that the changes in the matrix saturation will be small and the water is expected to travel only short distances.

MR. CORDING: Is that controlled by means of -- how can -- in other words, how would you change the amounts to the drills? Is there ways that you will be able to do that? How much benefit can you gain, how much can you change that 800 --

MR. WILSON: From the, quote, normal?

MR. CORDING: From the, quote, normal.

MR. WILSON: Is there somebody who could address that question?

UNIDENTIFIED SPEAKER: I'll take a crack at it. John (inaudible).

I think the AE in their writing of our -- Los Alamos in the writing of our fluid control specifications and our controlled blasting specifications will prescribe controls that go far beyond the normal construction job, you know, as far as sinking goes. There will be limits on the amount of water used that can be metered. I think we'll just in general keep a closer watch on what the people in the shaft bottom do.

At this point I don't think we really know how much we can cut back on water usage, but whatever we do we still have to insure a safe working environment if it's --

MR. NORTH: Could you give us a ball park, is it a 10 percent cut or a 90 percent cut?

UNIDENTIFIED SPEAKER: Right now I

couldn't tell you. It's been a while since I looked into it. I worked on it once a couple of years ago, but lately I haven't been involved, but I'll have to check the AE.

MR. WILSON: We can find out?

UNIDENTIFIED SPEAKER: We can get the latest status. I may not be able to get you an answer, but we can find out on them.

MR. BLANCHARD: Bob. Bob Pritchett works with REECo, who is involved with these kind of things on a day-to-day basis. Can you add something to this?

MR. PRITCHETT: I don't think at this point I could add anything extremely definitive to answer your question. We would prefer to drill with fluids for the industrial hygiene --

MR. BLANCHARD: Can't hear you. You have to talk louder.

MR. PRITCHETT: For the industrial hygiene benefits that we obtain. Water needles in machines can be -- can be purchased with smaller or larger openings and we would have to determine optimum amounts of water to be able to flush that open. It's possible to use some air in lieu of water once you're wet down.

MR. NORTH: Is industrial hygiene a driving issue, keeping the amount of respirable particulates down to some safe level for the work force?

MR. PRITCHETT: It could become a driving issue, with the stringent controls on that sort of things these days. We would prefer not to have to work in a supplied-air environment for the workers. Generally not too conducive to --

MR. NORTH: Is that an issue that's been analyzed using the supplied-air environment, so that you might be able to go further in minimizing fluid use?

MR. PRITCHETT: I don't believe we have analyzed that, sir.

MR. BLANCHARD: Warner, we're in the process of preparing a control document, a document that describes how we're going to control those things that need to be controlled, like blasting, like chemicals, the introduction of chemicals, ending on water use. Right now in Section 8.4 of the SCP we have 100 analyses or evaluations that include some bounding calculations. And maybe, Joe, you might want to help me out, but some of the bounding calculations talk about -- make some very big assumptions about how much water can be used.

And I have not translated those big numbers like the Gauthier and Peters calculations to the numbers that Bill is using now, but there's one calculation in there which includes some assumptions like a lake forming on top of Yucca Mountain and then changing the hydraulic conductivity of the rock right beneath it by a factor of 10,000, draining the lake in two days, and then where would the water go and how fast would it travel.

And if my recollection is right, the water would go through the Tiva Canyon and get into the bedded tuff and because the bedded tuff has a very large capacity for absorbing water, it would not fill up the bedded tuff. So if you look at the lag time to change the flux paths in, say, the waste package of the repository rise in the Topopah Spring, you end up with a calculation that says a thousand years later you don't see any water down there but maybe 10,000 years later the flux changes by a factor of two.

Now, a lot of these are bounding calculations based on available data, but we have gone through an independent technical review on these calculations. We're waiting for more interaction.

And, of course, we're also waiting for more information from site characterization to determine whether or not the values that went into these calculations are meaningful.

I don't know if that answers your question, but there are more things coming --

MR. NORTH: Not completely clear to the question. I'm looking at the issue of how much water is used per meter of shaft depth. We had 800 gallons. I'm wondering if one is going to try to depart from normal drill and blast methods, how far can you depart and what are the issues that drive the extent of that departure. And it sounds like the occupational hygiene issue of respirable dust is one of those.

MR. BLANCHARD: Certainly is.

MR. NORTH: There's an alternative of using an outside air supply and trying to get a sense of what are those trade-offs and how have you dealt with them in evaluating this method compared to, for example, raise boring.

MR. BLANCHARD: We don't have the answer to that question yet.

Hemmie.

MR. KALIA: Hemmie Kalia.

Two components in prototype testing. In the tunnel that we are doing prototype testing we have drilled on normal up to 150-foot deep to see if we can do them dry. We have been able to do that. And the industrial hygiene concern in a health and business sense, come collect air quality samples during operations. And we have found them to be very clear air using the dust-control technology that we are using. So we can capture almost all the dust particles in the drilling process.

So I think -- the other thing that we will be doing is -- as a prototype testing program is the drill, revolutionize the drill that you're looking at. You have the dry drilling concepts there.

MR. NORTH: Now, here's a good test of is this reasonably available technology for vertical drilling?

MR. KALIA: Yes. The dust-control technology is standard, it's off-the-shelf units that have been adapted to -- so it's really not -- basically what we use. Normal in the mining industry.

But they are not used in this industry as we are using them. And it's -- you have no problems.

There is a report that is to be released pretty soon, it's going to final review, to

Los Alamos, describing the technology, describing the standard units that we've used.

MR. NORTH: Has this technique been investigated for the experimental shaft facility?

MR. KALIA: In what sense?

MR. NORTH: Has this been looked at? If you can do this kind of dry drilling and achieve the dust control that you need, could that be used as a potential technique as opposed to the normal or modified drill and blast procedures?

MR. KALIA: This is the prototype testings to try to get the information, allow us to determine if we can do that in a commercial or on a production water (inaudible).

MR. BLANCHARD: Hemmie, she's not able to pick up what you're saying. There's just enough speed of your delivery and the accent that she's not able to get it.

MR. KALIA: Are you able to pick up what I was saying?

MR. WILSON: I think, Hemmie, one of

the questions -- Hemmie, one of the questions we're getting at is can we translate what we've done in the G tunnel to the vertical drilling of blast holes in the exploratory shaft itself? Has that connection been made?

MR. KALIA: Yes, in our prototype testing program that is ongoing. The next test that we'll be conducting along those lines, excavation effects, blast effects, (inaudible) blasting type concepts, and also (inaudible) drilling to see if we can do.

MR. CORDING: In time to be used with the exploratory shaft?

MR. KALIA: That is correct. These are now ongoing and will be completed at the end of this fiscal year or early fiscal year next year. By February or March we should have most of the information available.

MR. SALTZMAN: Is it clear that the drilling you're talking about in G tunnel is exactly the same as the drilling you're going to use in the ESF?

MR. KALIA: For instrumentation holes it will be pretty much the same concept. We have several thousand feet of drilling that we'll be doing to install these new technical instruments. For drill and blast -- for drill and blast, for mining the drills, would be similar equipment.

MR. SALTZMAN: Is that the point you

were looking for?

MR. BLANCHARD: Yes.

And the other thing is on every question here we certainly don't have an answer, a final answer for, but that's the purpose of our prototype test program out in G tunnel, is to acquire knowledge and understanding empirically, run the tests we need, so that we convince ourselves that we can transfer our results in the prototype test program out there at G tunnel into the exploratory shaft.

MR. NORTH: Now, does G tunnel give you the same set of rock materials as you have going all the way down? In other words, a mixture from the welded tuff to unwelded tuff of the kind you expect to encounter?

MR. BLANCHARD: Pretty much.

MR. WILSON: Both types.

MR. BLANCHARD: There are both bedded and welded tuffs there. It's just in a different location.

MR. PRITCHETT: Max, may I add something that might be pertinent?

Hemmie, I believe the dust control procedures that are being developed at G tunnel we've had quite good success with. One hole at a time.

MR. KALIA: Two.

MR. PRITCHETT: Maybe two. Which is somewhat of a different situation than we would be experiencing in a large number of drill holes for blasting purposes in the bottom of the shaft, and it would present some different kinds of problems as to how to achieve that dust control in a large, large drill hole matrix environment.

I would like to think at this time, though, that it's promising that we could develop some ways to at least become somewhat effective in controlling that dust to minimize the water. But there are some -- just some purely technical difficulties of machinery that would have to be overcome and some space limitations that would have to be investigated for the equipment in the shaft.

MR. NORTH: Do you have a report laying out what these difficulties are and what the contingencies are, in other words, what you will have to do if the difficulties turn out to be too great for this dust control method?

MR. PRITCHETT: I think the thing that I'm concerned with most is -- and I don't have those kinds of statistics in my head for what the threshold values are for them, for the environmental conditions. There are threshold values that our industrial hygiene professionals have established for those things and I could obtain those, if you would like me, for you, if you would like. I don't have them memorized.

MR. STANLEY: I would like to offer an answer.

MR. WILSON: What is you name, please, so --

MR. STANLEY: I'm Bruce Stanley.

From an A&E standpoint, to answer your question, we believe that we could off the top of our heads cut out about 50 percent of that 800 gallons per meter that was put up there on the board. Now, that's just a ball park figure. Now, we could fine-tune that below a 50 percent mark.

We must remember that we not only have drilling fluids, but we also wet down the muck pile for dust control. Then 20 to 40 feet above that we introduce concrete into the shaft wall. There again you have added moisture right up against the virgin rock mass. If that helps at all.

MR. NORTH: Does this include this experimental technique being used in G tunnel?

MR. STANLEY: No. This is a strict
construction A&E estimate.

MR. NORTH: So presumably the method
being tried in G tunnel could do better than that.

MR. STANLEY: We haven't received any
information about that drilling as of yet. But we do
want to conform to what the requirements are on the
A&E design.

MR. ISAACS: Let me see if I can ask a
question that might help clarify things, if not for
Warner, for me, okay?

My understanding is that this
dry-drilling technique that's being evaluated here is
not for drilling the exploratory shaft, that we're
going to go forward with a drill and blast method --

MR. BLANCHARD: That's right.

MR. ISAACS: -- to try and minimize the
amounts of water while conducting the construction of
the exploratory shaft. More water could be worse.
So we want as little water as possible.

The technique this gentleman here just

talked about is a way of trying to minimize it as we go forward, in addition to which we have to drill a lot of other holes down there to put instrumentation in as we go to characterize the site. Those kinds of techniques, we believe, if this is successful in G tunnel, could be implemented in a way that the additional drilling that was required could be done dry, and, therefore, further minimize the amount of water into the site; is that correct?

MR. BLANCHARD: That's it. That's exactly it.

And the document that Warner is referring to plans to control, which would include the analysis, the adverse impacts, is something that we now have under preparation. We've got the bounding calculations, when I talk we have over a hundred bounding calculations that establish what the limits are, what the expectations are, what the potential adverse impacts are, how far either fractures or rock stresses or water will migrate out based on the calculations and using the data that is available.

MR. NORTH: I think it would be very useful for us to go through what those are. What you're giving us here is a whole bunch of problems we would like to minimize. We would like to get a sense of how far can you go.

MR. BLANCHARD: I think that's another meeting. Perfectly happy to go through that with you

all. But I think that's a little different topic.
We haven't prepared for that.

We have the information available on page four of the SCP and it goes through all of the evaluations on the bounding calculations standpoint.

MR. ISAACS: Why don't we annotate the appropriate section of 8.4 and make it available, and based upon your review of that, if you would like to have a follow-up discussion of that we'll provide it for you. How's that?

MR. BLANCHARD: Sure.

MR. ISAACS: I think we ought to offer that up.

MR. TILLERSON: Joe Tillerson.

With regard to the point that Bill was making there and in particular with regard to the idea that the 800 gallons and that about 90 percent of that would be estimated to be removed, the point to make with that if we follow on down with the numbers is if you look at within one shaft radius, you're talking about a -- if that water were put into and distributed over a one shaft radius out, you're talking about only -- without using any of the special controls, you're talking about a three and a half percent change in the saturants.

So it is a small number now with people working to make the changes and it is a one-time input, it's not a continuing hit for a long period of time.

MR. NORTH: Let me be very clear about my concern. My concern is not about what you were going to do ultimately to the performance of the repository by this engineering activity, and I sense that's the question you're answering.

MR. TILLERSON: That's the question I'm answering, you are correct.

MR. NORTH: My concern is with what you do to the sampling, where we're trying to learn about the rock and the hydrogeology, and we are changing some fairly fundamental parameters by our construction technique. You haven't talked about what the variability is in these changes. You've given us some numbers for the changes. But the variability you introduce is another source of error when we're going to use this information, for example, for the hydrogeology models. And that's the concern

I would like to have you address.

MR. TILLERSON: You're correct in that I was answering the question with regard to the overall impact of the site. The other one is related to --

MR. NORTH: I think a very major issue here is what is the implication of the choice of the shaft construction methods for the information you get in the site characterization process?

MR. BLANCHARD: We are concerned with that and I think the next presentations, Bill's and Ken's, will really address that.

MR. NORTH: Fine. I will await their presentations, then.

MR. BLANCHARD: Recognize that there's a lot about the site characterization program and the ESF construction that they haven't yet developed, which I think will go a long ways towards either providing you if not the answer, then a lot of information to make you feel more comfortable, okay?

MR. NORTH: Please excuse my impatience.

MR. WILSON: But let me address your impatience one more time.

The question of the impact of this moisture on samples that we would obtain is, indeed, a real concern of the hydrologists, and the project investigator who is in charge of the matrix properties testing program has told me that it may be that the samples that are obtained from the shaft itself may not be suitable for analyses of moisture content, saturation, and matrix potential, because of the potential for changes in these properties.

However, again, we are conducting -- these samples will be obtained, by the way, one of the ways they'll be obtained is by taking large rubble blocks from the shaft and from that taking a core and using that core, then, to analyze for matrix properties and also to obtain water samples.

MR. DEERE: Excuse me, you say rubble blocks. You mean a piece that has been blasted, broken up, and then stressed?

MR. WILSON: The question is -- we're talking about matrix properties. The question is: How big a block do we need to try to get as near ambient conditions as possible? This is where another prototype test is being conducted, to assess the size of block that we feel is appropriate and necessary to -- and it may be we can't -- maybe it won't be big enough. I mean that's a question that still remains to be answered. It may be that -- so, supposing we can't get those kind of samples from the exploratory shaft. We do have the MPBH nearby where we have obtained core that we hope and expect will be relatively, as far as those kinds of properties, relatively undisturbed.

MR. ISAACS: Explain what the MPBH is.

MR. BLANCHARD: You have a view graph, why don't you pop it up.

MR. SALTZMAN: About second or third from the end of your presentation.

MR. WILSON: MPHB stands for multipurpose borehole, obviously. It is a borehole that will be drilled, as I mentioned earlier, adjacent to the shaft site, I can't remember the exact distance. Does anybody know?

MR. BLANCHARD: We think it's 60 feet.

MR. WILSON: Sixty feet. And in that borehole -- it has several purposes. One is to look for the presence of perched water. So we'll know whether to be concerned about that during the construction of the shaft itself. That's really a contingency test, so to speak. We will be taking core from which we will be taking matrix hydrology properties and doing -- obtaining samples for hydrochemistry analysis, water samples.

