STATE OF NEW MEXICO

ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION

CASE 10,693

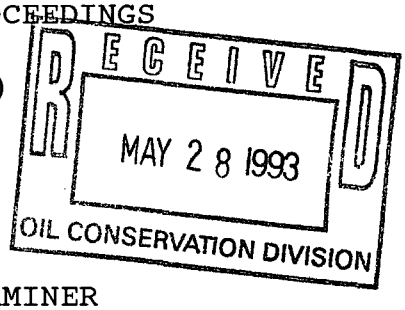
EXAMINER HEARING

IN THE MATTER OF:

Application of Pronghorn SWD System for salt water disposal, Lea County New Mexico

TRANSCRIPT OF PROCEEDINGS

(Volume I)



BEFORE: MICHAEL E. STOGNER, EXAMINER

ORIGINAL

STATE LAND OFFICE BUILDING

SANTA FE, NEW MEXICO

May 6, 1993

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WHEREUPON, the following proceedings were had at 10:53 a.m.:

EXAMINER STOGNER: This hearing will come to order again. I'm Michael E. Stogner, appointed Hearing Examiner for today's case.

At this time I'll call Case 10,693, which is the Application of Pronghorn SWD System for salt water disposal, Lea County, New Mexico.

At this time I'll call for appearances.

MS. AUBREY: Karen Aubrey of Santa Fe, New Mexico, representing the Applicant.

EXAMINER STOGNER: Any other appearances?

MR. STOVALL: Robert G. Stovall of Santa Fe, representing the Oil Conservation Division.

Appearing with me is Susan Kery of the State Engineer's Office. That's spelled K-e-r-y. The State Engineer's Office is going to provide testimony on behalf of the Division, but the Division is the only party to this case.

EXAMINER STOGNER: Are there any other appearances in this matter?

Ms. Aubrey, how many witnesses do you have?

MS. AUBREY: I have two witnesses to be sworn.

EXAMINER STOGNER: Mr. Stovall?

MR. STOVALL: I have two, and two others who I'll ask to go ahead and rise to be sworn in case they are called for.

EXAMINER STOGNER: Okay. In that case, will all witnesses at this time stand?

(Thereupon, the witnesses were sworn.)

EXAMINER STOGNER: Ms. Aubrey, Mr. Stovall, is there any preliminary matters that need to come up before we continue?

MS. AUBREY: Yes, Mr. Stogner, I have a preliminary matter.

On Monday afternoon the OCD sent me a copy of a prehearing statement by fax indicating that the Oil Conservation Division had entered its appearance as a party to this matter.

The description of the position of the Oil Conservation Commission in the prehearing statement is not clear on the question of whether the Oil Conservation Division opposes or supports the Applicant's Application.

I understand that the State Engineer's Office is here not as a party but merely for the purpose of providing testimony to the Examiner, and I want it -- I would like to have it clearly stated on the record that the State Engineer's Office is not a party, and I would

ask the Oil Conservation Division, of which the Examiner is, of course, a part, to state its position whether it is appearing in support of or in opposition to the Application.

EXAMINER STOGNER: Mr. Stovall?

MR. STOVALL: The prehearing statement which was provided to Ms. Aubrey does really reflect the position of the Division.

Injection into the aquifer -- into the Capitan Reef is something that has never been done before. The Division has denied one application for it. It's something that we think is going to be an issue to be addressed carefully because it could give rise to many more applications.

The Division is charged under two different programs with protecting fresh waters in the State. Under the Federal Underground Injection Control program, the Division is required under the Safe Water Act to protect drinking water sources, and there are drinking water sources in the Capitan Reef.

The Division is also required under the Oil and Gas Act to protect fresh waters as designated by the State Engineer's Office, and there are fresh waters within the Capitan Reef.

The Division is not -- it certainly -- it is

not supporting this Application; I can say that definitively.

The Division is not opposing this Application specifically, but rather presenting evidence with respect to those things that have got to be considered before this Application can be granted, because if this Application is granted it is likely to lead to a -- if you'll pardon the pun -- a flood of applications for injection into the Capitan Reef, because it's a great big, holey rock formation underneath the ground which could accept a lot of water. But it does contain fresh water supplies.

And given the Division's responsibility to protect those supplies, we want to make darn sure, if it's going to be approved, that we know that we can do it with the -- virtually absolute protection of the freshwater supplies that are contained within the Reef.

So in answer to Ms. Aubrey's question, I guess we are definitely not supportive of the Application, and I think the information which the witnesses provide -- are going to provide -- is going to raise some very serious questions which are not -- which are going to indicate that this Application may not be approvable, given the criteria and the matters which we have to consider.

EXAMINER STOGNER: Ms. Aubrey?

MS. AUBREY: Thank you. I believe, Mr. Examiner, as a matter of due process, that an applicant before this Examiner has the right to know whether or not the parties who appear are appearing in support of or in opposition to the Application, particularly when the party that is appearing is the body which is going to decide the Application.

This has not been called as a rule-making hearing. This is not a case which has been called by the Commission to consider rules and regulations for the injection of produced water into the Capitan Reef.

However, it is an adjudicatory hearing set on an application filed, as required by law, by Pronghorn Salt Water Disposal Systems. And given the fact that it's not a rule-making proceeding, I believe that there is a different standard of proof and a different procedure which needs to be followed.

We're prepared to follow the adjudicatory procedure, put on our case, show you by a preponderance of the evidence that we meet the criteria for authority to inject.

We are not prepared, however, nor is the case called as a proceeding to establish rules for the injection of fluid into the Capitan Reef, into any

other area than in our proposed injection well.

MR. STOVALL: My response to that is, I would agree procedurally with what Ms. Aubrey states.

What the Division witnesses, including the State Engineer's Office technical people, are going to testify to, as to what must be demonstrated in this case before the Application can be granted.

She talks about proving by a preponderance of the evidence, and I think the Division, the Examiner and the Director, needs to know what needs to be proven by a preponderance of the evidence.

It may in fact be that what is demonstrated today -- It will be precedent-setting in an adjudicatory sense. It's conceivable that it could lead to a rule-making of some sort.

But we are looking at the specifics of this case and the adjudication of this case and trying to provide information to help the Examiner and the Division make a determination as to what must be demonstrated, because there are some vast issues involved with respect to the protection of fresh water.

As we say, it will not be a rule-making, but it will definitely be precedent-setting.

EXAMINER STOGNER: Ms. Aubrey, does that satisfy?

MS. AUBREY: Well, I believe the Division's position is still not clear on the record as to whether, given that this is an adjudicatory hearing, it is appearing in opposition to or in support of the Application.

MR. STOVALL: Procedurally, Mr. Examiner, I will point out that although the Division has not been provided, other than graphs, some modeling information from Ms. Aubrey, we have made an attempt to provide her with the substantive information so she knows what issues to address. From a procedural due-process standpoint, she has been given the information which we intend to present, a substantial portion of it.

So I think she has the opportunity to address the issues which the Division considers important.

And again, I will not say -- I cannot say that the Division stamp, if you will, separating that from its adjudicator role, is coming out absolutely in opposition, but it is certainly not supporting the Application.

EXAMINER STOGNER: I can't see how he can make it any more clear, Ms. Aubrey.

MS. AUBREY: Thank you, Mr. Stogner.

EXAMINER STOGNER: Okay. You may continue.

MS. AUBREY: Call my first witness, Larry

Scott.

LARRY R. SCOTT,

the witness herein, after having been first duly sworn upon his oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MS. AUBREY:

Q. Will you state your name, please?

A. Larry Ray Scott.

Q. Where are you employed, Mr. Scott?

A. I'm a vice president with Lynx Petroleum Consultants, Incorporated, at P.O. Box 1979 in Hobbs, New Mexico.

Q. And Mr. Scott, what's your relationship to Pronghorn SWD System, the Applicant in this case?

A. I currently serve as president of the Rhombus Corporation, which is a wholly-owned subsidiary of Lynx, and Rhombus is the managing general partner for the Pronghorn SWD System limited partnership.

Q. Are you familiar with the Application of Pronghorn Salt Water Systems for permission to dispose of produced salt water into the Brooks Federal "7" Well Number 6, into the Reef formation?

A. Yes, ma'am, I am.

Q. Have you previously testified before the Oil Conservation Commission or one of its examiners and had

your qualifications made a matter of record?

A. I don't think so. I've been present at several of these proceedings, but I don't believe I was ever called to testify.

Q. Would you review your professional experience and degrees for the Examiner?

A. I received a bachelor of science degree in electrical engineering from the University of Texas in January of 1975. I had seven years of experience with Conoco, Incorporated, in various engineering positions, last two years as a supervising production engineer in the Hobbs office.

Subsequent to that time, I was a founding partner of Lynx Petroleum, and we are an independent production company and consulting company, primarily in southeast New Mexico.

Q. Is the Application filed by Pronghorn within your area of responsibility for the company?

A. Yes, absolutely.

MS. AUBREY: Mr. Stogner, are the witness's qualifications acceptable?

EXAMINER STOGNER: Are there any objections or questions, Mr. Stovall?

MR. STOVALL: No.

EXAMINER STOGNER: Mr. Scott is so qualified.

Q. (By Ms. Aubrey) Would you briefly describe what Pronghorn seeks by its Application?

A. We would seek approval to dispose of produced oilfield brine into the Capitan Reef formation over the depth interval approximately 3220 feet to 5000 feet in the Capitan Reef.

This project was initiated by myself as a result of recent difficulties with surface disposal operations in this area.

Q. And what difficulties have you had with surface disposal in the area?

A. The Environmental Protection Agency has closed one of the major facilities that were available to operators in this immediate area.

Q. In this area of southeast New Mexico, is there any economic necessity for the disposal of produced salt water?

A. Oh, absolutely. It's an area that's recently been very active from a Delaware development standpoint. These Delaware wells will typically produce salt water almost from day one, and hauling that water is proving to be a severe economic hardship.

Q. What is the alternative for an operator who isn't able to haul the water, in terms of the producing of these Delaware oil wells?

A. Shut them in or marginally produce them.

Q. Prior to filing the Division Form C-108, would you tell us what investigation and research you did in terms of coming to the conclusion that disposal in the Capitan Reef would be appropriate?

A. Well, we investigated not only the Capitan but all of the formations in that area for suitability with regards to a long-term disposal solution.

It turns out there is one other formation that is probably suitable, but it occurs at a depth of 15,500 feet, and therefore does not provide an economic solution to the problem.

Q. Did Pronghorn retain the services of any experts in connection with making the investigation into the appropriateness of the use of the Capitan Reef for disposal?

A. Yes, I did. Because we do not have any hydrological expertise per se on our own staff, we hired Mr. Mike Wallace with RE/SPEC, Incorporated, out of Albuquerque, to perform a hydrological study, model simulation of the effects that could be projected for our operations over a 50-year period of injection into the Reef.

Q. Have you met with representatives of the State Engineer's Office in connection with your

Application?

A. Yes, we have. I have met with representatives from the State Engineer's Office and the NMOCD on one occasion. And then subsequent to our having the model available for their review, we met again with representatives from the State Engineer's Office for their questions and comments regarding the science that we have prepared.

Q. Have you met with representatives of the local offices of the New Mexico Oil Conservation Commission?

A. I have not had a formal meeting with Mr. Sexton, but I've had several informal conversations with him regarding this project.

Q. In connection with the State Engineer's Office, who did you meet with?

A. Let me think. Tom Morrison, Andy Core, and Peggy Barroll.

Q. And did you provide the computer software necessary to run the model to the representatives of the State Engineer's Office?

A. It is my understanding from Mr. Wallace that he furnished copies of that software to the State Engineer's Office for their use.

Q. Did you discuss the concerns that the State

Engineer's Office had with your proposed Application with these people?

A. That's what both meetings were about.

Q. Did they tell you what their concerns were?

A. Yes, they are concerned about possible contamination of freshwater resources in the Carlsbad area and, in addition to that, freshwater resources that may be present in southeastern New Mexico, specifically the area southwest of Hobbs.

Q. Do you propose that this operation will be a commercial disposal operation?

A. Yes, it will be. Most of the water that will go into that system will be via pipeline from Delaware wells directly connected to that pipeline.

Q. Would you describe that pipeline, please, and how it's connected to the well?

A. Okay, this is a 20-mile, eight-inch PVC line with the northern terminal point -- I don't have a section, township and range, but it's about five miles south of Maljamar, just south of Highway 529.

The southern terminal point is just a mile and a half north of the Carlsbad Highway, two miles, approximately, northeast of Halfway.

Q. Is that pipeline in existence now?

A. Oh, yes.

Q. Did you build it?

A. Oh, no. That pipeline was previously a portion of the Laguna Gatuna gathering system that was disposing of produced fluids in Laguna Gatuna, a salt playa lake in the immediate vicinity.

Q. So the pipeline is presently in existence; is that correct?

A. Oh, yes, that's correct.

Q. And it's previously been used to collect brine for disposal?

A. Absolutely. Same purpose that we propose to use it for now.

Q. How many barrels per day do you expect to dispose of in this commercial operation?

A. Up to 10,000 barrels of water per day.

Q. And have you contacted potential customers to see whether or not there is a need for this service in the area?

A. Absolutely. In fact, I don't know if this is the time for it, but I have as Exhibit 2 six letters of Meridian Oil, Manzano Oil Corporation, Anadarko, Mitchell Energy, Yates Petroleum...

These letters are from operators with Delaware production operations in the immediate vicinity. They are letters of support for our proposed

Application and operations. They vary in content a little bit. Some even go into detail with regards to the economic impact of water disposal difficulties as a result of Delaware production.

Q. Mr. Scott, would you describe your experience or your company's experience in operating wells in southeast New Mexico?

A. I have no experience with a commercial disposal operation. However, my company does operate several waterfloods in southeast New Mexico, with the attendant injection that goes with those waterfloods.

Q. So those would be a disposal of water releases?

A. Yes, that is correct.

Q. Did you supervise the preparation and filing of the Form C-108?

A. Yes, I did.

Q. Let me have you look at what I've marked as Pronghorn Exhibit Number 1, which is a set of attachments to the 108.

A. Uh-huh.

Q. And I'd like you to go through the exhibit, using the exhibit as a guide, and describe the current wellbore status of the well and your proposed recompletion of the well as a saltwater disposal well.

MR. STOVALL: Ms. Aubrey, do you have copies of that exhibit?

MS. AUBREY: Yes, I gave them to the Examiner, but I can gather another set.

EXAMINER STOGNER: I -- You did?

MS. AUBREY: There were three sets of them here up here before you, Mr. Stogner.

(Off the record)

MS. AUBREY: Exhibit 6 is up on the wall.

MR. STOVALL: Okay.

EXAMINER STOGNER: I apologize for that. I had set them aside thinking they were from a previous case, but they are in fact in front of me at this time. I've submitted or given Mr. Stovall a copy and have an extra copy up here with me.

MS. AUBREY: For the record, we've already given a set of the exhibits to the representatives from the State Engineer's Office.

MR. STOVALL: Okay, the only one that I don't see is any letters, Exhibit 2, apparently.

There we go, okay. Okay, thank you.

EXAMINER STOGNER: Again, I apologize, Ms. Aubrey.

Q. (By Ms. Aubrey) Mr. Scott, would you look at Exhibit 1 and describe the present wellbore status?

A. This well is currently producing in the Salt Lake Yates Field through perforations, the interval 3026 feet to 3052 feet.

Q. Let me stop you there for a second and have you explain why it is that a presently producing well is being proposed to be recompleted as a saltwater disposal well.

A. This well is part of a four-well lease, the other three wells also producing out of the Salt Lake Yates Field.

These wells all produce fair volumes of water, and the operator was searching for a solution to his saltwater disposal difficulties when I approached him with my proposal. This was right in line with what they were looking for, to solve their saltwater disposal difficulties.

Q. Who was the operator of the well?

A. It's the J.F. McAdams Trust.

Q. Okay, let's go back to your discussion of Exhibit A to the C-108, which is the -- current schematic.

A. Okay, this well was originally drilled by the Texas company as the Muse Federal Number 1, in late 1956. It was drilled to a depth of 15,560 feet to test the Devonian formation, among others. The original

drilling and completion attempts resulted in a plug-and-abandonment.

Subsequent to that time, the hole was re-entered and a completion attempt was made in the Capitan Reef formation over two intervals, the first being 4970 to -75 feet, and the second being 4620 feet to -30 feet.

Both of these completion attempts swabbed large volumes of water, and the well was immediately squeezed over those intervals and plugged back to attempt completion in the Salt Lake Yates Field.

Q. Who's the owner at the surface?

A. The United States of America.

Q. Were the surface owner and the leasehold owner, the operator, notified of this hearing?

A. Absolutely.

Q. What arrangements have you made with the United States through the Bureau of Land Management for the use of the surface?

A. We contacted Ms. Bobbie Young with the BLM office In Carlsbad. We do not currently have approved surface right of way, but she indicated to us that that would be not difficult to obtain provided, of course, that the appropriate state permits...

Q. What arrangements have you made with the

McAdams Trust? Are you acquiring the leasehold from McAdams?

A. Yes, I have an option to purchase the interest in the Brooks Federal "7" Number 6 wellbore.

Q. And is that with the understanding that it will be converted to saltwater disposal?

A. Yes, that is correct.

Q. Let me have you look at the area map which is included in Exhibit 1.

A. That would be item C.

Q. Item C.

A. Okay.

Q. Is the circle drawn on the map the half-mile radius?

A. Yes, that is correct.

Q. Within that half-mile radius, are there any producing wells which produce from the same formation as this well is completed in?

A. No. All of the wells that are shown on that half-mile circle are currently or were completed in the Salt Lake-Yates-Seven Rivers Field. None of the wells penetrate to 3220 feet.

The deepest penetration is in Unit Letter P of 12 of -- That would be 20-32, and that's approximately 3126 feet.

Q. And 3220 feet would be the top of your proposed perforation -- perforated interval for disposal; is that right?

A. Yes, also the approximate top of the Capitan Reef.

Q. Are there any wells which are productive -- In the half mile, are there any wells which are productive from lower zones?

A. None.

Q. Are there any plugged-and-abandoned wells within the half-mile area of review?

A. There are several plugged-and-abandoned wells, all plugged out of the Salt Lake Yates Field.

Q. Sorry, are there any plugged-and-abandoned wells which were completed in the interval in which you propose to produce?

A. No.

Q. Let's go to the schematic which you've included in your 108 as Exhibit B, which is your proposed wellbore schematic.

Can you review for the Examiner your proposed recompletion of this well as a saltwater disposal well?

A. Yes, be happy to. What we propose to do is squeeze the existing perforated interval, drill out and test that squeeze, and then go down and selectively

perforate over the previously mentioned interval, the Capitan Reef, acidizing selectively with a total of approximately 5000 gallons of HCl.

Q. Is this going to be an open or closed injection?

A. Closed.

EXAMINER STOGNER: I'm sorry, what?

THE WITNESS: Closed.

Q. (By Ms. Aubrey) What will the average and maximum pressures be?

A. We anticipate the average injection pressure to be a vacuum. This area is generally considered by drilling contractors to be an area of severe lost circulation, and we would hope that to be the case here.

We would anticipate a maximum injection pressure on the order of 600 p.s.i.

Q. And would that be within the Commission guidelines of .5 pounds per foot from the surface?

A. Yes, well within those guidelines.

Q. Attached to the C-108 is a water analysis, Exhibit D, which appears to be an analysis of Delaware water. Is this an analysis of water which you propose to dispose of in the well?

A. That is correct.

Q. What is the TDS of this Delaware water?

A. Well, in this instance approximately 220,000 parts per million.

Q. The next water analysis, which is attached to your C-108 as Exhibit E, is what?

A. This is a compatibility test between -- that was run by Anadarko -- between their Teas Yates Water Supply Well, which is completed in the Capitan Reef, approximately 3600 feet. This analysis indicates that we might anticipate scale formation in the water disposal well as a result of our operations.

Q. And how do you -- Do you have any plan to deal with that scale formation?

A. Yes, we would. It would require periodically a mechanical cleanout, and possibly acid jobs.

Q. Based on this analysis which is Exhibit E, is it your opinion that the water in the Capitan Reef and the Delaware water are compatible for disposal purposes?

A. As much as is practical, yes.

Q. Let's turn now to Exhibit F, and what is that?

A. Exhibit F is a sample of the water from the Teas Yates Water Supply Well, operated by Anadarko, approximately four miles east southeast of our proposed

disposal location. This is the closest sample of Capitan water that we were able to obtain.

It shows total dissolved solids on the order of 105,500 parts per million.

At this time I'd like to enter Exhibit 3 and 4. These are the original well logs on the Muse Federal Number 1, over the Capitan Reef interval.

Q. So these are the well logs on the well in which you propose to inject?

A. That is exactly correct.

MR. STOVALL: Let me just clarify. The Muse Federal Number 1 is now the Brooks Number 7; is that correct?

THE WITNESS: It was originally drilled and plugged as the Muse Federal Number 1. It was renamed the Brooks Federal Number 7 when it was re-entered and completed in the Salt Lake.

Going back to Exhibit A, and with the logs in hand, we can see that the perforated intervals 4620 to -30, 4970 to -75 were in fact in the base of the Capitan Reef.

Those two perforated intervals were swab-tested, and although I do not have available a water analysis of the water that was swabbed from that wellbore, I do have on Schlumberger scout tickets --

and this is labeled Exhibit 4A -- RW [*sic*] samples from those intervals.

Q. (By Ms. Aubrey) So Exhibit 4A shows water resistivity from the wellbore in which you propose to inject?

A. That is correct, over two intervals at the base of the Reef.

These water resistivities indicate that the water contained in the Reef contains on the order of 50,000 to 85,000 parts per million total dissolved solids.

EXAMINER STOGNER: Ms. Aubrey, I'm going to interject here just a second. I want to make sure I've got everything, because I was following real good up until we started bouncing around the exhibits here.

Now, looking at Exhibit F, that is the water analysis from the closest disposal -- I'm sorry, from the closest supply well from the Capitan Reef?

MS. AUBREY: That's correct, Mr. Stogner.

EXAMINER STOGNER: Then we talk about Exhibits 3 and 4, which is essentially the well logs from the subject well today?

MS. AUBREY: That's correct.

EXAMINER STOGNER: Now I'm -- Bear with me. On the 4A, go over that again with me.

THE WITNESS: Okay, 4A are water resistivities that were apparently measured by Schlumberger on water that was being produced from the two intervals in the Capitan, you know, that this operator was attempting completion in.

Q. (By Ms. Aubrey) And this would have been in about 1963 -- is that correct? -- that these water samples were taken?

A. Well, these are actually dated 7-20 of 1963 through 7-25 of 1963.

EXAMINER STOGNER: Now, these water resistivities are from the subject well today; is that correct?

THE WITNESS: Yes, sir, that is correct.

EXAMINER STOGNER: And this represents the Capitan Reef water taken out of what perforations?

THE WITNESS: One set of perforations were at -- referring back to Exhibit A -- 4970 to -75. The second of perforations, 4620 to -30 feet.

Q. (By Ms. Aubrey) Mr. Scott, if you'd look at Exhibit 4A, can you explain where those perforations are shown on these scout tickets on the exhibit?

A. Let's look at the seventh line down on the scout ticket, would indicate the depth of samples.

EXAMINER STOGNER: Okay, I'm caught up again.

Thank you, Ms. Aubrey.

Q. (By Ms. Aubrey) Now, Mr. Scott, you had referred to Exhibit 3, I believe. Is that the E log on the Brooks Well which was run --

A. Yes, Exhibit 3 is the electrical log on the well in question. Exhibit 4 is a gamma-ray/neutron log on the well in question.

Q. Did you have any more comments you wanted to make about the logs at this time, or do you want to go back to Exhibit Number 1?

A. I don't have any more comments specifically with regards to this well.

Q. Let me have you look at Exhibit G to Exhibit 1. What is that, sir?

A. We made a visual examination of the area and could not find a windmill or pump or any other freshwater resources in the area of the wellbore, so I called the State Engineer's Office in Roswell to see if they had any freshwater resources of record in the area, and this is the letter that Mr. Fresquez returned as a result of that inquiry.

Q. So according to the State Engineer's Office in Roswell, there are no freshwater wells within a mile radius of your proposed injection well; is that right?

A. That is exactly what this letter says.

Q. Did you have any additional comments you wanted to make about Exhibit Number 1?

A. No, I do not.

Q. And you've already talked about 2 and 3 and 4.

A. Yes, I have.

Q. Let me have you look at Exhibit Number 5, and would you like to look at 5, 6 and 7 together?

A. Yes, if I could.

Q. Okay.

A. Five is some water samples, 6 is a cross-section in northeastern Lea County, and 7 is an area map showing the limits of that cross-section.

MS. AUBREY: And for your convenience, Mr. Stogner, there is a copy of Exhibit 6 on the wall.

THE WITNESS: In Order R-9790, the Division expressed great concern about freshwater resources in Lea County, New Mexico. And we -- At the time, I did not anticipate that our proposed operations would have any effect on those freshwater resources.

Now, subsequent modeling verified that. But on my own initiative I went back and pulled well logs from the Capitan up into the Eunice-Monument Field in the Central Basin Platform, and using log tops from Commission records and several that I had to add that

were not picked in the Commission, generated the cross-sections that is shown as Exhibit 6.

