RAS 5623 72-22-ISFSI-State Exhibit 159-Recd 4/24/02

CONDENSED TRANSCRIPT

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	Docket No. 72-22
	)	ASLPB No. 97-732-02-ISFSI
PRIVATE FUEL STORAGE L.L.C.	)	DEPOSITION OF:
	)	
(Private Fuel Storage Facility)	)	**GEORGE H. C. LIANG**
	)	
	)	**(Utah Contention O)**

Tuesday, April 17, 2001 - 9:14 a.m.

Location: Heber Wells Building

160 East 300 South

Salt Lake City, Utah

Reporter: Vicky McDaniel

Notary Public in and for the State of Utah

Template=SECY-028

SECY-02

SHEET 1 PAGE 1

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
Before the Atomic Safety and Licensing Board

In the Matter of) Docket No. 72-22
) ASLPB No. 97-732-02-ISFSI
PRIVATE FUEL STORAGE)
L.L.C.) DEPOSITION OF
)
(Private Fuel Storage) GEORGE H. C. LIANG
Facility))
) (Utah Contention O)

Tuesday, April 17, 2001 - 9:14 a.m.
Location: Heber Wells Building
160 East 300 South
Salt Lake City, Utah
Reporter: Vicky McDaniel
Notary Public in and for the State of Utah

PAGE 2

A P P E A R A N C E S

For the Intervenor: KURT E. SEEL, ESQ.
DENISE CHANCELLOR, ESQ.
ASSISTANT ATTORNEYS GENERAL
Office of the Attorney General
160 East 300 South, 5th Floor
Salt Lake City, UT 84114-0873

For the Applicant: PAUL A GAUKLER, ESQ.
ERNEST L. BLAKE, ESQ.
SHAW PITTMAN
2300 N Street, NW
Washington, D.C. 20037-1128
(202) 663-8304

For the NRC: ROBERT M WEISMAN, ESQ.
U.S. NUCLEAR REGULATORY COMMISSION
Washington, D.C. 20555

Also Present: John Mann

I N D E X

* * *

PAGE 3

P R O C E E D I N G S

GEORGE H. C. LIANG,
having first been duly sworn to tell the truth,
was examined and testified as follows:

EXAMINATION

BY MR. SEEL:

We're here today in the matter of Private Fuel Storage, LLC before the Atomic Safety Licensing Board in a matter to license a nuclear fuel storage facility in Skull Valley.

Q. Would you please state your name and address.

A. My name is George H.C. Liang. My business address is 100 Technology Drive Center, Stoughton, Massachusetts.

Q. My name is Kurt Seel. I'm an assistant attorney general for the State of Utah, and I will be taking your deposition today in the matter of Utah Contention O. Are you familiar with Contention O?

A. Yes.

Q. And it's my understanding you've been named as an expert witness in regards to Contention O.

A. Yes.

Q. Mr. Liang, have you been deposed before? Have you been deposed before? Have you had your

PAGE 4

deposition taken previously?

A. No.

Q. Ever?

A. No -- yes. Ever? I never have a deposition before.

Q. In this or any other matter?

A. Yeah.

Q. In that case, let me explain a little bit of a background. Do you understand how the deposition procedure works? I will be giving you a series of questions for you to answer.

A. Yes.

Q. If there's any ambiguity or if you don't understand the question --

A. Uh-huh.

Q. -- please ask me to clarify the question. Otherwise, I will assume that you understand what's being asked.

A. Okay.

Q. If you want to take a break, please go ahead and ask to take a break, and we will take breaks periodically. Only thing I ask is that you don't take a break while there's a question on the table. In other words, if I ask a question, I ask that you answer that before you ask to take a break.

PAGE 5

5

A. Okay.
Q. Do you have any questions at this time as to how this is going to proceed?
A. No.
Q. I'm now going to ask you a series of questions that relate to you being an expert and the topics for which you have been put forth as an expert in this matter. What I'm trying to do is find out where you're an expert and then put boundaries on where you're going to be giving expert opinions in this matter, and so that's the purpose behind a lot of these questions.
What is your educational background?
A. My education background, I did my undergrad in Taiwan, National Taiwan University. My major is in civil engineering. Then I did my graduate study at the University of Connecticut at the time where my focus is in the flow mechanics area, and that including hydrology, some other area like groundwater. Then I did my Ph.D. at the University of Connecticut. Focus mainly is wind and wave. I did my thesis in a laboratory wind tunnel 55 feet and then bring wind over the water surface, observe what's the mechanism between the air and the wave and the water.
Q. Since you graduated from University of Connecticut with your Ph.D., what hydrology related jobs

PAGE 6

6

have you worked on, generally speaking?
A. Oh, since then I've been working with Stone & Webster Engineer Corporation in Boston. Over the years I involve a lot of the project. In the early day, in the '70, '80, mostly in the nuclear project area, which I participate in my amended report including hydrology area, modeling of groundwater. And give you an example, in the Millstone 3 Nuclear Power Station there's one study which I participate is, what happen if a tank rupture in the building area, and then a scenario that hit the ground and the groundwater, how that will disperse into the nearest water body.
And over the years, other nuclear power station also involved, too, like the Shorehan project, Nine Mile 2. And some other, even the fossil plant. Most recent three, four years I'm involved a lot with the siting study of the fossil plant which all involve hydrology -- what happens if a storm come in to runoff, how are we going to control the water quality of the storm runoff before it leaves, and so on.
Q. So are you involved in siting monitoring wells and production wells, things like that?
A. Not really, but at one point we -- Stone & Webster is very diverse company. Not only in the power plant, we also have environmental cleanup. Sometimes

PAGE 7

7

because so many projects going on, they want some personal resource. I was asked a number of times to look into this so-called monitoring well. Ground well -- at the groundwater well, there was monitoring, and then give some technical input to the specification and so on.
Q. Do you usually look at -- you don't put in the well, or put in the wells yourself --
A. No.
Q. -- but you look at the well logs?
A. No.
Q. You don't look at the well logs?
A. Oh, yeah, I review well log. I have some there that come in. I do -- I did.
Q. Okay. And so you're experienced in well logs, well construction, and pump tests, or other types of aquifer tests?
A. Yes, I involved in -- when I worked with the Stone Webster, yeah. As a matter of fact, I -- most, on this one I also give some supervision to the engineer under me to prepare that kind of spec, like scope of survey and so on.
Q. There is a pump test, a test well in this matter that was installed at the site?
A. Yes.

PAGE 8

8

Q. And a pump test was done -- or I shouldn't say a pump test. Actually it was a static level test --
A. Right.
Q. -- that was performed on the site. Are you familiar with that well?
A. I reviewed the result. But the actual supervision of that pump test is under my coworkers at Stone Webster.
Q. Do you consider yourself an expert in test well analysis? Is this an area of your expertise that you would -- assuming the data came to you that you could look at it and give an expert opinion on test data from a well?
A. Yes, I consider myself in that -- if it have something, data in -- show me, I review it, yeah.
Q. Are you familiar with different types of geologic formations?
A. Geologic formation area is not my area, because that -- in Stone Webster we have another group of people, geotechnical group. They will do a lot of geological investigation, study, collect data and so on.
Q. For purposes of Contention O, subsurface hydrology, would you consider yourself an expert, then, in which types of formations would produce water in amounts that would be useful to PFS on the site?

SHEET 2 PAGE 9

9

A. I'm not in that area, no.
Q. Surface water modeling?
A. Yes.
Q. Do you do surface water modeling?
A. A lot.
Q. Okay. That would be --
A. But I have to qualify here, because sometimes if our project required -- I mean, we still -- not the latest project. We will formulate our Stone Webster model, but sometimes we using federal government ready available model, surface model and render modeling using.
Q. But you consider yourself an expert --
A. Oh, yeah.
Q. -- in the operation of those government models?
A. Oh, yeah.
Q. Okay. Were you involved in preparing or supervising the environmental report for PFS in this matter?
A. On section, surface hydrology section, yes, in the amended report and Safety Analysis Report.
Q. You also helped prepare or supervise the Safety Analysis Report?
A. Hydrology section.