MR. DEERE: Drilling with air.

MR. GERTZ: Drill dry.

MR. BLANCHARD: It's drill dry and it's drilled before the exploratory shaft construction starts, and there's one for each ES hole. So there's two MPBH's.

MR. WILSON: Then we'll have that hole available to us to monitor if there are, in fact, fluids that reach that far from whatever shaft construction method is used, we can log it for moisture content changes in the rocks surrounding the borehole itself. So it will serve as sort of a monitor hole as well as a pre-test hole right adjacent to the shaft site.

MR. NORTH: So that I understand some of the issues of my concern a little better, could you go through that list under exploratory shaft --

MR. WILSON: Yes.

MR. NORTH: -- and note which items are being compromised or degraded by either the blast effects or the fluid effects. For example, fracture mineralogy, is that what we're talking about?

MR. WILSON: Well, I'll just start at the top, work my way down.

THE REPORTER: Excuse me, may I change

my paper.

(Thereupon a brief recess was taken, after which the following proceedings were had:)

MR. WILSON: Well, I've discussed some of the conclusions that we drew concerning the introduction of fluids. And now I would like to look at the modification of fracture characteristics, which is the other type of effect on hydrogeology that we might anticipate.

And, here again, I would like to remind you what we talked about earlier about fractures in the unsaturated zone, that these are generally not preferential pathways for water unless the matrix is near saturation or the flux is very large.

MR. ALLEN: Is that an opinion or observation?

MR. NORTH: What does "generally" mean?

MR. WILSON: Creation or enlargement of a fracture in an unsaturated environment does not necessarily increase the likelihood of that fracture being a pathway, in fact, it may decrease the likelihood of it being a pathway. Because, remember, we talked about where the fractures were narrow. That is where the water crossed the fracture, where it's wide. The water is not likely to enter. In fact, you have a saturated fracture system and it drains, the large fractures are the ones that are going to empty first.

In fact, I think -- I made this statement because commonly we think in terms of saturated zone. That's what most hydrogeologists are experienced in and work from most of their careers. And we really have to think in different terms when we're talking about unsaturated conditions.

Nonetheless -- again, the prudency rule comes into bear here. We feel it's prudent to minimize the effects of blasting and we're going to use controlled blasting techniques as a result to minimize the extent and magnitude of the creation of new fractures or modification of existing fractures.

Now, we do have tests that are designed specifically to evaluate these effects. And I will -- those are some of the tests that are listed in that view graph we just showed and I'll get back to that.

I would like to comment, though, that some roughness of the shaft wall is desirable from a mapping standpoint. It allows the mapper to obtain a better perspective on the orientation of fractures, the surface of the fractures, the photography is more easily interpreted if there's some roughness on the shaft wall as a result of the construction.

And Mark assures me that the mappers are going to be able to distinguish between those fractures that are created by the shaft construction method and those that are natural in the shaft wall. And this is done based on the mineralization of the fracture surface, alteration, orientation, aperture size, a whole spectrum of criteria that could be applied to make this distinction.

We've discussed the hydrogeologic conditions that may be modified. Let's look at some of the geochemical concerns, the potential effects on a geochemical environment, primarily now by the introduction of fluids and materials.

An analysis, an inventory, a study was made of all the kinds of materials and fluids that are expected to be utilized during shaft construction. And those that were ascertained to be the most significant, potentially the most significant would be water, various solvents, and hydrocarbons that would be applied in the process -- in the construction process, the installation of a concrete shaft liner, which could have chemical effects on the adjoining natural waters, and there will be some gaseous products derived from the explosives in the drill and blast construction methodology.

Of course, we're concerned about altering the geochemical environment from a variety of standpoints. If it were significant enough and extensive enough, it could ultimately affect the waste package integrity. It could reduce the capability of tuff to retard transport of radionuclides. Fractures could be changed either by precipitation or solution to change the flow paths of water moving down through the system. And, again, it could bias the results of hydrochemistry and chlorine-36 tests. And the organics could support the development of microorganisms.

MR. DEERE: You just convinced me we shouldn't blast.

MR. WILSON: Let's look at the analyses and conclusions. Those are potential effects, I'll put the word "potential" in there.

MR. ALLEN: However.

MR. WILSON: Well, the conclusions that have been drawn from these analyses are shown here with regard to these fluids, that the amounts are small, the volume of rock affected is small, and the depth of penetration is likely to be small, be minimal, not to say that, nonetheless, it could be significant from the standpoint of the testing program.

The effect of a concrete shaft liner

from a geochemical standpoint was tested by using water from a nearby drill hole supply well, J-13, and evaluating when it becomes in contact with concrete what would be the chemical changes of that water. And you can see it would result -- it resulted in this test in an increase in pH and a change in some of the NA, et cetera, concentrations. Probably the formation of precipitates. But the effects -- it was concluded in this study that the effects are expected to be quite localized near the shaft liner itself.

MR. DEERE: Increased pH, does that mean more or less?

MR. WILSON: More basic.

MR. DEERE: More basic, yes.

MR. WILSON: Microorganisms, there's no known detrimental aspect of those at this time, at any rate, that I'm aware of.

The gaseous products from explosives was a concern, and so analyses were made and it's expected that there will be small amounts of these gasses that will be produced by the explosives. It's expected that most of these will be ventilated to the surface, however, some may penetrate from one to two meters into the fractured rock, and because of the concern about the chlorine-36 test, chloride will not be used in the explosive and not, therefore, be a by-product.

Now, I've talked about the hydrochemistry samples and the ability to obtain ambient conditions. And I talked about obtaining interior cores from the large block samples and our testing to evaluate whether we can, indeed, obtain meaningful and reliable samples. We'll also be obtaining cores from the radial boreholes, and I'll talk about that when I talk about the various tests in the exploratory shaft. And we'll be making analyses of tracers in any water samples we do obtain in order to be able to detect whether or not the samples have been contaminated by introduced fluids.

MR. GERTZ: Bill, the radial boreholes are those that we are experimenting with in G tunnel for prototype testing that Hemmie was talking about, that kind of equipment.

MR. WILSON: That kind, yeah. And I'll discuss those.

MR. GERTZ: Drill dry.

MR. WILSON: Drill dry. So hopefully obtaining good samples.

I have talked about the first two desirable features of a shaft construction method.

Those were the direct access and the minimal disturbance. And now this is the third, the ability to monitor what disturbances do occur.

We feel this is an important feature because we want to or need to verify the models that have been used to predict the affects of construction and be able to check our predictions then.

In the whole spectrum of exploratory shaft hydrologic tests that will be conducted at the main test level as well as at the shaft, we need to be able to account for these disturbances. First of all, know if they exist, and second of all, their magnitude and their extent so that when we analyze the results we'll have this information available to us.

In order to be able to do this, we need to have both pre- and post-construction data, so that we know what the conditions were prior to and following the construction of the shaft. And so we do have a whole series of construction phase tests that are designed explicitly to monitor these kinds of changes. In the rock-mass properties this is needed for both design and performance analyses and we need to assess the impact on the exploratory shaft testing program.

So what I have shown in this diagram and we can use it now for both -- for more than one purpose, I've listed here all the tests, the names of the tests that have been designed to be conducted within the exploratory shaft itself and at an upper demonstration break-out room and at the main test level near the base of the shaft.

And I have specifically indicated with an asterisk those tests that are monitoring -- tests intended to monitor the effects of shaft construction. So I'll go through those first and then we can look at the other tests and I'll address the question.

Geologic mapping in a sense is a monitoring test because we will be distinguishing between the natural fractures and the -- those created by the shaft construction. There are shaft convergence tests that are to be conducted at three stations along the shaft itself with extensometers to monitor the change in rock-mass properties and the change in shaft diameter.

There will be evaluations of mining

methods. This is sort of a monitoring of the mining method and what rubble size is being produced and if it meets the requirements of the scientists for obtaining their core samples. The blasting affects in general will be included under that particular test.

We've mentioned the radial borehole tests, and the next view graph, when I get to it, I'll explain a little bit more about those tests, as well as the excavation effects, but these are intended to monitor changes in hydrologic and rock-mass properties as the shaft is deepened. So they are -- these boreholes that are associated with these two tests are drilled and then the shaft is continued.

And there are "over-core" stress measurements being made both in the upper demonstration room and in association with the shaft emergence tests.

Now, what was your question?

MR. NORTH: Basically what I want to go through, and mainly -- maybe the radial borehole tests would address a lot of it.

MR. WILSON: Okay.

MR. NORTH: Is what information are you

losing through the blasting and the influence of the fluids as you go down in this experimental shaft facility?

Now, you've told us about what the

fluids and the explosives do, and from the point of view of the needs for site characterization, what are you losing by normal drill and blast procedures with your minimization put in, compared to another way of doing it, such as the raise boring?

MR. WILSON: And as part of the answer to that, you really -- it would be helpful to have a perspective of the overall site characterization program, because this is only one small part. So loss here may not jeopardize the whole program, obviously.

MR. NORTH: I agree, but those are issues we need to look at.

MR. WILSON: Yes, I agree.

Let's go through them.

The geologic mapping, we will be able to distinguish between fractures created and fractures natural, so we do not --

MR. NORTH: How well can we do that? What's the error rate? What's the error on that mark? Is that virtually no problem or nobody knows?

MR. DEERE: Nobody knows.

UNIDENTIFIED SPEAKER: You can do a pretty effective job of telling the difference between natural and induced fractures. You know, you're not 100 percent sure, but --

MR. DEERE: There must be a distribution where 50 percent of those that are there are fairly easy to see, another 25 percent that you're really not quite sure of, another 25 percent you never even question because you don't know.

UNIDENTIFIED SPEAKER: I don't think it's quite that bad. I expect it would be like 90 percent that you're sure, maybe five percent wishy-washy, you just can't figure out. There are several criteria you can use to decide, and, you know, it's easy -- or difficult to stand here and explain it. But if you see the relationships in the field of the natural and the man-induced fractures and all the criteria used, you better understand why you can tell a difference.

MR. NORTH: I think this is an area where we would like to have data and data on this kind of rock.

UNIDENTIFIED SPEAKER: Okay. We do have test beds that we have done some work in and that's why I am speaking with some confidence that --

MR. DEERE: Well, if you have a fracture that's partially opened and it gets opened a little bit more, you can't tell?

UNIDENTIFIED SPEAKER: Aperture is the one thing that's going to change, okay, but whether it's man-induced or a natural fracture, you can tell. Whether it's been disturbed or not, then that is one of the things that is tough to tell.

MR. DEERE: Right. So your mapping doesn't help you a bit in that case.

UNIDENTIFIED SPEAKER: It still gives you whether they're there or not, the continuity, the mineralogy, those factors. The aperture, I agree, is something that's up in the air, it's difficult to tell. But there are other ways to relate the aperture you see in the wall to the natural aperture, some of these other boreholes.

MR. ISAACS: Is this something that is conducive to being seen on the site tour?

MR. GERTZ: Oh, yeah, Max.

MR. BLANCHARD: I'm sorry, I didn't hear.

MR. ISAACS: The issue of how easy it is to distinguish between naturally-occurring and induced fractures, is this something that is conducive of being seen or demonstrated as part of the site tour that will be in June?

UNIDENTIFIED SPEAKER: It will be a lot

easier to be explained.

MR. BLANCHARD: Sure. The natural fractures have been conducting water for millions of years, they've got deposits.

MR. DEERE: All you've got to do is go into a tunnel-bored shaft and look one meter in the area that's been tunnel-bored and one meter beyond and you think you're in two different worlds.

UNIDENTIFIED SPEAKER: That's exactly right.

MR. DEERE: Or in a raise bored versus one that has been blasted. I mean they are that much different. There are so many fractures that are showing up that you're going to be mapping and over here those fractures are incipient, healed, or very tight, and they don't -- they don't map as an open fracture. And their conductivity, their effect on compressibility, their effect on sheer strength is obviously much different in your assessment if you see it in one condition versus the other.

MR. BLANCHARD: I'm sure you're right.

That's why we have a whole bunch of radial borehole tests that's on the next slide that Bill is going to talk to.

MR. DEERE: We would like to give you a

six-foot diameter radial borehole that goes a thousand foot and let you see how that is. It is great. Then you can go see the actual fractures there.

UNIDENTIFIED SPEAKER: I've seen holes.

MR. DEERE: Yes, yes, very helpful.

MR. WILSON: Now, fracture mineralogy studies, these are geochemical analyses of the fracture line -- fracture coatings, probably not substantially modified by the construction.

Seismic tomography will be used to get some indication of the rock -- the fracture density in a rock mass between sections. Let's see, is this to be done -- I'm trying to remember, Tom, between boreholes, between the MPBH and the shaft or at different depths within the shaft? Seismic tomography.

MR. MERSON: This is Tom Merson, Los Alamos.

There's a network of holes both in the ES-1 and in the ES-2 that will be correlated with a network of shots on the surface, on a surface ray, and those sensors will be located every 30 feet down the exploratory shaft and in an array in the drifts themselves.

Does that answer the question?

MR. WILSON: Does the shaft construction method impact the ability to get that kind of --

MR. MERSON: No, no. It is only a tomography to try to relate the geophysics of the strata, seismic.

MR. WILSON: Shaft convergence is a test designed specifically to evaluate the effects of the shaft construction, same with this.

Matrix hydrologic properties probably is the one area that could be most significantly affected by the shaft construction.

MR. DEERE: I'm not sure how the shaft convergence can help you evaluate the properties or distinguish between a disturbed and an undisturbed material. Anyway, our purpose is not to discuss the test procedures, because that's a whole subject in its own, but we would like to do that when we can do it at a later date. So --

MR. WILSON: Okay. The question of

whether we can get ambient matrix properties using this shaft construction still has not been answered.

The radial boreholes tests and the excavation effects test I'll discuss in a minute.

The perched water test, the contingency for that is, for example, this the plan is to sample and if appropriate to do hydraulic testing of any perched water body. I don't think that would be compromised ostensibly by this shaft construction method.

MR. DEERE: What if water leaks down a few feet and gets ponded on a more impermeable zone?

MR. WILSON: We'll be able to identify that because of the tracer.

MR. DEERE: What if it's there and the tracer dropped down there? You don't know what the concentration of the tracer is going to be, do you?

MR. WILSON: I see, if there's a natural fresh water zone there already?

MR. DEERE: Yes.

MR. WILSON: Knowing the concentration of the tracer in the water, they can back that out, I believe, but I'm not sure.

The hydrochemistry test, again, getting good water samples from both the matrix and the fractures, may be compromised to some extent. These two tests, which basically is an extension of the hydrochemistry test, we're taking steps to eliminate the chloride from the explosive, so there probably isn't a significant effect there.

I'm giving off-the-top-of-my-head answers. The PI's probably have a better feel for the details of these, and we can discuss those at some other time.

So those are the ones associated with exploratory shaft.

We mentioned the radial borehole tests and the excavation effects test. This is an early schematic, there have been some modifications since this particular diagram was made, but the principles are the same.

The idea is to drill radially from the shaft generally two boreholes at specified levels, at right angles to each other, depending on the directions of principal and minimal stress, and do this drilling at the time that the shaft has reached the depth where that drilling can be conducted.