The cross-section serves to show that the Grayburg -- Queen-Grayburg-San Andres-Seven Rivers are very, very likely in hydrologic connection with the Capitan Reef in this area.

Additional evidence that supports that is contained in these two water analyses, Exhibit 5, pages 1 and 2. The first water analysis is from the Capitan Reef. That's shown as the cross just above Well 618 on our area map.

Q. Your area map is Exhibit 7; is that right?

A. Exhibit 7, that is correct.

The second water analysis is the Chevron Eunice-Monument South Number 457. It is the B' terminal point of the cross-section. This is a San Andres water supply well for the South Eunice-Monument Unit.

Q. On Exhibit 5, where there's reference to a Jal water supply well, that's not a freshwater well, is it?

A. No, all water supply wells that have been completed in the Capitan, to my knowledge, have been completed for industrial purposes. That is, that water has been used to waterflood reservoirs on the Central

Basin Platform.

Q. On Exhibit 7, while we're here, there are well symbols with numbers behind them, 616, 617 and 618. What are those, Mr. Scott?

A. Those wells are part of the Capitan Observation Well Network referenced in several Capitan studies, among them, Mr. Hiss, Mr. Richey. I don't recall the dates. They would have been 1973 and 1985 studies, roughly. Those wells were used as data points for modeling water.

Q. Now, referring to the cross-section, which is Exhibit Number 6, do you have water analysis data for any of the wells that are shown on the cross-section?

A. We have water analysis data for the Eunice-Monument South Unit Number 457 only.

Q. Which would be the well on the far right of the cross-section?

A. That is correct. That well is not in the Capitan Reef. It is completed as an industrial water supply well in the Grayburg-San Andres. Dissolved solids there are 18,900 parts per million.

Q. And that water analysis is part of your Exhibit Number 5; is that correct?

A. Yes, that is correct.

Q. Let me ask you a question about your logs for

a minute, which were Exhibits 3 and 4.

In reviewing those logs, were you able to come to any conclusions about porosity or permeability?

A. Well, the old gamma-ray/neutron logs provide us with a qualitative indicator of porosity, and information from those logs was used as data input to the numerical model.

Q. And what number were you able to estimate for the porosity of the Brooks Well?

A. Eighteen percent was the number that we generated from that log analysis.

Q. Did you perform that log analysis yourself, Mr. Scott?

A. Yes, I did.

Q. Is that something which you're trained to do?

A. Yes, ma'am, I am.

Q. You're aware of water injection activities in the Eunice-Monument, aren't you?

A. Oh, absolutely.

Q. And where is that in relationship to the Capitan Reef?

A. It would be roughly at location B', on the area map shown in Exhibit 7.

In fact, there are numerous injection wells in the Eunice-Monument Unit, waterflooding and carbon

dioxide flooding for enhanced oil recovery in the Grayburg-San Andres.

Q. And what is your understanding of the position of the State Engineer's Office on that?

A. Well, there was a lot of consternation because the water in the Grayburg-San Andres is relatively fresh in that area, less than 10,000 parts per million total dissolved solids.

And until today I was unaware of their position, but I think a report that I saw this morning indicated that the Grayburg-San Andres should be exempt from UIC regulations as regards protection of drinking water because of its proximity to the oilfield.

Q. By your proposed injection operation, will you be increasing or adding to the pressure in the reservoir?

A. No.

Q. What's the geological name, thickness and depth of the proposed injection zone?

A. We propose to inject over the interval 3220 to 5050, into the Capitan Reef.

Q. And do you know what the thickness -- You calculated the thickness; that would be roughly 2000?

A. The reef -- That would be verified with Exhibits 3 and 4, would be approximately 1800 feet

thick at our location.

Q. Let me have you take out Exhibits 3 and 4, and let's confirm on the legs that the thickness is approximately 1800 feet.

You're looking at Exhibit Number 4; is that correct?

A. Yes, I am. Now I'm looking at Exhibit...

Q. Okay, on Exhibit Number 4 --

A. I'm on Exhibit 4, page 3; and I apologize, they're not numbered. The top of the reef would occur at approximately 3185 feet, as indicated by the very clean or leftward orientation of the gamma-ray log, which is the trace on the left side of the scale.

Q. And it continues to where?

A. It continues to the top of the Delaware, that we are estimating at approximately 5150 feet.

Q. Mr. Scott, what's your understanding of the definition of fresh water in New Mexico?

A. Water which contains less than 10,000 parts per million total dissolved solids.

Q. And what exactly is, in your understanding, total dissolved solids?

A. Well, that is the dissolved salts and minerals contained in the water. That would include sodium chloride, calcium carbonate, barium sulfate and

several others.

Q. What's the relationship between total dissolved solids and chloride content of water?

A. In the Capitan Reef, TDS would be approximately twice the chloride.

Q. Are there any sources, as far as you know or have been able to discover, any sources of drinking water within a mile of the proposed location?

A. We did not visually locate any, and the State Engineer's Office verified that.

Q. Have you examined the available geologic and engineering data for evidence of any hydrological connection between the proposed disposal zone and any sources of fresh water?

A. There are no hydrological connections with sources of fresh water in the immediate area, that is, within a mile of the radius of investigation.

We believe that there probably is hydrological connection between our operations and the freshwater resources in the Carlsbad area and in the Hobbs area, but only from a mathematical standpoint, theoretical standpoint.

There is no practical connection in the sense that, for example, if I put a bottle of dye into the Rio Grande River at El Paso, that bottle of dye is

hydrologically connected to the water at Brownsville and hydrologically connected to the water in Elephant Butte. Practically speaking, there is no connection.

Q. In your opinion, is there any practical connection, then, practical hydrological connection, between the disposal zone and the sources of fresh water?

A. No.

Q. In your opinion, Mr. Scott, will the proposed disposal of salt water in the Brooks Federal Number 7 well have any adverse effect on freshwater sources?

A. No, neither toward Carlsbad or in Lea County.

Q. Mr. Scott, let me have you look at what I've marked as Exhibit Number 7A, which is a proof of service with the Post Office return receipt cards attached.

From reviewing that, can you state that the Application was -- a copy of the Application was sent to the surface owner and to the owners, all leasehold owners within half a mile of the proposed location?

A. Yes, ma'am, that is correct.

Q. Mr. Scott, were Exhibits 1 through 7A prepared either by you or under your supervision and direction?

A. Yes, that is correct.

Q. Will the granting of Pronghorn's Application protect correlative rights, prevent waste and promote conservation of hydrocarbons?

A. Yes, it will.

MS. AUBREY: Mr. Stogner, I offer Exhibits 1 through 7A.

EXAMINER STOGNER: As far as 7A goes, there's only one copy; is that correct?

Are there any objections?

MR. STOVALL: No objections, and I don't need to see 7A; I'm not concerned with that from a party standpoint.

MS. AUBREY: Mr. Stogner, you'll note that there are two envelopes which are attached there. They were -- They're envelopes containing the Application which were returned marked "refused".

MR. STOVALL: Refused or not located?

MS. AUBREY: Refused.

EXAMINER STOGNER: Refused.

Let me make sure I understand. Exhibit 7A, notification pursuant to the requirements of the C-108; is that correct?

MS. AUBREY: That's correct.

EXAMINER STOGNER: And for notification requirements for the hearing?

MS. AUBREY: (Nods)

EXAMINER STOGNER: If there's no objection, Exhibits 1 through 7A will be admitted into evidence at this time.

MS. AUBREY: I have no more questions of the witness at this time.

EXAMINER STOGNER: Mr. Stovall, your witness.

MR. STOVALL: Mr. Examiner, I just have a few.

I am not going to question the witness on the C-108, simply because that's not what the Division here is specifically concerned with, but I would state in saying that, of course, that does not mean that it's not an issue which the Examiner shouldn't look at. The Examiner must look, of course, at the C-108 and all the traditional requirements of checking the proposed well and any of the wells within the area of review, but that's not the focus of what I'm going to ask about.

EXAMINATION

BY MR. STOVALL:

Q. Mr. Scott, you've identified the need, and I think the Division can concur that there is a need for the disposition of produced water.

But would you kind of go into a little more detail about the status, what's happened to existing

facilities and what other facilities are available and what types of facilities, particularly, more than just the specific ones for -- currently being used?

A. Okay, there are two surface disposal facilities currently being utilized for disposal of water in this area. One is located at Halfway, operated by Controlled Recovery, Inc. The other surface disposal facility is one that I believe is operated by Ray Westall in Loco Hills.

Now, in several instances operators have tried to develop on-site, on-lease disposal capability. But for the most part those injection wells have quickly pressured up and proven to be unsuitable for long-term disposal operations.

Q. Let me clarify then. In the OCD world a surface disposal facility is a facility in which water is placed on the surface of the ground --

A. Yes, sir, it's a --

Q. -- and evaporated?

A. It's a pit on the surface.

Q. Now, the ones you've described, do you know what -- I mean, are those lined-pit facilities?

A. I know that the CRI facility is unlined.

Q. Is it a natural, playa-type --

A. No, it is not.

Q. It's a constructed --

A. That is a manmade pit, yes, sir.

Q. You referred to Laguna Gatuna. That was at one point a site of commercial disposal; is that correct?

A. It was. That was a natural playa, a salt playa lake that has been closed down by the Environmental Protection Agency.

Q. And there, in fact, have been some others, have there not, in the immediate area?

A. Not in this immediate vicinity. I understand that there was one closer to Carlsbad that also ran into very similar difficulties as Laguna Gatuna.

Q. Now, you're talking about your well-handling about 10,000 barrels a day of produced water; is that correct?

A. Yes, sir, that is correct.

Q. Do you have any idea how much water is produced in that whole area? How much water is there to be disposed of in --

A. At the time that Laguna Gatuna was closed, they were disposing of approximately 100,000 barrels per month.

Q. That's about 3000 a day; am I correct?

A. Roughly 3000 barrels per day.

The current operations in the Delaware, from the operators that sent letters of support, would provide approximately 2500 barrels of water per day. However, these operators are telling me that their development activities have been curtailed by the high cost of saltwater disposal.

We arrived at our 10,000-barrel-per-day number because we thought that that was very reasonable from the mechanical limitation standpoint of that wellbore.

Q. Now, if we assume, then, that you were -- What about the pipeline? Let me ask you that first. This eight-inch line that you're talking about, how much water can that move into your facility?

A. Under gravity conditions, about 13,000 barrels per day.

Q. Okay. Let's assume for the moment that, based upon what you're saying, you believe you could handle -- You would have customers who could provide you with at least 10,000 barrels a day of water?

A. Not that I know of right now.

Q. You don't -- There's not 10,000 barrels in that area that need to be disposed of?

A. Not based on the history of that operation, no.

Q. But assuming if economical water disposal became available --

A. Then we could very -- The chances of getting to 10,000 barrels of water a day, I think, would be very good.

Q. If once you got to that limit or the limit of whatever the well could take, would you propose to go for a second well?

A. The system is loaded at that point, and I can't make any predictions along those lines but that is a possibility.

Q. Do you know -- You've identified, I think, two commercial disposal operators in the area. Do you know of any others? For example, Laguna Gatuna was operated by, I think, by Larry Squires; is that correct?

A. Yes, sir, that is correct.

Q. Is he still in the commercial disposal business, as far as you know?

A. No. That is, I know that he is not in the business.

Q. Okay. Have you looked at constructing additional evaporation surface disposal facilities?

A. We are of the opinion that surface disposal will become a less viable alternative as the years go

by.

There is already a lot of apprehension among the major operators with regards to the surface disposal facilities that are currently in operation, even though those facilities are fully permitted and operating not only under the letter but the spirit of the law.

That was one of the primary reasons why we started to investigate subsurface options. We believe this to be a better solution.

Q. I think I just have -- You talked about a hydrological connection between this area and freshwater zones in the Hobbs and Carlsbad area.

A. Yes, sir.

Q. And you say it's not a practical hydrological connection.

What would you -- What's your definition of a practical hydrological connection?

A. Discernible impact of our operations on any sources of fresh water.

Q. And when you -- Is this something that Mr. Wallace is going to go into --

A. Yes, sir.

Q. -- when you talk about discernible impact and --

A. Mr. Wallace is going to speak about that at some length.

Q. You used the analogy of putting a bottle of dye in the Rio Grande River, which is --

A. Yes, sir.

Q. -- a little bit less than 10,000 barrels a day of salt water into an aquifer.

A. But in the scope of the volume available in the Capitan Reef, that analogy is not very far off.

Q. And when you say that, do you have a basis by which you can quantify that? That's an opinion, if you will, and I'd like to have you back it up with some science if you --

A. No, sir, I would prefer, I think, to let Mr. Wallace speak about that too. That's his area of expertise.

Q. Okay. So in other words, when you've expressed that opinion, it's not based upon any science or analysis you've done, but rather stuff that Wallace has provided you?

A. That is exactly correct, yes, sir.

Q. I assume your water analyses in this case don't include any analysis of hydrocarbons, entrained hydrocarbons or anything, in the water; is that correct?

A. Well, the waters in the two wells in Exhibit --

Q. Is that 5?

A. -- Exhibit 5, didn't indicate any -- Well, there was a very small amount of oil in the water taken from the Jal water supply well number 3. That is, suspended oil in parts per million was six.

Both of these water samples did indicate fairly high levels of dissolved gas in the form of hydrogen sulfide.

In the case of the raw water taken from the Jal water supply well, it was 212 parts per million.

In the San Andres well at the Eunice-Monument South Unit, it was 255 parts per million.

MR. STOVALL: Mr. Examiner, I don't have any more questions for Mr. Scott at this time.

However, I will say before we move on to the next witness, Ms. Kery has had to leave. She had informed me some time ago that she had an appointment at noon, and so I'm going to request that before we start the next witness that we -- She will be back about 1:15. I'm going to request that we go ahead and take a lunch break, because -- I assume Mr. Wallace is your next witness?

MS. AUBREY: That's correct, Mr. Stovall.

EXAMINER STOGNER: Ms. Aubrey, do you have any objection to taking a lunch break?

MS. AUBREY: No, I have no objection.

EXAMINER STOGNER: Okay. I want to get some preliminary things out of the way with Mr. Scott while he's here as far as the C-108 portion of it and your Exhibit A or Exhibit 4, Exhibit A and B concurrently.

EXAMINATION

BY EXAMINER STOGNER:

Q. The 9-5/8-inch casing will be the casing that will be perforated and which the injection fluid is proposed to go into, and you will have 4-1/2-inch internally coated tubing; is that correct?

A. Yes, sir, that is correct.

Q. Okay. Let's talk about the cement of that 9-5/8 and the integrity of it or the historical aspect.

When was that 9-5/8-inch run and cemented?

A. It was run and cemented in 1956. You'll note there, approximately the middle of the page, Exhibit A, 9-5/8 is cemented to 8156 feet. There was a combination of weights. It was cemented with 5500 sacks of cement circulated to surface.

Q. Okay. Where did you get that information that it was circulated to surface?

A. That came from NMOCD well files at the Hobbs

Commission Office.

Q. Did it -- I wasn't -- Well, I was around in 1956, but not in the capacity I am today. Was it noted on there in any way -- This of course being a federal well, correct?

A. That is correct.

Q. Was it noted anywhere in there that it was witnessed that it was circulated?

A. Mr. Examiner, I cannot recall whether that note was made or not.

Q. Do you know if there were -- how many -- how much -- if it was measured, of how much cement was circulated to the surface?

A. I do not recall having seen that number either.

Q. Should this Application be approved, would the 9-5/8-inch casing be tested for mechanical integrity after the squeeze jobs would be performed?

A. Yes, sir, that is correct.

Q. Pursuant to whatever program was provided you through our district office in Hobbs?

A. Yes, sir, that is correct.

Q. Exhibit C, the half-mile area of review, when I look over there to Section 12, the adjoining section, that is, other than the subject well here, is the

deepest well at 3156?

A. That number does not correspond with the number that is present in the Commission records.

I believe the number that's in the Commission records is on page 2, item 6 of attachment 1, Brewer Drilling Company -- Item 6, Brewer Drilling Company, Monroe Number 1, located in P of 12-20-32. That penetration, according to Commission records, was 3126.

Q. So we're talking about a 30-foot difference.

Do you know if that penetrated the Capitan Reef?

A. It would not have gotten there, according to the log that I have on Muse Federal Number 1, just above.

Q. Do you know if there was a log run on that particular well?

A. Mr. Examiner, I do not know.

Q. Okay. For some elementary education here, Exhibit 4A, what information does this water resistivity provide me? Provide me, provide you, whatever the case may be?

A. Okay, Schlumberger provides log interpretation charts that allow us to go from the water resistivity to an equivalent sodium chloride solution in thousands of parts per million. Water

resistivity is directly correlatable to the total dissolved solids present in the water.

Q. And which I can refer, then, to the logs, Exhibits 4 and 5?

MS. AUBREY: Three and 4.

Q. (By Examiner Stogner) Three and 4, rather.

A. No, sir, you would refer back to Schlumberger's log interpretation chart book with these water resistivity numbers and the temperatures given to generate total dissolved solids contained in the water.

Q. And how do I interpret that data from this information on 4A? I mean, can I look at your resistivity and come up with a figure, or is it provided me, of what the total dissolved solids are?

A. No, sir, you would have to have a copy of a chart from that chart book. And I did not make copies of that because it is copyrighted material, but in the 1978 book it was chart GEN-9, and it's a resistivity nomograph for sodium chloride solutions.

Q. This is from the 1978 Schlumberger -- What's the name of the book again?

A. It's their log chart book.

Q. So what I would do, would take the resistivity information --

A. -- and the temperature.

Q. -- and the temperature, which is provided --

A. -- and go straight across to TDS in thousands of parts per million.

Q. And that would show up on that middle logarithmic scale, or scale that appears on this page; is that correct?

A. That is exactly correct, yes, sir.

EXAMINER STOGNER: Ms. Aubrey, can I hang on to this for --

MS. AUBREY: Certainly.

EXAMINER STOGNER: -- some time?

Q. (By Examiner Stogner) Going to Exhibit Number 7, the water analysis from Exhibit Number 5 is shown as the X above Well 618 in the far right -- lower right-hand corner; is that correct?

A. That is correct.

Q. Okay, and the cross-section which is depicted here is the B-B' of Exhibit 6; is that correct?

A. That is correct, sir.

Q. And the proposed disposal well is indicated essentially in the center, or at least the upper center, of this exhibit, correct?

A. That is correct.

Q. Was there any other water analysis that could be obtained closer to the proposed disposal well, or,

for that matter, in the direction back to the west?

A. Yes, sir, the Teas Yates Water Supply Well that is a part of our Application is a water analysis just four miles east southeast of our location, but it contains very high total dissolved solvents.

Q. And that is Exhibit E or F, the well you're referring to?

A. That would be Exhibit F, is a Capitan Reef water analysis.

Q. Do you by chance have the legal location on that well?

A. Yes, sir. It may take me just a minute to find it, but I believe I do.

EXAMINER STOGNER: Ms. Aubrey, I'll tell you what. Why don't we wait, and if you could provide that after our lunch break --

MS. AUBREY: Be happy to, Mr. Stogner.

Q. (By Examiner Stogner) While we're doing that, you might want to -- you allude on Exhibit D, the Exxon Federal Number 1 -- Let's try to get the location on those two wells while we're at it, or for that well too, because the way I understand it, your Exxon Federal Number 1 is your representative water sample for your disposal; is that correct?

A. That is Delaware water that we would be

disposing, that is correct.

Q. Would the water from this particular well be disposed?

A. Very possibly so.

Q. Or let me rephrase that. That would be on the eight-inch line system?

A. Very possibly so. One of our letters of support was from Anadarko, and they have indicated to us that they would very strongly consider connecting into the system in the event that our Application is approved.

EXAMINER STOGNER: Ms. Aubrey, have these letters of support been made an exhibit, or are we just referring to them as a part of the record?

MS. AUBREY: They're marked as Exhibit Number 2, Mr. Stogner.

MR. STOVALL: You gave me a copy, Mr. Examiner, so I assume you probably got one.

Q. (By Examiner Stogner) Mr. Scott, what did you send Meridian, Manzano, Anadarko, Mitchell, Yates Petroleum and C.W. Trainer for -- that you got this response, that you got these responses to?

A. Mr. Examiner, I don't recall sending them anything. Most of those, with one exception -- I sent Meridian, I believe, a prototype letter of support that

was, I believe, the one that we received from Mitchell Energy. All of those other letters we received in response to a telephone solicitation, told them what we were doing and how we proposed to go about it, and would they be willing to support us in our endeavor?

Q. Who in each particular company did you ask for, or did you have a contact in each one, or what type of individual were you seeking on your telephone solicitation?

A. Division managers, production superintendents, folks responsible for production operations in the area.

Q. Were those the only people in those organizations that you talked to or that you remember talking to?

A. Oh, I talked to several engineers, folks farther down the chain of command with regards to our operation, proposed operation. I --

Q. Are there any -- I'm sorry.

A. I have found that location for the Teas Yates Unit. That is in unit letter D.

Q. D as in dog?

A. D as in dog, Section 14, T 20 South, Range 33 East.

MR. STOVALL: 33 East?

THE WITNESS: Yes, sir, that is correct.

Q. (By Examiner Stogner) How about the Exxon Federal?

A. I have not found that location yet.

EXAMINER STOGNER: Okay.

MS. AUBREY: We'll have that for you when we return from the lunch break.

THE WITNESS: Oh, excuse me, sir, I just --

EXAMINER STOGNER: Oh, you found it, okay.

THE WITNESS: That is 1980 from the north line and 560 from the west line of Section 19, 19 South, 33 East.

EXAMINER STOGNER: Ms. Aubrey, do you have any redirect for Mr. Scott?

MS. AUBREY: No, Mr. Stogner.

EXAMINER STOGNER: Does anybody else have any questions of this witness at this time?

For the record, I want to point out that Mr. Jerry Sexton and Mr. Mike Williams are both here from our district offices in Hobbs and Artesia.

Do either one of you have a particular question of Mr. Scott at this time?

MR. SEXTON: No.

MR. WILLIAMS: No.

EXAMINER STOGNER: With that, let's take a --

MR. STOVALL: About an hour for Ms. Kery to come back.

EXAMINER STOGNER: How about reconvening at 1:20?

With that, we're at lunch recess.

(Thereupon, a recess was taken at 12:10 p.m.)

(The following proceedings had at 1:22 p.m.)

EXAMINER STOGNER: This hearing will come to order.

Ms. Aubrey, you may continue.

MS. AUBREY: Thank you. I call Michael Wallace.

MICHAEL G. WALLACE,

the witness herein, after having been first duly sworn upon his oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MS. AUBREY:

Q. Would you please state your name and your place of employment?

A. Michael Wallace. I work for RE/SPEC, Incorporated, in Albuquerque, New Mexico.

Q. Could you spell RE/SPEC for the court reporter, please?

A. Yes, R-E/S-P-E-C.

Q. Mr. Wallace, are you familiar with the

Application of Pronghorn SWD Systems for permission to dispose of produced salt water into the Brooks Federal "7" Number 6 well into the Reef formation?

A. Yes, I am.

Q. What is your occupation, Mr. Wallace?

A. I am a groundwater hydrologist.

Q. Have you testified previously before the New Mexico Oil Conservation Commission?

A. Yes, I have.

Q. Have you testified before Mr. Stogner, the Examiner?

A. No, I have not.

Q. Would you review your professional degrees and training experience for Mr. Stogner?

A. Yes. I have a master's degree in hydrology from the University of Arizona in Tucson.

I'm not sure how much detail I need to go into on that, but --

Q. When did you obtain your master's degree?

A. 1989. I finished the course work in 1986, however, and then I finished my thesis in 1989, when I defended it. My thesis was a three-dimensional flow and solute transport model of a deep well injection system into faulted stratigraphic units in the Texas Gulf Coast Area.

The coursework that I took as a graduate student consisted of graduate-level courses in aquifer mechanics, fluid dynamics, hydrogeology and a large number of relevant courses long those lines, all that were graduate level, some undergraduate level.

Q. Since you received your degree, have you received other professional training in the area of hydrology?

A. Yeah, I've taken about eight or nine short courses. I've attended a large number of seminars. Most of my work experience is also a learning experience, if you will.

Q. What are the primary technical areas in which you work?

A. Mainly in the quantitative analysis of groundwater flow systems and solute transport systems in groundwater, including at least three jobs where I've analyzed the effects of deep well injection activities of hazardous wastes into stratigraphic units in the Texas Gulf Coast region.

A large number of activities of mine were permitting activities where there was not an incredible amount of data. For the activity to be permitted, I had to spend quite a bit of time developing worst-case scenarios, conservative assumptions in order to satisfy

permitting requirements.

Q. What is your experience in contaminant transport modeling?

A. I've done at least fifteen fairly extensive contaminant transport models over the past ten years. They've all had different purposes. A fair number of them were done for remediation activities where groundwater was contaminated, others were done for permitting activities, and others were done for other activities that don't fall into those two categories.

The types of contaminants that I've looked at pretty much cover the spectrum of the issues in groundwater today, including hydrocarbon contamination, heavy metal contamination, other types of volatile organics. They cover a fairly wide spectrum of hydrogeologic regimes as well, including carbonate aquifer systems that are fractured as the -- and unsaturated zones, standard alluvial aquifer systems.

Q. Mr. Wallace, are you the author of any publications?

A. Yes, I am the author of several. I can't remember all of them off the top of my head, but they're listed in my résumé.