PAGE 10

10

Q. Hydrology section?
A. Yeah.
Q. Are you familiar with Contention 0?
A. Yes.
Q. And Contention 0 has many aspects to it regarding environmental impacts. Are you familiar with the environmental impacts analysis that PFS performed?
A. Yeah.
Q. What I want to do next is put some boundaries on where you are an expert in this matter. From what you've told me, sounds like you are an expert on surface water modeling.
A. Uh-huh.
Q. Is that correct?
A. Uh-huh.
Q. You are an expert in groundwater modeling?
A. Yes. As a matter of fact, I wrote an article on that and presented in a symposium. That in my resume on the publication. On the groundwater model to use remediation of hazardous waste site, compare different model.
Q. What about areas of environmental impact as far as degradation of surface or groundwater quality?
A. What do you mean by that, degradation?
Q. Adversely affecting the water quality of

PAGE 11

11

groundwater or surface water.
A. Yeah. As a matter of fact, this is one of the -- when we prepare project report, no matter if it is nuclear or fossil, within Stone Webster scope of work, usually after modeling the ultimate goal is to evaluate what the impact in the environment, because this is always required by federal regulation or NRC guidelines to prepare ER. So modeling is the first step to prepare, but the evaluation impact is the ultimate objective.
Q. Let me continue on that vein. When PFS decided to go out and study the potential environment impacts from its proposed facility, what is the general format for doing it? Is it structure? Does it scope out a whole universe of potential environmental impacts and then decide to go out and collect data on each of those? Or does it take some other approach? You mentioned that modeling was the first step in the process. Isn't there -- are there other steps prior to modeling? How do you decide what it is to model?
A. Let me answer your question. First, when I say those step is not saying that -- of course, you also have to go to the PFS project. But answer your question, say, specific for this, I was bring on board before that process, so those consideration, the

PAGE 12

12

boundary to this and how it is determined, I did not participate in that decision for this project, Private Fuel Storage project.
Q. So if I understand your answer correctly, the initial scoping as to potential environmental impacts from this project was not something you were involved with?
A. Yes.
Q. Okay. What areas -- what specific environmental impacts were you involved in analyzing?
A. For this project?
Q. For this project.
A. I was brought on board when the question from NRC about the PMF, which also the state have some contention on that subject, PMF.
Q. I'm sorry. What did you say after that? I just didn't hear you.
A. Oh. I was brought on board to work on this project when we received NRC question on the PMF on the Private Fuel Storage site.
Q. Were you involved in any analysis as far as determining contaminant pathways from the applicant's sewer or wastewater system?
A. Will you repeat the question?
Q. Were you involved in analyzing any potential

PAGE 13

environmental effects from the applicant's sewer or wastewater system?
A. Not analyzing, no.
Q. How would you portray your involvement in that?
A. I was involved when they -- when we received the question on the contaminant pathway, then I reviewed the ER, SAR to that subject, what the environmental impact would be.
Q. So your involvement in that analysis was reviewing existing documents that had been prepared by someone else?
A. Yes.
Q. Is that true as well for Utah's contention regarding contaminant pathways from PFS's retention pond?
A. Yes.
Q. You reviewed existing documents regarding that, but you did not actually help prepare those underlying documents?
A. Yes.
Q. Is that true as well for Utah's Contention 0 regarding potential for groundwater and surface water contamination?
A. Yes.

PAGE 14

Q. Is that true as well for Utah's Contention 0 regarding effects of applicant's water usage on other well users and on the aquifer?
A. Yes.
Q. And that's true as well for Utah's Contention 0 regarding impact of potential groundwater contamination on downgrading hydrological resources?
A. Yes.
Q. So if I understand correctly, your expert testimony today on Utah's Contention 0 would be based upon data and information provided in reports which you didn't prepare or supervise?
MR. GAUKLER: Objection. You may go ahead and answer the question. The objection is unclear. I don't think he testified to that, so...
MR. SEEL: Okay. I'm trying to find out what it is that he can testify to today, and my understanding is he's relying on documents that he didn't help prepare but merely reviewed.
Q. (BY MR. SEEL) Mr. Liang, I'm trying to put some boundaries on what it is you know and what you've done so we can figure out where you're an expert and we can expect you to provide expert testimony, and where you're not an expert and you won't be providing expert testimony on this matter.

PAGE 15

Did you help prepare the environmental report in this matter?
A. I need to -- specifically what area? Environmental covers so many section, so many area. And your question say, do I have to prepare my own report. I cannot answer. All I can only answer, say I prepare hydrology section of the environmental report.
Q. So you helped prepare the hydrologic section of the ER?
A. Yes.
Q. Did you rely on other documents or other information to prepare that section of the ER?
A. We used reference, and based on the scope of what required on the ER, which has NRC Reg guideline, we started to provide input data from the site or from existing literature, and then we decide which model to use. And then after running these all number required by -- all the information resulting, required by the NRC, we prepared the section.
Q. When you were preparing that section of the ER, were you doing it to comply with the NRC regulation?
A. Yes.
Q. Was that NRC regulation --
A. 4.2, Reg Guide 4.2, Environmental Report. That's the reg guide guideline give you what should be

PAGE 16

included in that hydrology section or other section. Very detailed, what you should be use and so on. Reg Guide 4.2 of NRC for all nuclear facility.
Q. In PFS's, Applicant's Responses to Requests for Admissions No. 119 of Contention 0, PFS has taken the position, it appears, that there was a lack of a direct hydrological link between groundwater and the surface at the PFS site. Are you familiar with that position?
A. Yes.
Q. PFS's position that there is a lack of a direct hydrologic link between groundwater and the surface?
A. Yes, I'm familiar with that.
Q. Are you able as an expert opinion to respond and answer questions regarding that issue?
A. Yes.
Q. Can you please explain in general terms how PFS reached the conclusion that there was no direct hydrologic link?
A. At the site?
Q. At the proposed site.
A. Yeah. The reason for that is, we -- during the preparation year we did an evaluation and survey, and we haven't found, or only few perennial stream, but

SHEET 3 PAGE 17

17

very -- none at the site.
And also we did some soil investigation by geotechnical group and found out that mostly is silt or clay or silty clay. Because there's no surface water at the site, there's hardly any interconnection between -- the link between these two, the surface water and groundwater area. That's my conclusion.
Q. So as I understand your answer, your conclusions or your expert opinions on that are based on two things: low amounts of precipitation and the permeability of the soils at the site?
A. Yeah.
Q. Is there any other factors that might have gone into that decision?
A. Also we think the five-mile radius of the site. We haven't found any permanent water body. The only thing we have found is more reservoir or pond for the irrigation purpose.
Q. We're talking about a hydrologic connection between the surface --
A. And the groundwater.
Q. -- and the groundwater?
A. Right.
Q. Is depth to groundwater a factor that went into your --

PAGE 18

18

A. Yes.
Q. -- conclusion?
A. Yes.
Q. Okay. There was factors: depth to ground water, the permeability of the soils, and the amount of precipitation at the site?
A. Yes.
Q. Based on those three factors, you came to the conclusion that there was no direct hydrological link?
A. Yes.
Q. To use those factors, I assume you had to collect some data of some kind on those three factors?
A. Yes.
Q. Okay. Could you please explain to me the data that was collected regarding the permeability of the soils?
A. The permeability of soil, we have a monitor well, CBT No. 5, which we install a casing two inches, become a monitoring well. The reason that this spot is a boring hole, but later on we decide to install a monitoring well, two-inch diameter. And our geology -- geotechnical group do a so-called constant head pumping test, and then after the data collected, the geotechnical engineers have a calculation, calculated

PAGE 19

19

that permeability is -- I remember is .142 feet per day.
Q. Is that the permeability of the surface soil, or is that the permeability of the soil in the screened area of the well?
A. At the screened area of the area, yeah.
Q. And I understand that PFS is proposing to use a well or series of wells to obtain water for under the site?
A. Yes, that's what I understand.
Q. And that this 0.142 -- was it feet per day?
A. Uh-huh.
Q. -- permeability is sufficient to provide water to the site?
A. Without calculation I cannot answer your question.
Q. I'm sorry?
A. Without calculation.
Q. Well, I guess -- would you consider that permeable enough to water that you would consider using it as a production well?
A. I believe so. But I want to add to it: also depend on how much water you're going to pump from the well. They are related.
Q. So the permeability that we were discussing is at the base of the test well CBT-5?

PAGE 20

20

A. Uh-huh.
Q. It's not the permeability of the surface soils. Is that my understanding?
A. True.
Q. And my understanding, getting back to these three factors, is that the permeability of the surface soils or the permeability of the soils under the site will prevent downward migration of surface waters?
A. Uh-huh.
Q. I have a figure here entitled Figure 2.6-23, entitled Canister Transfer Building Foundation Profile 3-3, looking east. It is from the Safety Analysis Report. Would you please take a look at that.
A. Yeah, uh-huh.
Q. Do you recognize that document?
A. Yes, I have seen the figures.
Q. Would you please describe to me the formations on there that you believe were going to prevent downward migration of surface waters?
A. Oh, that's easy, because on the clay, as we present in the SAR and ER and also in the Safety Evaluation Report prepared by NRC, saying in the Skull Valley the silt permeability is .2 to .6 inch per hour. That's on Safety Evaluation Report page 2-23. But this number was developed by U.S. Department of Agriculture.