These will be -- a variety of tests will be made with these boreholes. They'll be nitrogen injection tests, there will be instrumentation, monitoring of conditions. There will be ultimately borehole-to-borehole tests, but that come long after the shaft is completed.

One of the ideas is to put a borehole

above and below, and they should be above and below the contact to be interborehole testing, to determine the effects of the contact on flow of moisture, downward flow of moisture. So that this contact will be tested, this contact will be tested. There are also a couple within the Topopah Spring unit. The idea is to drill these holes and then monitor as the shaft is deepened until we no longer observe any changes within the borehole itself.

There is a whole 'nother set of longer radial boreholes now that will also be drilled out toward the multiple-purpose borehole, the vertical multiple-purpose boreholes. Those boreholes will be tested in conjunction with that MPBH to monitor changes caused by the shaft and the permeability in the vicinity of the MPBH.

These boreholes here are part of the excavation effects test, and there are only three shown but there's a whole series of boreholes that will be drilled at the point when the shaft is at this depth, and then these will be monitored as the shaft construction continues in order to evaluate the impacts of the shaft construction on permeability.

So, again, we're trying to obtain information about the effects of the shaft construction and the effects of contacts and drill out far enough, I think these are 30 feet -- 30 feet, which we expect would be into the ambient conditions of the rock.

MR. DEERE: Excuse me. Will there be tests gradedly at different areas out from the hole?

MR. WILSON: Right. There will be packer tests so you'll be able to see the changes as we move outward.

MR. GERTZ: Are you taking core from those holes too, Bill?

MR. WILSON: Core for property sampling and water sampling.

Well, to summarize here and set the stage for further discussion, I suppose, that the scientific considerations, the requirements or the desires of the scientific community in this project have exerted an influence on the selection of shaft construction method at Yucca Mountain. Part of those needs of the scientists are determined by the unsaturated zone setting that we are dealing with at this site. These requirements include to make hydrogeologic and geochemical observations, obtain reliable samples, and have access, minimize the disturbances from fluid losses and rock damage, monitor disturbances so that we can determine the effects on characterization and performance, and mechanical response. So this sort of summarizes the needs from the scientific standpoint.

Ken Beall, when he gives his presentation, will then discuss how those needs have been dealt with by the engineering group in designing and developing a shaft construction methodology.

MR. DEERE: Thank you, Bill. That's been very enlightening. However, it seems to me that more than half your discussion and half of the information you presented is how to mitigate the damage that we have done by blasting a shaft. And I just can't think that that's the engineering and the scientific answer that we should be coming to, that the scientific considerations exerted a major influence on selection of the shaft construction method. It seems to me like it was the opposite.

MR. WILSON: Let Ken describe the decision process we went through into selecting that method and then we can see if that was, in fact, the case.

MR. DEERE: We're premature, I know, yes.

MR. ALLEN: Premature to make that

first statement.

MR. DEERE: That one you mean or mine?

MR. ALLEN: That one.

MR. WILSON: Perhaps.

MR. DEERE: I will admit mine is premature.

MR. BLANCHARD: Just a minute. Before we break there's two things I would like to point out.

The first is in our site characterization plan there was some questions about climate and I think, Clarence, you asked them. Here is some xerox pages from it. If that's not enough we have a whole chapter on climate and some more tables and some more graphs. So if you want to take a look at that, it's here.

MR. ALLEN: I'm just curious.

MR. BLANCHARD: We have some people who are willing to talk with you about that. As you see, the precipitation changes by month, but total precipitation doesn't seem to change very much, it's just the monthly "annual" that changes from one to three inches.

Now, what we were -- we had asked Bill to present in a technical vein what the constraints were that scientists were placing on the engineers for construction method. I presented what I thought the regulatory constraints were. We tried to keep Bill and myself away from discussions about the engineering aspects.

Before Ken talks about this, I suggest that we take our 2:30 break so we get a chance to have a drink and go to the bathroom.

MR. DEERE: May I have 30 seconds first?

MR. BLANCHARD: Sure.

MR. DEERE: Bill, I think it was my last statement to you, isn't it true that a great deal of your effort is how to overcome the disturbance factors that you viewed? I mean every time you want to get a hydrogeologic sample or make an observation, you have to determine the amount of disturbance due to the introduction of fluids or due to the blasting, and this is what goes with this shaft construction method. And you have to factor those out. And the very best way you can, and obviously in an imperfect way, again.

MR. WILSON: Right.

MR. DEERE: So there are just a few scientific things that you want to do with any method we come up with.

First of all, you want to minimize

disturbances. We have methods to do that. Now, what's the other thing that you really want? You want to get the hydrogeologic characteristics, you want to get the perched water tables in an uncontaminated condition. You want to get access to maps.

MR. WILSON: And you want to monitor whatever changes do occur.

MR. DEERE: Why? So that you can make corrections.

MR. WILSON: By virtue of putting a hole in the ground, no matter how you put it there, you're going to have changes.

MR. DEERE: Exactly, but ones that we can live with or ones that are more difficult to live with?

MR. WILSON: But you need to know what they are and how big they are.

MR. DEERE: Yes.

MR. WILSON: So we can apply an understanding to performance and our testing program, so on. It doesn't matter what construction method is used, there's a hole.

MR. DEERE: If you want a 10 percent correction or a 90 percent correction. Maybe that's -- I mean it's only that. There is a disturbance. But we don't have to introduce water. We don't have to introduce nitrogen with the blast-driven mechanism. There are several things that would seem to me from a scientific point of view you would be better off if the information you want can be obtained.

MR. WILSON: I have no idea of that.

MR. DEERE: I don't think any of us, what we've read and what we have heard, disagree with any requirement that you have for your scientific, it's absolutely not, no objection.

MR. WILSON: If we were living in an ideal world we would eliminate all disturbance, we would eliminate all fluids going into the hole, into the shaft, we would eliminate any kind of blast effects, that's true. If we could do that and get the kind of information we need, let's do it.

MR. DEERE: That's our other question.

MR. BLANCHARD: So we have two, a double approach, any good scientists would take the empirical and modeling approach. Our empirical approach is to put the MPBH's 60 feet away approximately, away from each shaft before shaft construction, make tests and measurements. And then on an as-you-construct basis make observations, take samples and build radial boreholes, do tests that way. The modeling approach is in 8.4 of the SCP, which is hundreds of evaluations and calculations about how large an effect it will have and how far out it will go.

As Bill mentioned, the expectation is that the amount of water that can be driven out into the rock formation without any head on it is a curve like that. When you go out ten meters there's practically none. That's what the expectation is. Whether or not we find that in the real world with radial boreholes, we'll have to wait and find out.

That's also -- we have similar calculations about the blasting effects. They're only a few meters away too. Whether or not in the real world actually turns out to be the case is the proof of the pudding, actually running tests.

I've had somebody, Scott back here, arm waving at me quite a bit. Do you have just a moment before we break, Scott?

MR. SINNICK: Very quickly, the purpose for monitoring disturbance is not just so we can correct the values back for the in situ conditions, but it's also a controlled experiment that could help us understand the behavior of the rock mass. That was one of the reasons for monitoring the disturbance, is to help understand how the rock mass responds to an increased perturbation, what the repository itself is going to be. So the only purpose of those is not just to correct back and make sense out of the properties that have been disturbed.

MR. BLANCHARD: Why don't we break for, say, about ten minutes.

(Thereupon a brief recess was taken, after which the following proceedings were had:)

MR. BLANCHARD: Our next speaker is Ken Beall. It's all yours, Ken.

MR. BEALL: I guess one of the advantages or disadvantages of being the last speaker, sort of, is that you get to solve everybody else's problems.

MR. CORDING: We're waiting for you.

MR. BEALL: I'm sure we will have some

discussions during this. I will try to listen as closely as possible and will try to respond to a lot of your concerns.

First of all, you've heard this before

and I would like to say it one more time, and that is that the exploratory shaft facility is basically there to provide a facility to characterize the site, all right?

And my presentation here is organized in this manner. First I want to give you a quick overview of the exploratory shaft facility. I know some of you are familiar with it, but just to refresh a few terms. I want to go into the construction method selection criteria and then briefly go into the shaft construction methods.

Some of the view graphs I have are relatively simplistic. For those of you who are very familiar with these techniques, bear with me. I want to be sure that everybody here understands the various methods.

MR. ALLEN: Thank you.

MR. BEALL: Pardon?

MR. ALLEN: I say thank you.

MR. BEALL: You're welcome.

Go into a comparison of the

construction methods versus the criteria. And then a very brief conclusion. I know some of you have already peaked, okay?

This is the exploratory shaft facility

that is consistent with our type one design, which is our preliminary design. This is ES-1, which is our science and testing shaft. This is ES-2, which is our men and materials shaft. On the surface here we have our head cranes, ropes coming down into the hoist house where our hoists are at. These are the rest of the surface facilities to support the operation. And this is our main test level down in this area here. This is a drift that goes out here to one of the potential fault features, and likewise this is an exploratory drift that goes out to investigate other fault features. This is the upper demonstration break-out room that you've heard people refer to.

As far as some of the particulars associated with the shafts themselves, I had mentioned ES-1 is our science and testing shaft. ES-2 is the men and materials shaft. That is the shaft that we would use to hoist all of the excavated rock from the underground to the surface. Both shafts have a finished inside diameter of 12 feet.

The upper demonstration break-out room is approximately 600 feet below the surface. The main test level is approximately 1,055 feet below the surface. The shaft depths are as indicated.

In addition, ES-1, the design has the flexibility of where we can deepen that shaft down to the Calico Hills if the site characterization program determines that that's necessary.

You've heard some of these figures also. In reference to the main test level we have approximately 4,400 feet of test drift identified. The exploratory drifts out to the faults is another 5,000 feet. Our test rooms or our room sizes down there will vary from about 14 by 14 to 27 by 19 feet. We will excavate somewhere in the neighborhood of 160,000 tons of rock.

When one starts to establish the criteria on this project for selecting a construction method, you can very easily group it into the five categories that I've got shown here. What I want to do in the next few slides is to, first of all, identify criteria that discriminates between one shaft construction method and another, and then go through that criteria and briefly review some of the impacts and what have you.

If you take those five previous areas that I had shown and you go through those -- and when we get done with this process I hope you'll have an appreciation for how these came up, all right, but these are the criteria and the subcriteria that really discriminate from one construction method to another. The other areas that I will also briefly go into are other important criteria that we have to comply with but they really don't differentiate as much as these do to construction methods.

Starting into the site characterization area, with reference to rock observations, here the construction method must support comprehensive evaluation of the rock characteristics along the shaft wall. One of the primary features that Bill had indicated earlier was to investigate the fractures and faults. We will be looking at the apertures there. If there's any infilling we hope there has not been a lot of deterioration there to where there's been anything washed out or mechanical disturbance, all right? We will also want to look at the mechanical response of the fractures of the faults that we might encounter.

Relative to us proceeding with the excavation those are going to be time-dependent effects. We may want to take bulk sampling of those features. We may want to install instruments across them to, again, measure the response. And these are all time-dependent types of measurements that they'll be taking.

Looking at the hydrologic observations, again the shaft construction method must support a comprehensive investigation of the hydrologic characteristics along the shaft wall. One of the things that we will be looking for is perched water. We want to be able to detect that as soon as possible and also take samples as encountered.

In reference to the faults and the fractures, if there's any water that's coming out of those, we want to characterize that water. In addition, you heard Bill talk about establishing a saturation profile as we go down the shaft. We'll be doing that. We want to obtain as near ambient conditions as possible. We'll be doing that by taking large block samples from the face.

MR. DEERE: Will these be undisturbed samples that will be cut off or pieces off the muck pile that Bill mentioned?

MR. BEALL: I think there is --

MR. STANLEY: They're supposed to be

pieces of the broken muck from the bottom of the shaft, a minimum of one-foot size in diameter.

MR. DOBSON: We will take those samples but there are both as well, depending on the particular scientific activity, there are a few that require samples from the wall.

MR. BEALL: When we look at access to multiple horizons, again the construction method must support testing at various levels in the shaft during construction. This is not only for the predefined tests that we know of today, but also to characterize those unexpected conditions that we really won't know about until we encounter them.

Sample collection is another criteria where the construction method must support during construction comprehensive collection of the rock and water samples. We want to do this as soon as practicable after the excavation. We want to limit saturation changes. And one of the things that we also need to do is to obtain uncontaminated samples of the water that potentially we find during the shaft construction.

Here is a very popular subject, rock damage. Again, the construction method must limit impacts to the site, this is relative to the actual ambient conditions that are there. And also we want to limit those impacts on our ability to correctly characterize the site and also to limit any impacts on the performance of the repository.

Fluid losses, another criteria in the site characterization area. Here again the construction method must limit the impacts to the site. This includes fluid infiltration on the site ambient conditions. Again, it can impact our ability to correctly characterize the site. And it could also impact the performance of the repository.

Going back to the original outline of the discriminating criteria, I want to now go into the constructibility area. And in the context I'll be discussing constructibility really refers that when we construct the shafts we wouldn't be doing anything that would preclude their use in the final repository, if the site is determined to be acceptable.

The first area here is water and ground control. Here again the construction method must allow immediate access for controlling the results of the excavation process. This includes the control of groundwater inflow, the installation of ground support. And in installing that ground support we hope to be able to keep any overbreak to acceptable limits.

MR. DEERE: What is the control of the groundwater inflow? What is the intent, I mean?

MR. BEALL: The intent there. First of all, we want to be able to measure how much is coming in. They want to be able to measure or obtain uncontaminated samples of that. And then they will want to control where that water is going. And so rather than let it just continue to run down the shaft, we could install pumps, get it to the surface, what have you.

MR. DEERE: Not talking about grouting at all?

MR. BEALL: No. In fact, our design criteria does not allow us right now to use grouting.

Yes, Scott.

Scott Sinnick with Sandia.

MR. SINNICK: Scott Sinnick with Sandia.

That's a contingency, not necessarily expected, that we'll have any water --

MR. DEERE: Okay.

MR. SINNICK: -- coming into this facility.

MR. BEALL: The next area in

constructibility is unexpected conditions. Again, the construction method must be responsive to the unexpected geologic and hydrologic conditions that we encounter. We need to be able to identify those conditions quickly, we need to evaluate those conditions, take corrective and mitigating action prior to proceeding with the construction operation. Also like to point out that the NRC requires that we thoroughly characterize any unexpected conditions.

Overbreak. This is the ability of a construction method to minimize the excavation enlargement beyond the intended diameter. This can result when we could have inadequate control of the drilling and blasting or if we encounter fractured rock that is not supported properly.

Going back to the outline for the discriminating criteria, I'm down to the schedule aspects there. The particular criteria here is the construction time. When we look at the raise boring of the ES-2 option, the overall construction schedule is longer. Let me explain that and also when I go into the construction methods I think it will help some of you understand it, but I'll verbally describe it to you here.

Given you can raise bore a shaft you

have to have another shaft that is completed and you have the capability of hoisting mining rock out of that shaft, all right? You have to be able to mine over, intercept your pilot hole, assemble your drill bit, and then pull that drill bit up to the surface, as the cuttings fall down be able to transport those cuttings over to the other shaft, hoist them to the surface, all right?