I've authored or co-authored several publications that deal with flow and solute transport

issues associated with the WIPP site. Some were regional, some were local.

I'm currently working on a hydrogeologic flow model of the Delaware Basin that includes -- that overlaps part of the Capitan Aquifer. That's under contract to Sandia National Labs.

I've authored at least two papers on deep-well injection. One was a paper about deep-well injection of hazardous waste and what constitutes conservative assumptions and what doesn't. That was presented in 1989, I believe, at the National Water Well Association-sponsored conference, Solving Groundwater Problems with Models, in Indianapolis.

And my thesis was the deep well injection paper, as I've stated.

I've authored several other papers on various aspects of three-dimensional flow and solute transport. Coupled fluid flow modeling of brines flowing through deforming salt was a topic of some of my papers. And a large number of consultant reports for various clients all over the world.

Q. Mr. Wallace, when we talk about modeling can you explain exactly what that entails?

A. Yes, it could take quite a bit of time, and I think I'll start with a simple answer, and if you need

more detail I'll go into it.

Modeling is trying to simulate reality, using software tools that are based on mathematical formulations of reality.

Q. In order to perform that kind of an analysis, do you have to have any kind of -- special kind of training or experience in modeling?

A. It is sort of a case-sensitive issue. There are many things that can be modeled by people that aren't necessarily skilled in every aspect of modeling.

In fact, I think I could think of a good analogy, would be a car: Anybody can drive a car, and not everyone knows how to build a car. Some people that are expert drivers know a lot about how to build a car, may not have built one. And some people that know how to build a car may not know how to drive one.

So modeling is a very complicated subject that covers the spectrum. There are many models that people use routinely and they have no clue about what mathematics went into the model.

I consider myself a sort of intermediate between someone that builds models and someone that just applies them. I've modified a large number of models in my time and adjusted governing equations. I know quite a bit about the numerics that go into

building a model, but my main expertise is in applying models.

I think I should add that certain types of modeling -- and in this case I think that the Capitan qualifies -- is not -- The kind of modeling that I have done is not the kind of modeling that a novice should attempt to do without specialized training, such that I have received.

Q. In the course of your work in modeling, in your modeling work, do you make the decision as to which software to select, to use to create the model?

A. Yes, that's --

Q. And how do you make that decision?

A. Well, it's a lengthy process, or can be. I'm aware of a large number of models that are available to be used. I have to go through a fairly extensive, almost a formal list of questions that I have to pose about the model.

First of all, I have to -- Before I decide on a model, I have to collect data about what it is I'm trying to model and what the purpose of the model is. Those are fairly subtle points.

Once I've made a determination about what I need to be trying to get at, what questions I'm trying to answer, then I look at what models are available

that are the most suitable to answer that question.

So -- Does that answer the question?

Q. I think so.

A. In this case, would you like me to talk about this model?

MS. AUBREY: Why don't you let me offer you as an expert witness first?

Mr. Stogner, I tender Mr. Wallace as an expert in the field of hydrology.

EXAMINER STOGNER: Are there any objections or questions, Mr. Stovall?

MR. STOVALL: I recognize Mr. Wallace's competence, and I think if anybody is capable of carrying the burden he certainly has the expertise to, and I -- So I have no objections.

EXAMINER STOGNER: I do have a couple of items.

VOIR DIRE EXAMINATION

BY EXAMINER STOGNER:

Q. You said your master's degree was in hydrology. What was your BS degree in?

A. Plant and soil science.

Q. So the bulk of your geological training came with your master's degree?

A. Yes.

EXAMINER STOGNER: I hope I'm not overstepping here, Ms. Aubrey.

Q. (By Examiner Stogner) In the -- You are somewhat familiar with the Capitan Reef and its structure. And how would you classify it?

A. How would I classify it geologically?

Q. Yes.

A. I'm not being qualified as a geologist; I'm a hydrologist. I know that it's a varied Permian Age reef. I could tell you quite a bit about the geology, but I'm not claiming to be a geologist.

MS. AUBREY: Mr. Stogner, would you like me to ask Mr. Wallace some questions about the geology of the Reef? Would that assist the Examiner?

EXAMINER STOGNER: Well, what I was leading up to is how the geology which he mentioned, and what he has put into his model and what kind of particular models in this type of topography --

THE WITNESS: Right.

EXAMINER STOGNER: -- and hydrology and --

THE WITNESS: Well, there is --

EXAMINER STOGNER: That's what I was leading up to. But you answered my question, so I'll qualify him as a hydrologist and we'll take it from there.

MR. STOVALL: Mr. Examiner, just -- I do have

one question, and it goes more to the specifics here, and I'd just like to ask Mr. Wallace, if you ran the model that was applied in this case, did you actually do the model?

THE WITNESS: There was two series of runs. The first series of runs was done by someone else under my supervision, and -- very intimate supervision, I might add -- and the second series of runs in the Addendum was done solely by myself.

MR. STOVALL: Okay, that answers that.

DIRECT EXAMINATION (Resumed)

BY MS. AUBREY:

Q. Mr. Wallace, before we move on to the specifics of your testimony would you discuss for the Examiner your understanding and knowledge of the geology of the Capitan Reef?

A. Sure, and most of that is contained in an exhibit where I present a conceptual model of the Capitan Reef.

Q. Is that what we've marked as Exhibit 8 to your testimony?

A. Yes. Yes, there's quite a bit of discussion about the geology of the Reef in there, all of which was obtained from other sources in the literature.

The Capitan Reef is a Permian Age, ancient

reef. It is -- It defines a boundary between the Delaware Basin and what are called the shelf area north of the Reef.

It's heart-shaped. I presented pictures of it there. It's approximately 500 to 2200 feet thick and 10 1/2 miles wide. It's over a hundred miles long.

It outcrops west of the Pecos River as part of the Guadalupe Mountains and then dips sharply underneath the Pecos, continues to dip till it reaches a low area near what is called the Hobbs Channel, I believe, which at that point it bends southward and begins climbing back up where it emerges once again as the Glass Mountains.

I could go on. I'm not sure -- It's considered a carbonate aquifer. It's weathered near its surface, so the porosity and permeability increase where it's weathered.

There are -- The units that surround it are fairly complicated. The way it degrades into the shelf area is very gradual. There are extensive interfingering with the units of the -- I believe it is the Artesia Group, the Grayburg and San Andres formations, et cetera.

The Delaware formation underlies it.

The Delaware Basin units such as the

Castille, the Salado, the Rustler formation -- well, the Salado is part of the Rustler formation -- some of those overlap the Capitan on top. Otherwise to the south they seem to prevail.

It's a very, very complicated system, compared to other areas in the -- some other areas in the state, and there's quite a bit of speculation about flow regimes.

Q. Are there any -- Is there any other geological information or data that you need to discuss in terms of your running the models that you've run in this case and coming to the conclusions that you've come to in this case?

A. Oh, quite a bit. I don't know if we should bring it up now or later --

Q. Specifically in terms of the geology.

A. Yeah, well, the buried submarine canyons play a big role in the flow of water through the Capitan Reef.

The hydraulic characteristics -- There's a lot where geology and hydrology overlap, and off the top of my head everything that I could say about the hydrology might be considered an aspect of geology to some people, so I might have to defer that.

But I should add that as a groundwater

hydrologist, my training is in looking at the hydraulic characteristics of rock. And hydrologists have somewhat different ways at times of defining geologic units and stratigraphic units than other types of geologists do. And so for example, I cannot -- Some parts of geologic parlance or age or rocks, I don't have off the top of my head. I'd have to look it up.

Q. Have you performed a study of the Salado halite?

A. Yeah, I've performed several studies of the Salado halites.

Q. Would you describe your studies of the Salado halite?

A. Regarding this issue?

Q. Yes.

A. Well, I've looked at several maps, also in conjunction with my other model that I'm working on for Sandia Labs now, where I've looked where the Salado lies in relation to the Capitan Reef. And in the area where injection is occurring the Salado is above the Reef -- Well, the Salado is above the Reef throughout, wherever it's near the Reef.

But it starts to outcrop less than ten miles east of the Pecos River.

And the Salado is a halite unit. It's

practically pure salt. And where -- And it's very low permeability. In fact, the WIPP site is located in the Salado.

So I have quite a bit of experience examining the Salado.

But where it outcrops near the Pecos River is also an area where I have said in my report that it must be highly weathered, and there must be extensive dissolution going on. I don't think that has been contradicted by anything else I've heard to date. And I think that plays a -- that probably plays a very important role in the water chemistry of the Capitan.

Q. Can you describe the work that you've performed in connection with the Application we're hearing today for Pronghorn, just generally give the Examiner some idea of when you were hired and generally what you have done?

A. Yes. In November I was contacted by Larry Scott of Pronghorn to -- He was inquiring about the feasibility of injecting brines into the Capitan. He wanted me to take a -- to look at it and let him know if I thought that it was environmentally safe -- if it was potentially an environmentally safe practice.

So I did -- I collected some initial data, I looked at it, I got information from him about the

quantity of brine he was planning to inject, the water quality of the brine he was planning to inject, and the length of time he was planning to inject it for, and the rates. I guess that factors into the quantity.

And he indicated to me at that time that he planned on injecting 10,000 barrels per day for 50 years, into a well that would have been completed throughout the thickness of the Capitan.

I did some back-of-the-envelope types of calculations, including one where I made an assumption that the porosity of the Capitan was 20 percent.

I then made an assumption that if he was injecting into the Capitan throughout its thickness, that a cylindrical volume would be created by this injection activity that would displace Capitan water. This is called in hydrology a piston-flow problem.

I calculated how much volume of the Capitan would be invaded by the injected brine if the shape of that injected brine was a cylinder, and I assumed that the Capitan, for this calculation, was 1000 feet thick, even though I knew that where his well was planned on being, it would have been 2000 feet thick.

Plugging in that calculation to calculate the volume of a cylinder of constant thickness, I came up with a radius of 1280 feet, which would lead to a

diameter of approximately half a mile.

Then I looked at a map of the Capitan and I saw that a half a mile diameter circle appeared to me to represent no threat whatsoever to the distant fresh water supplies that I thought existed at the time.

At that point I agreed, or we agreed, we reached mutual agreement, to work on this study, and I -- The understanding was that I would study this in depth and eventually develop a model based on my study that would predict in more detail the impact of his injection activities.

I decided that I would like to model it for a thousand years beyond the point of injection. A thousand years is -- No one has asked that I model it for a thousand years. It seemed to me, based on my experience doing permits for this type of activity, that a thousand years would be extremely conservative.

Q. While we're on that, Mr. Wallace, can you speak to the issue of what is and what is not a conservative model for this sort of problem?

A. Yes, and the definition of "conservative" varies with every case you look at.

For our case, a conservative model is one that leads to a prediction in which the solutes that are being injected are propagated the furthest distance

away from the point of injection towards the point of concern, the points of concern in this case being primarily the Pecos River and the freshwater sections of the Capitan.

There are degrees of being conservative, and there is a point where being conservative departs completely from reality, and there are so many variables that factor into a model that it's quite an art to come up with a conservative model that is still based in reality.

I could make -- I could develop a model, for example, in which the injection -- the injected brine goes to China, but that would not be realistic.

And usually what I've done through the years is, when I have good data control, I use realistic numbers. And when I don't, I use conservative numbers. The numbers I get for those conservative values, I usually have to take from the literature or derive them indirectly from literature.

Q. What were your sources of numbers in this case?

A. Most of them were taken from the literature. I did no independent field work myself.

However, some of the values were taken from not just the literature exactly -- When I say "the

literature", I mean published literature that is generally available in a library. Some information I got directly from the US Geological Survey, some I got directly from the New Mexico State Engineer's Office here in Santa Fe and in Roswell, and some information I got directly from Larry Scott. And some of that information was site-specific to the well in consideration.

Q. Your study has been criticized as not being conservative in certain respects, and while we're going through your testimony on the study, I would appreciate it if when you come to one of those areas in which you have been criticized for not being conservative, if you would indicate in your testimony why you believe your approach is conservative and what a less conservative approach would be, if you would do that.

Let me start with asking you about your study. You prepared what's been marked as Exhibit Number 1 to the -- I'm sorry, Exhibit Number 8 to this hearing; is that correct?

A. Yes.

Q. And you've also prepared what's been marked as Exhibit Number 9; is that correct?

A. Yes.

Q. Let's start with Exhibit Number 8, which is a

report entitled *Capitan Groundwater Studies*.

When was that document prepared?

A. This document was prepared in March of this year.

Q. And it was prepared initially in draft form; is that correct?

A. That's right, but I have not altered it.

Q. So Exhibit Number 8, in fact, is the same as the draft which the Oil Conservation Commission and the State Engineer's Office have received; is that correct?

A. Yes.

Q. When was Exhibit Number 9 prepared?

A. That was prepared in April of this year.

Q. And why was Exhibit Number 9 prepared?

A. In response to comments by the State Engineer's Office. They brought up comments with the drafts. I decided it would be cleaner and simpler for me to address those concerns in an Addendum and refer to the initial exhibit, leave that untouched.

Q. And was that -- Was Exhibit 9 provided to the State Engineer's Office?

A. Yes. However, I had a phone call with Dr. Barroll earlier this week where she indicated to me that she had not received part of Exhibit 9, which are two series of calculations, which apparently she has

not seen -- until today, perhaps.

However, I offered to provide that to her immediately, and she indicated to me that that wouldn't be necessary.

Q. Would you turn to Exhibit A of your report, which -- I'm sorry, Section A of your report, which is Exhibit 8 --

A. Yes.

Q. -- and discuss your findings contained in that section?

A. Just the findings, or what led to it, or --

Q. Well, why don't you give us a little background, and then discuss the findings?

A. Okay. It seemed to me that in initial meetings with the OCD and the State Engineer's Office that a previous applicant for disposal into the Capitan was denied based on a claim, stated as a fact, that there were waters less than 10,000 parts per million in very close proximity to the injection point.

And going through that, I was unable to find any maps that showed where waters were less than 10,000 parts per million and where the waters were greater than 10,000 parts per million throughout the Capitan.

The only thing that I could come up with was -- in terms of a map -- was a map by Hiss from

1975, I think, I believe, and I think it will be included as an exhibit by the State Engineer's Office, where there was a certain well point that had 8800 parts per million of chloride. The referral in the State Engineer -- in the -- The referral by the State to the denial of the Application, I think, referred -- to the best of my knowledge, referred to that well.

Looking at that, it was clear to me and to Larry Scott that 8800 parts per million of chloride pretty much means that you have over 16,000 parts per million TDS, which is greater than 10,000 parts per million.

At that point, it seemed to me that there were some prevalent misconceptions within the State and perhaps even within the Applicants, and it seemed that it was time that a map be developed that shows the distribution of TDS, or total dissolved solids, in the Capitan.

So the first part of my data development was this study called "Ground Water Quality of the Capitan Reef", and the main point of this study was to try to take all the existing water quality information that was readily available in the literature and develop a map of TDS.

I had two main sources to go by. The first

was a report by Hiss from 1973. I think it's called "Observation Well Network, Carlsbad to Jal", which I think may not be an exhibit, but it's well known to the State Engineer's Office since they commissioned the work, and that map that I had already mentioned by Hiss of the chlorides.

I was only concerned with the area roughly around the proposed injection activity. The map and the report by Hiss cover a much larger area. So I focused on a limited area, and I went about trying to convert chlorides into TDS.

The way to convert chlorides into TDS is to first look at the water quality distribution, all the anions and all the cations that are contained in a sample of water that make TDS, and to see if they are chemically balanced, to see if they are similar chemically to other waters in the Capitan.

I developed a Piper trilinear diagram, which is shown as Figure A1. In that figure I've taken most if not all of the wells from the Hiss study of 1973 and plotted the cations and anions on this diagram. And probably the main point of that diagram to look at would be in the upper right area under the CA + Mg line. They all very closely hug that upper right boundary. That puts them in a so-called groundwater

chemistry facies, where -- which is similar to the chemical composition of seawater, relatively speaking.

Since the -- most of them came across as being very similar in chemical composition, it seemed justified to look at the relative proportions of chloride and see if I could extrapolate TDS from that.

I found out that the relative proportions of chloride were about 50 percent to the total TDS, and therefore I assumed that wherever I saw a chloride value for a well and nothing else, I could merely double that value and came up with total dissolved solids.

Q. Let me ask you a question about the area of your study. Did you study the entire Capitan Reef, Mr. Wallace?

A. No, I did not.

Q. Did you model or purport to model the entire Capitan Reef?

A. No, I never planned to model the entire Reef.

Q. Would you describe the area which you did model and which you did study?

A. Yes, Figure A2. shows the area -- well, that I ended up focusing upon after I looked at the general literature about the Capitan.

Actually, the model covers a slightly smaller

area than is shown in this figure.

But as I was doing the TDS study and considering what I was planning on doing, what purpose I had in doing the ultimate modeling exercise, it was clear that in order to model the impact of injection on fresh water, that I should just look at the area -- just extend my model boundary to the nearest points of fresh water.

And the nearest points of fresh water to the west of the injection activity lie along the Pecos River.

And the nearest fresh water to the right of the proposed activity is that area shown in the map that roughly constitutes that 10-line in the contour, line that I developed. There's a "10", and it stands for 10,000 parts per million. It's -- more or less covers Township 21 South and 22 South, Range 34 East.

I ended up actually moving my eastward model boundary quite a bit east of that.

Q. Why was that?

A. Well, a number of reasons. One is, there was quite a bit of uncertainty and speculation as to the nature of flow in that freshwater area.

There is a feature known as the Hobbs Channel and this Eunice-Monument field. It's believed by most

investigators that flow is either entering or leaving the Capitan from that area.

And it seemed to me -- it was sort of -- It might have been a style preference. I probably could have put the boundary where that first 10-part-per-million line is. I wanted to move it down beyond that a little further.

So I went down to a well from Hiss's report -- I don't recall the name of it at the moment -- that falls down around that 100 line, near the bottom of my map, that 100,000-part-per-million line.

Of course, the purpose of my model was to look at when the plume -- if and when the plume would hit the 10,000-part-per-million line, or how far it would push the 10,000-part-per-million line east. Same as -- The same point as on the left side.

Oh, in fact, you asked me to discuss why these things are conservative and if the State has claimed they're not.

I believe in an exhibit that the State will present they said that since I did not look at the entire southern arm of the Capitan, in which there's considerable evidence of fresh water farther down south -- I think their statement was, that rendered my conceptual model invalid. And it's still a mystery to

me why they would feel that.

Using the same logic, I should have modeled the entire Pecos River, which is full of technically fresh water too, which is at the western end of my model, or perhaps the entire Guadalupe Mountain system, which also has fresh water.

As I said earlier, I was looking at when this activity would impact the nearest freshwater, and that was the justification for my focus.

Q. From a professional point of view, do you believe that there was any need to model the entire Capitan Reef from your most southerly boundary to the Glass Mountains?

A. No, absolutely not.

However, I should say that when I first looked at the data, I was open to anything. I wasn't sure how far I'd have to set my model boundaries. I didn't have a preconceived idea where these boundaries would fall. If anything, I went farther south than I needed to go.

Q. Let me have you return to Section A of your report.

What was your conclusion about the quality of water in the area of the Capitan Reef which you did model?

A. Well, that it varied considerably, but not as considerably as one might suspect from what I had heard from the State initially.

I had gotten the distinct impression before I began that there were isolated pockets of fresh water throughout the Capitan that have yet to be discovered or haven't been found, and it was my initial impression before I even opened a book on it that that was the case.

Once I developed this map of total dissolved solids, it was clear to me that the only areas of fresh water within my study region are the areas immediately around the general vicinity of the Pecos River.

Within six miles going east or northeast from the Pecos, the water quality deteriorates significantly from maybe 300 to 800 parts per million down to 20,000 parts per million.

And it never gets any better for approximately 50 miles to the east when you get around that area that I've already shown as a freshwater zone to the east. But "getting better" is a semantic term, because although the water there is technically fresh, the evidence that I have seen shows it's high in hydrogen sulfides, is not potable water.

It is also an area of significant oil

activity, or it's associated with significant oil activity, where it's hydraulically connected to the San Andres and Grayburg units that were discussed by Larry.

So in fact, the water quality of the Capitan gets much worse than just 20,000 parts per million. There is a significant area, based on the data points that I developed this map from, where the water quality has a TDS greater than 50,000 parts per million. And there are also large areas where the TDS is greater than 100,000 parts per million.

And in fact, the area north of the Reef has -- and the area south of the Reef -- have waters with TDS greater than 200,000 parts per million, going almost up to 400,000 parts per million.

So the Capitan is wedged between vary saline units on all sides. In fact, the Salado halite that overlies the Capitan is extremely high in salt.

And another interesting thing that I discovered was -- as an aside -- was the Capitan, being a carbonate aquifer, should be high in calcium and magnesium, and one would think that the water would be high in that. But the high salinities have suppressed that component in the groundwater. And I did reach a theory about that, that I stated.

It was my belief that because the hydraulic

gradients -- given the hydraulic gradients that are in the literature, given what one might think would be the speed of water moving through the Capitan, I calculated that the Capitan could actually flush itself out every 20,000 years over this study area by a recharge from the Pecos of relatively fresh water. The Capitan has been there for much longer than that, and so has the Pecos.

And it seemed to me that the reason that you have this complicated distribution of high and low TDS is because of the connections that the Capitan have with the shelf units and the basin units north and south, above and below, that the Capitan is not hydraulically isolated from these units, and there is a complicated mechanism of water moving in and out.

So high-TDS waters are entering the Capitan at different areas along the Capitan.

And that Salado halite outcrop I referred to earlier that outcrops a few miles east of the Pecos River, I also believe, is a principal source of salinity to the Capitan because of its weathered -- because it's so highly weathered that recharge water percolating through the Salado halite is responsible for that sharp boundary in TDS that's shown to the left on this map, Figure A2.

Q. Would you explain what you mean by "hydraulic gradient"?

A. Yes, hydraulic gradient is one of the principal driving forces that compel water to move through an aquifer, or through a river for that matter. It's a -- It can be broken down into several terms. It's -- The terms that it can be broken down to are -- Well, head, for one thing.

Hydraulic gradient is a change in hydraulic head over a distance.

Q. What's "hydraulic head"?

A. Hydraulic head is a measure of the potential of water to move from one point to another. It's one measure, a potential.

It can be broken up into several terms, including elevation. Water generally moves from high elevations to low elevations, but it's also a function of pressure, what we call pressure head.

I don't know if I can explain it without a diagram at that point, but it's a ubiquitous concept in hydrology, and basically you look at a point in an aquifer and measure its hydraulic head, look at another point in another part of the aquifer, measure its hydraulic head there -- sometimes the hydraulic head corresponds to the water level in a well -- and then

dividing that change in hydraulic head over the distance between the two points, you can calculate a gradient, you can estimate a gradient.

Q. So when you talk about hydraulic gradient, it's not just an incline or elevation change underground?

A. No.

Q. It has other components as well; is that right?

A. Yes. And there's other gradients that drive groundwater flow.

Q. And what are those?

A. One is a density gradient. A density gradient can be thought of more simply as a buoyant force. Think of oil and water. If you inject, I don't know, olive oil in the bottom of a glass of water, the olive oil will rise to the top. That's a buoyant force.

Generally speaking, in most groundwater systems, it is a secondary force compared to the hydraulic gradient force.

Buoyant forces come into play when the density of the water varies significantly, especially in an aquifer that dips. It is a big factor in the Capitan, since the water quality varies so

significantly from one point to another and since the Capitan dips.

Q. Is there a variation between the density of the fresh water and the density of the saline water?

A. Yes. And the greater the salinity, the greater the density of the water. It can range, I think, up to ten percent difference in density, perhaps more than that.

In my model -- Well, this goes back to another one of my conservative assumptions that was criticized by the State Engineer's Office. I said that density forces are important in dipping aquifers. What that means is, if brine is injected into a fresher source of water and the formation that the brine is injected into is dipping, then there will be a tendency for the injected brine to follow the slope of the dip downward. And this can happen even if the hydraulic gradient is directed the opposite direction, if the circumstances are right.

Since the Capitan is dipping away from the Pecos River, then the injected brine, in my opinion, would have moved to the east, or there would have been a strong tendency for the injected brine to move to the east.

In my model, however, I did not give the

Capitan a dip. I made it strictly horizontal.

Therefore, the injected brine did not have this added tendency to move away from the Pecos River.

In the critique that I read of my application of this model regarding buoyancy forces, it was implied that I misapplied the concept of variable density. I believe that that is because of misconceptions in the State Engineer's Office of what variable density is and how it affects groundwater flow. I am not certain why, but I know that they are -- They are used for dealing with a concept called equivalent freshwater head, and that is a term that has been discredited in the industry for decades, ever since the Forties, by King Hubbert, who's a famous person in hydrology.

For strictly two-dimensional groundwater flow systems, in lieu of any other capability to model a vertical component, hydrologists used to use this concept of equivalent freshwater head, where they would calculate the density of water in a well and predict what level the water in the well would have risen to if it were fresh water. And at that level -- They would correct everything in an aquifer for this equivalent freshwater head and derive gradients, hydraulic gradients, and then they would make conclusions about where water was going.

Now, the fact is, as I pointed out, that the density gradient is really a buoyancy phenomenon, and it affects the vertical movement of denser water and lighter water over and above each other like oil and water mixing together.