PAGE 21

21

They analyze the soil at the Skull Valley.
On the categories, this so-called soil group classification is clay, silty clay and so on. That permeability, in my expert opinion, is very, very low.
Q. And that was in the Safety Analysis Report?
A. Page 2-23, prepared by NRC. Also presented in our -- I believe in ER.
Q. What was the permeability in the screened area of the test well?
A. Is .142 feet per day.
Q. And the permeability of the surface soils were -- I believe you said 0.2 to 0.6 inches per hour?
A. .2 to .6 inch per hour.
Q. How do those two permeabilities compare to each other?
A. That is the soil test result. The other one is, if you -- someone make the unit the same, then you can compare. I haven't done that.
Q. It's just a conversion of units?
A. Right.
Q. Could you do the conversion for me?
A. Yeah. I need a pen and paper.
So the clay permeability is from .4 feet per day to 1.2 feet per day, the permeability of clay, in comparison with .142 feet per day at 120 feet down.

PAGE 22

22

It's a range. The clay permeability had a range from .4 feet to 1.2 feet per day. That's my calculation.
Q. The clay ranges between 0.44 feet per day and 1 foot per day?
A. 1.2.
Q. 1.2. Having done the conversion, is there a significant difference between your calculation of the permeability of the surface soils and the permeability of the soils at the bottom of the test well?
A. I didn't get you at first. Will you repeat the question?
Q. Is there a significant difference in the permeability?
A. No. In my engineering, we say this the same magnitude order.
Q. So the soils from which PFS is intending to acquire water is just as permeable or impermeable, depending on how you look at it, as the soils which are going to prevent downward migration of surface water?
A. I won't say that. You see, the production of the water, not only when you heat the aquifer, is not only depend permeability. They are also when so-called transmittability. Because permeability is this way, the transmittability is from horizontal. There's two coefficient in there.

PAGE 23

23

Q. So this is a heterogeneity in the aquifers? The permeability in the three dimensions differs?
A. No. The permeability is vertical, the transmittability horizontal, coefficient. An aquifer is -- how much water you can do is not only permeability. You have other coefficient also affect the production of the well is the transmittability coefficient.
Q. Are you saying the permeability of the surface soils --
A. Uh-huh.
Q. -- does not determine the ability of it to transmit water?
A. I didn't say that.
Q. Well, let me ask this question, then. What is the difference between permeability and hydraulic conductivity?
A. I don't know that.
Q. Are you familiar with the term "hydraulic conductivity"?
A. I would say no.
Q. I have a document here which is page 5 of Stone and Webster Engineering Corporation calculation sheet entitled Determination of Aquifer Permeability from Constant Head Test, an Estimation of Radius

PAGE 24

24

Influence for the Proposed Water Well.
A. Uh-huh.
Q. I'd like you to take a look at it and see if you're familiar with that.
MR. GAUKLER: Could you show him the calculation, please. And also I'd like to have the revision of the data and calculations stated for the record.
For the record, it's revision zero, the calculation dated April 22nd, 1999.
A. Yeah.
Q. Mr. Gaukler has raised a good point. I understand that there was a newer revised version part of this document, which we received yesterday.
Here's a revised version of the same document. There's a page 5. Could you look at that as well and confirm your testimony?
A. Same page?
Q. Page 5, yes.
MR. GAUKLER: This is Revision 2, dated March 27, 2001.
A. You only want me to look at page 5?
MR. GAUKLER: If you need to look at the entire document, please do so.
THE WITNESS: Page 5, yeah.

Q. (BY MR. SEEL) There's a symbol on there identified as K.
A. Yeah.
Q. What is the --
A. The K is permeability, meter per second.
Q. What are the units associated with the K?
A. The unit? I said meters per second.
Q. Are those the correct units for permeability?
A. I believe so.
Q. I have an introductory groundwater textbook by the name of Freeze and Cherry. I'd like you to take a look at page 29.
A. Page 29.
Q. At the bottom there's two parameters -- sorry. Look at page 30 -- 29.
A. Twenty-nine.
Q. Two parameters, one identified as permeability and one as hydraulic conductivity.
A. Uh-huh.
Q. What are the units associated with the permeability?
MR. GAUKLER: Use as much of the document, the book, as you need to.
THE WITNESS: Yeah.

A. Okay, I'm finished.
Q. What are the units associated with the parameter of permeability?
A. The table did not show that. The table only show you from one unit how to convert to the other unit. There's a different way to express a unit. But this is so-called conversion factor for permeability. It is not the unit for permeability. So you have a unit, he show this table. If you have foot per second, how to convert to feet per second and so on.
Q. Why would the units change between the conversion? Why would the units between permeability and hydraulic conductivity be different?
A. Hydraulic conductivity, meter per second and then converted feet per second.
Q. But the units are the same. We simply have changed the system of units.
A. Correct, yeah.
Q. We've gone from metric to English.
A. To -- metric to English.
Q. Let's take a different approach. Is permeability, the units of permeability always length over -- excuse me. Are the units for permeability always length squared? It doesn't matter what unit or what type of system you're in, it's always going to be a

length squared?
A. Yes.
Q. And for hydraulic conductivity, will the units always be length over --
A. Length over time.
Q. -- time?
A. Per second. Yup.
Q. Getting back to page 5 of the Stone & Webster document.
A. Uh-huh.
Q. What are the units on permeability?
A. Liter per second.
Q. Are those the correct units for permeability?
A. There is a difference in the textbook and the calculation. The unit differs. But we can check back on the reference weighted formula or reason it from, because there's a reference for this formula, and I believe the formula also define the way, what units should be used in that formula.
Q. The question is, do we have a reference?
A. I would like to have a moment.
Q. Take your time.
A. According to this formula, permeability is expressed in meter per second. I analyzed this formula

by the unit of individual turn. L is lengths of the permeability test section in meter, and then Q is the water flow rate into the well, liter per minute. And then H is height of the water above static equilibrium level in meters.
I just operate the unit and come out -- after I all cancelled this, it came out as length over time.
Q. So it's really not permeability at all, it's hydraulic conductivity?
MR. GAUKLER: Objection. He didn't say that.
Q. I'd like to get back to the three factors that you relied upon to come to the conclusion that the surface soils at the site would prevent the downward migration of surface waters into the aquifer. There were three factors.
A. At the site, yeah.
Q. Correct me if I'm wrong. Those three factors were depth to the water, the groundwater, the low permeability of the soils at the surface, and low amounts of precipitation?
A. Will you repeat? I didn't follow.
Q. I understood there were three factors.
A. Yes.

PAGE 29

Q. The first being depth to groundwater --
A. Uh-huh.
Q. -- the low permeability of soils at the surface --
A. Yeah.
Q. -- and low amounts of precipitation.
A. Yes.
Q. This is from a document I believe you've already looked at. This is page 3.
A. Yes. This is an attachment to the calculation.
Q. And this is well construction log for the test well?
A. Okay.
Q. My understanding from looking at the log -- is that, at the bottom of the borehole --
A. Uh-huh.
Q. -- a sandy silt or silty --
A. Silty sand.
Q. Silty sand?
A. Uh-huh.
Q. And that was where you were going to be acquiring water for your pump well when it was installed?
A. Normally we extract water when we heat this

PAGE 30

water coming out, heat a depth which we have water pumping out. It could be some other location change, maybe deeper or shallower. But at that spot, yes, we will have a silty sand and we heat the water.
Q. This area here, is this sand in the construction log?
A. Yes.
Q. Is that not from the surrounding formation?
A. No. We put it when we install the well.
Q. And then there's this layer here?
A. Uh-huh.
Q. What's that say?
A. 125.5 to 122 elevation we put some bentonite, b-e-n-t-o-n-i-t-e, pellet, p-e-l-l-e-t, seal.
Q. So the bentonite isn't part of the surrounding formation?
A. No.
Q. Why did you put it in?
A. Because you have to seal the well, prevent the water coming in the side, which is a -- circumference is circular.
Q. It's to prevent water from coming up the well?
A. Uh-huh. No, no -- yeah, coming up it. Not -- we pump from here, but we don't want the water --

PAGE 31

without filter, because the sand is acting as a filter action, we don't want the water to come out and then become unfiltered. This sand is prevent this water coming out on the side way. We're actually pumping the water from here.
Q. And this is -- up here, this is cement?
A. Yes.
Q. And this is to prevent groundwater from coming up to the surface, not to prevent surface water from going down into the well?
A. Yeah, Yes. Actually, there's two way. We don't want surface water to -- we don't know what surface quality will be. Actually, it's a two way. We prevent the surface water because we don't want it to come down there. And we don't want the groundwater coming up the side way, you know, which will be -- affect our pumping from here.
Q. So the bentonite seal and cement bentonite placed around the well --
A. Yes.
Q. -- is to prevent water from the surface migrating down, and water from the subsurface --
A. Going up.
Q. -- going up. And that's to preserve the water quality?