Right now with our current construction methods we are basically concurrently sinking both shafts. Because of all the testing that is being done in the ES-1 shaft, the ES-2 shaft, all right, is down to main test level, completely outfitted, and, in fact, we are doing excavation over toward the other shaft, all right?

And so when you look at the raise boring option, all of those operations I described as far as mining over, pulling the raise bore up, putting liner in, outfitting the shaft, what have you, adds to the overall schedule.

MR. NORTH: How much?

MR. BEALL: Do you have a feel for that, Bruce?

MR. STANLEY: What was the question?

MR. NORTH: How much time does it add?

MR. BEALL: To the overall schedule.

I have a feel, I can't give you a precise number, but we're probably talking somewhere in the neighborhood of four to five months, something like that.

MR. STANLEY: I was going to say in the neighborhood of around nine months.

MR. DEERE: I would say about two or three months in the opposite direction.

(Laughter)

MR. BEALL: I need to talk to you some more.

MR. ALLEN: Pardon me. What is the total length of time envisioned here?

MR. BEALL: Right now?

MR. ALLEN: Yeah.

MR. BEALL: Okay. Correct me if I'm wrong here, if my memory serves me appropriately, right now ES-1 will take us approximately 24 months to construct. Out of that 24 months, approximately four months is actual construction sinking time, the rest of that time is strictly associated with all of the science work that's going on in the shaft, the installation of instruments, the calibration of them, and so forth, okay? So in the first shaft there's a significant amount of time that's being spent on the characterization part of the program.

MR. SALTZMAN: And that time is in full. It's not first four months and then 20 months.

MR. BEALL: No. I've got a view graph here that I'll show you. I think it will put it in perspective.

Go back to the five initial criteria I had, all right, I covered site characterization, constructibility, and then the scheduling aspects, all right? These are the things that really fall into the nondiscriminate category, all very important, though, things that we have to meet and comply with. Let me just go briefly through them so that you get an idea of the kinds of things that we're looking at.

As far as shaft goes, with the shaft diameters that we're looking at right now, probably any of the construction methods that I'll talk about can meet the needs that we have. If we have to start to increase the diameters very much, the raise boring options and the blind drilling options could potentially be a problem for us, because of shaft plumbness.

From an experience standpoint we believe that there are contractors and experienced personnel available for any of the construction methods that we would want to use or could use on the project. However, under a different set of economic conditions where the mining industry was probably in better shape, the oil patch was in better shape, we might be competing for some of that talent.

Health and safety. Again another area that's receiving major emphasis on the project. However, we believe that we can provide a health-safe environment with any of the construction methods that we have considered.

Environmental, again, another very important area to the project and to a lot of the state and federal organizations. We feel that we can again with any of the construction methods from an environmental standpoint do a very good job with that.

This view graph, these are the test locations in the ES-1 and ES-2. The SRBT, those are the short radial borehole tests, there are seven of those that are identified now throughout the shaft here. The LRBT's, the long radial borehole tests, I believe there are six of those identified. The SCT, those are the shaft convergence tests, there are three of those.

This is the upper demonstration

break-out room here. This is the MPBH that you have heard about. There's one for each ESF shaft. And the MPBH in this area was just removed for clarity.

Currently we have identified 20

locations in the ES-1 shaft where we have to provide a landing and access to the scientists to go in and install their tests and determine the locations, drill the holes, put the instruments in, calibrate, and what have you.

In addition, we have in the schedule allocated three hours for every two meters of shaft depth just for the mapping part of it.

When you look at the short/long radial borehole tests here and shaft convergence tests, this is where we actually shut the construction shaft sinking operation down for two weeks while they go in and install those tests and calibrate the instruments and what have you.

And then if we encounter perched water we will stop the construction of the shaft for an indefinite period of time while that is completely and totally characterized, documented, before we proceed.

You may wonder with the MPBH there, you know, why we wouldn't know that we have a perched water table, all right? We very well may find that. But also the MPBH is relatively small compared to the shaft. At that particular location it may not have penetrated the first water zone, all right, or the inflows could be so small that in that size of a hole we wouldn't be able to detect it.

Going back to my original outline, and I would like to just briefly go through the five construction methods and so that you get a good appreciation of those.

MR. ALLEN: Incidentally, on the perched water test, do we know from the holes that have been drilled thus far that there are perched water pockets or are we just --

MR. BEALL: My answer would be no, and I'm sure there are people back here who can address that in more detail.

MR. BLANCHARD: Bill, you've been involved in drilling many holes out at Yucca Mountain, both unsaturated zone and you've looked at the core holes. Why don't you tell us what your experience has been.

MR. WILSON: We have encountered in one unsaturated zone borehole we are stopped by the (inaudible) of water. This water when it was sampled -- above the water table. This water when it was sampled was determined to have some of the organics from a nearby drilling hole drilled with fluids. So we don't know if it was entirely perched water -- natural perched water or it was induced by this nearby drilling. Other than that, we're not aware of any other examples of perched water.

We have other borehole testing designed on either side of Ghost Dance Fault which we'll be looking at a site that we think is potentially favorable from perched water --

MR. ISAACS: Do we expect perched water?

MR. WILSON: It's one of the conceptual models. We don't expect it.

MR. CORDING: In very low permeability, it's evaporating at the wall, you can't see it, in other words, visual it.

MR. WILSON: You mean in a drill hole or shaft or either one, I guess? It's possible there will be minor seeps like that that we'll hope to be able to detect at the shaft, but we might not. I don't know if we would be able to see them in the drill hole or not. The drill holes are all drilled dry, so any moisture that's encountered is observed. But its extent and nature may be difficult.

MR. DEERE: But I think perched water has been hit at the Test Site --

MR. WILSON: Oh, yes.

MR. DEERE: -- in driving some of the

drifts. I recall crossing this incline where we had water flowing down this inclinal axis and causing a lot of swelling in the end of our tunnel floor.

UNIDENTIFIED SPEAKER: And T tunnel also.

MR. DEERE: Dripping water there, yes. So it's something that could occur.

MR. WILSON: Um-hmm.

MR. BEALL: Scott, did you have something?

MR. SINNICK: I was asking Bill if there was some seeps in some of the other hydro holes. Whether that is returning drilling fluid or natural, we don't know.

MR. WILSON: The presumption is probably returning drilling fluid. We don't know for sure.

MR. NORTH: Is there any reason to believe that there might be perched water from a structure near one or both of the shafts? Ghost Dance Fault is quite a ways away.

MR. WILSON: It depends, I suppose, on the impact of the faults east of the shaft and whether they are capable of having the same effect that Ghost Dance Fault might have. If down-dip flow does occur and these faults also are structurally favorable, then it's possible.

MR. NORTH: Is there any reason to believe that you would get perched water in one of these shafts but not the other?

MR. BEALL: Could happen.

MR. WILSON: I suppose anything is possible, but I would not expect that.

MR. BEALL: The shafts are 300 feet apart, so --

Let's go into the five construction methods. This is just basically a cartoon for the raise boring option. And be sure to keep in mind the fact that this shaft here needs to be completed totally. You need to have all of your conveyances installed, you need to be able to excavate and hoist rock out of this particular shaft, all right, excavate over to where you intercept your pilot hole that was initially bored and then transport your bit down -- your completed shaft to the underground and install it.

I'm not used to having a tether.

Install it and then you basically pull that bit back up to the surface and take the segments of drill pipe off as you're doing that.

Your principal investigator here basically has the capability to observe the cuttings. Really does not have access to the shaft walls during this operation.

MR. ALLEN: If you temporarily halt the operation or is that --

MR. BEALL: Then you can start to get into the health and safety area to where you're subjecting people to some environments that I think a lot of us would feel uncomfortable with, all right? Until you can run a camera, I think, up there and be sure of what kind of ground conditions you have, I don't think you would want to try to put a person in there to observe anything. And then also you would have to have a conveyance in there, a torpedo or some type of piece of equipment in order to lower the person down.

MR. ALLEN: Do you agree with that, Don?

MR. DEERE: In general, yes. We have gone up behind one of these when we got one of them stuck or hit a fault and the question was do you abandon the hole, and there is a lot of debate. It was finally decided we should try to reclaim it, so an Alimak was laid. And we went up behind it with an Alimak and placed liner plates behind it, and then to get through the bad zone, which was about 20 meters thick, was a succession of a half a meter a day thing, with people going up with the Alimak climber and hand-mining, placing support, going another meter, and they got through. They saved 1,200 foot of shaft that was going to be abandoned. But it is a dangerous situation and it's not common. So in general it's not a good place to go into while work is on.

MR. BEALL: Especially on a project like this with a tremendous amount of visibility, what have you.

MR. DEERE: Before you remove that -- and I'm not sure of the next one here. Probably the majority of the raise bored shafts constructed here in the United States, the muck must be removed by pneumatic muck removal --

MR. BEALL: Sure, sure.

MR. DEERE: -- with pipes.

MR. BEALL: Please, this is a cartoon. You'll see one of the methods where we've got a conveyor where the pneumatic can be used also.

MR. WILSON: Ken, yes. Is there any need to use fluids in any part of this construction method?

MR. BEALL: Usually in the raise boring operation they at least have a mist to help control the dust. We could probably, I think, raise bore without that if we sealed the area off down here and had a pneumatic or a conveyor type of collection system. So I think we could minimize the amount of fluid usage on it.

MR. WILSON: How about in the pilot hole?

MR. BEALL: I'm assuming that's done dry.

MR. DEERE: Done dry.

MR. BEALL: Absolutely without fluid. Just mist on the muck pile, but you don't have to do that.

MR. SALTZMAN: What size diameter hole would you need for the first shaft in order to bring the muck up?

MR. BEALL: It depends on how accurate the pilot hole is, okay? You'll see in my later view graphs one of the advantages of conventional sinking or raise boring and slashing is that you end up with a vertical shaft, one that is basically straight and plumb. Depending on who you talk to you can get different numbers on what the target is at the main test level that you can hit with that pilot hole, all right? Probably something in the range of two to three feet is within reason. Now, you may have some better numbers on that.

MR. DEERE: I would say my experience goes from about one foot to 40 feet. Those are not considered successes.

MR. BLANCHARD: I don't think he answered the question.

MR. DEERE: Those were not considered successes.

MR. BLANCHARD: The question is about the size of the hole.

MR. BEALL: I haven't finished.

Now, what happened is let's say this is a true vertical shaft. As this pilot hole is going down you correct that.

MR. DEERE: Yes.

MR. BEALL: It does that.

Now think of a conveyance that you're going to pull up that with personnel in it at a thousand feet a minute, all right, and you basically have the equivalent of a vertical roller coaster. You're going to be banging people around. It gets to be a very hazardous, dangerous situation. Something like that action, then your hoisting speeds would have to be reduced significantly.

Now, the way you overcome that typically is that you go ahead and you increase the diameter of the shaft for those deviations in your pilot hole, all right, and then you install rope guides that hang plumb and then you have a conveyance that basically travels off the rope guides. So you end up with a larger diameter shaft.

We could be adding three or four feet very easily to the diameter that we would typically need in a conventional sinking, right, in order to accommodate that.

Does that answer the question?

MR. SALTZMAN: Not quite. The idea was to come down with a first shaft relatively quickly through drill and blast, to drift over and then use raise bore for the second one, what would have to be the diameter of the first shaft in order to take the muck out from the second one?

MR. BEALL: You mean the smallest?

MR. SALTZMAN: Yes.

MR. DEERE: That's a key question, right there.

MR. BEALL: Finished inside diameter,

maybe ten feet, Bruce, excavated 12?

MR. STANLEY: A study was done to try to determine the minimum size of a shaft for the ESF. Various sizes were considered. And after all of the factors were taken under consideration, the minimum size that would satisfy all the needs was 12-foot diameter. So any further than that --

MR. BEALL: Yeah. That may have some additional requirements in it where if our main goal was to sink the shaft as small as possible and as fast as possible, we could maybe get by with a ten-foot finished ID. You have to have enough room to get your conveyances in there, your utilities.

MR. DEERE: This is the first stage?

MR. STANLEY: First stage.

MR. DEERE: We haven't talked about this yet, but it's as you have mentioned --

MR. BEALL: Understand.

MR. DEERE: -- the potential to have a first-stage shaft that goes down relatively faster and then later ream to --

MR. STANLEY: Or slashes.

MR. DEERE: No, we're trying to get
away from slashing. So it's raise bored. It's
reamed by raise boring.

MR. BEALL: Which, the second shaft?

MR. DEERE: First shaft.

MR. BEALL: Also the first.

UNIDENTIFIED SPEAKER: Both.

MR. BEALL: So then you would come back into the first one and raise bore it after you did the second shaft.

MR. DEERE: If you wanted it -- if you couldn't live with the eight-foot or the nine-foot diameter.

MR. BEALL: Yeah, we would probably have to do that.

MR. DEERE: Then you would put on your raise and then ream it with the raise boring, which should take the better part of ten days.

MR. BEALL: Okay. The reason I'm sort of smiling a little bit is that things on this program, and rightfully so, don't happen usually as quickly as on other projects, all right?

MR. DEERE: I'm understanding that.

(Laughter)

MR. BEALL: I understand what you're

saying because I came out of the commercial environment, and I mean we did things very quickly. In this program there are a lot of requirements that have to be satisfied, there's a lot of documentation that has to go along, a lot of inspection, a lot of QA, and it's all very important and you can't bypass a lot of those things. Some of the things that we're used to seeing done very quickly, on this project just take longer in order to do.

MR. ISAACS: I'm still interested in Jerry's question and an answer. If you're only considering the diameter of the first shaft for the consideration of taking out the material that's generated from the raise boring at the second shaft, how big did that first shaft have to be?

MR. BEALL: I think we're probably looking at a finished diameter of somewhere around ten feet. When you start getting smaller than that you can't hardly get construction equipment down in there to be able to muck out the blasted rock and what have you, okay?

When you get so confined -- in fact, when you look at the time it takes to sink shafts versus -- diameter wise, you'll find out that when you hit the 14- to 16-foot range of diameter you can actually do those in less time than you can the smaller shafts, because you've got all of the interference and confinement. And you can get your crews and stuff down, that you can't in the smaller-diameter shafts.

MR. CORDING: Just in terms of getting it out, keep the muck moving out, hoist, I'm not talking what you need to sink with different methods, but, you know, there's a lot of very large underground gas storage projects, propane and ethane, that are constructed out of three- and four-foot diameter shafts.

MR. BEALL: I don't know how you could conventionally sink a three- or four-foot diameter shaft.

MR. CORDING: My point is we're talking about two different things. One point is what is the minimum it takes to remove material and the other is what does it take for a given method to get the shaft down.

MR. BEALL: On the first shaft we can only conventionally sink it or blind drill it. But I think the blind drilling option is not viable because of the loss of the fluid.

MR. CORDING: My point was more trying to separate a little bit and saying what does it take to get muck out? The other words, what does it take to drive a shaft?

MR. BEALL: All right. Going on to the next construction method here, I'll call this one the raise boring/slashing option. Again, you have to have another shaft that is over here completed to the point of where you can hoist the mined rock out. You come in and you excavate over, you intercept your pilot bore, then you raise bore a four- or six-foot diameter shaft, and then you put your stage in up at the collar here and you start using control drill and blast methods, slashing the shaft as we go down, the broken rock falls down here, and is then taken over to the other shaft and hoisted to the surface.