And in fact, one of the people at the State Engineer's Office asked me for some clarification. They brought up an analogy regarding my model. They said, Let's imagine that God put two columns of water next to each other, both of the same height, one of variable -- one of high density and one of fresh water, like this. And the implication is that this added density gradient would -- this is a red pen, and this is a blue pen -- that the red pen would displace the blue pen because it's higher density, because the equivalent freshwater head of this red column is higher than the freshwater head of the blue column.

But I explained that what actually happened would be this, that the denser water would slide down and underneath the fresh water, the fresh water would move up and over the denser water until one was on top of the other.

It seemed to me that my point was made clear to that individual, and I think that that issue might have disappeared from the critique. I'm not certain of

that.

Q. So your choice -- your choice in the model of assuming no dip away from the Pecos, then, is conservative?

A. Yes.

Q. Assuming a dip away from the Pecos would in fact have what effect on your model?

A. Well, I haven't modeled it. But if I had, it would either delay the movement of the plume towards the Pecos or enhance the movement of the plume to the east, this plume of brine that's being injected.

But as I said, it is a secondary -- In this case, I believe it's a secondary phenomenon.

Now, there are areas where it's not a secondary phenomenon, like DNAPLs. But we're not talking about DNAPLs; we're talking about 200,000 parts per million of brine or 250,000 parts per million being injected into an area of the aquifer that's already 50,000 parts per million of brine.

So the density effect, I believe, would be secondary, but it was there. But I chose to ignore it, and I ignored it in a fashion that made my model more conservative.

Q. Let's move to Section B of your report, which is entitled "Conceptual Model of Ground Water Flow in

the Capitan Reef".

Can you review for the Examiner what is contained in that section of the report?

A. Yes, this summarizes my understanding and determinations, conclusions, beliefs of the salient features of the Capitan Reef as it applies to my numerical model. This is -- Basically, this is my understanding of what's going on there. There's a lot of things that I talk about that no one understands completely, and I generally provide the best guess on what's going on.

I talk about the geology, the hydrologic setting, I give the dimensions of the Capitan Reef, the hydraulic parameters of the Reef, what the man-made activities, how they're impacting the Reef, how they're believed to be impacting the Reef. I discuss some of the salient hydrologic features that, as I said, play a role in my model.

I do have at least one figure in that section where -- There's two figures, actually. The first figure is Figure B1, where I've reproduced from some Hiss data some submarine canyons, and I speak a little bit about these submarine canyons. They are areas where clastics and other fine-grain sediments have filled up the canyon, the submarine canyons that were

in the Reef. They are of lower permeability than the rest of the carbonate reef, and they function as constrictions to flow through the system. That's one of the things that I bring up in that same figure.

Q. Regarding the canyons, Mr. Wallace, is the existence of the canyons subject to any dispute?

A. No, nobody disputes that those canyons are there, and I've never heard any serious disagreement about the size of these canyons or the hydraulic permeabilities of these canyons. There's no dispute about that whatsoever.

Q. What is the dispute, then, that surrounds the issue of the submarine canyons?

A. Referring to the comments made by the State Engineer?

Q. Yes.

A. They prefer that I not use the word "barrier to flow". In this draft report I referred to these canyons as barriers. They asked that I change the word to "constriction", which I agreed to do and I mentioned in the Addendum.

However, during the verbal conversation they acknowledged that they can function as barriers to flow, but in our case -- Well, they would function as barriers to flow, for example, if someone were

injecting brine within a shallow section of the Capitan, just east of one of these canyons; they would be a partial barrier. And I never said they were a complete barrier to flow.

Q. What is the relevance of the existence -- or the function of the canyons to your model?

A. They're not in my model.

Q. Why is that?

A. Well, because constriction, barrier -- They're an impediment. They represent an area of reduced hydraulic conductivity. It was conservative to eliminate them from my model. They were never in my model at the beginning. All I did was mention them here.

They do, however, serve to explain other things that I was criticized about.

Q. So that I'm clear, Mr. Wallace, you ran your model as if the Canyons did not exist?

A. Right.

Q. Would that have the effect, in terms of the model, of eliminating any constriction or impediment or barrier to the flow of the brine?

A. Yes.

Q. And is that why, in your opinion, that is a more conservative way to model the Capitan than putting

the canyons in?

A. Oh, absolutely.

Q. Okay, what other --

A. I would like to add something about the canyons while we're on it.

Q. Okay.

A. One could think of these canyons as inverted dams. Look at an analogy of a river. Where a river is flowing, it has a gradient, a hydraulic gradient. The river moves from high elevations to low elevations.

When a river becomes a reservoir, when the course of the river encounters a dam, a lake builds up, and the gradient of a lake is very flat. But there's also spillways in dams. So they're not barriers to flow in the river; they are constrictions, so to speak. And the water continues.

There's a hydraulic connection through a river, just as there is a hydraulic connection through here, but the gradients are flatter in areas where a dam exists, and going -- There's some questions concerning the calibration of my modeling, so to speak, that factor into that.

Q. Before we get to that, let me ask you about your choice of a number for hydraulic conductivity of the Capitan. How did you calculate that?

A. I didn't calculate it. I got it directly from Hiss, from a --

Q. Before we go much farther with Hiss, who is Hiss?

A. Hiss was an employee of the US Geological Survey, and he spent almost a decade, on and off, studying the hydrogeology of the Capitan Reef. He did his doctoral dissertation on the Reef. He did a study, or maybe a number of studies, that were co-sponsored by the US Geological Survey and the New Mexico State Engineer's Office, back in the Seventies.

Q. Are his findings and numbers and reports published?

A. Yes, there is at least -- there's several maps, special maps -- oh, these were also co-sponsored by the New Mexico Bureau of Mines and Mineral Resources also. So some of these maps are sponsored by that agency.

There's a report from 1973 that I've already mentioned, and there's this doctoral dissertation.

There's also a paper that will be included as an exhibit by the State Engineer's Office, from 1980, I believe that was in one of the New Mexico Geological Society guidebooks.

Q. So in coming to your calculation or coming to

the number you used for hydraulic conductivity, you used data that was originally generated by Hiss; is that right?

A. Right. Oh, by the way, would you indulge me to --

Q. Sure.

A. -- go back regarding this issue of whether or not the submarine canyons were barriers to flow or not?

One of the studies that Hiss did in 1973, or that he completed in 1973, was to try to determine the impact upon the Pecos River of water withdrawals from the Capitan near the Texas/New Mexico border in the southeast corner of the state, and there was no conclusion stated in that report.

However, when I looked at it and looked at the data, he looked at a series of observation wells, and he looked at the drawdowns, which means the rate at which water was dropping in these observation wells with time, and he monitored this activity for several years.

And in that report it shows that although water levels had been dropping for several years in the eastern half of my study area, they weren't dropping at all west of the county line between Eddy and Lea County. In fact, in some of the wells they were

rising.

Looking at that, it seemed to me that whatever activity was causing water to drop, water levels to drop in the Capitan in Lea County, was having no effect on water in the Capitan in Eddy County. And from my way of thinking, that means there is a lack of connection there. And a lack of connection means there is a partial barrier to flow. And I believe these submarine canyons have something to do with that.

Q. Would the difference in water level -- the dropping of water levels be explained, in your view, by the existence of the canyons?

A. I think that they -- Yes, they're the strongest evidence.

They're also evidence for something else that was observed in those water levels, that factors into another criticism that was leveled against my work, and that was the flat water gradients near the Pecos River.

The water tables do not have quite the slope to it, the hydraulic head does not have quite the slope to it in Eddy County within the Capitan as it does in Lea County. And as I mentioned earlier, if you consider these submarine canyons as inverted dams, just like a lake, they create flat gradients. And of course the tradeoff is that on the other side of the dam is a

steeper gradient, the spillway, for example.

And in my model, which I'll talk about later, I assigned a constant gradient over the domain. So I was unable to reproduce in my minute detail the subtleties of steepening and lowering of gradients throughout the aquifer, but there's reasons for that.

Q. Mr. Wallace, what is hydraulic conductivity?

A. It's the ability of an aquifer to transmit water. It is -- An analogy would be the resistivity of a circuit or of a wire.

Q. And why is that an important concept to your report and your model?

A. Well, in some cases it's not important at all. It depends on the scenario that I modeled.

In the scenario -- And I have to talk about those scenarios later. Obviously, you're unfamiliar with the scenarios at this point.

But generally speaking, the higher the hydraulic conductivity, the more rapidly water can be transmitted through it, given all other things being equal, including the gradient.

That's not true when you have a prescribed flux boundary condition in your model. In a prescribed flux boundary condition, which I simulated and I'll talk about later, I'm injecting water at a constant

rate. That water is being injected into that aquifer, no matter what the hydraulic conductivity, and it will move the same distance, no matter what the hydraulic conductivity.

The thing that would change if the hydraulic conductivity were much higher would be the hydraulic head gradients would not be as steep. So -- And the steepness of the hydraulic head gradients impacts -- It's all tied together, the conductivity and the hydraulic gradient play a role.

But if you're prescribing a flux, you are mandating that water shall move from that well at this rate, no matter what the hydraulic conductivity, then that's what happens in the model.

Now, the hydraulic conductivity value I took was stated by Hiss to be an average of five feet per day.

Hiss also spoke about areas west of the Pecos, or in the Pecos area, where the Capitan tends to outcrop and it gets closer to the surface where, naturally, the Capitan will be more highly weathered, more broken up. Carlsbad Caverns is an example of the Capitan breaking up, so to speak. The hydraulic conductivity goes up.

And he said west of the Pecos River, or in

that general area, hydraulic conductivities of as much as 25 feet per day have been encountered. He didn't say that east of the Pecos.

But because of the focus of my modeling study, this is an example of a number that I have from the literature, that I didn't have to derive, and it made no difference in my first scenario what the number was anyway.

Q. Why is that?

A. As I said, the prescribed flux boundary condition rendered it a moot point, so I used what was a realistic number.

It was interesting in that critique of my work, that the State Engineer's Office said that there are areas of the Capitan where hydraulic conductivities greater than five feet per day exist, 20 to 25 feet per day, but they did not mention where those were. And that data was taken from areas outside of my study area.

Q. And areas west of the Pecos River; is that correct?

A. Right. And I said that in my own report. I said the ranges of hydraulic conductivity go to 25 feet per day.

Q. Referring you back to your report, Mr.

Wallace, are there any other comments that you want to make about Section B, which is the Conceptual Reef Model?

A. Yes, I think that the area of fresh water in the eastern part of the Capitan that's within my study area should be discussed, and that area was postulated by Hiss, not a fact, that that's an area where waters of the Capitan are discharging into Hobbs Channel and out of the Reef. That water is recharging in from the Guadalupes, from the Pecos River and from the Glass Mountains, and converging at a point where the Hobbs Channel is, roughly, and leaving the Capitan.

He goes on -- The very fact that he was concerned about these oil and gas activities in the southern part of the state where they're pulling water out of the Capitan, he speculated that at some point flows might be reversed, in that water might be drawn into the Capitan from the Hobbs Channel as a result of the pumping activities that he acknowledges existed at the time.

And given everything else I spoke of, given the fact that his chloride map and his -- and he had never developed a total dissolved solids map of the area, when you look at that zone of fresh water and the orientation of it in relation to that Hobbs Channel,

and the Capitan --

Q. Can you tell me which figure you're looking at?

A. Yes, figure A2. That zone of fresh water is bounded by the two 10,000-parts-per-million lines in the northeastern area of the Capitan.

It was my conclusion that even as he wrote that, waters were being pulled in from the Hobbs Channel and southward towards these oil and gas activities to the south. And I think that's important. It plays a role in a lot of other things.

For one thing, it's consistent with everything that he said. I just did one more look at it by doing a TDS map. It's consistent with the cross-section that Larry Scott showed earlier, and it helps explain quite a bit about the water quality distribution in that area.

Q. So when you say waters are being pulled in, in that northeast area, do you mean as opposed to falling out the Hobbs Channel, they're being pulled in?

A. Yeah, they're being pulled into the Capitan.

Q. From what formation do you believe they're being pulled in?

A. The Artesia Group formations, the Grayburg and the San Andres, for example, in this location.

There might be other areas.

I think it's probably reasonable to assume that all the way along the southern margin, and maybe even in the northern margin of the shelfward side of the Reef, is an intimate contact with these other units, and water is intermingling.

But particularly along the southern side, maybe going down where the oil and gas activities are, they're not just pulling water out of the Capitan, they're pulling water out of these other units that are in hydraulic contact with the Capitan. That's another reason why they probably never impacted this area around the Pecos, as was originally feared.

Q. Do you have any other comments about Section B?

A. I'd like to take a minute and look.

Yes, I make a comment about the hydraulic connection between the Pecos River and the Capitan where I claimed they are -- I mistakenly claimed they are separated by 500 feet of what I called the Artesia unit. What I meant was the Artesia Group.

And where the Pecos River overlies the Capitan is an area of steep dipping of the Capitan, and I wrote that based on that report by Hiss, which was written in 1973 and was sponsored by the State

Engineer's Office, where he has a figure -- I think it's Figure 3 -- where he shows a cross-section of the -- In fact, I have that figure in my report. It's in a different section. It's Figure D4. We should probably take a quick look at that.

I presented this figure to kind of give an indication of the calibration of my model. However, it serves this purpose too, where you can clearly see to the left, at the top, the Pecos River is singled out, and directly below the Pecos River is roughly 500 feet of what is labeled as the Artesia Group, and below that is shown the Capitan Aquifer.

Another criticism that was leveled at my work was evidence that actually the Pecos River was separated from the Capitan by a small thickness of alluvial material, which should be distinguished from the Artesia Group, which has laminated layers. It has low-conductivity layers and high-conductivity layers.

It's still irrelevant to my model.

Q. And why is that, Mr. Wallace?

A. Because my model assumed that the Pecos River fully penetrates the Capitan Aquifer. So my model assumes that the Pecos River is basically 500 feet lower than it is, and is roughly a thousand feet thick, so that any water reaching that position, horizontally,

where the Pecos is, automatically is in the Pecos from my -- if the injection activity showed it.

And consider buoyancy forces too. Given higher density brines, in reality they would have to move upward through relatively impermeable material that is 500 feet thick. Very hard to conceive of that happening.

Nonetheless, my conservative assumptions in the model rendered that point moot.

Q. What is the reason that you chose to model the Pecos River as cutting through the Capitan Aquifer, instead of where you know it is?

A. Well, for one thing it makes it simpler to address these issues for permitting bodies like the ones we're at now.

The other issue is that it's extremely conservative, as I've said. And the fact is that there probably is hydraulic connection between the bottom of the Pecos and the Capitan, and I'm not disputing that.

However, there is evidence of confinement. There is a report by the New Mexico Bureau of Mines that suggests that wells tapped in the Carlsbad area into a unit they call the Carlsbad Reef were confined. And "confined" means they were under pressure and separated by impermeable material.

However, there's also evidence that the -- Lake Avalon, for example, on the Pecos, is discharging up to 20,000 acre-feet a year, directly into the Capitan.

It's my feeling the Pecos River -- and I think there's a consensus -- is a major source of recharge to the Capitan Aquifer. I haven't heard anyone imply that the reverse is true.

So there is a hydraulic connection. I'm working with a simple two-dimensional model. The Pecos is a major point of concern in the State Engineer's Office, one which we sought to address. It made sense to include it in the model. It seems to me it's close to the position where fresh water is farthest east. The freshwater zone extends maybe up to six miles east of the Pecos and, as I mentioned before, I'm looking for the nearest areas of fresh water.

Q. Any other comments you want to make about Section B, Mr. Wallace?

A. No.

Q. The next section of your report deals with your modeling assumptions; is that correct?

A. Yes.

Q. Am I on the right section?

A. Yes.

Q. To the extent that you haven't already addressed your assumptions, could you go through the assumptions that you have included in this section for the Examiner?

A. Yes. Would you like me to interject relevant comments that I've read by the State Engineer's Office at this point?

Q. If that seems appropriate to you.

A. Okay. One thing I need to correct is, at the beginning of this section, I said that this was the first time the Capitan had been modeled, and apparently that's not true.

In spite of the fact that I asked for relevant information about the Capitan and modeling, I only learned three days ago that there had been another model of the Capitan that the State Engineer had sponsored, apparently, or somehow they affiliated with, and I have not seen this report, although it's referred to in that exhibit.

Q. What's the name of the report that you haven't seen?

A. The author is Hathaway. It was from some proceedings before the Supreme Court regarding Texas versus New Mexico, probably tied into the Pecos River litigation.

I don't know if it changes things. I doubt it. I doubt that anything came up there that would have substantially added to my report, but I haven't seen it. So in any event, I was wrong to say this was the first time, because apparently it wasn't.

Then going down through the assumptions -- I should point out -- I would like to give a broad perspective about my assumptions and some of the criticisms that were leveled at them.

The criticisms in the report, that other exhibit by the State Engineer, I think they perpetuate misconceptions about the Capitan in approximately eight or nine different major categories.

And because they were sort of in a shotgun approach, it was hard to make sense of all them and tie them into a cohesive whole.

So I'm just going to summarize them here, then I'll go through my assumptions, and I'll go back and forth, so please bear with me.

I think there were misconceptions perpetuated on, one, the concept of variable density flow and the relation fresh water had.

Two, on basic concepts involving aquifer hydraulics.

Three, on the concept of hydraulic

connection.

Four, on groundwater chemistry.

Five, on aquifer storage.

Six, on the nature of what is a conservative assumption and what the degree of a conservative assumption is.

Seven, on the concepts of hydrodynamic dispersion.

And eight, on the concepts of fracture flow.

So, having said that, I will start going through my list of assumptions, and some of these I have already covered.

As I said, I assume the Capitan was flat. I talked about the nature of conservancy on that issue.

I assume it has a constant vertical thickness of a thousand feet. That's a conservative assumption because the average thickness in my study area is probably more like 1500 feet.

And the reason that's conservative is -- I would have to go back and talk about this piston flow issue, right, and that factors into my porosity assignments too.

If you assume that the water that's invading the Capitan from the injection point moves out like a cylinder and this cylinder has a constant volume when

all is said and done of a certain volume, then if the cylinder is tall, to maintain a constant volume, if you squeeze it like a pancake, then the areal extent of it will have to move out father.

So by bringing the Capitan down to 1000 feet from 2000 feet, I've compelled the contaminant plume to move out farther in this direction.

Now, how far more could I squeeze it? Well, I could squeeze it to an inch and, like I said, it would move out -- it would probably go to China at that point, the injected volume.

But what I did was, I -- You know, I didn't do a detailed study of the geometrically weighted average thickness of the Capitan unit. I looked at a map by Richey that shows -- It was an isopach map of the Capitan Aquifer. It showed the variation in thickness and included the submarine channels. Most of those submarine channels stopped about a thousand feet, meaning the incision only went down about a thousand feet into the Capitan, leaving another thousand feet unincised.

So it seemed to me that a thousand feet was a reasonable value. And as I said before, I like to use reasonable numbers when I can. In my opinion, this is a reasonable and conservative value, especially

considering where the injection is occurring. The Reef is actually 2000 feet thick.

I'll talk about porosity too. Porosity goes into this. I could find no numbers for porosity for the Reef, and the porosity obviously has a great impact. It's really the same thing. If you lower the porosity in this cylinder, the areal direction, the areal boundaries, will move out further.

Now, Larry Scott had done some work, as he talked about earlier, in trying to come up with the porosity, and one of the reasons he did that is because I could find no numbers in the literature for porosity. He came up with a range of, I think, roughly 30 percent to 18 percent. I used the lowest number, 18.

Now, maybe I could have used lower numbers, but to me that was the lowest number he gave me, and it seemed to me that they wouldn't be considering that zone for injection if the porosity was much lower than that, because the porosity plays a strong role in the transmissive properties. The porosity plays a strong role in that too.

Q. Now, are you aware that the calculated porosity from the logs run on the Brooks well showed a porosity of 18 percent?

A. Right, I'm aware of that.

So, that was -- Those are some of the assumptions.

I assumed a constant width of 10.25 miles. That's not a conservative assumption; it's a reasonable assumption.

Another assumption I made is that the Capitan was surrounded by impermeable boundaries, both above and below, and to the north and the south. And as I talked about earlier, it's very unlikely that the Capitan is hydraulically isolated from all the units which surround it.

However, by constraining all the injected fluid, and the fluid that's already there, to move through the Capitan and through the Capitan only, that will help further propagate the plume that's being simulated as being injected. The only directions that water can move out of my model domain are into the freshwater zone to the east or the freshwater zone to the west. That's a very conservative assumption.

I already spoke about how the Pecos River flow penetrating the Capitan is conservative. I assumed that the Pecos River was fresh. I put that in quotation marks. I said that the total dissolved solids content of the Pecos River was zero parts per million, when actually I believe its average content at

that location is over 300 parts per million.

If I had put in the average concentration there of 300 parts per million, I would have diminished something that's called a concentration gradient, which I haven't spoken about yet, which is another factor that drives solutes through ground water. I maximized the concentration gradients by making the Pecos River zero parts per million.

The assumption of a constant pressure boundary delimiting the eastern end of the model is not necessarily a conservative assumption. As I mentioned, it allows a reduced model domain size. It is a common practice in modeling, and for the purposes that I was considering it was more than suitable.

The values of hydraulic conductivity of five feet per day, the porosity, I've discussed.

The issue of longitudinal dispersivity of 100 meters and transverse dispersivity of 10 meters and the molecular diffusion coefficient, five times ten to the minus ten meters squared, are listed there.

There's a mistake there. It was a typographical error that the State Engineer pointed out. It should be five times ten to the minus ten meters squared per second for the coefficient of molecular diffusion.

Those numbers --

Q. Let me stop you there, Mr. Wallace. Was that a mistake you made when you calculated, or simply when the report was typed?

A. It was a mistake when the report was typed.

Q. So is your calculation of that coefficient accurate?

A. Yes. And it wasn't calculated; it was taken from a textbook called *Groundwater*, which is considered the Bible of hydrology, by Freeze and Cherry, 1979.

These are contaminant transport parameters, which I believe that the individuals involved in this case don't have extensive experience working with, particularly when applying them to numerical modeling.

There's a lot of factors that have to be considered when you employ these numbers in a model, and most of them -- I don't want to bore you and go into them, but dispersion as a concept I should explain. And I like to use analogies. I think I would use the analogy of an ink drop in a lake.

If you take an eyedropper and drop a drop of ink in a lake, you can see it break apart and expand in all directions. It attenuates until you can't see it anymore. That is a dispersion process.

Now, that process is dependent on a lot of

factors, including the concentration gradients, the ink content of the lake and the ink content of the ink drop, the velocity of the water in the lake. If you put an ink drop in a river, instead of moving out radially and dispersing, it will move out longitudinally and disperse as the river carries it along.

If you put an ink drop in an aquifer, it has even more dispersion because it has to work through tortuous pathways through the pores of the rock. And it's a very widely used concept in modeling but is not a perfect one. And at this point there are conflicting viewpoints on how to handle this process.

Once again, this is a secondary process in the movement of solutes through an aquifer. The primary process is controlled by hydraulic gradients. And the movement of solutes through an aquifer in response to hydraulic gradients is known as advection.

And the secondary process, which is this attenuation, is known as dispersion. Now, dispersion -- Many investigators, countless investigators have tried to measure this number. And they have found over the years that when they try to measure this number in a laboratory with a sand column, they come up with a number. When they try to measure this process in the

field, like in a tracer test where maybe two wells are separated by a hundred feet and a slug of dye is injected from one well and the other well is monitored to check for it -- When they do those kinds of experiments, they find that the measured dispersivity values go up an order or two of magnitude.

Then when regional modeling studies are performed, that value goes up even another order of magnitude.

And there is currently no feasible means using the state-of-the-art tools today to correctly simulate that change, that scale effect. In other words, it may not be fully understood.

Now, the implication is that to be on the safe side, to be conservative, it makes sense to use as large a number as is reasonable.

Now, I used the number for the dispersivity of a hundred meters in the longitudinal direction, and I used the lower value in the transverse direction, meaning longitudinal in the direction of major flow, which is towards or away from the Pecos in this case.

And that value of 100 meters was taken from that textbook, Freeze and Cherry -- I could cite the page. It's a peer-reviewed book. There was a critique made of my value of 100 meters by the State Engineer's

Office where they cited an NRC report that I had never seen before, which, from my familiarity with NRC reports, I happen to be of the opinion that most of them are not peer-reviewed. So I don't know about the credibility of that value.

Nonetheless, if for example I used a number of 200 meters, this attenuation factor is a double-edged sword, meaning as the plume attenuates, its concentration -- It's the same thing as saying its concentration is dropping.

And if you use a higher dispersivity, then you may move the front of this plume out further.

But when you're talking about injecting 250,000 parts per million into 50,000-part-per-million water, then that front is going to disappear rapidly until pretty soon maybe the only evidence of that plume is a 51,000-part-per-million line at some point.

So it works both ways when you talk about that number. And as I said, dispersion is a secondary effect.

I think I'm boring everybody, so I should move on to other --

MS. AUBREY: Mr. Stogner, would this be a good time to take a break?

EXAMINER STOGNER: I believe it would at this

point. A ten-minute recess, would that be sufficient?

MS. AUBREY: That would be fine with me. How about you, Steve?

EXAMINER STOGNER: Pardon?

MS. AUBREY: That would be fine with me.