PAGE 32

A. That's one of the reasons, uh-huh. I look at that very carefully. And they were confirmed through a Driscoll, author by Driscoll, Groundwater Handbook, the construction of the well.
Q. The construction of the well was to --
A. Is very -- follow the guideline according to the book of Driscoll, Groundwater Handbook. Put the sand and then sealed it by cement and so on.
Q. If they had not put in the seal, would this have punctured this zone of surface silt and clays that PFS asserts will prevent downward migration?
MR. GAUKLER: Objection. What would puncture it? It's not defined.
Q. (BY MR. SEEL) The borehole in which the well is installed.
A. Uh-huh.
Q. It would have punctured that -- step back. If they had not put the seal in place around this well, would it have provided a pathway for surface waters to migrate into the aquifer?
A. I don't understand your question.
Q. What is the purpose behind putting the bentonite and cement bentonite seal in the well?
MR. GAUKLER: Asked and answered. You may answer it again.

SHEET 5 PAGE 33

33

A. I already answered. The reason, because we don't want the groundwater coming on the side way, rather than we like water coming up from the well casing itself. That's the reason.
Q. If the bentonite seal and the cement bentonite portion of the well was not there, could surface waters migrate down into the aquifer?
A. No.
Q. If the question is not clear --
A. No, no, surface water would not migrate. If you don't have this sand or the bentonite over there, the surface water will not migrate, no.
Q. Surface waters would not migrate down through this area?
A. Uh-huh.
Q. Why not?
A. Because there's soil surrounding it.
Q. So why bother to put in a bentonite seal at all?
A. Because, as I say earlier, it prevent the water coming up from the side way, not from the casing, the well casing itself.
As I say earlier, the bentonite pellet also let the water stay down so they can go into the -- through the wells the sand have the filter effect, so it

PAGE 34

34

keep the water you pump in from the casing clear. You don't want some sediment or something to come up when you pump the water. This practice also for any residential when you have your own water well supply from your backyard.
MR. GAUKLER: We've been more than an hour. Can we break?
MR. SEEL: Why don't we take a break.
(Recess from 10:25 to 10:41 a.m.)
Q. (BY MR. SEEL) Mr. Liang, I'd like to return to the three factors that PFS relied upon to reach its conclusion that surface soil at the site will prevent the downward migration of surface waters.
I have a document here entitled Figure 2.6-2, Plot Plan and Location of Geotechnical Investigations, Sheet 1 of 2 from the Safety Analysis Report, Revision 8. Would you take a look at it, please.
A. Okay.
Q. There are a number of borehole locations identified on that document.
A. The symbols say "boring location," yes.
Q. Are you familiar with this document?
A. I reviewed the document.
Q. You reviewed this document?

PAGE 35

35

A. Uh-huh. After they present in the ER.
Q. Were you involved at all in the drilling of these boreholes?
A. No. A colleague.
Q. Your --
A. My colleague at Stone Webster.
Q. Colleague?
A. Yeah, my co-worker.
Q. Approximately how many boreholes are located on that map?
A. Based on the symbol -- one, two, three, four; one, two, three, four, five. Four times five is twenty.
Q. Do you know what the diameter of those boreholes were?
A. If my memory right, it's about two inches. I may be wrong. Or one inch.
Q. I'll show you another document entitled Boring Log.
A. Okay, yeah.
Q. Boring B-1.
A. Uh-huh.
Q. Stone & Webster Engineering Corporation, Sheet 1 of 2, dated 8/31/99.
A. Uh-huh.

PAGE 36

36

Q. Please take a look at that.
A. Okay.
Q. In the area identified as methods.
A. Uh-huh. You mean the boring log, yeah. Methods.
Q. Methods. It should identify the -- actually, would you read that section?
A. Drilling soil: 3-1/4 inch inside diameter hollow stem augers. Sampling soil: Two-inch outside diameter split spoon, 24 inches long, 3-inch outside diameter Shelby sampler, S-h-e-l-b-y sampler, 30 inch long. Drilling: Rock.
Q. Thank you. Where it says "3-1/4 inch inside diameter hollow stem augers," does that mean the auger was 3-1/4 inches in diameter?
A. As I understand it, something like this, and then inside diameter means this.
Q. Inside the hollow stem?
A. Uh-huh.
Q. So inside the hollow stem is 3-1/4 inches in diameter?
A. Inside diameter.
Q. So the outside diameter of the auger itself would be more than 3-1/4 inches?
A. True.

PAGE 37

37

Q. So the borehole was at least 3-1/4 inches?
A. During the drilling, yes.
Q. It would have been at least 3-1/4 inches diameter?
A. Yes.
Q. Would you read the comment section of that document?
A. "No groundwater or bedrock encountered. Backfilled to ground surface with soil, marked with stake."
Q. Do you know why they didn't backfill these boreholes with something other than soil?
A. I don't know. However, based on my expert opinion, why fill with something else?
Q. Well, when PFS drilled their well, they backfilled with a cement bentonite mixture and a bentonite seal.
A. That is because for different purpose.
Q. My understanding is PFS has taken the position that the surface soils are permeable enough to prevent the downward migration of surface waters to the aquifer. Is that correct?
MR. GAUKLER: Asked and answered. You may answer it again.
A. I don't understand. You say pick a

PAGE 38

38

position. Will you clarify what that means?
Q. PFS has concluded that the surface soils are impermeable enough to prevent the migration of surface waters to the aquifer.
A. With this in the ER or SAR, I forgot, we'd say is very little chance to infiltrate into the ground from the surface water.
Q. What if there were holes punctured in that surface layer? Would those holes act as a pathway for surface waters to migrate to the aquifer?
A. I need some definition of puncture. Because if I say you have a membrane or some soil, then puncture I understand. When you have a soil, I don't know how you define a puncture.
Q. A borehole of a minimum diameter of 3-1/4 inches.
A. If you have a hole in the ground, clear, no obstruction on that hole, you say pathway, I will agree this.
Q. In your expert opinion, would backfilling the boreholes with soil sufficiently seal that zone so they could not act as a pathway for surface waters?
A. Yes, because that soil is pretty much what was coming out in the drilling operation. As a result, those soils just, you know, because you have a hole, so

PAGE 39

39

those are coming on the side way. After that you fill that, yes.
Q. Disrupting those soils when they were drilled wouldn't affect their permeability?
A. Your question pretty general, because we are doing something on one spot. I don't know that we're going to change. On that hole itself, I would say it could.
Q. When soils are placed back into a borehole, are you familiar with how that process takes place?
A. That's a common practice. I don't know the detail of the process.
Q. Do you know whether the geologist on the rig is the one who fills in the borehole?
A. No.
Q. The driller? The driller's helper?
A. I cannot answer this question, because we have a -- I have a co-worker. He was at the operation when the driller drilled this thing, make sure everything follow the rule procedure or the scope of survey we developed, Stone Webster.
Q. Do you know whether they placed the soils back into the hole and compressed them so that they were the same density as the surrounding soils?
A. No, I don't know this.

PAGE 40

40

Q. Do you know whether they just shoveled the dirt back in?
A. No, because I was not there.
Q. If the soils weren't placed back in the hole and compressed to the same density as the surrounding materials, would that change the permeability of those soils within the borehole?
A. In my expert opinion, no. If they compact, put back the soil which originally come from the hole, I don't think it will change the permeability. That's only my own expert opinion.
Q. Do you know why the state well drilling regulations require cement or bentonite placed into boreholes instead of just soil cuttings?
A. No, I don't.
Q. Do you know if the original field logs that were taken by the person who logged the hole would indicate how they backfilled those boreholes?
A. I reviewed a couple of the bore logs specifically to ER, CBT No. 5. I didn't read any they described the method to backfill back to the borehole.
Q. Are there boring logs that were handwritten in the field from which this boring log was generated?
A. I know if a technical -- I mean, a geotechnical engineer supervised this, he himself would

SHEET 6 PAGE 41

41

make some field note. And later on after contract completed, he would probably generate log, and then if any discrepancy he will fill in.

Q. But the field logs exist, as far as you know, for these boreholes, the original field logs?

MR. GAUKLER: Objection on what you mean by "original."

MR. SEEL: Handwritten. Unless the driller or the geologist on site somehow through a computer generated that document right there, there must be some underlying documents from which that document is derived.

MR. GAUKLER: Is that a question?

Q. (BY MR. SEEL) In your opinion, do people in the field collect raw data that they write down in a field notebook?

A. This is my understanding. This is general engineering practice.

Q. And it's from those field notebooks that this boring log was derived?

MR. GAUKLER: If you know.

A. I believe so.

Q. Do you know if those field logs have been disclosed to the State of Utah?

A. Not to my knowledge. I don't know anything

PAGE 42

42

about this.

Q. My understanding is that PFS intends to install at least one sewer system or disposal system of some kind on the site. Is that correct?

A. I think -- I'm not in that area, but my colleague which is in Denver engineered and designed the sewer system. So I don't think I am in the position to answer your question.

Q. Are you familiar that the sewer system will involve liquid disposal to the subsurface?

A. I know the sewer system in general, how it works, yeah.

Q. Is your colleague Mr. Lewis?

A. Wayne Lewis.

Q. He's the individual who would be familiar with the design and operation of the system?

A. Is in my belief, yes.

Q. Would he also be familiar with the ultimate fate of the fluids that are going to be put down in that system? Or would that be the area that you would be familiar with?