One of the advantages of this method here, all right, is that you end up with a plumb and straight shaft, okay? For your conveyances you can use rigid guides, have safety dogs, what have you. But, again, you can only do that when you've already got one shaft that's completed.

Another option that uses raise boring, all right, is the V-mole, an excellent method.

MR. DEERE: Before you go into that,

can I just make a comment?

On the last one that you showed, I think we should say this is probably the most common method that is being used for shafts where you have

this thing, is to use either the raise bore or an
Alimak raised climber and then slash.

Like you say, the hole can wander
around on the inside and you don't care. You're just
using it to drop the muck down to take it over. And
you bring it right straight on down. And that is the
conventional method.

MR. BEALL: Let's look at the V-mole
here. That is a method that was developed by Wirth
over in Germany. One comment I would like to make,
somebody suggested that the technology be available
in this country. I know in past repository programs
the DOE has opened up the bidding to anybody. So
it's not -- we just don't look at technology being
available in this country. It's anywhere in the
world.

Anyway, this --

MR. DEERE: Would Congress accept Japan?

MR. BEALL: A Japanese firm did the
shaft outfitting and the initial underground
excavation on the WIPP project, "Obiachi", I believe.

Is that right, Jim?

MR. DEERE: Because you recall they were just awarded a contract in Washington for the Washington Metro about a year ago and Congress said, no, you don't, not after you don't let our construction people go into Japan. And they had to rebid.

MR. BEALL: You're talking about an area now that can change depending on people also (inaudible). But we do look at technology being available anyplace.

MR. ISAACS: I think there's nothing to preclude us from considering those. We have a contract with foreign potential vendors for casks, for example. Certainly there can always be an overlay of policy on top of that. But right now we don't preclude it. There's nothing in the law that would preclude it that I'm aware of.

MR. BEALL: Anyway, this is V-mole method of construction. Again, you intersect your pilot hole and you raise bore. You have to install your bore here with a stage behind it and put your liner in. And the cuttings, this is just a conical cutter head here with the cutters on it. The cuttings basically fall down here. Again they can be conveyed pneumatically or what have you.

Now, if we all had our druthers, including us, I think, on the project, we would love to be able to have the technology of where we could do that without having any of this placed. It has been tried numerous times. Dr. Deere, you may be more familiar with this than I am. I know the Bureau of Mines has tried this. The problem they also run into is to be able to remove the cuttings and convey those to the surface in a blind dry drilling operation. They've never been able to do it successfully. And that is the reason that Wirth went off and developed this particular technology to where the cuttings now would fall down to the lower level, all right? Let me tell you, if we had a technology that was available, I think we would be using it instantaneously.

Another construction method is what I call blind boring. This is a wet drilling operation. You start from the surface. This is a collar structure here with your drill rig and power swivel up on the top there. You have your bit body down at the bottom that has your jet nozzles which pick up the cuttings or keep the turbulent up where the cuttings eventually come up and they come up to the dual-stream purified water settlement ponds and the drilling mud is recirculated.

These are the doughnut weights. Those are the things that create the pendulum effect to try to keep that shaft plumb and vertical, however, we still have verticality problems with this particular method. We used that on WIPP and, Jim, I don't know if you recall our target on WIPP, but it seemed like it had a 30-inch radius, I might be mistaken there. But, again, if the shafts aren't plumb, then you end up potentially with operational problems in your conveyances.

MR. WILSON: I don't think the position of your principle investigator meets the scientific needs.

MR. BEALL: That's true. In this particular case we just don't have access to that.

Now, you can drill with reduced heads. You'll see in some of my later view graphs where there are some disadvantages I think associated with that. But then a lot of times you want to keep your drilling mud surface up toward the surface to control any inflowing water or it also provides a ground stablization effect to keep any sloughing ground from coming in.

The next method is conventional shaft sinking. When I use that term on this project, I'm assuming that we're talking about controlled drill and blast conventional sinking. Here we show ES-1 and ES-2. Because of all the testing work that's being conducted in ES-1, ES-2 is completed, totally outfitted. We have some minimal excavation going on in the underground there and as ES-1 is coming down.

I want to just show you some of the details associated with the stage there. It's called the sinking stage. This is a three-deck stage that we probably will end up with on this project. Those desks are there to help install the forms, place the concrete lining, do some scaling on the shaft walls if necessary.

Your cryderman is also partially suspended there. The cryderman is nothing more than a clam shell that picks up the broken rock, puts it in a bucket, that is then hoisted up through the sinking stage there where it picks up the cross head, which is on rope guides, and takes it on to the surface.

Here, and this has been one of the primary requirements from our site characterization people, is that the principal investigators have direct and continuous access to the shaft as it is excavated and as the shaft walls are exposed, okay? So if we encounter any unexpected features, we can evaluate those and react in the proper ways.

One of the modifications that we will make to that stage is that we will put a mapping deck on the bottom of it, which is shown right here, which has a stand for the photography, and we'll have a good base to do that.

Okay. Going back to my original presentation outline, now I would like to go into comparison of the construction methods versus the criteria. Everybody is interested in that. This is probably more the results of that type of a comparison, all right?

Max, was this the place that they can't ask questions?

(Laughter)

MR. BEALL: Okay. Raise boring. First of all, all of us agree we get minimal rock damage from that particular construction method. We have minimal overbreak in good ground conditions. However, some of that ground is fairly fractured out there and during the raise boring operation we can encounter sloughing ground, we hope we don't, but we could.

And in a raise boring operation that hole will stand there for some time before we can ever get a stage down there to potentially do anything about it. And so that ground could continue to come in on us and create other problems that we would, you know, potentially not want to address.

MR. DEERE: I think experience has shown that with vertical raise boring this is less a problem than when we go to the incline.

MR. BEALL: I understand. And I appreciate your comment. It's a valid one. But yet there is some risk even though it might be minimal.

Now, this particular method doesn't provide for the early and continued access that the site characterization people have requested, all right? It also doesn't allow for the collection of bulk samples, all right? We only have our cuttings basically at the bottom of the raise bored shaft to look at.

It also does not let us initiate any fluid control measures or any ground control measures for the sloughing ground. You could very easily think of the situation of where if you have a very small inflow from a perched water table it may only flow for a day, but you may miss that opportunity, you may not detect it with all the dust and what have you that is going on with a raise boring operation. So you potentially may miss some of those things that we're really looking for. Also, we may not detect unexpected conditions as quickly as what we would like to.

And then the last bullet there, at least with the sequence that we're looking at, you can't start ES-2 until ES-1 is completed, and so if you raise bored that, then by definition it's a longer construction schedule.

MR. NORTH: Could we go down this list again considering that we're going to do ES-1 by the method that was described with the normal as-modified drill and blast, and now ES-2 is to be done with the raise boring.

So you have a shaft completed 300 feet away and you've looked at the rock at every level. Now, for example, does that suggest that the overbreak problem might be less because you have information now on the rock 300 feet away? And go down similarly the other points.

MR. SALTZMAN: Just before you do, for clarification, you mean do the whole test program that we had intended to do for ES-1 as we had intended it?

MR. NORTH: Right. And then raise bore the second shaft and make the comparison on that basis.

MR. BEALL: Say it again.

MR. NORTH: ES-1 gets done by the methods that you have described, the drill and blast with minimizing the fluids, et cetera.

MR. GERTZ: Scientific shaft.

MR. NORTH: Yeah, scientific shaft. Now we're talking about raise bore the second one, given all the information that you have developed on the first one.

MR. BEALL: All right. More knowledge.

MR. NORTH: Right.

MR. BEALL: Gotcha. This would stay the same. We would have, I think, more confidence in this because we -- if we hit some sloughing ground we would know about that, all right, and we might choose that that's not a good thing to do at that time, all right? But if the ground was good we would have more confidence, but then also anybody that's been in the underground you go 300 feet away and, you know, you could encounter a different set of circumstances, all right? So it doesn't take care of this one probably completely.

We still don't have the continual access that the scientists have requested for detecting the unexpected conditions.

MR. NORTH: You've got it in the first shaft.

MR. BEALL: We do have it in the first shaft, I agree.

MR. NORTH: When you get better access to undisturbed rock later.

MR. BEALL: Right, I agree.

We can't get our bulk samples at that time, but, again, we've got those out of the ES-1 shaft and as we put a stage down the raise bored shaft if we wanted to, I think we could get bulk samples out of the wall.

MR. DEERE: I think it would be much better. I wouldn't take a piece off the muck pile.

MR. BEALL: Right, I agree, okay.

John. John Robson with DOE.

MR. ROBSON: One point. If you sink ES-1 test shaft down and wait until you've completed that and have the results to determine what method or how you do ES-2, I think you're then -- you then have a tremendous procurement problem on the critical path.

MR. BEALL: No, I don't think we were talking about that. I think we are assuming we are going to raise bore ES-2 and we would have the equipment there. Procurement would be in place, all right? At least that's the assumption that I was working on.

MR. ROBSON: Realizing the world we live in, the procurement times are by the FAR's and they're not what any of us who work in the outside world are accustomed to. So at least the current scheme of things doesn't allow for that kind of real-time decision making.

MR. DEERE: You would have to assume it was going to be needed and have it ordered.

MR. ALLEN: Also is it possible of some of the things presently envisioned for the first shaft, such as that middle-level experiment room, could not be delayed until the shaft was sunk all the way down?

MR. BEALL: Joe, can somebody help me out there, the upper demonstration break-out room, the timeliness of that?

Correct me if I'm wrong, Hemmie, but I believe the testing sequence demands that those rooms be mined and the excavation effects tests, which take a tremendous amount of time, be conducted prior to the continued sinking of the shaft. The excavation effects test is a series of holes around the unmined shaft perimeter that are then instrumented and monitored as the shaft is sunk down beyond the level. I've got an old -- after the break I can show you on an old logic diagram that shows a tremendous perturbation in the shaft sinking to accomodate the testing requirements.

MR. DEERE: I think when we make an adaptation of putting raise boring over in number 2, then we really have to look again at how we would split up the scientific activities to get the same information. It may well be that part of that scientific room will have to be in a raise bored number 2 if you're going to consider raise boring at all. You get down, you come up with a six-foot raise bored hole. That is the one that you start coming down and doing your radial testing, doing your --

MR. BEALL: That is physically possible, however, I believe, and any of the testing people correct me if I'm wrong, the results of those from the shaft excavation tests will be utilized in, I don't know what the right term is, validate, verify that we are doing the right thing down below when we break out on the main test level and mine between the shaft, we're counting on those results.

MR. KALIA: We're essentially trying to reverse the sequence. You are saying that let's do some of the test of the ES-1 in ES-2.

MR. DEERE: Possibility.

MR. KALIA: We don't know what that brings in. The concern is to get the error as early as we can and as early as we can get it.

MR. DEERE: Yes, I know.

MR. ISAACS: If I understand the situation, it's kind of an interesting option here. I mean one option is you drill this by conventional means, this first shaft as quickly as possible, go over and then raise bore the second shaft, in which case you lose lots of things that the program needs, which are synthesized or consolidated on this first view graph. That's got some problems associated with it.

The second alternative is, well, do the first shaft slowly and scientifically and do the break-outs and the scientific tests that we need and go through in the fashion that we're talking about, go over in a disciplined fashion and raise bore the second one. There you wind up losing some of the benefits of schedule by having gone through the conventional second shaft at the same time you're doing the first.

So it's hard for me to conceive so far,

anyway, of an option that combines both of those virtues.

MR. DEERE: I think it requires rescheduling of the tests to optimize the use of the raised bore, I think there has to be some modification in the program. Is that modification able to get you better information in reasonably the same time or not?

MR. BLANCHARD: I need to bring out one point, and that is when we finished the final EA's --

MR. ALLEN: What?

MR. BLANCHARD: The environmental assessments that were published in '84 and '85. The layout for the construction of the exploratory shaft was one conventionally-constructed shaft and one raise bored shaft, and based on many analyses -- what, many arguments and discussions and analyses, we reluctantly gave up the raise bored shaft to a second conventionally-constructed shaft for a whole lot of reasons, one of which, very important of which, was the last item on Ken's view graph, and that was when we -- every time we did a PERT analysis of what the conflicts were it turned out that we gained confidence that it was going to take us longer to do it that way than it did to conventionally construct both but at different rates.

MR. NORTH: It seems to me that's the essence of your trade-off, the quality of the information from the rock damage issue versus the schedule, and I asked the question how much and we got a variety of answers on it.

If I look through these points in the middle, if we consider that we have the information from the first shaft, the risks on the second shaft would seem to be fairly small, speaking as a nonspecialist in these areas. And I would really like to see that analysis, what the problems are in terms of a schedule versus the quality of the information you get. Because, like everybody else, I'm thinking about a period years in the future where you're really going to need superb-quality information as part of the licensing procedure, and if raise boring the second shaft will give you much better information, it seems to me that's a very good argument in favor of doing it that way.

And that's really the analysis I would

like to see laid out, is that quality of the information versus the schedule and versus any other risks from this consideration, the other points on the slide, that may be significant.

MR. STEIN: I think that you have to recognize what you're saying has a lot of validity but it's also a presumption, I assume that the raise boring of the second shaft will result in a superior quality of data than proceeding by the method that we have on line here.

So before you, you know, you kind of leap into that approach, you have to make some judgment as to whether the quality of the raise boring data is truly superior to the quality of the data that you would get from the second shaft sunk in a conventional manner. Would you agree?

MR. NORTH: I think that is an excellent question. And at this point I see it as a hypothesis that the information is much better. And what's driving that hypothesis is the rock damage from the fluids and from the blast.

Now, maybe you can get all the good information you need, the superb-quality information on undamaged rock from the radial boreholes on the first shaft, but you're going to be sampling as opposed to have the whole thousand-foot shaft to look at in an undisturbed state.

MR. SALTZMAN: Except for the MPBH.

MR. NORTH: Which is a small hole and

doesn't give you the same quality information. I'm just saying that's the analysis I would like to see.

MR. GERTZ: I think the further analysis: How big of a part does that play in the overall site characterization program? This is one hole out of 300 holes we might be drilling. It just happens to be bigger, these two happen to be bigger than the other 300, and different depths, but how much more confidence do we have under the assumption that raise bores give us better information?

MR. STEIN: I think that that's an excellent point that Carl makes. The shafts serve a scientific purpose as constructed in our program, but the shafts are the introduction, if you will, and not the entire program. The shafts give us access to the underground, and we have a rather extensive program that is underground, if you will, as well as a rather extensive program that we'll talk about tomorrow that is from the surface. So, again, the shafts do provide us with information, but it is important that we do get underground but get underground in a way that we can at the same time get quality data, but it isn't the entire program. It's only a very small fraction of our entire program.

MR. GERTZ: Just to put it in

perspective, I believe we have 106 studies plans, of which only 16 of them are involved with the exploratory shaft. The other 90 are surface-based test study plans. So I don't know, maybe the scientists can tell me, but how much information do you get from the exploratory shaft percentage-wise versus the entire site characterization program?