EXAMINER STOGNER: Okay, ten-minute recess.

(Thereupon, a recess was taken at 2:53 p.m.)

(The following proceedings had at 3:15 p.m.)

EXAMINER STOGNER: Okay, this hearing will continue.

Ms. Aubrey?

MS. AUBREY: Thank you, Mr. Stogner.

Q. (By Ms. Aubrey) Mr. Wallace, do you have additional comments that you'd like to make about Exhibit 8, which is your -- the main volume of your study?

A. Yes, I still haven't talked about -- well, one last -- two last assumptions, I guess. Yeah.

There's an important assumption that I made, that factors in quite strongly to Exhibit 9, which was the Addendum I had to prepare, and that was, I had to assume an initial distribution of brine. It was -- It goes back to the very first part of this exhibit where I calculated TDS, and it goes back to the controversy about where that brine comes from, why is the Capitan

full of brine if it's a carbonate aquifer that's in intimate connection with the Pecos River?

And so what I chose to do is really not make an assumption about where the brine came from; I just assigned the brine -- that TDS distribution as it exists today, or based on what we know from the data, as an initial condition in the model, so that as one moves through the model you will encounter 100,000 parts per million of brine in some areas or 10,000 in others, and everything in between.

But there's an implicit assumption that's made when I do that, and the implicit assumption is that there is no source for the brine, because I'm not providing any additional brine to the model over the next thousand years. So I just say it's another God assumption, that at point -- time T equals zero, all this brine suddenly exists in the Capitan.

Then, because of the limitations of this model -- and all models have limitations; there's not a single model in the world that doesn't -- that assumption has ramifications that are subtle in the model results. And later I'll talk about the model and explain a little more about that.

But what it really means is that because of these diffusion processes and dispersion processes that

I spoke of, that all of this brine will tend to mix with itself, and the 100,000-part-per-million zone will kind of blend into the 50,000-part-per-million zone, the 20,000-part-per-million zone will blend into the 10,000.

And if I let the model run long enough, even without any injection, the entire model would eventually reach a state where it all has the same exact same concentration, and that's because the concentration gradients, the model that's simulating them is driving this movement of contaminant, even if the water is not moving.

And later on I'll talk a little bit about the two scenarios I modeled, one in which the water doesn't move, meaning there's no regional gradient, and one in which there is. In the case I just mentioned, that would be for where the water wasn't moving.

In the case in which the water does move according to a regional gradient, even if I hadn't injected any brine, that whole pattern of brine would move and migrate slowly from the west end of the model to the east end until finally it would have disappeared from the model entirely. So that's an important assumption to consider.

The final assumptions I made were about the

source term, which as I said, it was a constant source of brine, meaning a constant flux boundary condition, as I pointed out, is not affected by the values of hydraulic conductivity.

I used an injection rate of 12,500 barrels per day and a TDS concentration of 250,000 parts per million, and I simulated this injection for a period of 50 years, and I assumed that the screened zone of the well fully penetrated the Capitan, which is -- all of those are either realistic or conservative, because 250,000 parts per million is the maximum concentration expected. It's not the average brine concentration by any means. And 12,500 barrels per day is the maximum injection rate that would ever be applied.

Now, I'll try to talk briefly about my model. I think I've covered enough ground, really, that you have a pretty good idea of what the model is simulating, but I broke it up into two basic scenarios.

The first scenario is one in which I set conditions at the west end of the model. I set a head boundary condition, constant head, equal to the elevation of the Pecos River, from data I collected from the Roswell State Engineer's Office. It's sort of an average elevation from 1989 data.

And I set the right end boundary condition to

a head equal to a value in a well that I obtained from Hiss's 1973 report.

Now, granted, those are two points at very different points in time, but we don't have any data for that east end of the model on hydraulic head at this point in time, and we do have data on the Pecos River.

The gradient ended up being -- Oh, I did discuss that, because the trend seems to be that water levels are lowering in the Pecos near the right end of the model, that maybe the head boundary condition should be even lower there. So that's another conservative assumption, because the greater the distance between the heads at either end, the greater the gradients. And the greater the gradients, the faster flow will move away from the Pecos.

So I don't have flow moving away from the Pecos quite as fast as perhaps I could have justifiably done.

In that model I will direct your attention to Figure D1 where for purposes of explaining the model we developed what I would call a cross-section, A-A', that goes through a slice of the model parallel to the north and south boundaries, and bisects the position of the proposed disposal well.

Subsequent figures look at head and total dissolved solid concentrations along that line as predicted by the model.

Figure D2(a) is a depiction of the model grid. The development of a grid for a model like SUTRA can become somewhat of an art, and I think it's been pushed to its limit in this case by my worthy modeling assistant. He used what is called a grid-generating program to develop this and customize this grid specifically for this injection simulation and only for this injection simulation.

That very complicated pattern of cells around the injection point are made because with this model every single cell will have a data point, a data output associated with it from the model. And we collect that output and then we contour the results and use it to look at the results.

We wanted more resolution around the immediate area of the injection point, because I already knew from my earlier calculation that I did on the back of an envelope, so to speak, that this plume wasn't likely to go out much more than a mile or two around the injection point.

And so what I wanted to do is, I wanted to be able to capture the nuances of transport and flow in

the area within a couple miles of that injection point. And this area, as you can see, covers a span of nearly 60 miles by 50 miles, so that is why we have a detailed grid. And Figure D2(b) shows a close-up of that grid. That was necessary to look at the patterns around there.

So, going on to results, in order to do the first scenario in which I had a constant gradient where water was slowly moving away from the Pecos and towards the east end of the model, the first thing I did was run the problem without any injection to come up with a steady-state head distribution, and that is shown in Figure D3.

We're calling this freshwater head, to be consistent with the terminology that Hiss has been using. And you can see how the heads vary somewhat from 3150 on the left to 2650 feet on the right.

Then normally in a model, you would calibrate a model. For the purposes of my study and the fact that I used worst-case assumptions, conservative assumptions, and the lack of data, I just compared this type of steady-state distribution to what exists in the literature.

And the main source of that that was available to me is shown in Figure D4, which I adapted

from Hiss's 1973 report, where if you look at that figure you will see a cross-section that I've already discussed. There is a small dotted line that represents the water table, the equivalent freshwater head water table, for January 1st, 1970, as expressed by Hiss.

And then I have superimposed upon that solid large dots of the head distribution that my model defines as an initial condition.

And as you can see, there's very little difference between the position, the vertical position of my dots, and that small dotted line.

This is another area where I was criticized, I believe, or the model was, because there's a small difference in elevation between the dots in the -- roughly in the left half of the domain, and there's virtually no difference perceivable on this scale on the right half of the domain.

This is where that flat gradient issue was pointed out. This is where I've already spoken about the submarine channels that function as dams, that cause backup of water and flatten out the head gradients.

If they would have preferred that I put in these submarine channels to flatten the gradient, I

would have been happy to do so, but I was trying to be conservative.

So I cannot be conservative, be ultraconservative and match real-world data at the same time, in every single case. And this is an example where I didn't closely match.

However, I should also point out the fact that the vertical scale of this figure is already extremely, extremely exaggerated. The difference in horizontal distance is roughly -- I don't know, 80 miles, I think. And at the same scale of 80 miles, the vertical distance only covers about 10,000 feet or maybe two miles.

So these differences between measured heads and my predicted heads are already greatly exaggerated on this figure to begin with. And in my professional opinion as a modeler who has done quite a number of these, that was more than an adequate match. In fact, I was rather pleased.

Going on, I had to assign that initial TDS distribution that I spoke of, which is the same figure for a third time that you're seeing, Figure D5. And you also you can see the boundaries of my numerical model domain now. And you may notice that the western boundary of the model pretty much bisects Lake Avalon.

And most of the Pecos River in that area is several miles to the west of the western boundary of the model.

In any event, I proceeded with the model. I simulated the injection, superimposed over those activities, and the results are summarized in other figures, Figure D6 and Figure D7, Figure D8 and Figure D9 and Figure D10. And in those figures they show various ways of looking at total dissolved solids, along that A-A' cross-section.

You can see in that figure, the Figure D6, that there's a spike of total dissolved solids as a result of the injection activity, shown at two different points in time during the injection, and then how that spike has dissipated after a thousand years.

Figure D7 looks very similar to the initial contour distribution of Figure D5. In fact, it's very difficult to tell major differences anywhere. But if you look at the location of injection you'll see a small circle. That small circle represents a 100,000-part-per-million contour line, and I believe it is less than a mile in diameter after 50 years.

Of course, there is diffusion going on there, so I had to get a more close-up look. And the close-up look is shown in Figure D8. And this is where that highly refined model grid came in handy. These are the

same points in time as before, and you can see a very close-up view of the contaminant distribution directly around the injection point.

Now, as an aside, when I presented these results to the State Engineer on March 30th, a comment was made that I didn't show every single contour line that could be shown, and really that's impossible to do. It's a judgment call when you show contour lines.

And I brought up the point that they have all the data; they can make any type of contour plot they want from the data at hand.

And they indicated to me that that would be acceptable, because I volunteered to contour other data for them.

But for my purposes, this seemed to make the case and clearly spell out what the model was simulating, which is that you see a minor dip in that 50-part-per-million contour line to the west towards the Pecos. And then after the injection ceases, the 50 actually moves even farther to the east after a thousand years because of that regional gradient moving everything away from the Pecos.

Figure D9 is a vector plot. In this figure which is also the same time periods, these arrows vary in length, I would like to point out. The magnitude of

the velocity of the water in these areas, which is still focused around the well, is shown as a function of the length of the arrow. So you'll see some arrows that are very, very tiny, some have longer lengths.

The longest length of the arrows is in the area immediately around the injection point.

As you can see, nowhere within a mile west of the injection point are any arrows pointing towards the west or towards the Pecos River.

Now, another critique was raised about the model -- very misleading, I would add -- that strongly suggested that this injection activity was creating a reversal in gradients that was going to push saline water towards the Pecos, 20 to 30 miles to the west.

And a velocity arrow -- These velocity arrows are directly calculated from the hydraulic gradient information that the model calculates.

So a velocity arrow is a direct manifestation of gradients. It has a direction, which a gradient has, and it has a magnitude.

And there is no arrows west of the injection point, as I said -- I mean, within -- beyond a mile west of the injection point -- that point west.

So there is -- the model does not suggest that injection activities create a reversal of

gradients towards the Pecos. That statement couldn't be further from the truth.

The final figure regarding this scenario is Figure D10, where the -- we've tried to show a number of other factors, such as the head changes and the initial head and the initial conditions.

This is complicated to go through, and I think I'm going to skip it for the sake of time, because it doesn't add substantially to the discussion, unless you guys want to go over it in redirect.

The change in freshwater head -- The following figures stem from scenario two. As I've said, scenario two is a scenario in which I assumed there was no gradient at all in the model, that the water is not moving from the west end of the Pecos -- from the west end of the model to the east end.

This factors into that earlier comment made by the State Engineer's Office as well, where they say I failed to reproduce flattened gradients near the Pecos River. I think that this model should cover any concerns, because the entire gradient is flat throughout the entire model. So their point being that small perturbations in head could create a flow towards the Pecos, and that's what I've done here. I've maximized that concept.

This is what I consider probably the most conservative scenario that I've addressed, because if any injection brine is going to get to the Pecos, it's going to be very difficult for it to get there if the gradient is away from the Pecos.

And that's what the consensus is, that the gradient is away from the Pecos.

But if the gradient wasn't away from the Pecos, then this is what my model simulates.

And if you go to Figure D13 you will see a figure very similar to the previous contour figures, where a tiny little circle, not quite a mile in diameter, represents the 100,000-part-per-million line for the injection activity.

And Figure D14 is another close-up about that model, at the same times as before, that shows where the 250,000-part-per-million line is, and several other parts per million.

Figure D15 is another vector plot that shows that in this case, yes, water is moving in all directions away from the point of injection, during the injection activity. And once the injection activity ceases, there is no longer any gradient for water flow in any direction. And as a result, all the arrows have diminished to zero.

Now, you might -- I should point out that when an arrow vector has a zero magnitude, it is not even drawn. And I should point out that in the area around the injection point there are many blank areas that weren't present in the previous arrow figure. That means water is not even moving there. And the areas where arrows are moving towards the Pecos in these examples, the arrows are extremely short.

Nonetheless, there was a minor western movement of the 10,000-part-per-million line in this model. It was barely detectible. These things are difficult to contour for numerical contouring packages, but there was a westward movement of that 10,000-part-per-million line, and I attributed that, as I spoke about earlier, to the superposition of my assumptions about where all this brine was coming from.

As I said before, when I put an initial condition of brine throughout the model, it's going to naturally diffuse towards lower-concentration waters, whether we inject or not.

As a result, the State Engineer's Office suggested that a run be performed in which I did exactly that, where I simulated everything except injection for a thousand years, and that was the purpose of Exhibit Number 9.

Q. That's the Addendum to your report?

A. Right.

Q. And what is the conclusion you can draw from the work you did that's reflected by Exhibit Number 9?

A. Well, I performed both calculations. I used a different contouring package at this point.

As I said, I did this modeling and an assistant did the other one, and we are in the process of transferring different graphic systems. We used several. And I elected to use a different graphic system to portray the information. It's called Spyglass Transform. It's available commercially. I thought it would be helpful because I can do different types of annotation and gray-scale contours.

In this case, you can see the results in Figure 1 and Figure 2, on the very cover of the report.

Figure 1 shows simulation including injection For those of you who can see that, there's a -- in the lower X axis, if you go over to the 30 mark, which is 30 miles to the right, and go up, you can see a faint circle which represents the injection point.

Q. And that's in Figure one; is that correct?

A. That's in Figure 1.

Q. Okay.

A. There's also an expanded Figure 1 later on in

the text where you can see the same circle.

And if you look down at the same 30 mark for the Figure 2, which is simulation without injection, you no longer see that faint circle.

Now, these gray scales correspond one for one with the contours I showed in Exhibit 8, meaning the very bright area near the top of the model is the 100,000-part-per-million area, the next successive shade of gray is the 50,000-part-per-million, the next darker is 20,000 -- 20,000 to 50,000 -- and before that is, I think, 10,000 to 20,000. It corresponds directly to the other -- the other things. That's right, the dark area is 10,000 to 20,000, right.

Now, you can see the shape of the Capitan Aquifer. It's the same model; the only difference is the graphics package.

And if you look at the westward end of the contour lines, I was unable to detect any difference, any western movement of that line. And that is exactly what I predicted, that there would be no difference.

There's a few other thing that I included in this Addendum.

I acknowledge their concern that I no longer refer to the submarine canyons as barriers to flow, and I provided two different additional calculations.

The first calculation was a derivation of the storage coefficient. The storage coefficient is another hydrological term that the State Engineer is very familiar with, because it's an input to the MODFLOW code, which they use almost exclusively, I believe.

The SUTRA code is a more sophisticated code than MODFLOW when it comes to these types of problems. In fact, MODFLOW cannot simulate this kind of situation, because MODFLOW cannot simulate contaminant transport.

But SUTRA does other things as well. And what SUTRA does is, the terms that come together that make up the storage coefficient, SUTRA has broken down those terms, and you have to input those terms.

And the storage coefficient is sort of a measure of the sponginess of an aquifer. And those terms are tied into the porosity of the aquifer, the compressibility of the water, the compressibility of the aquifer, and the density of the fluid in the aquifer.

And so if one puts in the values in SUTRA, which I did, you can back out an equivalent term, for those who are more comfortable with storage coefficients, and you come up with the storage

coefficient roughly equal to 0.0005, which is fairly low for storage coefficients but well within the bounds for storage.

Now, whether or not that's conservative or not, to me it's basically irrelevant. It has basically very little impact on the final results concerning contaminant transport.

Nonetheless, when I indicated to the State Engineer by phone earlier this week the value which they were unable to determine on their own, they seemed to think that that was conservative.

The other calculation is a derivation of -- well, what we're calling equivalent freshwater head. It was another thing that could have been calculated. It's an artif- -- It's an option in SUTRA.

SUTRA normally iterates on pressure and not head. It normally gives you concentration outputs in terms of mass balance and not in parts per million. And this is an option where you put in numbers somewhat differently than one would normally do if they're iterating on pressure.

So in the interests of being forthcoming about everything which we were doing, which we were at every step of the way, I did some calculations towards that end too, to help explain that.

Q. Mr. Wallace, based upon your study, experience, background and training, can you reach a conclusion as to whether or not the injection of brine into the well covered by this Application will have any effect on the freshwater sources -- fresh water existing either to the east of or to the west of the injection site?

A. Yes, I believe it will have no discernible impact.

Q. And over what time period can you reach that conclusion?

A. Over a thousand years.

Q. How far in your calculation will the plume of injected brine move over that period of time?

A. Well, the model indicates that the eastern so-called boundary of that plume -- I'll have to look again. It was so small I didn't even try to determine how much that movement was. But I think it's -- I think the model shows that it might move a mile --

Q. And that --

A. -- a mile to the east.

Q. Is that away from the wellbore?

A. It doesn't even move that far. Yes, in fact, the front of the plume -- what you might call the front, which I was calling the 100,000-parts-per-

million line since the diffusion -- expands to within a diameter -- within a radius of a mile away.

There's actually diffusion, so there's minor impacts beyond that. But it probably dissipates completely by five miles.

Q. And this is over a time period of a thousand years?

A. Yes.

Q. Mr. Wallace, based upon your study of the Capitan Reef, do you have an opinion about the hydrological connection between the disposal zone --

A. Yes.

Q. -- and any source, underground source of fresh or drinking water?

A. Yeah, several conclusions.

First, I want to say that as a hydrologist, I believe that everything in that entire county is hydrologically connected to everything else. Wherever there's a water table, there's -- Whatever the geological units that are under that water table are hydrologically connected.

The Artesia unit is hydrologically connected to the Capitan, is hydrologically connected to the Delaware, which is connected to everything else.

Wherever the pore spaces are filled with

water, that's what hydrologic connection is.

Now, I'm going to bring up a few examples in support of that analogy. And I realize there is some kind of administrative distinction regarding the term "hydrologic connection", but it's an alien concept to me.

As Larry Scott stated, the Rio Grande River is hydrologically connected throughout its length, from its source in the Rocky Mountains to its discharge point at the Gulf of Mexico, and therefore it's hydrologically connected to the Pacific Ocean, for that matter.

But as Larry said, if someone discharged some source of contamination in the Gulf of Mexico, I don't think the State Engineer would be concerned about that, even though according to their definition there's a hydrologic connection.

But there's better examples than that. Another -- A much better example is the WIPP site.

The WIPP site is a repository for radioactive waste, and it is only about 15 miles south of this injection point. And in fact, it is upgradient from the Pecos River, and it is hydrologically connected to the Pecos River. And I haven't heard any objections raised by the State Engineer regarding the WIPP site.

Another example, which is probably, maybe, the most adequate example, is the San Andres unit. Now, the San Andres unit is a zone of extensive injection of oilfield brine wastes.

The San Andres unit is also a source of fresh water near the Pecos River. It is hydrologically connected, and it happens to be in the very same geological unit. Yet the State Engineer has not banned any deep-well injection -- or any oilfield brine injection activities into the San Andres.

Q. Are you aware of whether or not the San Andres has been designated as an exempt aquifer?

A. As of today, I am. This is something that we've been curious about for a few months now. We do know that the -- In my opinion, also, as I said, all these units are hydrologically connected.

It turns out that the zone of fresh water in the Capitan in the eastern region of my model, appears to be intimately connected with the San Andres there. And that has already been pointed out by Hiss, where he says that's the area where waters from the Capitan are discharging out.

And I -- My only problem with that is, I think they happen to be discharging in at the moment.

But whether they're discharging out or in,

they're connected.

And this is a point about the geology factor. I'm a hydrogeologist, meaning I look at rocks in terms of their ability to transmit water, not what their geologic nomenclature is.

In my opinion, there's no distinction that can be made, in terms of an aquifer, between the zone of the San Andres and the Eunice mine and field area, and that part of the Capitan where the fresh water exists.

There's another -- Another administrative distinction that I was wondering about was this definition of fresh water, the TDS being less than 10,000 parts per million.

I've noticed in some of these exhibits, I think are going to be prepared later, is, that distinction applies to fresh waters that are being used or conceivably will be used for beneficial use. And I think the basis for -- I'm anticipating. I think the basis for the exemption for the San Andres area is because it cannot be put to a beneficial use other than reinjection.

Q. Why is that, Mr. Wallace?

A. I think it's the high hydrogen sulfide content of the water, the high hydrocarbons. It's a

source of hydrocarbons. People are pumping oil out of those zones.

And the high hydrogen sulfide content is also -- there is data that it also exists in that freshwater zone of the Capitan, which makes sense since they're hydrologically connected.

So I cannot perceive a beneficial use being put to that water. Therefore, I don't think it qualifies as fresh water under that definition.

Q. Mr. Wallace, were Exhibits 8 and 9 prepared by you or prepared by others under your supervision?

A. I prepared 95 percent of the exhibits. Some of the model contouring output was provided by my assistants, under my direct supervision.

MS. AUBREY: Under your supervision.

Mr. Stogner, I offer Exhibits 8 and 9.

EXAMINER STOGNER: Are there any objections?

MR. STOVALL: None.

EXAMINER STOGNER: Exhibits 8 and 9 will be admitted into evidence.

Q. (By Ms. Aubrey) In your professional opinion, Mr. Wallace, will the granting of Pronghorn's Application protect correlative rights, prevent waste and promote the conservation of hydrocarbons?

A. Yes.

MR. STOVALL: I object to that particular analysis, because I think we're talking about just water and fresh water; we're not talking about hydrocarbons. He's not qualified as a petroleum engineer, so...

MS. AUBREY: Well, may I respond to that?

EXAMINER STOGNER: Please.

MS. AUBREY: I believe that testimony has been given today that the safe and environmentally sound disposal of produced brine is necessary in order to continue to encourage the production of hydrocarbons in this area, because one of the options, one of the few options that are available, will be that the production will stop if there's no place to put the produced water.

That certainly affects the prevention of waste, the protection of correlative rights and the promotion of the conservation of hydrocarbons.

And I don't suppose this is an enormously large point either way, but I do think the objection is misplaced.

EXAMINER STOGNER: Mr. Stovall?

MR. STOVALL: Mr. Wallace hasn't talked at all about the production. All of the references to that came from Mr. Scott.

It's just simply outside Mr. Wallace's declared expertise or testimony, and I think he is not the one to make that assessment, based upon what he's testified to here at this point.

EXAMINER STOGNER: Ms. Aubrey, I concur with Mr. Stovall. The objection is sustained.

MS. AUBREY: I have no more questions.

EXAMINER STOGNER: Okay, thank you.

Mr. Stovall, your witness.

MR. STOVALL: Mr. Examiner, in the interest of time I'd like to spend a couple minutes. I've got all sorts of questions written down, but I don't think I need to ask them all. And I'd like to just take a couple minutes to go through and see if I can weed them out and come up with the ones that really mean something.

EXAMINER STOGNER: How much time?

MR. STOVALL: Oh, if I could have five minutes I could probably save fifteen.

EXAMINER STOGNER: Okay, five-minute recess at this point.

(Thereupon, a recess was taken at 3:52 p.m.)

(The following proceedings had at 4:00 p.m.)

EXAMINER STOGNER: This hearing will come to order.

Mr. Stovall, your witness.

MR. STOVALL: Mr. Wallace, I'm sure you'll be glad to hear that I think my conclusion was right, that by taking a few minutes I've saved a few, which means I've saved you a lot of questions.

CROSS-EXAMINATION

BY MR. STOVALL:

Q. What I understood you to say at the beginning is that the purpose of a model is to try to recreate reality in some way and say, this is what will happen in this world if we change things; is that right?

If we do something to this regime, I have a way to test and see what will happen when I do that?

A. Well, if I said that, that wasn't entirely correct. Models --

Q. Well, that's my interpretation, so --

A. Okay. Well, models have manifold purposes. There's so many purposes to a model I couldn't begin to talk about all of them.

But I would just modify that slightly and say the purpose of a model is maybe to -- well, the purpose -- Boy. In general, these types of models, the purpose is to try to make a realistically based assessment of the result of some activity.

But the purpose of this specific model was to

predict -- was to determine whether or not the injection of brine as proposed by Pronghorn would have a detrimental effect on freshwater sources within the Capitan. That was the purpose of the model. That was the only purpose of the model.

Q. Now, did I understand you correctly when you described the Capitan, or is it a fair interpretation, that the Capitan is in fact a somewhat complex geologic structure, and --

A. Well, in some ways it's actually very simple; you can think of it as a tube. But in other ways, yes that's true.

Q. I mean, when you say it's a tube, I think of a tube as -- Well, let's take this example. You described your model something like this cylinder, this cup that I'm holding up. It's a cylinder, it's got height and diameter; is that correct?

A. Right.

Q. And then your model kind of says what happens -- If I fill that cylinder with a saline water and then go put some more saline water into it, your model says what will happen to it; is that what's kind of going on?

A. That's close.

Q. Okay. Then you talked about some submarine

caverns, if I'm not mistaken?

A. Yes.

Q. Correct me if I'm wrong, if I've got the wrong terms.

But what you've done now is, you've taken, if I look at your exhibit here and your modeling assumptions, you've taken this regime and kind of boiled it down to about five basic sets of assumptions that you have made about it.