MR. GAUKLER: Objection. What do you mean by ultimate fate? Unclear and ambiguous.

Q. Where is the water that's going down the sewer system going to end up?

PAGE 43

43

A. That is area I'm not in a position to answer, because that is design the sewer engineer would know.

Q. Were you asked to give PFS -- strike that. PFS intends to use water from at least one source through the construction and operation of this proposed facility. Is that correct?

MR. GAUKLER: Object as vague and ambiguous.

Q. Does PFS need water to construct its site?

A. Yes.

Q. Has PFS proposed where it intends to obtain that water?

A. Will you ask this question again?

Q. Has PFS proposed a source for the water it intends to use to construct the site?

A. Yes.

Q. Were you responsible for determining the potential environmental effects from using the water from that source or sources?

A. No. But I reviewed the section which provided by my company colleague.

Q. Are you able to give an expert opinion as to the environmental effects associated with using the water at the site?

MR. GAUKLER: Object. It's unclear when you

PAGE 44

44

say using the water at the site, the environmental effects of. Are you talking from environmental effects of water use at the site in terms of water being used in the construction process, or water being obtained, environmental effects of water being obtained from some source, i.e., the well?

Q. What are the potential sources of water that PFS is proposing?

A. As I read the ER, they proposed either on site, if they found available quantity of groundwater, or they would truck in from outside source, or for some aspect of the need they would bring in some bottled water.

Q. To determine a potential environmental effect on a source of water, do you need to know where that source is?

MR. GAUKLER: Objection, vague and ambiguous question.

Q. Can you identify for me the exact location of the off-site sources?

A. No, because I'm not involved the original proposal where to get these waters' source outside.

Q. Do you agree that you need to know what the source of the water will be before you can take the next step and analyze what the potential environmental

PAGE 45

45

effects may be to that source?
MR. GAUKLER: Objection, vague and ambiguous question. You may answer if you can.
A. You have to repeat the question because I don't know if you're talking about outside the -- outside the site or on site or both.
Q. Precisely. How can you determine the environmental effects for using water from the source if you don't know where that source is?
MR. GAUKLER: Objection, ambiguous.
A. I remember ER section have addressed what your question is, but I can't remember exactly where the section or which chapter regarding your question about identify the source of the water come from. And they addressed what kind of impact would be and so on. It's already been addressed in the ER, which I don't know which section it is, because I originally did not participate about this proposal or calculation of how much water used during different phase of the PFS project into construction operation phase.
Q. So you believe the environmental report looks at each potential source of water for this facility and analyzes --
A. Address the impact.
Q. Analyzing the environmental impact for each

PAGE 46

46

of those --
A. Address the impact, yes.
Q. -- sources?
A. I remember I have read the section, but I can't remember exactly which section. Or during the phase of answer in RAI, NRC request for additional information, I remember. But I don't know which specific question. But this issue had been addressed and answered either in the ER or in the response to NRC RAI about the water source, where it come from, what the impact would be if we choose that way.
Q. Has PFS determined what the aquifer is under the site?
MR. GAUKLER: Objection, vague and ambiguous. Answer if you can.
A. You mean the aquifer of what? Where the aquifer is?
Q. Has PFS determined what constitutes the aquifer under the site?
A. I still don't understand your question: constitute aquifer.
Q. I show you a document.
A. Okay.
Q. It is from NUREG-1567, Section 2, page 2-12, subsection 2.4.5 entitled Subsurface Hydrology.

PAGE 47

47

A. Uh-huh.
Q. Would you please read that section for me?
A. Paragraph 2?
MR. GAUKLER: Please show him more of the document, please. What NUREG number is that, did you say?
MR. SEEL: 1567.
THE WITNESS: Second paragraph. Under the section --
MR. GAUKLER: We'll get you more of the document.
THE WITNESS: If the site is located --
MR. GAUKLER: Wait till you get more of the document.
THE WITNESS: Okay.
I would like to have the title of the NUREG, what the title of the NUREG 1567. Do you know the title of the NUREG 1567 before I go into the --
MR. SEEL: No, but I can go upstairs and get it for you if you'd like.
THE WITNESS: Okay. So I'm going to read what you request on second paragraph.
MR. GAUKLER: Wait till he gets it.
(Recess from 11:11 to 11:19 a.m.)
THE WITNESS: Okay. Actually it's Review

PAGE 48

48

Plan, also the Reg Guide 1.17. That is my guess. I just wanted to confirm that. Okay. Let me read to you what you request, the second paragraph.
"If the site is located over an aquifer which is a source of well water, the groundwater aquifer (S) beneath the site, associated hydrological units, and they are recharged and the discharge areas should be described, the results of a survey of groundwater users, well location, source aquifers, water uses, static water levels, pumping rates, and the draw-down should be provided.
A water table contour map showing surface water bodies, decharge and discharge areas, and the locations of monitoring wells to detect leakage from storage structures should also be provided. Information on monitoring wells should include well head elevations, screened intervals, installation methods, and a representative hydrochemical analysis. An analysis bounding the potential groundwater contamination from site operation should be provided. A graph of time versus radionuclide concentrations at the closest existing or potential downgradient well should be included."
Q. In your expert opinion, has PFS performed work that would comply with that paragraph?

SHEET 7 PAGE 49

49

A. Some have. Some we plan to do. Because too many mentioned there. I will identify which one we already --
Q. In the first sentence it talked about an aquifer.
A. Yes.
Q. Has PFS determined what the aquifer is?
A. In the ER itself, no, we have not identified the aquifer.
Q. The first sentence states, "If the site is located over an aquifer which is a source of well water." If you've not identified the aquifer yet, could you identify what the source, or the source for well water?
A. We drill a CPT operating well and put a casing on it and we found some groundwater.
Q. Would you please identify those areas in the paragraph in which PFS has --
A. Okay.
Q. -- performed work and those which you indicated that they would be performing in the future?
A. We have done to send either in the SAR or in answer request for additional information from NRC the result of a survey of groundwater user within five-mile radius of the site -- well locations, source aquifer,

PAGE 50

50

water uses, static water levels, pumping rates. We have described in the Skull Valley where the groundwater recharge and decharge area.
That's all.
Q. You indicated that PFS has performed a survey of the groundwater users?
A. Within file-mile radius of the site, yes.
Q. I'm sorry; what was that?
A. Within five-mile radius of the site.
Q. Why did PFS choose five miles?
A. Not only this site, any nuclear facility required to investigate at the radius of five miles.
Q. If there were impacts to the environment or impacts of the aquifer outside of five miles, would PFS have studied that?
A. Not to my knowledge.
Q. PFS did not do an independent analysis as to how far impacts to the aquifer may be caused?
MR. GAUKLER: Objection.
Q. Yeah, it was poorly worded. In your expert opinion, is five miles the outer boundary at which impacts to the aquifer may be observed at the site?
A. I can't answer your question. Will you repeat the question? I'd appreciate.
Q. Is a five-mile radius a reasonable radius to

PAGE 51

51

be looking for impacts?
A. I don't like -- if I don't refer to guideline, in my expert opinion is too conservative. It's more than necessary. But the guideline required it. In my expert opinion, it's too conservative, is more than needed.
Q. And the reasons for it being too conservative are?
A. I don't know. Because that is the -- I don't know this requirement, because the -- what the technical behind the NRC, they said the guidelines saying that you have to have a radius of five miles. I don't know. They may be -- my guess is because of conservatism, because normally a -- well, I shouldn't say that. I will stop here.
Q. Will the use of water at the facility have an environmental impact on the aquifer?
MR. GAUKLER: Objection, vague and ambiguous. Many type of potential of environmental impacts, so if you have any particular ones in mind.
MR. WEISMAN: I'm sorry, Mr. Gaukler. Could you speak up a bit?
MR. GAUKLER: I'm sorry. There's many different types of environmental impacts. What type are you referring to, in general?