MR. STEIN: The exploratory shaft as well as the boreholes that we have is the introduction to the underground. But whether or not the site is suitable is a function of the remainder of the program that we have underway.

MR. ALLEN: You can't deny that the nature of that unsaturated zone above your repository is terribly important. You understand what's going on there in the overall characterization program.
And those two shafts are our --

MR. ISAACS: We have hundreds --

MR. STEIN: I think it is very important, I agree with you completely that it is important, and I think there are a number of methods, why it hasn't come out clearer, of the approach that we're taking to sink some of these small boreholes in a dry environment, and why that hasn't come out clearer is something I'm not quite sure about.

But, nevertheless, most of the construction, hopefully a good bit of the construction of the shaft and the drill holes for the explosives will be done dry, basically dry. I hope. I mean that's what my understanding is for some of the work that we have underway right now that will permit us to do that.

But, nevertheless, again, it's a very important issue that we are addressing here and I do agree that we need to analyze it, but it's only a fraction of the underground.

And, furthermore, I would say that a significant part of our understanding of this site and the confidence of this site is, in my view, is from the repository horizon down to the saturated zone. I think we need to understand what the geology is to the repository, but I believe that as we go further down that is a very -- and perhaps in my point of view, just my point of view, I think that is perhaps the most important part of the program.

MR. ISAACS: I want to bring us back to

one point because I still -- my earlier point is still a little bit confusing.

Our notion all along, I believe, was that by convention methods we would drill this first let me call it scientific exploratory shaft from which we thought we could gather all of the necessary information that was necessary to be gathered from shafts, that there would be in addition multipurpose boreholes, literally a couple hundred, 300 other dry drill holes to help us in that area, and that the second shaft, as I understand it, is necessary for safety reasons and it's necessary for ventilation and taking out material and men and was not principally a scientific hole, correct?

MR. BEALL: Correct.

MR. ISAACS: That's the first thing that I think that we believe. I think the point that's being made here is we've gone with the concept we have as I understand it because we thought we could meet all of the objectives of the exploratory shaft from a scientific point of view by the first shaft going down conventionally.

Now, the issue of whether or not there's information that's lost, that's valuable, or let me even say necessary to use the word in the law, that would come -- that would be not available from this technique but would be available from a raise bored second shaft, thereby making the second shaft also a scientific shaft or perhaps the scientific shaft, is lost on me. I don't see that coming out. That's the thing that I'm trying to grapple with that I don't see the mechanism or the trigger that says make that second shaft a scientific shaft. That seems to be where the argument lays right now.

MR. WILSON: Are the advantages, Don, the fact that there is minimal rock damage and no fluids? Those are the two keys?

MR. DEERE: Yes. And we were driven there by your reports. This just doesn't come out from anyplace. With getting familiar with the objections and getting everything you have, and we see that we want to minimize water, we want to minimize blast damage, and we have a big program to try to find out how much damage we did do and then to subtract out -- why not subtract out the damage before you do it?

MR. WILSON: Remember, a part of that is to evaluate the effects of the repository and drifts and so forth. Not only the shaft itself, the other kinds of openings made.

MR. ISAACS: Horizontal.

MR. WILSON: Horizontal for the repository itself. And for the test drifts, so on. That information is transferred.

MR. DEERE: All right. This is another question which we'll be talking about tomorrow. Are we tied in with conventional blasting for all the underground work for now in the future? So why evaluate damage by blasting so we can use it later when we may not want to use it later?

MR. WILSON: Part of it is also the redistribution stratus.

MR. DEERE: Yes, but that's minimal at the stress level we're talking about, this strength of material. That's just absolutely minimal compared with blasting.

MR. CORDING: Really the effects at repository level you have to look at in that rock, and that's at the repository level, so there's relatively little you can derive from information 500 feet above it in terms of what -- how it applies to the repository.

MR. DEERE: You mean on loosening effects.

MR. CORDING: On loosening effects 500

feet in the shaft are not going to help you in regard to understanding what's happening in the actual repository level. If one were wanting to get the best view of that rock, looking at it as a geologist or an engineering geologist, somebody looking carefully at the rock, and the effects, the rock mechanics effect, everything, having one of each would be very desirable. Because then you can see some things in each. Then you can put things -- in one the things you can't get from the other. Neither one is trying to do all of the work in terms of the scientific depth. There could be some advantages there. For example, how much fracturing you really see. That would be questions that would be answered by being able to compare two different types of structure.

MR. BEALL: Maybe to finish up the rest of your question, I think we've already talked about this particular bullet here. And as far as the unexpected conditions, if we had already gone down in the ES-1 we should have probably encountered most of those, but still you may not pick up some things until you get over to that second shaft.

All right. Going on to the --

MR. STEIN: Ken, that last bullet, how

long does it take to construct each one of the shafts, based on our present plans?

MR. BEALL: Right now?

MR. STEIN: Yes.

MR. BEALL: You mean ES-1 and ES-2?

MR. STEIN: Right. They're going to start about the same time, are they not?

MR. BEALL: We start ES-1 first. We have a 24-month time period from the start of that until we actually have it finished and completed. Of that 24 months, probably about four months is actual construction time. The rest of it is testing time. After we start ES-1, we then start ES-2.

MR. STEIN: How soon do you start the second shaft?

MR. BEALL: Time-wise after?

MR. STEIN: Relative to the start of the first shaft.

MR. BEALL: I don't have that. Do you have that on the tip of your tongue, Bruce?

UNIDENTIFIED SPEAKER: I don't think it's --

MR. BEALL: It's not simultaneous. I think it's within a few months.

MR. PRITCHETT: Between one and two

months later.

MR. STEIN: It's one and two months. Let's say two months later. How long does it take to complete the second shaft?

MR. BEALL: I don't have that number. I can see the schedule.

UNIDENTIFIED SPEAKER: About a year.

MR. PRITCHETT: Nine, ten months.

MR. DEERE: In fact, I think I ripped it out.

MR. STEIN: So you say about nine months later, so about a year later after you start the first shaft you complete the second shaft, is that what you're saying?

MR. PRITCHETT: A year before ES-1 is completed.

MR. STEIN: So you have a year that you're waiting for completion of the second shaft?

MR. SALTZMAN: You have a drift-over.

MR. GERTZ: You have a drift-over.

MR. STEIN: Yes, I realize.

MR. MERSON: But in that year they are also doing the demonstration break-out room at the main test level, which helps you. So they're doing some of the early testing in the undisturbed main test level in that year before they make the connection. That one demonstration break-out room test saves some time.

MR. STEIN: Let me go back again to

make sure that I understand. The first shaft, to get to the bottom of the first shaft takes how many years?

MR. BEALL: Approximately two.

MR. STEIN: So it's two years to get the first shaft and in the meantime you have the second shaft that is being sunk?

MR. BEALL: Correct.

MR. STEIN: So that the second shaft gets down before you complete the first shaft?

MR. BEALL: That's correct. And we excavate some of the main test level --

MR. STEIN: Then you go across.

MR. BEALL: That's right, make the connection.

MR. STEIN: I thought it was worthwhile to bring that out, what the schedule is at the present time, because the first shaft is what's driving that schedule.

MR. ALLEN: I understood Don to say, I thought, maybe I'm wrong, that the raise boring shaft, if you did it that way, once you got it into operation, started going, might be a matter of 12 or 15 days.

MR. DEERE: Let's say three weeks.

MR. BEALL: His numbers are appropriate

numbers, at least in the commercial environment.

MR. ISAACS: It's interesting. Let's just for the sake of argument flip the names of our exploratory shafts 1 and 2, because it sounds to me very much like our exploratory shaft number 2 is kind of what you were suggesting, get down there fast with exploratory shaft number 2.

MR. DEERE: You can't by sinking. To get there fast you have to raise bore.

MR. ISAACS: No. But I'm saying let's say that's our first exploratory shaft. You've got to sink one.

MR. DEERE: Yeah. I see what you mean.

MR. ISAACS: Let's call our exploratory shaft number 2 your exploratory shaft number 1, because it's going down quickly with a shaft. It sounds like the issue is: Which is more appropriate for the program, a two-year program to do our exploratory shaft and the mapping on the way down with the traditional method, which meets the requirements that were up there, or raise boring this shaft, which gives you a nice clean shaft but loses some of those abilities that we talked about earlier? And that sounds to me like the trade-off that's there.

Do you understand what I'm saying?

MR. DEERE: Sure. I'm not sure I agree with you, but I understand.

MR. ISAACS: That would be too much to ask.

(Laughter)

MR. DEERE: No, because I don't want to do away with some of the tests and observations in the first shaft. I think you have to make observations that are virgin and those are the ones that have to be looked at and say which ones can be pulled out and done from the other. But there are some that you have to see them on the way down and so it --

MR. BEALL: If I was to guess, Don, maybe what would happen is we would end up with two ES-1 shafts.

MR. SALTZMAN: What would be added on is the time for drifts because you would have to go down with the first one, drift over before you could start the second one. So you would have to add that drifting time into the first one, so it would be two years plus the drifting time plus the raise bore time.

MR. CORDING: But you still might have increased the rate at which you did the first one if you took some out of it.

MR. DEERE: Twenty-four months, four months to sink and 20 months to study. That's what led us into looking at alternatives. Damage by water, damage by blasting, that took us to another alternative. When you have those two things to look at, schedule and damage, you have a lot of possibilities to make combinations and we're not sure aren't interesting to look at it.

Now, you have looked at it once. We don't know all of those results. You're telling us some of them now. And maybe you will convince us. It's not clear.

MR. BEALL: Shall we proceed?

MR. DEERE: Press on.

MR. BEALL: Let's look at the raise boring and slashing operation, really a combination of the mechanical and the controlled drilling and blasting.

This particular method provides early and continued access for site characterization during slashing of the larger diameter shaft, all right? It also allows for the collection of bulk samples. The shaft will be plumb and straight. However, the raise bored hole offers no control for inflowing water. And so if we do hit a perched water table when we're raise boring, we don't have any way of controlling and getting uncontaminated samples. In fact, it could drain itself before we ever got there.

Also, the ambient hydrologic conditions could be compromised by the initial raise bored hole. We may not detect unexpected conditions in the raise bored hole. Whether we pick them up during the slashing operation would depend on what the unexpected condition, I think, is.

In this case overbreak can be limited with controlled blasting techniques and also the timely installation of ground support if we encounter sloughing ground.

But, again, using our particular sequence, all right, this particular method results in a longer construction schedule, since we have to have ES-1 down to the main test level completed so that we can hoist the mined rock and the rock for the slashing operation back to the surface.

If we look at the raise boring and the V-mole option, here again it's a mechanical mining method, you have minimal rock damage there. It provides us with early and continued access for the larger-diameter shaft. We can detect, evaluate, and respond to unexpected conditions in the larger bored hole. We have minimal overbreak and we can also install ground support in a timely way.

The shaft will be plumb and straight because the V-mole bore is a laser-guided machine and we can end up with a very plumb shaft. It does allow for some collection of bulk samples. You don't have as much access to the actual drilling face in the V-mole as you would in a slashing operation, but I think we could get a good number of the bulk samples there.

However, again, the ambient hydrologic conditions might be compromised because you have the initial raise bored hole that's been standing there for some time, and we cannot initiate any water control for inflowing water in that raise bored hole. And we may not be able to again detect the unexpected conditions in the raise bored hole.

And, again, since this is really a raise bored option with the sequence of the shafts, construction of shafts that we presently are looking at, it creates a longer construction schedule.

MR. DEERE: And all of these disadvantages for shaft 1 already having been done and this is only for shaft 2?

MR. BEALL: Yes, this is only for shaft

2. That's the only way you can use the raise boring options on your second shaft.

If we look at the blind drilling, which is a wet construction method, here again we will get minimal overbreak in good ground conditions, although sloughing has occurred in blind drilling operations.

This particular method does not provide for the early or continued access of the site characterization. It doesn't allow for the collection of bulk samples. About the best you can do there is to get cuttings out of the return on the drilling mud.

One of the potential problems here, and this has been observed in other boreholes on the site, we have the potential of hydrofracting the rock from the drilling mud and that could end up damaging the rock.

Drilling fluid losses could also adversely impact the site characterization and potentially the performance of the repository.

This method offers limited ground

control for water inflow and sloughing ground. If you keep your drilling weights high enough you can keep water, at least low-pressure water from coming in and also can control some of the sloughing ground conditions.

Again, we may not detect unexpected conditions with this method. And then this shaft probably will not be plumb nor straight, which would cause us to go to a larger-diameter shaft.

MR. DEERE: What diameter would be used in the blind drilling or in your studies what did you consider? Was it a full 14-foot diameter?

MR. BEALL: It would have to be a larger one than that, because you have to take the plumbness problem and add that to the diameter of the shaft, all right? So if you could hit a target of three feet down at the bottom, then you would add another three feet or maybe a little bit more to the diameter of the shaft.

Also if you use rigid guides, which typically you want to do on your personnel (inaudible), it's not mandatory, then the buntons, which are the structural cross members that, you know, go across the shaft itself, almost have to be custom cut and fit for each station. And those are located typically on about a ten-foot spacing on two sides of the shaft, and then your wooden guides are attached to those, okay? And so you've got to be able to have a flexible bunton in place plus with all the flexible connections so where you can use that guide and that bunton so that you maintain a good vertical line for your conveyances.

MR. DEERE: What are the largest diameters they can drill here at the site?

MR. BEALL: At the site. They're probably smaller than what's been done elsewhere. Where did my construction people go? Is that Bob? Just in time. What's the largest diameter shaft that's been drilled out on the site, Bob?

MR. PRITCHETT: One hundred forty-four inches, as far as I know. Fourteen feet.

MR. BEALL: You look at the new Robins rig, I think they advertise they can drill much larger diameters, but they've had some problems with their (inaudible). I think we can go significantly larger, especially with the depths we're talking.

MR. STEIN: Is that the one they used in Australia for testing?

MR. BEALL: No. I think that's the Mobile Miner you're referring to.

UNIDENTIFIED SPEAKER: I think that was the Santa Fe drilling thing they took down to Mount Isa. I think you're right, it did go a little bit bigger, but I forget the diameter that it was capable of achieving.

MR. BEALL: I think they were advertising initially somewhere in the 30-foot diameter range at about 3,000 feet or something like that. And with the diameters we're looking at I think we would be well within. But there are also only what, one of those rigs around, maybe two.

(Thereupon a brief recess was
taken, after which the following
proceedings were had:)

MR. BEALL: Did you have a question, Dr. Deere?

MR. DEERE: Yeah.

Hasn't there been a couple attempts or a couple of shafts done by the V-mole without a pilot hole with hydraulic removal of muck? That's under development in Germany and it seems to me that there have been two done in the last couple years. But I believe they were research model -- research projects where they were attempting to develop it.

MR. BEALL: Do you know what size diameter, anything? I'm not aware of it. Is anybody else here in the room aware of that? I mean I'm aware of some of the attempts that have been tried in this country.

MR. DEERE: I think I have an article and I'll look for it in my room tonight.

MR. BEALL: I would sure like to see it.

MR. DEERE: Because the Germans really want that mileage. As you pointed out, that is really needed, if you had that capability. Because you have access down at the bottom and the muck is pumped up hydraulically rather than blown out pneumatically. And the first one didn't work because they kept getting chunks too big when they hit a fractured zone, it was coming in, so they had to put a type of pressure in and reduce the size to what they could handle. So they're in the second stage of development. I think I can find this data.