And I forget in which of these sections -- They're actually not lettered. But I see this one's called Modeling Assumptions, is what I'm looking at.

A. Yes.

MS. AUBREY: Are you referring to Exhibit 8?

Q. (By Mr. Stovall) I'm referring to Exhibit 8, correct.

A. Yeah, there's an assumption section.

Q. And that's what I'm talking about.

A. Right. What I've done is, I've listed most of the assumptions that I believe as an expert are pertinent to the issues at hand and to implementing the model.

Q. And I think I heard you -- I mean, I know you said there are many variables in this aquifer that you have to kind of take into account and --

A. That's right.

Q. -- and make some predictions based upon those.

And you've taken this model, you have made a -- As I say, you've again taken it down to basically five groups of assumptions, which are -- appear to me to be fairly -- simplify this whole aquifer regime quite a bit; is that correct?

A. These may be called five groups of assumptions, but within each group are a number of parameters that I discuss, and it probably breaks out into more than 30 parameters, I wouldn't be surprised.

And these are the same kinds of parameters that are used in just about any groundwater model. In fact, these are more parameters than are used routinely by the State Engineer when they use MODFLOW. I'm quite certain of that.

So what I've done is no different than what occurs constantly throughout the world every time a model is done, whether it's a model of global warming or stress analysis on the wing of an airplane.

Q. Okay. And when you've taken these -- Let's take the number 30, since that's the one you used, different parameters. If you were to change any one or combination of them, that would change the results of

the model, would it not?

A. It would, and that's where my expertise in the nature of conservative assumptions regarding hydrogeologic problems comes in. I have developed an expertise in what kinds of assumptions are conservative and what are not. That's part of the -- you might call it the art of it, and the experience base on which the model must be built on.

Q. How do you test your assumptions? How do you find out if they are correct assumptions?

A. Most of my assumptions have already been tested in the literature.

If you would ask me about a specific assumption, I'd be happy to point that out, because every assumption has a different effect.

Q. Let me ask that question somewhat differently, because I think there are two parts of it, and I didn't really ask it properly.

How do you test your assumptions as they work in this model to determine if there's -- if in fact that really is what happens in the real world?

A. This model isn't the real world. This model is, in my opinion, something you would call the worst case.

This is part of the art of modeling, is in

lieu of modeling reality, which is not possible, you always lean towards the side of worst case.

If you're not interested in a worst-case prediction, then you shouldn't be making worst-case assumptions. But if you are interested in a worst-case situation, then you make worst-case assumptions.

Q. Well, what if I asked you -- I mean, you've said worst case. Let me just take an example. What if I asked you -- You have assumed this 1000-foot thickness which you have described as conservative, because as you -- again, using my big old mug here as a container, if I've got 1000 liters in a mug that is twice as thick, it's going to be much thinner; is that correct? Much smaller diameter? I mean, excuse me, twice as tall. It's going to be a much smaller diameter; is that correct?

A. Yes. However, I want to point out, there's a degree of conservancy of assumptions, which is --

Q. Oh, I understand that. Now, let me finish the question. I don't disagree with you on that, that there is a degree of conservancy.

But how you would respond if, say, another hydrologist were to say that a 1000-foot assumption is not necessarily conservative because there is a transmissivity issue that perhaps 2000 feet would

actually be more conservative because it would give you a more conservative transmissivity.

A. Well, are you asking me that question?

Q. I'm asking you how you would answer that question if another hydrologist were to say he disagreed with the argument that 1000 feet was conservative.

A. Oh, okay. Well, I think a very good answer for that, and that goes back to my constant flux boundary condition in this case.

A higher transmissivity might help water move farther under the same hydraulic gradient, but it won't help water move any farther or any faster if a prescribed flux is being applied to that water.

In this case, my model was a prescribed flux boundary condition. That means it doesn't measure what the gradient is. The water is going to move out at a rate that's dictated by the prescribed flux.

In fact, like I say, that's another reason my model is conservative. If you stretch out this cylinder and make it higher and narrow that volume in, that's the same point I said before: Given the prescribed flux of 10,000 barrels per day moving out, it's not moving out as far, as fast, because it has more volume to occupy vertically. That's the point.

This business about transmissivity, that stems back to a mindset that's prevalent in the State Engineer's Office, I believe, about transmissivity and hydraulic gradients, and I assume that's because they commonly use prescribed head boundary conditions which create gradients that move water through systems, instead of a prescribed flux boundary condition.

So in a prescribed flux boundary condition it does not matter what the thickness is; the fluxurate will move out. And in fact, the greater the thickness, the less the flux.

Q. So in other words, am I hearing correctly, and I think I heard you say before, that with regard to that issue specifically and with regard to some other things, you have a disagreement with what you've seen from the State Engineer's Office to this point as to what issues are of concern and what matters need to be looked at in order to make an evaluation of what will happen? Is that --

A. They would have had an excellent point if I would have used a prescribed boundary condition at the injection point. But I didn't, and there's really no debate about it in my mind, and probably in the mind of any other expert in the field of hydrology that understands the difference between the boundary

conditions.

Q. Doesn't your model have fixed heads at either end and not a fixed flux? Is that --

A. Yes, it does -- Well, in one scenario it has fixed heads. In another scenario it does have fixed heads but has no gradient.

And the question is not heads; it's the question of a gradient, a hydraulic gradient.

Now, it is true that in the first scenario I have a gradient that is directing water to move away from the Pecos, and my gradient is less than could have been applied. If I would have made the transmissivity greater, then as a matter of fact, given the same gradient, the water would have moved even more rapidly away from the Pecos. So it doesn't work that way either.

It does move more rapidly towards that freshwater zone, but I've considered that and I think that if you double the thickness -- You lose more in the other conservative assumptions than you gain in that one.

Q. Now, your model -- and we're getting into some technical stuff, and I'm not an expert on this and I don't claim to be -- but your model, talking about moving towards that eastern end, I think the State

Engineer's Office probably would have some questions with respect to the assumption that you're going to move away from the Pecos.

But your intervals, your contour intervals, are 10,000 parts per million; is that correct?

MS. AUBREY: Referring to what?

MR. STOVALL: Well, I'm referring to the exhibit that has shown up several times called D13. I think D7 also.

THE WITNESS: Sure, D7.

Q. (By Mr. Stovall) This is the one that has shown up several times where you're showing your -- what's the -- your dissolved solid contours?

A. Right.

Q. Now, do you understand that within the context of the rules that the Division operates under, that, first the 10,000 is the definition of a freshwater zone, as defined by that -- or fresh water as defined by the State Engineer's Office?

A. No, I don't under- --

MS. AUBREY: Well, I object to that, Mr. Stogner. That's only part of the definition of fresh water.

THE WITNESS: That's what I would assume too.

MS. AUBREY: That is not the entire

definition of fresh water.

MR. STOVALL: Let him tell me that, then.

THE WITNESS: That's not the entire definition.

Q. (By Mr. Stovall) What's the rest of the definition, as you understand?

A. I'd prefer to read directly from one of your exhibits.

MR. STOVALL: Okay. Have we given you a marked set?

MS. AUBREY: Yes, you have.

MR. STOVALL: Oh, good. Okay.

Q. (By Mr. Stovall) Let's assume for a moment -- Let me deal with the 10,000 figure, and I'll let you get to that when Ms. Aubrey finds that.

Are you aware that, dealing with the 10,000 issue, that if it is fresh water, that any degradation is prohibited? And that's really the question I wanted to ask, so I'm not sure if a total definition makes a lot of difference.

A. You mean --

Q. In other words, if you took a water from 3000 to 3500, are you aware that that is prohibited under our requirements to protect fresh water? It's the degradation, not the taking it outside of the limits,

that is our requirement.

A. Oh, yes, I understand that. Yes.

Q. Does your exhibit, again, the D -- I'm using the contour, and we've referred to D7, so let's stick with that, Figure D7.

How does that help us determine if there is any degradation in that sense? And we're looking to the east again.

A. To the east?

Q. Well, because that's where you've really talked about -- I mean, that's the direction you're assuming the gradient flowing.

A. Well, I guess the degradation issue isn't relevant there, because in my opinion it doesn't qualify as fresh water under that definition.

But maybe you could ask -- I don't know, a different question about -- something about the 10,000-part-per-million line?

Q. Well, in other words, using the contour lines of 10,000 parts per million, it doesn't give us a change within that range, does it? It doesn't show -- If it did go from, say, 3000 to 5000, you wouldn't see that on this, would you?

A. Well, before I answer that question, there's something else I need to explain about my model, and

one -- It's the concept of dispersion, as I talked about before.

Q. Uh-huh.

A. The fact is that when you -- As I've already said, the contaminant drips with time because of the initial condition, whether or not injection occurs.

Secondly, there is a concept associated with any model modeling dispersion called an infinite tail, which means you can inject a point, a particle, a part per million of contaminant into an aquifer, an infinite aquifer, and you will have within one second of the injection a measurable quantity of contaminant all the way out to infinity. It will be infinitesimal, but it will be measurable.

Those kinds of things -- Generally, it's based on experience and knowledge of the model and the realities of a system. There comes a point where you have to cut that off and say, This is real, this isn't.

Now, in my case, what I do is -- I always knew from the start when I turned on these models, there was going to be infinitesimal effects throughout the model once injection goes on.

And the effects that I saw were consistent with what I expected to see.

Q. Okay. Your expectation -- I mean, your test

is based upon a homogeneous condition; is that right? A homogeneous aquifer?

A. Yeah.

Q. Is this a homogeneous aquifer, in your opinion?

A. No, not at all.

Q. How many aquifer tests are available for the Capitan? Do you have any idea? Or do you know what --

A. I know of about one or two that I recall reading about.

I'm sure there's quite a bit over by Carlsbad -- wells over there.

Q. Now, is that a sufficient, then -- Now, okay, when you're taking one or two, when you're saying there's some more over by Carlsbad, where are the one or two that you're familiar with, geographically?

A. I think they were over by Carlsbad as well.

Q. Okay. What about in the area where you've run your model?

A. No, and as I said before, the value of hydraulic conductivity I used was not important.

Q. What happens -- I mean, your model is based upon injection from one well; is that correct?

A. Right.

Q. What happens if you add additional wells?

Would you not have to go back and retest this? Would it not change what would happen?

MS. AUBREY: Well, I object to that question. It goes beyond the scope of direct, in the first place. In the second place, it goes beyond the call of the case.

MR. STOVALL: As I indicated at the outset, Mr. Examiner, we are dealing with a novel -- a new issue. We've only had one other case in the history that I know of for the -- request for an injection into the Capitan.

This is a unique aquifer, and we are concerned about the precedential value of it.

And in order for us to make a decision, I think you have to look at the potential for additional injection.

And since we are trying to recreate reality with this model, I think I need to hear if there is an effect on the model by the addition of other injection points.

MS. AUBREY: May I respond, Mr. Stogner?

EXAMINER STOGNER: Yes.

MS. AUBREY: At the outset of this hearing we pointed out to the Hearing Examiner this was not a rule-making case but it was an adjudicatory case, and

was a case involving an application for authority to inject into one well.

This is not a case in which the expert has been asked to, on behalf of the Commission, make a prediction based on an injection from any number of wells other than the one well we're talking about here.

The expert has not said that his model is an attempt to duplicate reality or project reality. In fact, he said just the opposite.

If the cross-examination is going to take this turn, then I don't see how it can proceed without serious objection.

Mr. Wallace is not here on behalf of the Commission, he is not here to establish statewide rules for injection into the Capitan Reef.

He is here to talk about his conclusions and support them with his science on the effects of injection from one well, and that is the area in which he should be cross-examined.

MR. STOVALL: Mr. Examiner, what I'm trying to figure out is, from the Division's standpoint, as I said at the outset, we're not here to -- We are here to determine what standards must be satisfied, and the standards that are set in this case will affect the outcome of future cases, and I think we need to

understand how the tool -- I'm not asking him necessarily what the results would be of an additional injection.

I'm asking him if it would affect the outcome of his model if there were additional injection in here, because the scenario I would envision is that if we got another application, we would come in and add another well, another model, another well. And we need to figure what we're looking for. We don't know what they're trying to -- what they need to prove until we understand all of the effects, because it is a precedent-setting case.

MS. AUBREY: Well, Mr. Stogner, I assume that every case decided by this Division is precedent-setting in some degree.

We are operating under the rules set out that exist today, Rule 701, which deals with injection of fluids. Those are the rules, the standards are set out. This isn't a case in which you have no standards. In fact, Mr. Stovall's going to put on a witness to tell you what those are, as they exist today.

So this is not a case in which the call of the case permits the establishment of new standards or new rules for injection into the Reef, and we've been talking about this problem all day long.

This is a case in which you are asked to grant authority under the existing rules for injection into the Capitan Reef formation by the Applicant in one wellbore.

EXAMINER STOGNER: Ms. Aubrey, was this Application submitted administratively in the beginning?

MS. AUBREY: No, it was not.

EXAMINER STOGNER: So you had sought it to come to hearing initially?

MS. AUBREY: That's correct.

EXAMINER STOGNER: Am I to assume that when I look at Exhibit -- or Figure A2, that you all are requesting a unitization for this one well in this aquifer?

MS. AUBREY: I don't believe that's our request, Mr. Stogner.

EXAMINER STOGNER: No, it isn't. And that's one of the things that we have done around here in the past, many times. Dual commingling -- I mean, I'm sorry, dual completions were initially heard to set some sort of precedent, because if we let one person do it, everybody else will.

And that's exactly what we've got here. It has not been done. You've come to hearing on this

matter because it hasn't been done.

If we set precedents, then why did you even come to hearing today? If we haven't allowed it before, then what are you doing here?

MS. AUBREY: Well, Mr. --

EXAMINER STOGNER: So you can't go by that argument.

Nor are you seeking some sort of a unitization where this is the only well and you have a monopoly out here in this particular situation.

So we are trying to set some sort of establishment to allow for this, or not to allow for it, or how to work it in.

If we allow -- and I like his analysis, we drop one piece of red ink in a pond, that may not. But how many drops of ink are we going to allow before the pond turns pink? That's what we're essentially doing here, yes.

So in essence, there is some merit to Mr. Stovall's questioning, and things that has to be considered. There's a lot more than meets the eye than just one request for a saltwater disposal in the Capitan Reef with this situation, and if we're going to continue today we need these sort of questions answered.

MS. AUBREY: Well, Mr. Stogner, I am not sure that the witness is prepared to hypothesize about the effect of additional wells. He may be. If he is, I suppose that then he can be helpful to you on that point.

MR. STOVALL: With respect to that, I mean, the witness began his calculations on the back of an envelope with -- based upon his expertise, and he's offered his expert opinion. I hope he can at least say whether additional wells would affect the model calculations or not.

EXAMINER STOGNER: If you can keep your questioning to some sort of a generality, Mr. Stovall, I will allow it.

Q. (By Mr. Stovall) Yeah, I don't want to know what the effect is; I want to know if there could be an effect.

A. Okay. Of course there could be an effect. I can't say what the degree of the effect will be --

Q. I'm not asking you --

A. -- without doing modeling.

It's my opinion -- and Mr. Scott and I have discussed this; I think this will be helpful -- is that in order to evaluate other applications if they should come down the line, that assuming this one was

permitted, that the influence of this one, this one be factored already as the earliest activity, and every additional activity be thrown into a model very similar to this one, so that they all are modeled and the impacts of all of these injection activities are added to the preceding activities that already exist.

And I have always felt that that would be a tool that the OCD would use, or the State Engineer's Office would use as a planning tool to find out where they're comfortable about continuing to allow this activity.

It's a finite activity. There is only so much oil out there.

Q. Can you tell me what that number is?

A. No.

Q. Okay. Following through on your suggestion there, if we are to do that -- if the Division were to permit this, and we're really figure out how to define that -- I mean, I'm not sure that we know how.

If we were permit this well and then another application were to come in, would you recommend that we do some sort of monitoring of the aquifer to determine whether or not your model has predicted accurately what's going on?

A. I think there might be a point at which

monitoring might give you extra assurances, but I don't feel at this point that monitoring is required.

Q. Well, I guess my concern is that -- and you've testified before the Division before and you know that the Division looks with some skepticism upon models for the very reasons that you've testified about today, and I'm trying to find out what you can offer us that could help us to determine how much reliance we could place in a model, in any model, as it's applied to a given situation.

A. Well, a model is basically an extended calculation. And if I -- If a stranger walked to you today and asked you how long it would take him to get to Albuquerque from Santa Fe, you'd be thinking in your head, and maybe you'd have to do a calculation saying, Well, I assume he's going to drive at 60 miles an hour, and he's not going to encounter any traffic, and Albuquerque is 60 miles away, so I predict it would take an hour.

In a way, that is a model. And in fact, you're probably pretty safe to say that.

But you don't know everything about the system. But still, through experience and through estimating those things you can tell.

Q. Okay, let's take that one step further.

Given that -- Accepting that that's a model, if I plug in that we've got a -- It really is a time-distance model; that's a relatively simple calculation. It's just how fast is he going to go over a known distance; is that correct?

A. Yeah, but that's a reality model too. And I'd better clarify, that's not a worst-case by any means.

Q. Absolutely. But if I want to make a determination, if I throw in, say, we've got a bad-weather situation, he has to go slower, I can offer him a variety of numbers fairly quickly -- is that not correct? Say if you go 50 miles an hour it'll take you this long, if you go 75 it'll take you this long. It's relatively simple to plug in the variables; is that not correct?

A. Well, it seems simple, but actually it's an incredibly complex determination.

Q. Oh, Mr. Wallace, please.

A. It is. Okay, I'll give you another example. This is a better example. Allow me, please.

EXAMINER STOGNER: Excuse me, I really don't know where we're going on this. Mr. Stovall, can you get back --

MR. STOVALL: Well, I'm about to ask him

another question, actually. I wasn't going to interrupt him, but I've got another question that would --

EXAMINER STOGNER: Well, I'm going to interrupt him, because I don't want to know how long it takes to get to Albuquerque.

Q. (By Mr. Stovall) What I'd like to know -- I mean, it appears to me that one of the benefits of a model would be that you can change the variables to find out what the effect is; is that correct?

A. Depending on what you're trying to find out, that's true.

But I think I have a pertinent answer to this.

Take a cataract, a waterfall. Water is moving down a cataract. You want me to tell you, if you inject ink in the middle of that waterfall, where is it going to go? Now, I can't tell you all the variables about where the water is moving through the rocks and the crevices. But I can tell you it's going to go down, and it's very unlikely it's going to go up.

And given what I know about the waterfall, I consider this a very similar case to that. It's very clearcut to me.

The water is moving away from the Pecos, and

the likelihood that it's going to go up this waterfall, so to speak, is extremely unlikely. And that's why I don't think monitoring is required.

Q. One last question: Have you calculated -- Have you factored into your model the impacts of any other existing wells that have -- could affect the flow in the aquifer?

A. Implicitly I have, through the gradients that I've assigned at the lower east model, that constant-head boundary condition I used in scenario one, is really probably an artifact of all the water withdrawal activities that are being done by the -- by oil and gas operations south of there.

Q. But you've not specifically looked at those and examined those. You made some assumptions about them; is that correct?

A. I've looked at some discussion about them in the literature, but I didn't go through a detailed tabulation of the effects.

MR. STOVALL: I have no further questions, Mr. Examiner.

EXAMINER STOGNER: Any redirect, Ms. Aubrey?

REDIRECT EXAMINATION

BY MS. AUBREY:

Q. Mr. Wallace, what does your study show about

whether or not the injected brine will, within a thousand years, reach the freshwater source to the east of the injection well?

A. My studies indicate that it will not.

Q. So there will be no degradation of that water because the injected brine will never reach it; is that correct?

A. Not precisely.

Q. Well, let me withdraw "never". Within a thousand years?

A. That's what the model indicates.

MS. AUBREY: That's all I have, Mr. Stogner.

EXAMINATION

BY EXAMINER STOGNER:

Q. So that I can understand Figure D8, Initial Conditions, then after 23 1/2 years you have a contour, then after 50 years, then after a thousand years. The 50-foot line has actually migrated up to the north and east.

Am I to assume when I look at that, that by just this 50 years of injection, that the water will get better?

A. No, that's an artifact of the modeling assumption that I discussed earlier, where I started out with an initial condition of this distribution of

contaminants. And as I pointed out, even if I didn't have the well on, if that well was turned off, in fact, that 50-part-per-million contour line would have moved even further to the east, according to the model, because I make no assumptions about the source of the contaminant. I just set it there and let it slide down the hill, so to speak.

So that's an artifact.

Q. Isn't it also your assumption -- Mr. Stovall pointed out, you're assuming this is a heterogeneous aquifer; is that correct?

A. No, I am assuming it's a homogeneous.

Q. Okay.

A. I mean, the model assumes it's a homogeneous aquifer.

Q. Of a thousand feet?

A. Thickness, yes.

Q. Okay. In your model, that's assuming that each foot has equal amounts of injectivity going into it; is that correct?

A. Yes.

Q. Can I classify this aquifer as a karst topography or karst water aquifer?

A. I do not believe that would be a nearly correct term for this zone.

You could classify it as a carbonate aquifer. It's -- There's areas of it, of course, of the Capitan Reef, that become karst. But I don't -- I haven't seen any evidence of that in the literature for the zone that I've modeled.

Q. And when you -- So if I view the Capitan Reef at, say, Guadalupe Peak, where -- I think you'll probably agree that that's a karst topography?

A. (Nods)

Q. Is that a "yes"?

A. Yes.

Q. Then I'm not seeing the same formation in this area?

A. In this area you have 2000 feet of overburden compressing the Reef, significantly reducing the size of those pore spaces.

Q. When you talk about a carbonate reservoir, would these large porous spaces that I'm assuming that were formulated when the Reef was laid down, are compressed to, say, fractures, or are we going to have some sort of a channeling, and -- with your knowledge of aquifers?

A. Well, in carbonate aquifers I think that both could exist. It's possible that both could exist.

The -- For example, the Culebra is a

carbonate aquifer in the Delaware basin, in the Rustler formation, that has been extensively modeled through a porous media approach, you might say, with contaminant transport modeling done. And it is very similar -- I mean, in the sense that it's a carbonate aquifer -- to the Capitan. And it's fractured, it's fissured, it may have vug nodules.

The larger the scale you look at a carbonate aquifer, the more effective your assumption is of an equivalent porous medium. And I'm looking at a very large scale in the Capitan.

EXAMINER STOGNER: I'm going to vary it a little bit. Mr. Scott, are you still here?

MR. SCOTT: Yes, sir.

EXAMINER STOGNER: The perforated interval is what?

MR. SCOTT: Gross interval would be approximately 3220 to 5050.

EXAMINER STOGNER: And what's that in actuality?

MR. SCOTT: I would say -- We don't have the actual number of perforations pinned down for our completion yet. My guess is, we've been looking at at least 500 holes and possibly more than that.

EXAMINER STOGNER: Up and down equally

between the 3220 and 5050 interval?

MR. SCOTT: I think we would probably try to perforate equally spaced as much as possible on porosity spikes.

EXAMINER STOGNER: In looking at the intermediate casing, there was a DV tool set at 4585. What was that purpose?

MR. SCOTT: I am not sure what the purpose of that DV tool was, but I have seen reports on the original drilling of the well that indicated a lost circulation zone in the Capitan below 4500 feet.

EXAMINER STOGNER: Mass loss circulation, or did it say?

MR. SCOTT: No, LCM. The actual drilling report said drilling ahead with lost circulation too.

EXAMINER STOGNER: Do you know if a majority of your holes are going to be past that DV tool?

MR. SCOTT: Well, sir, just saying that 4500 is closer to the bottom of the hole than it -- I mean to the bottom of the interval than it is to the top of the interval, I would say that possibly a third of those holes would be below the DV tool.

Q. (By Examiner Stogner) Mr. Wallace, the reason I went to Mr. Scott, this is telling me this is not obviously homogeneous, nor are you saying that it

is, but your model is indicating it.

Are there parameters in such a model, in modeling such a reservoir, where different steps could be taken that would show, not every zone, but perhaps different zones, that there is known to be some sort of porosity change or vuggy material occurring in that area?

A. I guess you are referring to a vertical stratigraphy within --

Q. Yes.

A. -- right?

Q. In this instance, yes.

A. As opposed to things like these submarine channels that kind of create horizontal heterogeneities in the aquifer.

Q. Yes.

A. Of course, a model can simulate as many layers as the computer is capable of handling. The more layers you put into a model, the greater the computational effort requires. That's one of the reasons that once again that we go to a worst -- what we think is a worst case.

I think that you are concerned that there is a significant vertical stratigraphy; is that correct?

I guess I'm not asking you the questions, so

I'll let you --

Q. I'm trying to find out how viable such a modeling is in my own mind, in this type of a topography or an aquifer.

A. I -- One thing that I was considering when I was building this model, it goes back to the water quality data that I didn't discuss before, but when I did that water quality study, several of the wells had samples from several different elevations within the Capitan.

Some of the wells, I think it was -- samples were taken from -- oh, I think about eight different intervals within the same well.

When I plotted -- I worked that data up and did a composition analysis through this trilinear diagram, and although I believe the TDS may have varied, the relative composition didn't, meaning it still had the same geochemical facies.

And that was one of the things that suggested to me that there are not zones, that I think you're implying, that are separated from each other. I think that vertically I believe the Capitan has good hydraulic connection.