PAGE 52

52

Q. (BY MR. SEEL) I'm referring to in general draw-down of the aquifer and the impact it may have on the availability of water resources in the valley.
A. Excuse me? You want me to address that?
Q. Yes.
A. I'd like you to repeat the question.
Q. I'd like to repeat it, too.
A. I don't understand it.
Q. Will the use of water at the facility have an impact on the availability of water resources in the valley?
A. I believe we have addressed the issue based on our 42 years of average annual use of the water if we coming -- withdraw from the well, and what kind of impact on the nearest well user.
Q. PFS is not the only water user in the valley, however. Is that correct?
A. In the valley, yes.
Q. Has PFS done an analysis to determine whether the cumulative impact of all the water users in the valley is having an adverse effect upon the availability of water resources in the valley?
A. We did in one calculation demonstrate that based on those 42 years annual actual rate, if we withdraw that amount from the well aquifer what kind of

PAGE 53

53

impact would be on the current use of well water.
Q. Will there be sufficient water resources in the valley to satisfy PFS's needs in 40 years?
A. Yes.
Q. And how did you come to that conclusion?
A. Based on that 42 years annual use is 2,040 gallon per year, transfer to 1.42 gallon per minute. And also in other unit is 2.29 acre feet. That kind of compared to the other user or the availability of the aquifer is so insignificant.
Q. Where did you get the data to compare it to these other -- where is the data for these other users in the valley?
A. Oh, we based on those five -- a table or a figure we presented within those five-mile radius.
Q. And you determined that the recharge to the area within the five-mile radius is greater than what is being extracted by those current water users?
A. I base on the -- what available from the aquifer data which I extract an understanding from Hood and Waddell, W-a-d-d-e-l-l, the paper, the publication. I forgot the last name. And they indicate an aquifer in the Skull Valley, how much recharge and decharge quantity.
Q. So is PFS relying solely on the Hood and

PAGE 54

54

Waddell 1968 report for its conclusions, as to the conclusion that recharged --
A. I believe we answered that question during the answer one of the request for additional information addressed. After Hood publication we have more reason in 1987. Their conclusion is not too much different from Hood. Also, I remind you the State of Utah using Hood for their 1987 to host superconductor, supercolliding project, they also rely on that report.
And we have to conduct some research. There's just no more -- not a more recent publication available.
Q. But PFS is relying on the Hood and Waddell report in coming to this conclusion?
MR. GAUKLER: Objection. Mischaracterizes the witness's testimony.
Q. (BY MR. SEEL) Is PFS relying on anything other than the Hood and Waddell report to come to its conclusion?
MR. GAUKLER: What conclusion are you referring to specifically?
MR. SEEL: The conclusion that the amount of recharge to the aquifer is greater than the amount being used in the valley. If that's not the right conclusion --

PAGE 55

55

A. We used the Hood information and get the information about charge or recharge of the aquifer.
Q. How much is actually being used in the valley today?
A. I don't know. They said some number in there. I do not memorize the paper.
Q. I understand.
A. So many number.
Q. But if I understand you correctly, PFS is relying on the number in the Hood and Waddell report for its conclusion.
A. If I remember right, talking about 5,000 acre feet compared to what we propose going to draw, 2.29 acre feet. That -- my expert opinion is insignificant.
Q. The question is whether the data from 1968 is still accurate, and my question to you is, why do you feel the data from the 1968 report is still accurate?
A. I have answered already. Because previous question, I don't know which question -- '87, they say another publication concluded. Their study conclusion is not much different from Hood's result.
Secondly, State of Utah using the same report for 1987, their planning of this project.
Q. Was that facility located -- to be located

PAGE 56

56

in Skull Valley?
A. If I remember right, answer to that question I think is using Skull Valley, yes, the groundwater from the aquifer in the Skull Valley, yes.
Q. Are there any other reasons why you believe the 5,000 acre feet figure included in the Hood and Waddell report is still valid?
A. My conclusion I think based on all available information. Oh, well, that's -- ever since the Hood publication, the balance of the aquifer had not been changed significantly.
Q. If new wells were being put into the aquifer, installed in the aquifer since the Hood and Waddell report, would that change your opinion?
A. That depend on a lot of factor -- how much water individual well will withdraw.
Q. What other factors?
A. That's one of the factors I just mentioned, depending on quantity of individually the withdraw from the aquifer.
Q. Are there any other factors that would go into that determination? Do new wells automatically mean more extraction from the aquifer?
A. Yeah, if you have a new well you just extract from the aquifer, yeah.

SHEET 8 PAGE 57

57

Q. So has PFS determined how many new wells have been installed in the aquifer since the Hood and Waddell report?
MR. GAUKLER: I object to this whole line of questioning on lack of relevance. You can answer that question if you know.
A. I don't know.
Q. If the groundwater table is lower, would that have an environmental impact on vegetation in the valley?
A. If the groundwater table is low, I don't know how that interconnected vegetation. I would say no.
Q. Do some types of vegetation extract water from the subsurface out around the groundwater table?
A. I don't know, because I'm not in that area of my study.
Q. Are you familiar with the Hood and Waddell report? Have you read it?
A. I read very casually, not word by word.
Q. Do you know what evapotranspiration is?
A. My understanding of that word means evaporate and escaping to the air.
Q. What does the transpiration part of that term mean?

PAGE 58

58

A. I only know the first part. Transpiration, I don't know what exact mechanism in science.
Q. If the groundwater table is lower in the valley, would that allow saline water from the Great Salt Lake to encroach into the aquifer?
A. I don't know the answer to this question -- to your question.
Q. Is salt water generally denser than fresh water?
A. True.
Q. Are you aware of any areas in the United States where saline water has encroached on fresh water aquifers?
A. Yes.
Q. What areas would those be?
A. Florida.
Q. Do you know what the cause of the encroachment was?
A. I don't know the exact cause, but one thing, the factor which determine is the distance between the aquifer and what the source of salt water. That's a very important factor.
Q. I'm going to hand you a copy of -- I'll hand you all of the Hood and Waddell report. I'd like you to look at page 28. There's a table on use --

PAGE 59

59

A. Twenty-eight, okay.
Q. -- in which there is -- I'd like you to take a look at it so that I can ask you about it.
A. Starts at page 28, right?
Q. Page 28, that's correct.
(Witness reviews document.)
MR. GAUKLER: Are you going to ask specific questions with respect to the table?
MR. SEEL: About the dates on the table and use during those dates.
MR. GAUKLER: He's going to ask a specific question about the table. If you need to look at more of the document, feel free to do so.
THE WITNESS: Okay. The table.
Q. (BY MR. SEEL) My understanding is that -- well, what does the table describe as far as use of water in the Skull Valley?
A. The table is percent of -- is estimated well discharge based mainly on a measurement made during a reconnaissance during 1963 and '65, electrical power consumption, acreage and pumpage, reported by the U.S. Army.
Q. Can you tell me what the total usage of water in 1957 was, according to that table?
A. Total rounded is 3,500. The unit is acre

PAGE 60

60

feet.
Q. Can you tell me what the amount estimated according to the table is in the subsequent year?
A. 1963, no total. 1964, a total of 4,100. In 1965 is 5,000 acre feet.
Q. So between -- if I understand the table correctly, Hood and Waddell estimate that between 1957 and 1965 the amount of water usage in the valley increased by how many acre feet?
A. Nine hundred acre feet.
Q. In 19 -- my understanding is PFS has taken the position that that 5,000 acre feet per year usage rate has not changed since 1968 when the report was written?
A. No. We say change means the available or recharge of the aquifer.
Q. I'm sorry?
A. It's user, amount of use.
Q. I don't understand the difference. Would you explain that to me? Is PFS relying on the 5,000 acre feet per year annual usage rate that Hood and Waddell came up with as being the current usage rate?
A. No, we do not -- I don't believe we used so-called usage, rather than we're using the first page. If you look at the -- let's see, where's the -- right

PAGE 61

61

here. We present this number in our ER. Estimate every annual groundwater recharge and discharge in the range of 30,000 to 50,000 acre per year. We use that number in our ER, SAR. We did not use this number anywhere, I believe, in our ER or SAR. I may be wrong, but that's my memory. That's what I had read those sections, ER section, SAR section.

Q. Has PFS done any studies as to the current amount of well usage in Skull Valley?

A. Recur amount?

Q. The current amount of water being pumped from wells in Skull Valley.

A. I don't know of -- I don't understand your "recur."

MR. GAUKLER: I object to this whole line of questioning as relevance. You can answer if you can. Go ahead and rephrase the question.

Q. Has PFS done any studies as to the annual amount of water being pumped from wells in Skull Valley?

A. For all the user.

MR. GAUKLER: Entire Skull Valley, you're talking about?

A. Entire Skull Valley? Not to my knowledge.

Q. Will the amount that's being pumped pump the aquifer dry in 40 years?

PAGE 62

62

A. I don't understand your question. Forty years, you're referring to Private Fuel Storage project?

Q. That is correct.

MR. GAUKLER: Objection; vague and ambiguous, also lack of relevance.

Q. How do you know there's going to be any water in the aquifer in 40 years?

MR. GAUKLER: Objection, lack of relevance.

A. I don't know answer to this question, your question.

Q. Don't you need to know how much they pumped in order to answer that question?

A. I know how much the PFS will pump, 2.29 acre feet on every -- over 42 years life of the facility.

Q. And how do you know that the aquifer will still be able to produce that much over the course of --

A. My expert opinion is compared to other user, even -- this is insignificant.

Q. Precisely. And those other users are? Where did you get the data about the other users?

A. Within five miles we presented in the ER and SAR. They have quantity use, when they installed the well, how deep of the well, what kind of elevation from the ground surface to the water.

Q. And is the water table dropping in those

PAGE 63

63

wells?