MR. BEALL: I would appreciate that.

Anyway, let's look at the conventional shaft sinking method. This method does provide early and continued access for the site characterization activities. It allows the collection of the bulk samples that are needed. We can initiate water and ground control measures immediately. We can readily detect, evaluate, and respond to unexpected conditions. Overbreak can be limited with the controlled blasting techniques and also with timely installation of ground support. The shaft will be plumb and straight. And with our particular sequence that results also with a minimum schedule from a construction standpoint.

I have one last view graph here. I guess all of you understand what that one says.

MR. CORDING: Talking about the negative aspects of this technique.

MR. BEALL: At least from an engineering perspective, when one considers all of the criteria, all right, it's our judgment that the conventional shaft sinking method is the best construction method for ES-1 and ES-2.

Now, we have also put together a summary of some of the documentation associated with this decision over probably about the last, what, seven years, Jim, something like that, started back in 1982. We have copies of that that you people can take and look at and if you have specific questions on it, we would be more than happy to sit down and discuss those.

MR. BLANCHARD: We can mail those -- how big is the package, Jim?

Okay. You want to take it in your briefcase.

MR. BEALL: Any other questions or turn it over to Max to pull the regulatory and site characterization and engineering part of it together.

MR. DEERE: Do we need that or do we have that one?

MR. BEALL: You should have that. Don't tell me somebody left it out.

MR. BLANCHARD: What is that, the conclusions?

MR. CORDING: I had one question. With the fractured zone around the shaft, you've got a concrete-lined shaft, a fracture zone around it, if it is to be incorporated into the facility or just be even left not to be used but to be left within the facility, what is the approach, has there been a design for the -- for the shaft in terms of reducing flow or taking care of some of the problems around the shaft in terms of the fracturing?

MR. BEALL: You heard Bill earlier refer to the MPZ. There's been a tremendous amount of work in that area analyzing what the impacts of that modified permeability zone would be. And I believe it's Section 8.432; is that right?

MR. BLANCHARD: 8.43.

MR. BEALL: 8.43 anyway, to where a lot

of that work is summarized. There's been significant number of analyses on that and we can surely highlight that information for you also. And so it's -- the bottom line is, is that they don't see that being really an adverse impact on the performance of the repository.

MR. CORDING: So, in other words, there would be no treatment of that zone?

MR. BLANCHARD: No. I can help with that. And I think Joe Tillerson from Sandia wants very much to help with that. Come on, Joe.

The thing is, we have not fixed anything in terms of design with respect to integrating the exploratory shaft facility into the repository and there's nothing that prevents us during the early phases of taking out the shaft liner and doing whatever we want to do to the rock ten years from now for whatever we decide is the appropriate thing to do.

So the shaft liner is in there now to facilitate the in situ test program. And there's no reason why we couldn't take the shaft liner and do whatever people think needs to be done at that time before we incorporate it into the repository.

Joe.

MR. TILLERSON: There's two things, possibly three that I would like to say. One is relative to precluding water from coming somewhere into the shaft and then being diverted at the repository level and reaching the waste.

There are two principal things that we are considering and in one case have done. One is with regard to location of the shaft. Locating the shaft significantly above the zone of the probable maximum flood is one of the passive measures that we have taken to aid in precluding water inflow coming in at the top of the shaft and coming down.

Obviously that does not necessarily preclude from Bill's view graph the idea of if you had perched water and it intersected the shaft. Hence the sealing components, the sealing program that we have consists of multiple components, some of them near surface, some of them are just below where we change formation, and some at the repository level.

So the anchor to bedrock seal and the various sealing components on the way down the shaft in the current designs would be keyed into the formation, so going beyond certainly the zone of blast damage and now the end of the formation in an attempt that if there was water, to divert that water back out into the formation.

And then a shaft station seal is one of the components that we would use in order to limit the potential for any water that might get into the shaft from being diverted laterally into the repository where the waste would be stored. We have a physical stand-off distance between the shafts and where the waste would be stored on the order of several tens of meters, and we have the design such that the water -- such that we have sloped the drifts such that if water would come in it would have to build up and essentially flow uphill in order to reach rooms where wastes would be in place.

Those are some of the aspects of opening the shaft out of (inaudible), putting in multiple sealing components between the surface and the underground, and then requiring if water came in at the shaft it would have to move uphill to get in the waste emplacement region. Those are some of the types of things we have done.

Talk a little bit more about those

tomorrow with regard to integration with regard to repository design. Those are some of the things that we have done in order to try to eliminate such an incident.

MR. CORDING: You have by necessity, you have a shaft going down into -- before you've finalized the design of your facility, and is it possible -- your feeling is that you can take any condition that you finally end up with in terms of your design and go back to that shaft and it won't be a -- you can restore it to whatever condition you need to do? You haven't created something that is now there that you wish wasn't there or it's going to give you problems for the entire facility?

MR. TILLERSON: That is our current belief.

MR. BLANCHARD: Yes.

MR. TILLERSON: Yes. Obviously another option would be to go out here way away from the site and look at the rock over there, some distance. Maybe it's tens of feet, maybe it's hundreds of yards or meters or whatever you want to look at. But one way to more isolate things would be to move much further away.

We have the belief, though, that with

the exploratory shaft located as it is, the construction method as we are using it, that that will lead to acceptable behavior relative to both the quality of data and the need for the data from the actual column in which you're depending upon and then the relative to post-closure impacts. That it would not impact the performance of the site sufficiently such that there would be a problem.

MR. STEIN: Let me add that we had to do an analysis in order to make that judgment, and that analysis is in 8.4.

MR. TILLERSON: The analysis is the subject of 8.4. In fact, 8.4 of the SCP, specifically Section 8.43 is relative to the post-closure performance impacts. 8.42 is related to the design. 8.42 is written from the standpoint of assuring that you do not have test interference, test to test, construction-test-type of interference that will preclude gathering good-quality data. And basically 8.41 is related to the representativeness type of questions. So section 8.4 in its entirety is intended to look at the three principal regulatory concerns that we have talked about up to this time.

MR. BLANCHARD: Edward, the excavation effects test program that Bill Wilson outlined on his view graphs are geared towards acquiring for us the empirical information that can be added to a repeat of the evaluations that Joe was talking about in 8.4 that allow us to have the proof both from a theoretical standpoint and an empirical observation standpoint that we can show it would not have an adverse impact on the site by constructing the exploratory shaft. And so the monitoring and the test program for excavation effects regardless of construction method we use would have to acquire that information so that we could present it in the license application.

MR. TILLERSON: Section 8.4 has also resulted in the development of numerous detailed criteria that are being imposed upon the exploratory shaft title two design, and then as part of the evaluation of the title two design there will be analyses made under the auspices of the quality assurance program that will be made to assure that the design as it has changed from title one to title two will meet those types of criteria.

And then there are evaluation points that we have in mind relative to during construction, before you start, as you evaluate your multipurpose borehole, the information you have learned during the construction of the shafts as far as has water gone enormous distances, has it not, what is the evidence relevant to that in regard to the stand-off between tests and how far in the shaft would be underground.

Some of that built-in evaluations on the way that says use the information you have used up to this point in time to make these decisions. Can I put the infiltration test --

THE REPORTER: I'm sorry, I couldn't hear you.

MR. BLANCHARD: Can he put the infiltration tests a certain distance away, and he's acquiring the information from the test program to determine how far away.

Scott.

MR. SINNICK: I would like to make a comment on performance. I think one thing we have to keep in mind, what we've looked at so far is that certain things happen when we get so much water in the shaft, how can we get that from interacting with waste.

Something else we have to keep in mind, what would happen if the shaft weren't there? This mountain is ubiquitously fractured, has probably very high transmissivity under saturating conditions. The condition is an 80 time increase in permeability relative to in terms of what amount of water might be available to infiltrate anyway. So although just increasing something by 80 times may seem significant, if you already have the capacity to transmit much more water than is available to transmit, that becomes almost an irrelevant increase then, because the natural capacity is already there. What we have to look at: Is there anything that the shaft does that increases the chance of water getting to waste?

MR. DEERE: It short-circuits your natural blankets because of different layers.

MR. SINNICK: If those natural blankets provide some sort of tightness that is in themselves -- would prevent water from getting to waste if it were available at the surface. But if the natural site could already transmit that water, whatever is available, then there's nothing to short-circuit because the preferential pathways, as Bill mentioned, may already be there for conditions that would have large amounts of water.

MR. DEERE: Down the faults that are natural shortcuts.

MR. SINNICK: Or the ubiquitous fractures throughout the entire mountain.

MR. CORDING: Of course, the cartoon does show coming down, hitting various layers, ponding in various layers, so you're getting that horizontal barrier, different elevations, that often occurs in the more plastic lower-strength materials.

MR. SINNICK: Yes.

MR. CORDING: Sometimes a fault tightens up through those. They do help us in some cases.

MR. SINNICK: We don't know whether the fault conduits are actually barriers or conduits.

MR. WILSON: It may depend on whether we're talking about saturated or unsaturated. If we're talking about unsaturated faults --

MR. SINNICK: In many cases hydrologically you have to take saturate openings, the large openings are the barriers, the small openings are the conduits.

MR. DEERE: You lose your capillarity effect.

MR. BLANCHARD: I'm not trying to cut down the discussion, I think the discussion is good, it's really what we hope to have, is a good communication, effective interaction.

And I promised you a roll-up conclusion

that was only one view graph, but I also expected to draw on the information presented by the other talks. And this, I think, effectively brings out the four key things that led us to reach a conclusion that conventional mining probably best supports both the regulatory and the scientific needs for site characterization.

Routine accessibility on an as-we-go basis. To make testing measurements and understand what the impacts are on the rock as we go and use that information as we continue on in the process.

Limited disturbance of the in situ rock conditions. There is some. The point is important to remember that any construction method is going to perturb the rock conditions. We're just talking about more or less and then the question is how much of a perturbation will occur and to what extent is that going to be a problem.

And what I would like to do is to take a couple of the view graphs that Bill Wilson showed to you earlier and just reiterate a point.

When he talked about the analyses that were done, you've heard me mention a time or two and Joe Tillerson has mentioned that 5.42 and 5.43 are these approximately 100 different evaluations and analyses that say here's what we think the impact is likely to be. Now, bear in mind we don't know that because we haven't done it. But expected change in matrix saturation near the shaft in the modified permeability zone, right around the shaft, it goes up three percent. We're predicting at ten meters out it's only one percent. That ain't much. And at ten meters away from that shaft is not very far. So we're not projecting significant changes in anything.

MR. NORTH: Significant for what? For performance evaluation, I'll accept that. From point of view of site characteristics, I'm not convinced. I'm thinking about the inputs to the very detailed hydrogeological models and the errors that will be introduced even by very small changes that may occur there.

What I would like to be convinced of is that you will get that data another way. If you can convince me of that, fine, I'll go way. Otherwise I'm going to continue to be irritating on this point.

MR. BLANCHARD: No, no, your point is well taken. Come back tomorrow.

MR. ALLEN: We'll be here.

MR. NORTH: We'll be here.

MR. BLANCHARD: Remember, the

exploratory shaft, we're not getting all of our hydrogeologic information or even most of our hydrogeologic information about that three-dimensional block from these tests. These tests are geared towards acquiring how it would change the rock properties near the exploratory shaft.

We're going to gain knowledge of vertical and lateral changes in terms of the hydraulic properties of the bedded tuff, the Tiva Canyon, the Topopah Spring, and the Calico Hills by the surface-based program. And we've got two different approaches in the surface-based program to try to get that information.

But we do have some changes. Whether or not the tests, empirical tests run during the construction phase prove this out is something to watch.

With respect to changes in rock-mass permeability, again, Scott mentioned the modified permeability zone, where the values change by 20 to 80 percent. Eight meters out it's two times. Again, they're predictions. And people can reanalyze the predictions, they can look at the nature of the information we used when we put it in and our calculational methods.

And during December and January we had an independent technical review team of about 25 people examine every one of these calculations. We looked at the need of the calculation on method, the equations that were used, made a judgment as to whether or not they were appropriate calculational techniques for the application for which they were applied, and then we looked at the data that was used in the calculation to see if they were reasonable. The results of that suggested that in some cases maybe we should have chosen a little different method or a little different data.

MR. ALLEN: Did that group write a report?

MR. BLANCHARD: It's called the design acceptability analysis. It's four volumes, about that thick. I don't know that there was anything in there that suggested that we were really far off and we ought to throw these calculations out. However, there were a number of recommendations and we're in the process of determining how best to incorporate the recommendations from that independent analysis.

MR. ALLEN: That was a non-DOE group?

MR. BLANCHARD: No, it was not a non-DOE. It was not a peer review. Perhaps sometime in the future a peer review might be called for on those. But that was an analysis of the calculations -- there were many aspects of the DAA, but the one I'm referring to now is looking at the calculational methods and the data that was used in these evaluations.

And all of the team that did this was independent from the group of people who did the first evaluations or wrote the reports or authored the reports, provided the data. So it was an independent team. So it's an independent check within the system. And if there's reason to believe that we need to look at this in a more rigorous fashion, such as a peer review, maybe that might be called for, I don't know.

Looking at the geochemical effects from constructing the exploratory shaft, again we're talking about things, changing the shaft liner and the composition, changing the pH, forming some precipitates, but again they're localized. So we stay within the modified permeability zone, we address the question that you ask and sometimes later, ten years from now, maybe we want to pull that shaft out, try to confirm what the changes were, and slowly, gradually mine away some of the (inaudible) of that rock in that modified permeability zone, trying to keep the effects even more localized before we went into incorporating that into the repository.

And finally, other things from the

construction effects, like the use of explosive products. There are small amounts. Big thing we really want to get is to make sure that we get valid measurements on chlorine-36, because we would like very much to determine the age of the water in that unsaturated zone, wherever we can find it. And so using explosives without chlorine-36 we think will be a big benefit, and also the MPBH and the radial boreholes out we think will give us a good handle on the chemistry of the samples. And always using tracers in whatever water we use we can determine source and where it went. So then that talks about limited disturbance.

Finally timeliness. We don't have the bottom line on that. It's obvious we have analyzed it, we've got a lot of people working on scheduling activities. It's been our perception for quite some time now give them the construction conditions. The real critical path to the whole operation is conventional mining ES for the scientists and if it takes two years to do that it takes two years. If we could shorten up the time for the other ES it doesn't matter, it's not on the critical path. Even if we did it in one week, it doesn't matter.

MR. DEERE: Unless it would affect your

two-year.

MR. BLANCHARD: Sure, if it could reduce the two-year, then would be a real benefit.

MR. DEERE: I don't think that's the argument. The argument --

MR. BLANCHARD: It may not be. We can certainly pull out the schedules, if you would like to look at them, and talk about the assumptions that we made.

Finally, demonstrated technology. Being a group of conservative people in this program we've adopted the demonstrated technology from the conventional drill and blast method using as many controls as we can place.

MR. ALLEN: Reasonably demonstrated technology.

MR. BLANCHARD: Yes. But, again, you all may know better than we do about some of these techniques with respect to how feasible they are, where they've been demonstrated feasible.