I don't know if that directly answers your question.

Q. Well, I'm leading up to the 18 percent porosity. Was that a little too liberal? Could it have been a larger number to more adequately reflect such a lost circulation area?

A. Oh, yes. Oh, but I have to -- There's something that needs to be clear. Just because the size of a pore -- the average size of a pore is larger, that doesn't mean the porosity is larger.

Take, for example, the difference between clay and sand. Sand has larger grains, and as a result the pores between the sand grains are larger than the pores between clay particles.

But consistently, if you ever measure the porosity of clay versus the porosity of sand, the porosity of clay is greater, yet clay is less permeable. It kind of factors in things.

From my orientation, a conservative model is one that generally minimizes porosity, because given a prescribed flux boundary condition, once again, let's say you're pumping water through an eight-inch hose, and you're pumping five gallons a minute. The water will move at a certain velocity. But if you constrict that hose to maybe one inch and you're still pumping five gallons through, if you pump for the same period of time, that water moves much farther away.

So that's why it's a conservative assumption to use a lower porosity than a higher one. It's also why it's a conservative assumption to use a lower thickness than a higher thickness.

EXAMINER STOGNER: Any other questions of Mr. Wallace?

MR. STOVALL: I have none.

MS. AUBREY: I have none.

EXAMINER STOGNER: Anybody? You may be excused.

Ms. Aubrey, do you have anything further?

MS. AUBREY: I have nothing further.

EXAMINER STOGNER: Mr. Stovall, I believe we're ready for your witnesses.

MR. STOVALL: Yes. Call my first witness, Mr. Catanach.

DAVID R. CATANACH,

the witness herein, after having been first duly sworn upon his oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. STOVALL:

Q. Will your please state your name and place of residence?

A. My name is David Catanach, and I live in Santa Fe, New Mexico.

Q. And how are you employed, Mr. Catanach?

A. I'm employed as a petroleum engineer with the Oil Conservation Division here in Santa Fe.

Q. And have you ever testified before the Division or the Commission and had your qualifications as a petroleum engineer accepted as a matter of record?

A. Yes, I have.

Q. And in fact, are you not also a hearing examiner for the Oil Conservation Division?

A. That's correct.

Q. And as such, you are familiar with the rules and regulations of the Division and the implementation of those rules?

A. Correct.

Q. And within your duties at the Division, have you -- do you oversee the implementation of the Federal Underground Injection Control program?

A. That's correct.

Q. And what is the purpose of the Underground Injection Control program?

A. Well, the purpose -- Let me back up a little bit.

The Safe Drinking Water Act, which was passed by Congress back in the late 1970s or early 1980s necessitated the promulgation of rules, and these were

promulgated by EPA in order to effectively allow the protection of fresh water by injection, and that's what the program is all about.

Q. Are you familiar with the Application in this case?

A. Yes, I am.

Q. And is it an application that falls within the Underground Injection Control program requirements?

A. Yes, it is.

MR. STOVALL: It is a UIC application.

At this time I would tender Mr. Catanach to the Examiner for voir dire on his qualifications, if you would like. Otherwise, I would offer him as an expert.

EXAMINER STOGNER: Ms. Aubrey, do you have any questions?

MS. AUBREY: I have no questions.

EXAMINER STOGNER: Or objections?

MS. AUBREY: No, no objections.

EXAMINER STOGNER: Mr. Catanach is so qualified.

Q. (By Mr. Stovall) Mr. Catanach, would you summarize the OCD rules and regulations and the applicable federal regulations as they relate to the Application which is being considered today?

A. Yes. I'm going to read some of these, Mr. Stogner, and try and get through them as fast as I can.

Q. These are prepared as exhibits, are they not?

A. Yes, they are. This has been marked as exhibit packet number 1, or Exhibit Number 1.

Q. Correct. Just describe that so we know what it is, and if there are any questions about the identity of it, we can clarify that. But that is --

MS. AUBREY: My only question is that my copies of the exhibits aren't stamped with exhibit numbers, so if I could just see a set.

MR. STOVALL: Oh, I'm sorry, yes. That's why I was asking before.

THE WITNESS: The first page of Exhibit Number 1 is just an excerpt from the Division Rules and Regulations, and I'm going to cite Rule 701-E, a portion of that, which concerns saltwater disposal wells, and part (2) of that says that "Disposal will not be permitted into zones containing waters having total dissolved solids concentrations of 10,000 milligrams per liter or less except after notice and hearing, provided however, that the Division may establish exempted aquifers for such zones wherein such injection may be approved administratively."

Q. (By Mr. Stovall) Let's continue on through

the -- There are some federal regulations that define water -- certain water standards and some of this terminology; is that not correct?

A. Correct, and these are found in the 40 CFR Code of Federal Regulations, and that's in fact where I got these from.

I'd like to just go over some definitions here, and the first one being at the bottom of the page, on the right-hand side, "*Underground source of drinking water (USDW)* means an aquifer or its portion Which supplies any public water system; or Which contains a significant [*sic*] quantity of ground water to supply a public water system; and Currently supplies drinking water for human consumption; or Contains fewer than 10,000 milligrams per liter total dissolved solids; and Which is not an exempted aquifer."

Q. Let me ask you there, this is the definition of underground source of drinking water under the Safe Drinking Water Act; is that correct?

A. Under the Federal UIC regulations it is.

Q. Correct, and it is not necessarily the same as what the State Engineer's definition of fresh water would be; is that correct?

A. Correct.

Q. And we are only talking UIC at this time?

A. Correct.

The next page, I would like to -- in the middle of the page on the right-hand side -- just go over the definition of an aquifer.

It "...means a geological 'formation,' group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring."

And lastly, I'd like to go over the portion at the bottom of the left-hand column, "Prohibition of movement of fluid into underground sources of drinking water." And let me just read that:

"No owner or operator shall construct, operate, maintain, convert, plug, abandon, or conduct any other injection activity in a manner that allows the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 CFR part 142 or may otherwise adversely affect the health of persons. The applicant for a permit shall have the burden of showing that the requirements of this paragraph are met."

Q. Now, this is in all cases of injection of fluids into underground strata which are within the

jurisdiction of the Oil Conservation Division. These are the criteria that you have to consider. I mean, these are the primary definitions; is that correct?

A. That's correct. The Division rules and regulations are based upon the federal regulations and are at least as stringent as those.

Q. Now, let me ask you, the Division handles many injection cases, does it not?

A. That's correct.

Q. Some of them administratively and some of them by hearing process, depending upon certain factors in the rules?

A. Correct.

Q. Does the Division normally take an active part as a participant in a case of this nature?

A. No, it does not.

Q. Why in this case is the Division presenting you as a witness, and why did we ask the State Engineer's Office to participate?

A. Well, I think that there is no policy currently in effect that the Division has regarding injection into the Capitan Reef, and due to the precedent-setting nature of the Application, I think we wanted to take an involvement in it.

Q. Is it fair to say that the Capitan Reef is

known to contain fresh waters?

A. Correct.

Q. And that -- Do you have an opinion as to whether it is interconnected in the --

Well, what is the Aquifer? Is it defined? Do you know what the aquifer is, the Capitan?

A. Do I know --

Q. I mean, is the Capitan Reef as a whole an aquifer?

A. I believe the studies and the literature I've read says that it basically is an aquifer that is connected.

Q. And do you believe that this -- what happens today will set a precedent for -- potentially, for future applications of this type?

A. I do.

Q. Let's go into more specifics at this point.

By what process could an applicant obtain authorization to inject into an aquifer containing less than 10,000 parts per million TDS?

A. I think under the rules they can come in and apply for an exempt aquifer status, in which case we would probably exempt a portion of the aquifer.

Or they can do what the Applicant is doing in this case, just on an individual-well basis.

The other -- Let me get into the other part of it, Mr. Stovall, in that when the Division -- When the Oil Conservation Division applied to EPA back in 1980 or 1981 for primacy to implement the UIC program, we had the opportunity at that time to propose exempted aquifers to EPA, and we did so.

That is the other method by which an aquifer may become exempted.

Q. How do you identify an exempt -- What are the criteria for exempting an aquifer? Let me -- Do you have an exhibit which sets forth that criteria?

A. Yes, I do. It's the last page of Exhibit Number 2. Would you like me to read that?

Q. Just summarize those criteria. I don't think we need to read the entire thing.

A. Okay. An aquifer -- Well, an aquifer or a portion thereof can be classified as exempt if it meets some criteria. One of them is that it does not currently serve as a source of drinking water, it cannot now and will not in the future serve as a source of drinking water, because it is mineral, hydrocarbon or geothermal energy producing; it is situated at a depth or location which makes recovery of water for drinking-water purposes economically or technologically impractical, or it is contaminated to the point where

it's economically or technologically impractical to do so.

Q. Now, you say the Division has exempted some aquifers and determined they are exempt based upon these criteria?

A. That's correct.

Q. Has the Division determined that any portion of the Capitan Reef is an exempt aquifer?

A. To my knowledge, the Division has not.

Q. Has the Division ever conducted any studies to determine the suitability of injection into the Capitan Reef?

A. Yes, and if I could refer to Exhibit Number 3, that's also a two-part exhibit, and where I got this from was the primacy application that the Division submitted to EPA back in 1981.

This was a part of that primacy application, and specifically it's a part dealing with aquifer protection and exemption. And the first part -- Actually, it's in reverse order. I have it in reverse order.

The first part of this document is actually the one that's marked page 49.

The second part is marked Appendix II, which is an appendix to this section.

Q. Now, the first part you're referring to at the top, it says Program Description and then --

A. Correct, that's actually the first part of the document.

And it appears -- I wasn't around at that time, but it appears that the Division did undertake a study which included some of the Permian-age formations in Lea County and did in fact look at the Capitan Aquifer as well.

Q. And did it reach any -- Were there any conclusions that were reached?

A. Yes, I'd like to make some -- just some points from this document, if I could. The first is located on page 12 of Appendix 2.

Q. Okay.

A. And I'd like to just go ahead and read that.

"A fresh-water aquifer <u>does</u> exist in the Capitan Formation and associated San Andres Formation and Artesia Group. Most of the fresh water is produced from wells which occur in clusters within the trend of the Capitan Reef and Hobbs Channel. However, within such clusters there are almost always wells producing saline water from the same depth. Neither data nor geologic theories allow the delineation of a boundary for fresh water."

Q. That's specifically addressing the Capitan; is that correct?

A. Well, that's -- I don't think that specifically addresses the Capitan. I think it references the San Andres and Artesia Group as well in that paragraph.

Q. Oh, not exclusively, yeah, I'm sorry. Specifically, but not exclusively?

A. Correct.

Q. What about conclusions? There are some conclusions, are there not, that are not necessarily consistent?

A. I'm sorry, Mr. Stovall, let me go back to -- Let me go back to page 4. I missed something on page 4.

Q. I was going to take you back there in a minute, but that's all right. Go ahead and do it now.

A. Okay, it's at the bottom of the page, and this is a subscript to something that goes on in the main body of this paragraph.

And this references, "A possible exception is that fresh water may occur in the Reef limestones of the Permian Capitan Formation. Injection into the Capitan has never been proposed and therefore the State's regulatory position toward this aquifer has not

been established."

Q. Now, when that footnote is referring to an exception, it is referring to the exception which permits oilfield brines to be injected into Permian-age rocks; is that correct?

A. Correct.

Q. With the exception of the Capitan?

A. Correct.

And the last part I'd like to reference in this particular document is -- I believe you mentioned this. This document is a little bit unclear.

It appears that -- In this last portion that I'm going to read, it appears that the Division is asking EPA to allow them to exempt the Capitan Aquifer, because it is included in the Permian-age group formations.

Why don't you -- Let me go ahead and read that.

MS. AUBREY: What page is that?

THE WITNESS: That is on page 19, I'm sorry.

This is a Summary of In-Depth Study: "A review of UIC criteria for aquifer exemption indicates that the Permian aquifers of Lea County should be exempt from protection; existing injection activities need not be curtailed. The criteria indicate that

waterflood wells are allowable because of their importance to hydrocarbon production. This conclusion would apply anywhere in New Mexico. Brine disposal wells are allowable because the economics of such disposal more than compensate for the economic value of the fresh water. This conclusion is limited to Lea County, where there is abundant low-cost fresh water available from the Ogallala Formation, such that the Permian water is clearly not a cost-effective source of drinking water in the area."

Q. (By Mr. Stovall) Now, let me ask you, Mr. Catanach, first, just in a general statement, it talks about the economics, more than compensating the economic value of fresh water.

Is that categorically a correct statement today?

MS. AUBREY: Well, I object unless Mr. Catanach is going to be qualified as an expert in those areas. He's not the author of this report.

MR. STOVALL: I'm asking him from the standpoint of a Division policy, I guess the Division policy expert, rather than from a pure economic expert.

Q. (By Mr. Stovall) Let me ask you, do you know anything about the economics of disposal, versus the compensation for the economic value of fresh water?

A. I really don't.

Q. Can you say that that is an accurate statement, then?

A. I cannot say that that's accurate.

Q. Okay. Do you know, in fact, whether there is abundant low-cost fresh water available for drinking water in the area from the Ogallala at this time?

A. Yes, I do know that that's correct.

If I may, Mr. Stovall, I'd like to go back now to the first part of this document, which is the main body of this report, and I'd like to reference the last page. As I said, it appeared in the Appendix that the Division wanted the Permian -- all of the Permian formations exempt from protection. This is on page 53 of that first document that I cited, the one entitled --

Q. The other part of this exhibit?

A. Correct, entitled Program Description, and it's the three-page document.

Q. Okay.

A. Are you with us, Mike?

EXAMINER STOGNER: No.

MR. STOVALL: This document.

THE WITNESS: There you go.

EXAMINER STOGNER: What page?

MR. STOVALL: The third page of that --

THE WITNESS: The third page.

MR. STOVALL: -- page 53.

EXAMINER STOGNER: Okay. I couldn't see the numbers. Okay.

THE WITNESS: Okay, and I'd just like to read an excerpt from the middle of this:

"Based upon this study the Division proposes that the Tansil, Yates, Seven Rivers, Queen, Grayburg and San Andres formations of Lea County be classified as exempt aquifers."

This report does not request that the Capitan be exempt.

Q. (By Mr. Stovall) So it specifically omits it?

A. Correct.

Q. Now, let me ask you -- You know, this is an application for injection in the case of a single well.

There's also a provision in Rule 701, in accordance with the UIC regulations, discussing two alternatives for disposal into an aquifer containing fresh water. One is by an individual application such as this case, and the other one is in the case of exemption of aquifers, exemption of an entire aquifer; is that correct?

A. Correct.

Q. And there are such aquifers, as you have just related, into which injection is permitted, and that is handled administratively; is that correct?

A. Correct.

Q. Now, in your opinion, in looking at this Application and what you've heard today and what you know about the Capitan, are the criteria which should be considered for an individual application such as this one significantly different than those which should be considered for an exemption of the aquifer itself?

MS. AUBREY: Well, I object to that. I don't think sufficient foundation has been laid for Mr. Catanach to answer that question.

MR. STOVALL: He is the expert in the UIC program and understands the criteria, understands how individual wells need to be considered and how the -- and the process for -- or the criteria for granting an exemption. And you can look at the documents containing the criteria. Are they significantly different?

MS. AUBREY: Mr. Stogner, if you can look at the documents and read the criteria, then that is a question for the Hearing Examiner to answer and not

this witness.

MR. STOVALL: The criteria to which I am referring are contained in -- on page -- on Exhibit Number 2. Excuse me, the -- Yeah, it's Exhibit Number 2, the *Federal Register* notice which Mr. Catanach referred to earlier.

Let me rephrase the question, if I may.

EXAMINER STOGNER: Let's try that.

Q. (By Mr. Stovall) The criteria which have been set forth for exempting an aquifer, these are the criteria that were used to exempt the other aquifers that you've already referred to; is that correct? In the program document? I assume it followed the UIC criteria.

A. I'm not entirely sure that that's correct, Mr. Stovall, because there was some argument within that document that maybe we didn't agree with the criteria. It probably was based on most of them. I can't answer that for certain.

Q. Well, as the agency with primacy under the UIC program, are we not responsible for following the federal regulations?

A. Correct.

Q. And so there's a presumption that the criteria were satisfied in one way or another?

MS. AUBREY: I object, Mr. Stogner. The witness has just explained that there was a dispute, and he doesn't know whether the criteria were followed or not. So it's improper for Mr. Stovall to continue to ask him questions about whether or not the criteria were followed.

EXAMINER STOGNER: I have to agree with Ms. Aubrey.

MR. STOVALL: All right, I'll drop that question.

Q. (By Mr. Stovall) What criteria should be considered for this individual Application, Mr. Catanach?

A. I think you're basically -- Whether or not it's an aquifer exemption or an individual application, I think you're basically talking about the same thing.

The individual application is probably on a much smaller scale than maybe an aquifer exemption would be, but I think that the same criteria should apply.

Q. Have you ever had any other applications similar to this one?

A. I have, yes.

Q. And what happened with that application?

MS. AUBREY: I object on grounds of

relevancy.

MR. STOVALL: Well, there is some relevancy. We're looking at whether in fact you can deal with it on an isolated case basis. This is precedent-setting, and we want to establish that there is in fact a basis to look at what will happen.

MS. AUBREY: So the record is clear, Mr. Stogner, in that case there was no hydrology put on at all. There was one witness called, a petroleum engineer.

MR. STOVALL: I only want to know if there was an application. I don't intend to use the case or the details of the case.

MS. AUBREY: And the cases are not similar, nor was the testimony similar. I believe it's impermissible to draw a conclusion from whatever happened in that other case to this case.

Q. (By Mr. Stovall) Have there ever been any other applications for injection of water into the Capitan Reef?

A. Yes.

Q. And was that application approved or denied?

MS. AUBREY: Mr. Stogner, you haven't ruled on my objection, which was to that same question.

MR. STOVALL: I've withdrawn the question and

asked new questions.

EXAMINER STOGNER: Where are we on the objection at this point? Now, he did rephrase his question. I heard that.

MS. AUBREY: I continue to object on the grounds of relevancy as to what happened in the other application being testified to in this case. It makes not difference. They're not the same case, and the evidence before the Hearing Examiner was not the same.

MR. STOVALL: I'm not submitting the evidence; I just want to know if there was an application.

MS. AUBREY: That question has been answered.

MR. STOVALL: And I want to know if it was approved or denied. That's --

EXAMINER STOGNER: Well, with that I'm going to allow the witness to answer that question because I see some relevance, and my cross-examination of this witness may even take that a little bit further.

THE WITNESS: That application was denied.

Q. (By Mr. Stovall) Have you ever had any inquiries or requests about injecting produced water into this -- into the Capitan Reef, other than that application and this one?

A. I have had some inquiries. I can't remember

specific instances. What I will say is --

Q. I don't need to know. I just want to know if there have been other inquiries --

A. Yes.

Q. -- is that correct?

A. Yes.

Q. And based upon that, and upon your knowledge of what has happened, as the director of the UIC program do you have any reason to think there might be additional applications?

A. I have reason to believe there will be additional applications.

Q. Given that information, and given the fact that according to your testimony the criteria used to examine this Application are really the same, it's just a matter of scale, would it be better to approach it on a case-by-case basis?

And I'm asking administratively, remembering again that what we're trying to do is establish precedent for the Division.

Or would it be appropriate for the Division to look at it on an area-wide basis and determine how those criteria should be applied for the case of many wells?

A. In my opinion, I think it would probably be

better to look at it on an area basis, because I think we're going to get some applications that are going to essentially constitute an area so we might want to look at the effects as a whole at the same time.

Q. And you heard my question to Mr. Wallace earlier, and he was talking about he really only modeled with respect to one well.

Would that modeling information be more useful if it did include multiple wells? I mean, would it help you make a decision if you were making the decision in this case?

A. Well, Mr. Stovall, if he knew where the wells were going to be located, if he knew how many wells there were going to be, it would probably be more useful, yes. But we have no idea at this point.

Q. Or if you knew the limits of the saline zones of the Capitan, would that help? And the flows from those saline zones towards the freshwater zones?

A. Correct.

Q. And the existence of any barriers that might exist?

A. Correct.

Q. And the potential uses of water in the aquifer, of the fresh water in the aquifer?

A. Correct.

Q. And better analysis of the character of the water in the freshwater zones of the aquifer?

A. Correct.

Q. Now, in addition to the UIC program requirements -- That's under the Safe Drinking Water Act, is it not?

A. That's correct.

Q. And again, if an aquifer qualified for exemption under the Safe Drinking Water Act and under the UIC program, would that necessarily mean that injection should be allowed into that aquifer?

A. It's my understanding that the State Engineer may have something to say about or may have its own concerns regarding injection, other than drinking-water concerns, and I think those are going to be addressed.

Q. If there may be other uses, other than just drinking water, for which fresh water might be used?

A. Correct.

Q. And is the Division charged with the responsibility of protecting fresh water as defined by the State Engineer's Office?

A. That's correct.

MR. STOVALL: I have no further questions of Mr. Catanach, and I would like to move the admission of Exhibits 1 through 3.

EXAMINER STOGNER: Are there any objections to the exhibits?

MS. AUBREY: I have no objection, Mr. Stogner.

EXAMINER STOGNER: Exhibits 1, 2 and 3 will be admitted into evidence.

Ms. Aubrey, your witness.

MS. AUBREY: I do have a request, since it's about 5:15. If we're going to be here much longer I need to make some child-care arrangements, and I wonder if I could have a 15-minute recess?

EXAMINER STOGNER: Mr. Stovall, how much longer are we going to be here?

MR. STOVALL: Check --

EXAMINER STOGNER: With that, let's go ahead and take a 15-minute break, because --

MR. STOVALL: We've got about 20, 25 minutes of --

EXAMINER STOGNER: Okay. Then let's take a 15-minute recess at this time, and we'll reconvene.

(Thereupon, a recess was taken at 5:12 p.m.)

(The following proceedings had at 5:40 p.m.)

EXAMINER STOGNER: Hearing will come to order.

Mr. Stovall?

Q. (By Mr. Stovall) Mr. Catanach, when we were talking about exemption of the various aquifers from the -- to allow -- which would allow injection into those aquifers, and your statement was there was some question about the criteria and discussion about the criteria --

A. Correct.

Q. -- and referring back to your program description on the first page, is that a correct statement?

MS. AUBREY: The first page of what, Mr. Stovall?

MR. STOVALL: I'm sorry, the Program Description is that part of Exhibit 3.

MS. AUBREY: Starts on page 49?

MR. STOVALL: Starts on page -- The one you've got in front of you, yes.

Q. (By Mr. Stovall) Now, there are two separate things referenced in this Program Description; is that not correct? There was a procedural method by which exemptions could be granted, and the criteria under which those exemptions could be granted?

A. Correct.

Q. And the criteria was what I was referring to earlier, and the last paragraph on this first page,

does that not state that the criteria are applicable; it was the procedures which the Division questioned at the time of establishing the exempted aquifer?

A. Yes, that is correct, Mr. Stovall.

MR. STOVALL: Okay, I have no further questions, Mr. Examiner.

EXAMINER STOGNER: Thank you, Mr. Stovall.

Ms. Aubrey, your witness.

MS. AUBREY: Thank you, and thank you for accommodating me, Mr. Stogner.

CROSS-EXAMINATION

BY MS. AUBREY:

Q. Mr. Catanach, you've attached some regulations from the CFR as an exhibit. I think they're your Exhibits 2 -- Exhibit 2; is that correct?

THE WITNESS: Correct.

MR. STOVALL: Exhibit 1 and 2. Some of them are part of Exhibit 1, Ms. Aubrey, and some of them are part of Exhibit 2.

MS. AUBREY: Thank you.

Q. (By Ms. Aubrey) Do you know whether or not the attachments from the CFR that you've marked as exhibits are the same as they were in 1980 when your Exhibit 1 -- sorry, your Exhibit 3, was prepared?

A. I believe that they are. I don't know of any

instance where they're not.

Q. Do you know whether they've been amended since -- in any fashion since 1980?

A. I can't tell you specifically if they've been amended, no.

Q. So the state is bound by the criteria as established from time to time by the EPA; is that correct?

A. That's correct.

Q. At the time of these -- the 1980 Program Description -- It was 1980, wasn't it, Mr. Catanach?

A. 1980 or 1981.

MR. STOVALL: Actually, it was right on the cusp. It was December 31st, 1980.

Q. (By Ms. Aubrey) Was disposal, surface disposal into unlined pits permitted in this part of New Mexico?

A. Probably in the R-3221 area, which I don't -- I'm not exactly sure this is in that area.

Q. There was disposal occurring in playas and lakes --

A. That is correct.

Q. -- at that time; is that correct?

Where's the Eddy County report that's referred to in your exhibit?

A. Where do you see that reference, Ms. Aubrey?

Q. On page 50, there's several references to Appendix A-1, the Eddy County report.

A. I did not present that as an exhibit. I do have that here.

Q. Does that deal with the portion of the Capitan Aquifer which is in Eddy County?

A. I can honestly say I do not know.

Q. Now, the San Andres formation, which was exempted at the request of the OCD, contains both fresh water and saline water; is that correct?