A. Not significantly, based on the available data to me.

Q. And what about in the rest of the Skull Valley?

A. Oh, I've read a report. They say in the Dugway, they say public water supply. In that particular location is simply water elevation -- I mean, groundwater elevation is significantly buried, reduced because of pumping. But that is 19 miles from the site, as I recall.

Q. So to clarify: the 5,000 acre feet that's being used, that Hood and Waddell says is being used in the valley, may or may not be accurate?

MR. GAUKLER: Objection. This is asked and answered. We've gone over this many times. It's not relevant, and now you should move on to a new topic.

MR. SEEL: If PFS wants to take the position --

MR. GAUKLER: We said we don't rely upon the 5,000 feet. I don't see why you need to come back to it. You've asked this many different ways. I've been very patient. My patience is running out.

A. I'm not in a position to judge the Hood paper to answer that. But I believe their data is very

PAGE 64

64

accurate, because they are very extensive, very thorough study, based on my technical in this area. Very thorough. One is a hydrologist, one is chemist. One or the other.

Q. And it's a comprehensive inventory of the water, groundwater resources in the valley?

A. Yes.

Q. Would you please turn to the last page of that report.

A. Okay. This is -- 57 is some reference. The last page?

Q. Page 40 of the report entitled "Proposals for Additional Studies." Would you please read the first two paragraphs of that?

A. Page 40, first two paragraphs. "Because Skull Valley has a potential for development, a detailed water resources investigation is needed to refine the estimates given in this reconnaissance. Such a study should include the following considerations:

1. A comprehensive inventory of the water resources of the valley should be made to supplement coverage of this reconnaissance. Detailed data should be obtained on the hydraulic characteristics of existing wells, the discharge characteristics of both the large saline spring in the valley and the large mountain

SHEET 9 PAGE 65

65

springs, the use of water in the valley, and the availability of surface water supply."

Q. Do you agree that the authors of that report seem to indicate that greater level of investigation is required beyond what they did in Skull Valley? Strike that.

Does the statement of the authors correspond with your prior testimony that this was a comprehensive report?

A. At the time I believe that's very comprehensive. As a matter of fact, I did a lot of research before coming here. All the conclusion at end of the paper always recommend something further be done. That's natural. Because nobody can claim, I'm the exhaustive, this is it. Nobody would have the authority saying that.

MR. SEEL: Lunch?

(Lunch Recess from 11:59 a.m. to 1:10 p.m.)

EXAMINATION

BY MR. WEISMAN:

Q. In answering one of the earlier questions, you talked about two parameters, permeability and transmittability.

A. Yes.

Q. I just wanted to make sure that I was clear

PAGE 66

66

on what the difference between the two of them is. Maybe I can shortcut this just a little bit. I understood from your answer that you measured permeability at the surface from the top down.

A. Uh-huh.

Q. And I'm going to infer from your answer that permeability of a sample of material may vary depending on the direction. You might measure it from the top or from the side, and you might get different answers. Is that correct? So permeability could vary in the X, Y, and Z directions? That's what I'm asking.

A. Yes. The answer is yes.

Q. Okay. So when you answered the question, you said that you measured the permeability from the surface. That's only in the up and down direction, correct?

A. That's our pumping procedure defined, yes.

Q. Okay. So for transmittability, would that be the permeability in a direction parallel to the surface?

A. That is my understanding that the transmittability is the horizontal.

Q. Okay. So that would be -- the only real difference between permeability and transmittability would be the direction of the flow; is that correct?

PAGE 67

67

A. When you say "only difference," I'm not quite sure.

Q. I mean, they would use the same units. You're measuring the same -- I'm asking if you're measuring the same sort of thing, but the difference is in the direction.

A. Yes.

MR. WEISMAN: Okay. That's the only question I had.

THE WITNESS: Okay.

EXAMINATION

BY MR. GAUKLER:

Q. I had one short, quick question. We've heard a lot of talk about units for expressing permeability --

A. Yes.

Q. -- you just talked about. Is it true that you can express permeability in units of area as the function of time or in your distance over time?

A. Yes. I have seen different textbooks. One textbook expand in the area over time. Some other they're using linear distance over time. Others using area over time.

MR. GAUKLER: Okay.

MR. GAUKLER: No further questions.

PAGE 68

68

MR. WEISMAN: I think we should go back on quickly for one comment, and that is, Mr. Blake informs me that the term is "transmissibility" and not "transmittability." But I must have heard it wrong.

THE WITNESS: You're correct.

MR. WEISMAN: So with that, I will be done.

MR. SEEL: I may have some follow-up. Just give me a second.

FURTHER EXAMINATION

BY MR. SEEL:

Q. As a follow-up to the questions that were just asked on permeability, and permeability may vary depending on the X, Y, or Z axes, the three dimensions in space, has PFS done any testing to determine whether the permeability in those three dimensions in the test well screened area vary?

A. No.

Q. So they could be -- the permeability in all three directions could be the same?

A. Could be the same, could be different.

Q. How would one go about determining whether they're different or not?

A. I don't know. I don't know the method how to determine the difference.

Q. When dealing with porous media -- and we're

PAGE 69

69

dealing with porous media flow; is that correct?
A. Uh-huh.
Q. Dealing with porous media such as silty sand, would you expect the permeability to differ depending on the dimension?
MR. BLAKE: Dimension or direction?
MR. SEEL: What's that?
A. Yeah, I don't understand dimension.
Q. I guess I'm using dimension as direction.
A. Direction, okay. Will you repeat the question again?
Q. When you did -- let's step back. When you did the pump test, there were certain assumptions built into that pump test formula?
A. Yes.
Q. Was one of those assumptions that you're dealing with porous media?
A. Yes.
Q. Was there another assumption that that porous media is homogenous?
A. Was what?
Q. Homogenous?
A. What does that mean?
Q. Has the same characteristics in all three dimensions.

PAGE 70

70

A. My understanding is we did not go into that assumption, saying that different dimensions is different or vary.
Q. You're experienced in groundwater modeling, are you not?
A. Yes.
Q. Would groundwater models usually assume that the apropos parameter is the same in all three directions?
A. Normally we decide which dimension or direction use depending on what direction you extract the water. Vertically, say, then we're more focused on the vertical direction, the permeability.
Q. I'm sorry, I didn't understand that. I just didn't hear what you said.
A. Normally we focus the permeability dimension is where we -- which direction our water were pumping to. So vertical direction will focus on the permeability in the vertical direction.
Q. Is that what the formula that was used in the static head pump test assumes?
A. Yes, it is.
Q. It does not assume that the aquifer parameters are all the same in all three directions?
A. I don't know the formula will require the --

PAGE 71

71

other than direction of the pumping flow, have to be -- provide as an input for that formula other than the direction you're pumping the -- pumping the water out.
Q. Let's step back to the basics.
A. Okay.
Q. What is the formula based upon? The formula that we use in the static head test, what formula, what physical equation is it based upon?
A. Oh, it's based upon according to what formula is in the Q and then the -- let me see. The head of the -- define in the formula, because we just take out from one of the reference. H is the -- let me see how they defined H.
Q. Is that formula based upon Darcy's law? Are you familiar with Darcy's law for fluid flow through porous media?
A. I know the formula, yes.
Q. Does Darcy's law -- is one of the basic assumptions of Darcy's law that you're dealing with homogenous material of a uniform particulate size?
A. I think that's how the formula based upon, uniform size.
Q. So based of Darcy's law, Darcy's law assumes you're dealing with a medium in which the parameters of that medium are the same in all three directions?

PAGE 72

72

A. When you say medium all the same in all direction is the same group of soil or the size of soil, or what?
Q. Permeability or the ability of fluid to flow.
A. Yeah.
Q. That Darcy's law assumes that the medium flows equally well in each direction.
A. I thought the thousand dollar assumption is what they call homogeneous of the media of the soil. I would say this is the same what you just inferred.
Q. So if the formula in this pump test is based upon Darcy's law --
A. I don't know. I don't know that it is or not, is or is not.
Q. Are you aware of any groundwater flow formula which is not based on Darcy's law that involves porous media?
A. If not homogeneous, is there another similar Darcy's law formula which will apply in homogeneous media of the soil, I don't know.
Q. What are the units for transmissivity?
A. If I remember right, it is area over time.
Q. And you say that is the same as permeability? Is that how I understood your testimony?

SHEET 10 PAGE 73

73

A. No. I say permeability can be expressed in terms of area over time or linear over time.
Q. It can be expressed as both?
A. Yes.
MR. SEEL: No further questions.
(Deposition was concluded at 1:23 p.m.)
* * *

PAGE 74

74

C E R T I F I C A T E

State of Utah)
ss.
County of Utah)

I, Vicky McDaniel, a Registered Merit Reporter and Notary Public in and for the State of Utah, do hereby certify:

That the deposition of George H.C. Liang, the witness in the foregoing deposition named, was taken on April 17, 2001, and that said witness was by me, before examination, duly sworn to testify the truth, the whole truth, and nothing but the truth in said cause;

That the testimony of said witness was reported by me in stenotype and thereafter transcribed into typewriting and that a full, true, and correct transcription of said testimony so taken and transcribed is set forth in the preceding pages.