Now, what I would like to do is to have

more open discussion, should you wish, with Bill and Ken here as the presenters and myself, to talk about things that you think are left up in the air or maybe to go into some details we haven't yet brought up or to look at some slides and ask -- examine more about how did we develop this perception.

(Thereupon a brief recess was taken, after which the following proceedings were had:)

MR. BLANCHARD: I think we're ready.

MR. DEERE: In our consensus, we wanted to have a chance to talk together a little bit about what our feelings are and how much we would like to continue discussion on this topic this evening.

I think that we would have no concluding statement that we would want to make at the present time. The majority of us feel we would like to hear tomorrow's presentation, which is part of the overall plan, and that we should get more familiar with that.

There is, however, one combination of shaft 1 and 2 in testing that we think might merit looking at or thinking about. I believe that this concept has already been brought out in several statements that we have made, but perhaps it would be well to repeat it, and that would be the possibility of doing the first shaft in a somewhat smaller diameter, small enough that later it can be reamed out by raise boring to its final diameter, but yet not so small that you get into difficulty in rates of sinking.

And I think Ken has told us that would be perhaps ten feet in diameter, is about a minimum you would want to think about. We had used eight foot as a --

MR. BEALL: We're in the same ball park.

MR. DEERE: Okay. Let's say nine feet. We have lots of three-meter shafts that we have used for things such as this.

Okay. So if one, then, could highball the scientific studies on the way down you could reduce construction time from 24 months to some lower figure.

MR. WILSON: Would you explain highball.

MR. DEERE: Highball means where you drop the geologist in and you give him an hour instead of three hours. That we don't do at that time all of the scientific boring or the observations that you want. There will be some that will have to go on at this time. So there will be the periods of developing some of the things that you have. So this is a question of removing part of the information -- a part of the test from the first. If you can't do that, then there is no way we're going to add on to the schedule time, as your studies have already shown. Therefore in our consideration yesterday and in our little discussion now, there does have to be a reduction.

What do we gain from a reduction in that testing?

Well, we gain time in getting down to the bottom of number 1 shaft, driving across, and coming up with the raise boring in the second shaft. We should have both shafts completed, open, in much less time than is on the present program.

The second shaft could be raise bored to a diameter such as seven feet, six feet, or eight foot, eight foot being a common one, which gives perhaps a little bit more stability, a little bit less disturbance. And this, then, would become a diameter in which you would be working from the top down doing your testing, sampling, boreholes, shot-creting any questionable areas, rock-bolting if necessary, and coming on down at the pace that you want.

Meanwhile, shaft number -- shaft number 1 could be raise bored with the material pumped out through shaft 2 by pneumatic -- not pumped out, but blown out with pneumatic handling, which, as I pointed out, is not a new method but is the most common method of removing the muck. So this means shaft number 2 while you're working in it will have a 30-inch pipe or a 24-inch pipe over at the side taking muck up for a couple weeks period while you're working in shaft 2. Then the lining is done in shaft number -- shaft number 1.

You have a facility in which mining equipment, rooms, the other part of the thing is operating. So you have an operating facility while the testing, the scientific testing, sampling that has not been able to be made in number 1 is now being made in number 2.

The important observations in number 1 are not only the geologic mapping, but allowing the geologists to look for the perched water and to sample the perched water. So there will be times where you're not highballing at all. You're shut down for a week or you're shut down for two weeks. But you still get the opportunity to do the photography and to do some work. I don't think it makes any difference if he's down there one hour or three hours. It's not going to slow it down that much. But it does seem that 24 hours is a little bit of a lengthy period.

MR. WILSON: Twenty-four months.

MR. DEERE: Twenty-four months. Before you're able to get together and then drive between the two shafts.

Now, what do we gain by this? Well, this is the question. Do you gain enough to venture into a change in a scheme that has already been engineered and programmed and costed to a certain extent? That in our mind is the question.

We want you to be able to get better scientific information, not poorer information. We want to have a rock that is less damaged, has less permeability increases by raise boring rather than the blasting. So we know there will be benefits, better scientific information, losing none, what we've said before, better walls. And we feel with these modifications there will be no schedule penalty.

Now, this requires more detailed studies to disprove or to prove that, and the question is, in our minds: Is there enough at gain to make it worthwhile to interrupt all of the engineering studies that have been going on? And I think that's the position in our mind. We'll be talking about this tonight. We wanted you to hear it in our thinking.

We would like to say we have reviewed the processes, we have reviewed the thinking, the studies that have gone before, and we are in agreement that this method is equal or better than any alternative methods that we could come up with; or to say we feel that there is another method that might be preferable. And so we're right at this -- at this stage now. If one cannot combine that one and two in the scientific test and have it worked out into that schedule, we cannot add them on and gain very much.

Yes, Bill.

MR. WILSON: I would like to be sure that what you claim are gains are, in fact, gains, regardless of whether they outweigh the other changes that would be necessary.

For example, mapping the shaft wall. I'm assuming what you're saying, you get better and more information from the raise bored wall than from the mine and blast wall; is that correct?

MR. DEERE: I think you could map them

both and it wouldn't affect the schedule that much. I think you can still do your mapping of shaft 1.

MR. GERTZ: Yeah, your scenario would still map shaft 1 as you go down, I believe the way you articulated it.

MR. DEERE: Right. Whether you try to cut down on that or go ahead. But I think you still would be able to photograph it, you still would be able to map it. Now, whether you would want to do all of the details that you would later do over in shaft 2 would have to be up to you.

MR. WILSON: You may be able to do more details in shaft 1 than shaft 2 because of the roughness of the walls.

MR. CORDING: Or you can map shaft 1 twice, as you (inaudible) drill and blast, and after you raise bore it. If you want a good comparison of the difference --

MR. WILSON: How does the fact that we're going to be putting a liner in as we line it --

MR. BEALL: No, no, no, we wouldn't do that.

UNIDENTIFIED SPEAKER: Yeah, it would be shot-creted at some point.

MR. WILSON: Okay. What other tests

would we gain from the raise bore measurements that would be an improvement over the drill and blast?

MR. DEERE: Certainly you'll be able to get samples that have not been disturbed by blasting.

You'll be able to get them out of the wall, whether they're overlapping drill holes or whether you actually take a six-inch core.

MR. WILSON: Again, I guess the question is: How critical is that?

MR. DEERE: Well, I think in some of that you will have to answer that for us. These were points that you were trying to minimize and minimize and minimize and we agreed with your concerns, and if you're not concerned about it, well, then maybe our concerns will be lessened.

MR. GERTZ: The question, just to clarify further, would be: Can we get better data this way than our radial boreholes or other techniques that we had sought to use to find good representative data?

MR. BLANCHARD: One of the questions I have is if we conventionally did a smaller shaft to start with and we had the radial boreholes and the --

THE REPORTER: I'm sorry, I can't hear you.

MR. BLANCHARD: The MPBH gives us a pristine environment before we start the construction, presumably, if you can go with the word "pristine", which most people have a problem with. Then as we do this the smaller conventionally-constructed shaft, we still have radial boreholes which will be measuring the excavation effects on hydrologic parameters and rock properties. And at some point we'll have empirical information that would either confirm the distance or what the rock -- the effects are for construction radially out around that borehole. And if they're within a certain zone of who really cares, the changes and the degradation of the properties is not really significant. Then one might come away with a different feeling about the need to raise bore.

In other words, sure, everyone here thinks right now that the raise bore would give us a smooth wall, but if our predictions are right or if our predictions about the extent of the modified permeability zone and rock-mass permeability and our results are confirmed or our predictions are confirmed or it's less than that, then maybe the amount of change in the rock properties is just not significant.

On the other hand, if they were wrong

and it was a lot larger, then the results -- early results from the modified (inaudible) from the radial boreholes would begin to tell us something.

MR. DEERE: But you would still be

ahead by raise boring your second shaft, I mean from a construction standpoint and a time schedule and cost.

MR. ISAACS: I want to bring a measure of programmatic overlay to those things because you've said them a few times. I think it's important to bring some programmatic reality to that kind of a statement.

I think in my own mind that we have to ask ourselves: Has the project developed a process for site characterization that is clearly adequate? And if there are marginal advantages to be gained by an alternative, I think you're absolutely right, we ought to evaluate and see whether those advantages are large enough to weigh in adapting the program in some sense.

But let's not forget the thresholds over which one has to climb in order to make that kind of a change to the program in reality and the fact that when one weighs that off against the benefits, those benefits need to be there not to strive for perfection but for unambiguous adequate site characterization. Because in order to change a 6,300 page site characterization plan in any substantial manner at all, which would in itself take a very, very large effort and take the program off track, number one.

Number two it would require a new comment period starting from scratch, also many, many new months. It would clearly raise the overall schedule both for starting this program, and I tried to go through in some fair detail for you all back in Washington the history of this program to tell you about the many pressures on us from all sides of this program, and one of them clearly being the fact that there was a tremendous amount of pressure from the start moving dirt in this program, and the fact that the carrying charges for this program, whether you're doing work or not, unfortunately, are about $400 million a year. And the people who are footing that bill are looking for some results.

So I'm not saying any of this to say let's not do it. What I'm suggesting is this is a very serious implication to make this kind of an adjustment to the program at this point in time. We ought to do it but we ought to go into it with not only the technical view of can we enhance the program, and I would suggest we say is it inadequate now or is it barely adequate and are we enhancing it well above that point or are we making some kind of variations on a theme that when balanced against these other programmatic implications say, well, you know, maybe yes, maybe no, but these guys have done a thorough analysis, one can skin this cat in a different way, but perhaps it's not worth that effort. So I ask you to look at all those perspectives as you -- as you and we juggle these considerations.

MR. DEERE: Well, Tom, I think those statements are very good. If we're making a suggestion that there could be a little savings on the schedule by another method and you also get better scientific information and you lose six months because a change in the documents, then you really have to question whether the change is really beneficial. And I guess that's why we're discussing this today.

MR. ISAACS: Sure.

MR. DEERE: But it's not just construction time, it's the change in --

MR. ISAACS: Sure.

MR. DEERE: -- all of the program

authorizations that you have now.

MR. DEERE: Very difficult.

MR. ISAACS: No question.

MR. GERTZ: Let me add one other

subject to it. I think sometimes my colleagues refer to me as a pretty aggressive project mananger and a risk-taker. I'm one who does like to get dirt moving and things like that. But in this project we are faced with a regulatory regime unexperienced by any of us. It's the first time a repository is ever going to be licensed. Our experience in time frame of licensing power plants has not been too good recently either as far as going over data. And when you refer to highballing, that was your words, not my words, the first shaft, although I would like to think that would be a practical approach I don't know if that's a realistic approach in the regulatory environment we work in.

When we talk about qualifying QA programs, and Bill's scientists are here in the next month, they're going to have to go through audits with ten or 20 people sitting around a table asking them what they're doing and asking them how they're preparing the plans, are they filling this out, it's a very slow, methodical process we go through to make up plans, much less carry out fieldwork. So it's just another reality of the schedule that I'm just passing out for general information for you.

MR. ALLEN: By the same token, the same

regulatory agency that is looking over your shoulder here, NRC, is going to be demanding the very best quality they can get.

MR. GERTZ: Yes.

MR. ISAACS: Please don't take our comments as being defensive, simply broadening the effect that when we look at the implications of things like this in the real world we need to address the full balance of considerations, and those are some of them that we all need to take into account, not that it's not legitimate and, in fact, valuable to review whether or not there's not a better way to skin this cat.

MR. BLANCHARD: Certainly when your scenario gets firm enough in your mind that we're ready to sit down and write it, we'll be perfectly happy to try to provide whatever information we can to help you make an assessment.

MR. GERTZ: For us to make an assessment.

MR. WILLIAMS: I would appreciate the

opportunity to make one short comment. I'm Bob Williams from EPRI.

In the past 15 years I've sat on the back benches in five or six reviews by the National

Academy of Sciences, various panels. I am particularly impressed with how quickly this particular group is getting to important technical and scientific questions. But in those 15 years I haven't yet learned to keep my mouth shut, and I feel compelled to blurt something out here today, because I think it will be constructive to your deliberations tomorrow.

I think there are two things that I have to blurt out. The first is hang tough on the concept that better data that's going to require less adjudication and adjustment and haggling is going to be worth a somewhat longer construction schedule and characterization.

Second, let me say that we in the utility industry are struggling mightily to provide the leeway that is needed for realistic schedules. Right now a realistic schedule for the program is like grabbing 11,000 volts of AC. Program managers are immediately incinerated.

So I've listened for years to debates

about pros and cons from three to six months in a characterization schedule, but from the perspective of two or three years later, the things that were haggled about have still not happened. So please don't make your decision on this different type of shaft sinking placed on the ephemeral two or three or six months of schedule difference.

Now, I guess my final word would be to keep your eye on the overall site suitability evaluation and the strategic perspective. And I think a strategic hydrogen bomb went off today and nobody rose to debate, which was that a modified permeability zone is insignificant compared to other paths for vertical permeability. And that is that rocks that get cracked from shaft sinking don't really make any difference in the overall site hydrologic performance.

So I'm blurting it out much too quickly and much too directly. But I would like to say an awful lot is hanging on (inaudible), so I think you should either have some presentations on that tomorrow or get that agendized for your following meeting, because it says really that much of this hydrologic characterization isn't going to make much difference if the vertical faulting is dominated by structures much larger than the shafts that you're talking about.

I hope that's helpful to you.

MR. BLANCHARD: Well, are there any

other closing remarks for the afternoon?

We do have pending before us two items that we'll carry over to tomorrow. (Inaudible) The other is give you an annotation of what's in 8.42 and 8.43 so you can peruse the evaluations at your leisure.

MR. DEERE: I have the 8.42.

MR. BLANCHARD: We'll tell you what's where and where it's important and why it's important.

MR. DEERE: Fine.

MR. BLANCHARD: And then this other question which you pose now, a possible scenario for doing an analysis on it.

Did I miss anything that look like items that you want to cover?

MR. ISAACS: Questions about the design acceptability analysis was one. I don't know if there was ever a clarification as to whether or not you wanted it. Clarence raised the issue as to whether it was available. You said it was this thick.

MR. SALTZMAN: Also NRC comments.

MR. NORTH: We have those. Somebody mentioned that since 1982 there have been a whole series of evaluations and alternatives.

MR. BLANCHARD: Yeah, we have that over

there. Those are finished.

MR. GERTZ: Jim, yeah.

MR. BLANCHARD: Did you want those mailed or did you want to take those?

MR. NORTH: I would just as soon have one as soon as you can get them.

MR. GERTZ: Give us four of them.

MR. BLANCHARD: Will you let us know tomorrow about the DAA or do you want to make that decision now?

MR. ISAACS: Design acceptability analysis.

MR. BLANCHARD: That was produced after the SCP, in December, January.

MR. VOEGELE: Max, maybe it would be appropriate to have a view graph tomorrow morning to show them what we were doing and let them decide if they want to pursue that topic.

MR. BLANCHARD: Make that decision after we give you a view graph, fine.

Thank you very much.

(Thereupon the taking of the proceedings was adjourned until Wednesday, April 12, 1989, at eight o'clock a.m.)