I further certify that I am not of kin or otherwise associated with any of the parties of said cause of action and that I am not interested in the event thereof.

WITNESS MY HAND and OFFICIAL SEAL at Saratoga Springs, Utah, this 23rd day of April, 2001.

Vicky McDaniel, RMR
Utah License No. 87-108580

PAGE 75

75

Case: In the Matter of Private Fuel Storage
Case No.: ASLPB No. 97-732-02-ISFSI
Reporter: Vicky McDaniel
Date taken: April 17, 2001

WITNESS CERTIFICATE

I, George H.C. Liang, HEREBY DECLARE:

That I am the witness referred to in the foregoing testimony; that I have read the transcript and know the contents thereof; that with these corrections I have noted, this transcript truly and accurately reflects my testimony.

PAGE-LINE	CHANGE/CORRECTION	REASON

____ No corrections were made.

George H.C. Liang

SUBSCRIBED and SWORN to at , this day of , 2001.

Notary Public

Case: In the Matter of Private Fuel Storage
Case No.: ASLPB No. 97-732-02-ISFSI
Reporter: Vicky McDaniel
Date taken: April 17, 2001

WITNESS CERTIFICATE

I, **George H.C. Liang**, HEREBY DECLARE:

That I am the witness referred to in the foregoing testimony; that I have read the transcript and know the contents thereof; that with these corrections I have noted, this transcript truly and accurately reflects my testimony.

PAGE-LINE	CHANGE/CORRECTION	REASON
5 17	in the fluid mechanics area	typo error
5 21	tunnel 55 feet long and then	typo error
6 4	I have involved in lot of projects	typo error
6 6	I participated in environmental report	typo error
6 9	which I participated in, what happens	typo error
6 10	, and then assume a scenario	typo error
6 11	that the fluid hit the ground and the	typo error
6 14	stations also involved, .., like Shoreham	typo error
6 18	if a storm occurs, results in runoff,	typo error
6 23	but at one point, I did involve.	typo error
6 24	Webster is a very diverse company.	typo error
7 2	technical personnel resource support	typo error
7 18	I was involved in pumping test when	typo error
7 19	As a matter of fact, I most recently,	typo error
8 14	-- if it has	typo error
8 15	something in well analysis, data came in	typo error
9 8	I mean, we still do lots of modeling	typo error

[continued on next page]

_____ **No corrections were made.**

George H.C. Liang

SUBSCRIBED and SWORN to at Stoughton, Norfolk County, Comm. of Massachusetts, this 15th day of May, 2001.

Evelyn S. Clegg
Notary Public
my commission expires: 5/24/2002

PAGE-LINE	CHANGE/CORRECTION	REASON
9 9	but not on the latest project.	typo error
9 11	models, surface water model, and run	typo error
9 12	the models.	
9 21	On sections,	typo error
9 22	in the environmental report	typo error
10 20	to use in remediation of	typo error
10 21	different models.	typo error
11 3	the areas when we prepare project report,	typo error
11 22	say those required steps is not saying that I participated in every step on PFS project	typo error
11 23	have to go to the PFS project management.	typo error
11 24	specific for this I was brought on board	typo error
11 25	, so those considerations: the	typo error
12 1	format to do this and how it is determined,	typo error
15 3	I need to know specifically what area?	typo error
15 4	Environmental Report covers so many sections, so many areas.	typo error
15 5	And your question did I help prepare the environmental	typo error
15 6	report? I can not answer. All I can answer: I	typo error
15 7	prepared hydrology section of	typo error
15 13	We used references	typo error
15 14	, which has a NRC Reg guideline	typo error
15 18	by the reg guideline, all the resulting information, required by the	typo error
15 25	That is the reg guide, guideline gives you	typo error
16 2	Very detailed, what you should be used	typo error
16 25	or only few perennial streams,	typo error
17 1	very few, or none at the site.	typo error
17 17	we have found is some reservoirs or ponds	typo error
18 19	well, CBT No.5, which we installed a casing	typo error
21 1	They analyzed the soil at the Skull Valley.	Typo error
22 14	In my engineering experience, we say this	typo error
22 15	order of magnitude.	typo error
22 21	, not only when you hit the aquifer,	typo error
22 22	only depending upon permeability, but also depending upon so-called	typo error
22 24	There are two	typo error
22 25	coefficients in there.	Typo error
23 6	You have another coefficient also affecting	typo error
27 17	back on the reference based formula or the reason it derived	typo error
27 19	I believe the formula also defines the way	typo error
28 1	by the unit of individual terms.	Typo error
28 6	I just calculate the unit and come out --	typo error
28 7	after I cancelled all same units in this calculation,	typo error
29 25	Normally we extract water when we hit this	typo error
30 1	water coming out, hit a depth which	typo error
30 2 & 3	It could be deeper or shallower at some other locations. But at that spot, yes , we	type error typo error
30 4	have a silty sand type of soil and we hit the water.	typo error
31 11	Actually, there are two ways.	typo error
31 12	don't want the surface water to go down	
31 13	surface water quality will be	typo error
32 3	a Driscoll's book, authored by Driscoll,	typo error
32 6	Is very important to follow the guideline	typo error
33 20	Because, as I said earlier, it prevents	typo error
33 23	As I said earlier, the bentonite	typo error
34 1	keeps the water which you pump from the well casing, is clear.	typo error

[continued on next page]

PAGE-LINE	CHANGE/CORRECTION	REASON
34 3	This practice is also for any	typo error
34 4	residential use when you have your own	typo error
35 1	After the information was presented in the ER.	typo error
37 25	You say taken the	typo error
38 5	Were these in the ER or SAR, I forgot, we'd	typo error
38 6	say there is very little chance to infiltrate	typo error
38 25	, you know, because you drill a hole, so	typo error
39 1	those are coming from the side way.	typo error
39 20	everything follow the rule and procedure, or	typo error
40 9	which originally came from the hole	typo error
40 20	specifically in the ER, CBT No. 5	typo error
41 1	make some field notes.	typo error
42 6	colleague who is in Denver	typo error
42 17	It is my belief, yes.	typo error
43 1	That is the area I'm not in a position to	typo error
43 2	answer, because the engineer designed the sewer system would	typo error
44 21	No, because I'm not involved in the original	typo error
45 11	I remember the ER Sections have addressed	typo error
45 14	identify the sources of the water come from.	typo error
45 19	much water used during different phases of	typo error
45 20	project, from construction to operation phase	typo error
48 13	water bodies, recharge and discharge areas,	typo error
49 22	We have done and sent to NRC either in the SAR	typo error
49 23	answering to request for additional information from NRC, the	typo error
50 2	described in the ER: in the Skull Valley where	typo error
50 3	recharge and discharge area.	typo error
51 2	I don't like to go to a five-mile radius.	typo error
51 3	the guideline. In my expert opinion it is too	typo error
51 5	, it's too conservative, and is	typo error
51 9	I don't know. Because that is the guideline.	typo error
51 10	don't know the bases of this requirement, because the guideline what the	typo error
51 11	technical bases behind the NRC's thinking. The guideline	typo error
51 12	saying that you have to cover a radius of five miles. I	typo error
51 14	, because normally a pumping well, I shouldn't	typo error
52 24	based on those 42 years annual average rate,	typo error
53 6	Based on that 42 years annual average use	typo error
53 7	gallon per day, convert to 1.42 gallon	typo error
53 8	unit is 2.29 acre feet per year. That amount	typo error
53 15	within a five-mile radius	typo error
53 23	, how much recharge and discharge	typo error
54 4	the answer to one of the request for	typo error
54 5	we have found one more recent reference published	typo error
54 8	Hood data for their 1987 effort to estimate water needs for hosting the Superconducting	typo error
54 9	Supercollider Project. They also rely on	typo error
55 2	information about discharge or recharge of	typo error
55 20	, I don't know which question. I said in '87,	typo error
55 24	,their proposal planning of hosting SSC project	typo error
56 9	Oh, well, that's the conclusion ever since	typo error
61 10	Current amount?	typo error
61 14	"Current."	typo error
62 14	feet per year over 42 years life of	typo error
63 6	I've read a report. It said in	typo error
63 7	Dugway, there is a public water supply.	typo error
63 8	location was sampled for water elevation changes.	typo error

[continued on next page]

PAGE-LINE	CHANGE/CORRECTION	REASON
63 9	is significantly lowered, and reduced	typo error
63 21	5,000 acre-feet.	typo error
64 2	, based on my technical experience in this area	typo error
64 3	One of the authors is a hydrologist, the other is a chemist	typo error
67 21	textbook expressed in the area over time unit	typo error
72 9	I thought the assumption is	typo error
72 11	would say this is the same as what you just	typo error