A. That's my understanding.

A. And it's also productive of oil and gas; is that correct?

A. That's correct.

Q. Do you know whether or not the San Andres water that's technically fresh because of TDS content is potable water?

A. Strictly by TDS?

Q. No, are there other contaminants in that water which prevent it from being used as drinking water?

A. I'm not sure. I assume there are probably parts of the San Andres that are fresh that do not contain hydrocarbons.

Q. Fresh water and drinking water aren't the same thing; isn't that correct?

A. Probably not, no.

Q. You can have water that has a -- let's say a 9000 TDS, which would not be suitable for human consumption; is that correct?

A. That's correct.

Q. And TDS content doesn't address, for instance, the oil content of the water; is that correct?

A. That's correct.

Q. It also doesn't address the hydrogen sulfide content of the water?

A. That's correct.

Q. Were you with the Division in 1980?

A. I was not.

Q. Do you have any personal knowledge of why the Capitan was not included in the request to exempt aquifers that's contained in the documents you've provided?

A. I do not know.

If I can elaborate on that point, there was -- and I got this from some other Division personnel -- there may have been an agreement between Mr. Pete Porter, the Director of the Oil Conservation Division,

and Mr. Steve Reynolds, who was then director of the State Engineer's Office, not to allow injection into the Capitan Reef that may -- I researched this, and I could not find anything in writing regarding this so-called agreement. I do not know if it actually existed. That's -- It could have been a part of that.

Q. But you don't know?

A. I do not know.

Q. You were asked some questions by Mr. Stovall about how you would proceed if this were called as a case for exemption of the aquifer, and you were asked if it would be helpful to have additional information. Do you recall those questions?

A. I do.

Q. Isn't it true that it's always helpful to have more information than you have at the present time?

A. Of course.

Q. Isn't that something that the Division regularly encounters in dealing with matters of oil and gas production since, of course, we can't see what's going on?

A. Correct.

Q. So this is not an unusual situation for the Division, in that you're being asked to deal with a

physical situation that you cannot see and may not be able to directly measure?

A. That is correct.

Q. This is very much, in fact, similar to the questions of reservoir engineering which you're called upon to deal with on a weekly basis; is that correct?

A. That is correct.

Q. And it will always be better to have actual empirical data to answer those questions with, correct?

A. Correct.

Q. In your exhibit, the Appendix to Exhibit 3 or part of Exhibit 3, on page 3, the statement is made that, "The rules for injection control are not changed by such a distinction" -- as salt water/fresh water distinction -- "and consequently State regulations are correct in allowing injection below the base of the deepest existing underground source of drinking water."

Do you see that statement, sir?

A. I do.

Q. Do you agree with that statement?

A. I don't know what the context of that statement is, Ms. Aubrey.

Q. Okay. The preceding sentence is, "In Artesia, the major benefit of a detailed geohydrologic study was to show that some rock units deemed by the

State to be salt-water aquifers are in fact non-aquifers which contain fresh water."

Is that "non"? It looks like it in my copy.

A. Right.

Q. And that is the distinction that the author of this document is referring to?

A. I would agree with that statement, yes.

Q. In fact, Pronghorn is proposing to inject below the base of any underground source of drinking water in that area; isn't that true?

A. Well, I'm not exactly sure that the Capitan Reef at this point was ruled out as an underground source of drinking water.

Q. Do you know of any deeper source of drinking water?

A. Than the -- Than the what?

Q. Any source that -- I'm sorry, any higher source of drinking water in the area?

A. In the area of this Application?

Q. Right.

A. No, probably not in this area.

Q. Now, this report, your Exhibit 3, starts from the hypothesis that injection into rocks of Permian age or older is permitted. Do you agree with that?

A. I think with the exclusion of the Reef, I

would agree with that.

Q. And the exclusion language is found on page 4 of your exhibit, and it says, "A possible exception..." Isn't that correct?

A. Correct.

Q. And it says, "A possible exception is that fresh water may occur in the reef limestones..."

A. Correct.

Q. It doesn't say that injection is not permitted into the Reef, even though it's older than Permian.

A. It does not say that, no.

Q. On page 12 of your report -- of your exhibit, in the middle of the page, there's a discussion of the Capitan Formation and the San Andres Formation and the Artesia Group. Do you see that, sir?

A. Yes.

Q. Do you agree that that supports the conclusion that the San Andres and the Artesia Group are hydrologically connected to the Capitan?

A. I think that's the assumption. I would agree with the assumption.

Q. On page 13 of your exhibit there's a statement which I'd like to read to you. It's in the first paragraph.

It says, "Perhaps one-fifth to one-quarter of all brine disposal in southeastern New Mexico occurs into zones which are potentially protected aquifers. If injection to these aquifers is disallowed then all the wells listed in Table 1 would be out of compliance with UIC regulations."

This report is dated December 31 of 1980.

Would it be your opinion, Mr. Catanach, that even more of disposal in southern New Mexico, more than the one-fifth or the one-quarter identified in 1980, occurs into zones which are potentially protected aquifers?

A. Well, I think the one-quarter to one-fifth refers to the Permian formations which were exempt by the Division and EPA.

So I think yes, there are probably a lot more.

Q. Now, the San Andres has been exempted; is that correct?

A. That's correct.

Q. And that is a formation which is productive of fresh water, at least fresh water under the State Engineer's definition; is that correct?

A. In some areas, I believe that's correct.

Q. So brine is being injected now into the San

Andres?

A. Correct.

Q. And that's occurring in the Eunice-Monument area; is that correct?

A. I don't have any actual well data, but I'm sure that it probably is.

Q. Eunice-Monument is roughly north and east of the Capitan Reef; is that correct?

A. I don't show it on this map.

MR. STOVALL: Mr. Catanach, let me show you D7, and you can see where Hobbs is, and I think you know where it is in relation to Hobbs.

THE WITNESS: I suspect the Reef is -- You're talking about the Eunice-Monument area?

Q. (By Ms. Aubrey) Right.

A. I suspect the Reef is probably south.

Q. South of the Reef?

A. Southwest from Eunice.

Q. On page 15 of your report, there's a discussion of economic impracticality.

You are aware of the economics, generally aware of the economics of oil production and saltwater disposal in southeast New Mexico, are you not?

A. Somewhat familiar, yes.

Q. And are you aware of any use to which water

can be put which has a high TDS content and is contaminated with oil and hydrogen -- is also contaminated with hydrogen sulfide?

A. Do I know where that water can be placed?

Q. Do you know if there's any use that it can be put to?

A. Not that I know of.

Q. The definition of fresh water that we're using here is one that is contained in Exhibit -- which hasn't been introduced yet, but it's marked as OCD/SEO Exhibit C, and it says that "All underground waters in the State of New Mexico containing 10,000 milligrams per liter or less of dissolved solids are hereby designated by the State Engineer pursuant to Section 70-2-12-B.(15) New Mexico Statutes, 1978; except that this designation shall not include any water for which there is no present or reasonably foreseeable beneficial use that would be impaired by contamination."

Do you have an opinion, sir, as to whether or not introducing high-TDS water into high-TDS water is a contamination?

MR. STOVALL: By "high-TDS", Ms. Aubrey, you're referring to over 10,000?

Q. (By Ms. Aubrey) Well, we can refer to --

Let's start with 10,000, Mr. Catanach.

A. I would say that if it's known to be going into directly an area that has high-TDS water and not migrate anywhere else, I would not oppose it.

Q. The -- As you briefly discussed, the end of the appendix to Exhibit 3, which is entitled Summary of In-Depth Study, concludes that aquifer exemption should be granted for the Permian aquifers of Lea County.

Do you agree with that statement?

A. That's what the document says.

Q. And the document does not, in that paragraph, which is a summary of the study, exclude the Capitan Reef; is that correct?

A. It does not.

Q. Waterflood wells and saltwater disposal wells are important for hydrocarbon production, aren't they?

A. That's correct.

Q. Important things to have?

A. That's correct.

Q. Do you have an opinion as to whether it's environmentally more sound to dispose of produced brine on the surface in playas or to inject it into a formation which contains high-TDS water?

A. I would say the safest method of disposal is injection into a safe disposal zone.

MS. AUBREY: May I have one moment, Mr. Stogner?

EXAMINER STOGNER: Yes. How long do you need?

MS. AUBREY: Thirty seconds.

EXAMINER STOGNER: Oh, okay. We can just go off the record.

(Off the record)

Q. (By Ms. Aubrey) Do you know of any Permian-age drinking water in Lea County?

A. That is currently being used as drinking water?

Q. Right, or within your knowledge has been used as drinking water?

A. Not to my knowledge.

Q. Will you agree that the Capitan Formation in Lea County is below the base of all drinking water?

A. The Capitan Formation is below the base of the Ogallala Formation, which contains fresh water. That's as far as I'll go.

Q. Okay. Given what you know now and what you've learned in the course of this hearing, is it your opinion that there are portions of the Capitan Aquifer in Lea County which would qualify for exemption under your criteria set out in your Exhibit 3?

A. I don't believe I've reviewed the evidence enough to make an educated opinion on that, Ms. Aubrey.

Q. Do you know whether or not the information generated by Mr. Hiss in his reports on the Capitan Reef was used as a source for the information contained in your Exhibit 3?

A. Yes, ma'am, it was.

Q. You have some attachments to that Appendix. One of them is Figure 7, which is a schematic geological cross-section of the area.

A. Figure 7?

Q. Figure 7.

A. Okay.

Q. Can you see the cross-section, which is Pronghorn Exhibit 6, and tell me whether or not in your opinion the information contained on Figure 7 is consistent with the information contained on Exhibit 6?

Here's another copy of this also.

A. Looks to be approximately the same, Ms. Aubrey.

MS. AUBREY: That's all I have, Mr. Stogner.

EXAMINER STOGNER: Thank you, Ms. Aubrey.

Mr. Stovall, any redirect?

MR. STOVALL: No, I think not.

EXAMINER STOGNER: With that, I have no other

questions.

Are there any questions of this witness? He may be excused.

Mr. Stovall?

MR. STOVALL: Mr. Examiner, my next witness, or the Division's next witness, is Tom Morrison from the State Engineer's Office. And because I am not as knowledgeable in hydrology-related subjects as the State Engineer's Office is, including their counsel, I have asked Susan Kery of the State Engineer's Office to conduct the examination of Mr. Morrison on behalf of the Division.

MS. KERY: Mr. Stogner, I have a procedural question for you.

I'm only calling Mr. Morrison as a witness, but he co-authored the main memorandum that he'll be testifying to, and there's a possibility that on cross-examination he may want to defer to one of the other co-authors to answer the question. So I'm wondering if you want me to qualify them as experts before Mr. Morrison testifies.

EXAMINER STOGNER: Ms. Aubrey, do you have any other comment at this point?

MS. AUBREY: Yes, to the extent that any other witness is going to give testimony about that

report, I would ask that they be qualified as a witness.

And at this moment I would like the record to reflect my objection to an attorney for the State Engineer's Office appearing to represent the Oil Conservation Division in this matter.

EXAMINER STOGNER: Mr. Stovall, do you have any comment on Ms. Kery --

MR. STOVALL: I don't know the basis of the objection, so I don't -- I mean, I don't think there's any legal basis for the objection.

MS. AUBREY: Well, Mr. Stogner, Mr. Stovall showed himself and Ms. Kery on the prehearing statement as representing the Oil Commission, but Ms. Kery is employed by the State Engineer's Office and does not represent the party, at least the nominal party, to this case.

MS. KERY: I would agree that I'm not representing the Oil Conservation Division. I'm basically doing this as a courtesy to the Division to expediate the testimony of this witness. But I do not represent --

MR. STOVALL: Mr. Examiner, I believe the Division could associate in counsel with attorneys who are not employed by the Division. I don't think that's

incorrect.

MS. AUBREY: That may be true, but Ms. Kery has just made it clear that she's not associated, she's not representing the Division, she's not the Division's lawyer in this matter, and she's proposing to do this for the Division, and my objection --

MR. STOVALL: This is a tactic by Ms. Aubrey to keep the information out, and I think we ought to just proceed with the examination.

I could do it. It would take much longer because I would have to familiarize myself with the process -- with the information, not with the process.

EXAMINER STOGNER: Ms. Aubrey, inasmuch as, I'll have to admit, this is somewhat unusual in the history that I've been here. However, in the historical records that I've reviewed, this was somewhat of a -- not perhaps these two agencies, but the Division and with other agencies presenting evidence and testimony.

I'm going to go ahead and allow for this to expediate, and your objections are so noted.

MS. AUBREY: Thank you.

MR. STOVALL: Mr. Examiner, I might make a recommendation with respect to the other witnesses. I would suggest that Ms. Kery put on Mr. Morrison,

qualify him, go through the -- Let's find out before we spend a lot of time qualifying the other witnesses.

If they get called, let's qualify them at that time, just for expediency.

EXAMINER STOGNER: Ms. Aubrey, do you have any objection to that procedure?

MS. AUBREY: I don't have any problem with that, as long as they're qualified as experts before they testify.

EXAMINER STOGNER: Why don't we go ahead and do that? And if they need to be qualified, we'll do it at that time.

TOM MORRISON,

the witness herein, after having been first duly sworn upon his oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MS. KERY:

Q. Would you state your name and residence, please?

A. Tom Morrison, Santa Fe, New Mexico.

Q. And where are you currently employed?

A. I'm employed with the New Mexico State Engineer's Office.

Q. And could you give us a brief history of your tenure at the State Engineer's Office?

A. I've been employed with the State Engineer's Office for 14 years. For that full duration I've been with the Hydrology Section, within the Technical Division, within the Office.

My primary function during that period was to perform hydrologic investigations to determine the impacts due to the use of new proposed water wells, or due to the use of existing water wells. To perform that function, I developed new groundwater flow models, or I used existing flow models in our agency.

During that period I was also involved on numerous other activities for the agency with respect to the performance of hydrologic investigations, primarily in the determination of water-level declines or stream depletions, and also water-quality changes due to new wells or existing water wells.

During the past three years I've served as the Chief of the Hydrology Section. My primary function in that position has been to supervise and direct the activities of the hydrologists in the Section. Our primary function is to serve the agency in performing hydrologic investigations.

Also during the past three years, I am responsible for conducting modeling exercises, similar to the first -- the eleven years prior to my assignment

as Chief of the Hydrology Section.

Q. And how many hydrologists are under your supervision at this time?

A. There's six hydrologists.

Q. And could you state your educational background, please?

A. I have a bachelor of science degree in civil engineering in 1978, and I also have graduate coursework in the field of hydrogeology.

I've also taken a number of short courses in the field of hydrogeology. One was a course in groundwater and fractured flow, advanced groundwater modeling techniques, analytical modeling techniques, and several other courses related to hydrogeology.

Q. And are you a professional engineer?

A. Yes, I am.

Q. And for how long?

A. Since the mid 1980s.

MS. KERY: At this time I'd like to tender Mr. Morrison as an expert in hydrology.

EXAMINER STOGNER: Ms. Aubrey, any objections?

MS. AUBREY: May I ask Mr. Morrison some questions about his qualifications?

EXAMINER STOGNER: Please.

MS. AUBREY: Thank you.

VOIR DIRE EXAMINATION

BY MS. AUBREY:

Q. When you say you've taken short courses, what do you mean, Mr. Morrison?

A. I'm talking about courses ranging from three days' to two weeks' period.

Q. What has been your training in the area of contaminant transport modeling?

A. In one of the hydrogeology courses I took, we had a section of the course devoted to contaminant transport.

Q. Have you ever run a contaminant transport model?

A. Yes, I have.

Q. How many?

A. I've done three contaminant transport models.

Q. And what software do you use for those?

A. I use the Cricket Transport Code, and the other ones, we're using a -- the MODFLOW, with a contaminant transport package.

Q. Do you have any experience with the SUTRA software?

A. No, I don't.

Q. How much of this course that you took was

devoted to contaminant transport modeling?

A. I don't recall. It was not a primary focus of the course yet; it was a portion of the course.

In my modeling investigations -- required me to do extensive study to be able to perform contaminant transport modeling.

Q. How many graduate courses have you taken?

A. Approximately three.

Q. For how many hours?

A. Nine, I believe.

Q. What percentage of your work deals with contaminant transport modeling?

A. Very little. I would say probably less than five percent of my time.

Our primary responsibility is to assess water-supply problems, water-level declines and stream depletions. Only occasionally do we get into a situation where we need to assess water-quality changes for the determination of whether or not a new well will impair existing water rights.

Q. Do you have any specific experience with the Capitan Reef?

A. Yes, I do.

Q. What is that?

A. My experience has been due to several

projects. We have a modeling project underway now for the Carlsbad Underground Water Basin. I have been in charge of directing and supervising that investigation.

I've also been involved in some evaluations for the WIPP site.

I've been involved in a request last year from the OCD to evaluate the Anadarko Application. Mr. Andrew Core of my staff performed that evaluation, and I was involved in directing and supervising his work on that project.

I've also been involved in the Capitan due to this Application.

I've also been involved in the Capitan due to our analysis for declaring areas which have not been declared as underground water basins. Part of the Capitan, I believe, is in that system.

MS. AUBREY: I have no more questions.

EXAMINER STOGNER: Okay. With that, your witness is so qualified.

MS. KERY: Thank you.

EXAMINER STOGNER: Ms. Kery?

DIRECT EXAMINATION (Resumed)

BY MS. KERY:

Q. Mr. Morrison, are you familiar with the Application that is the subject of this proceeding?

A. Yes, I am.

Q. And what is this familiarity based on?

A. My familiarity is based upon a review of reports prepared by the New Mexico Bureau of Mines and Mineral Resources, from a review of reports performed by the US Geological Survey, a review of our files within the agency.

As I said before, a year ago Andrew Core of my staff evaluated the Anadarko Application. At that time he became well acquainted with the Capitan Aquifer.

My familiarity is also based upon a review of the material in our files, with respect to our previous policy.

My familiarity is also due to meetings with Mr. Wallace and Mr. Scott on this particular Application.

Q. Did you review any information submitted by the Applicant specifically?

A. Yes, we reviewed Mr. Wallace's draft study which documented his development of his solute transport model.

Q. And did you receive a request from Mr. Van Ryan at the OCD concerning this Application?

A. Yes, we did.

Q. And what was the date of that request, and what was the subject of that request?

A. The date of the request was March 25th, 1993, and Mr. Van Ryan advised us that the OCD had received another application to inject water into the Capitan Aquifer. At that time he acknowledged that he had been informed by the Applicant that we had been provided a report by Mr. Wallace's -- by Mr. Wallace, soliciting our approval of the project.

Mr. Van Ryan indicated in his letter that the OCD was concerned that injection of salt water would degrade freshwater sources in the Capitan Aquifer.

Mr. Van Ryan's letter requested that we offer input to the OCD on the locations of fresh water and whether or not freshwater degradation would occur as a result of this Application.

Q. And how did you process -- How did the Hydrology Section process this particular request?

A. We began by reviewing Mr. Wallace's draft report on the development of the solute transport model, and we also reviewed the literature that I referred to previously by the New Mexico Bureau of Mines and the US Geological Survey, and also the information in our files.

We were advised by the OCD that they would

like for us to prepare a document which outlined for them the problems and uncertainties contained in the modeling work performed by the Applicant. That's why we performed the document, as a courtesy to the OCD.

We also evaluated the State Engineer policy on applications to inject brine into underground water within the State of New Mexico. This policy is presented in Mr. Steve Reynolds' July 10th, 1985, letter to Mr. Dick Stamets of the New Mexico Oil Conservation Division.

The 10th -- the July 10th letter states in part --

Q. And is this letter State Engineer Exhibit/OCD Exhibit Number C?

A. That's correct.

Q. Or letter C?

A. Yeah, it defines what fresh water is, and it's been made reference to previously in this hearing.

It states in part, "All underground waters in the State of New Mexico containing 10,000 milligrams per liter or less of dissolved solids are hereby designated by the State Engineer pursuant to Section 70-2-12-B.(15) of the 1978 Statutes; except that this designation shall not include any water for which there is no present or reasonably foreseeable beneficial use

that would be impaired by contamination."

The letter goes on to say that, "The surface waters of all streams within the State of New Mexico regardless of the quality of the water within any given reach are designated for protection."

Also attached to the July 10th, 1985, letter from Mr. Reynolds was a memorandum by the Chief of the Hydrology Section, Mr. P.D. Akin. That has been --

Q. That's been marked as Exhibit Letter D, OCD/SEO Exhibit Letter D; is that correct?

A. That's correct.

Q. Okay.

A. And the purpose of this memorandum was to provide information on the designation of freshwater supplies to be protected against contamination from injection activities, and this was probably the basis for Mr. Reynolds' July 10th, 1985 -- It was probably the basis for our determination of what fresh water was.

In Mr. Akin's April 10th, 1967, letter, he states in part, "It would appear, then, that water containing 5000 parts per million or less dissolved solids should be afforded definite protection against possible deterioration of chemical quality and it is suggested that provision for protection of supplies

containing 10,000 parts per million dissolved solids or less be made in those areas where water of better quality is not available and where such water is usable or is currently being used for livestock watering purposes."

Based upon the review of this material, the published reports, Mr. Wallace's draft report, we prepared a memorandum to the State Engineer dated April 7th, 1993. This would be Exhibit D, I believe.

Q. No, it's Exhibit A.

A. Exhibit A, okay. We provided this memorandum to the State Engineer, which was to address the OCD concerns, which requested us to outline any problems or concerns in the document prepared by Mr. Wallace.

Mr. Eluid Martinez, the State Engineer, issued his April 7th, 1993, letter to Mr. Van Ryan, which transmitted our review and reiterated the State Engineer policy on brine injection into the Capitan Aquifer.

Q. And that letter is marked as Exhibit B; is that correct?

A. That's correct.

Q. Could you outline what the findings of the Hydrology Section were, based on your review of all of the information you testified to?

And if you need to refer to -- I believe it's that map --

A. Yes.

Q. -- is that correct? Feel free to do --

A. Figure 3 and Figure 5, which are on the wall.

Our major findings are listed on page 2, 3 and 4 of Exhibit A, and I would like to review only the major findings at this time.

Finding 1 states, on page 2 of Exhibit A, "Available data indicate two regions in the area of interest in which fresh water is located in the Capitan aquifer. One region is in the vicinity of the City of Carlsbad near the Pecos River and the other is about 18 to 20 miles southeast of the proposed injection site. At the proposed injection site, the average TDS concentration calculated from known data points within the Capitan aquifer is approximately 50,000 parts per million."

Figure 3 is provided up here on the far right, on the wall, and was prepared by us. Figure 3 is a copy of Resource Map Number 4 by W.L. Hiss of the New Mexico Bureau of Mines and Mineral Resources. O

On this map, chloride concentrations are shown --

MS. AUBREY: Mr. Stogner, I have an objection

here. The map may be the Hiss map, but we've had no testimony as to who colored in the yellow area or the other areas.

MS. KERY: I can ask some foundation questions.

THE WITNESS: I'm testifying that we used -- I'm getting right to the point of -- We used Hiss's map, and based upon his information we colored in the areas which we deemed as being -- containing fresh water.

Q. (By Ms. Kery) And could you please explain what the different colors on the map signify?

A. Yes, I'm getting to that. The proposed injection site is marked by the red arrow.

The Capitan Aquifer is a tube-shaped figure which is bounded by the dark green line on the top and the purple line on the bottom.

The Pecos River is toward the left of the figure and is shown by the dark blue line.

The city of Carlsbad, Mr. Hearing Examiner, is located right here.

EXAMINER STOGNER: If you're going to say "right here", you need to be a little bit more specific for the --

THE WITNESS: Okay, I'm sorry. We're near

where the Pecos River intersects the boundary of the Capitan Aquifer on the lower side of the Aquifer.

EXAMINER STOGNER: And I think it's designated with a pink line --

THE WITNESS: Yeah.

EXAMINER STOGNER: -- at least on my exhibit. Okay, I'm sorry. Go ahead.

THE WITNESS: The area shown in yellowish-green are representative areas in which the Capitan may contain fresh water.

Fresh water was defined by the State Engineer, as discussed previously, as water containing a total TDS, 10,000 milligrams per liter or less.

We used Mr. Wallace's statement that chlorides constituted 50 percent of the total dissolved solids. We simply doubled these estimates on this map to obtain TDS.

I would like to draw your attention to Township 21, Range 35, which is southeast of the proposed well site by a couple of townships.

Capitan wells are designated on this map by the letters CPAQ, and in that township you'll see a well in the -- around Section 7 or 8, that has a chloride concentration of 1600. If we double that, we get a TDS of 3200.

Also in the next township over -- it would be Township 21, Range 34 -- we have a couple of wells which have -- which are producing from the Capitan, and they have concentrations of 2600, and also there's one of 5000.

In the next section down, we -- In Township 22 we have a well which has a concentration of 2200.

So we do have zones southeast of the proposed well site which, based upon Mr. Wallace's information, we would expect to have a TDS of 5000 milligrams per liter or less.

Looking towards the west of the proposed injection site, in the vicinity of the Pecos River, we also have a few points which we've outlined. We're looking at Township 21, Range 27. There is a Capitan well with 3800.

Getting right next -- where the river is, in the very southwestern quarter of Township 21, Range 27, we have a Capitan well with a chloride content of 82.

In a report prepared by Richey, by the US Geological Survey -- I believe the number of that report is Water Resource Investigations Report 84-4077 -- it's a 1984 report and it indicates that in the late 1950s we had approximately 16,000 acre-feet per year of water being withdrawn from the Capitan Aquifer

in this area.

The City of Carlsbad produces water from the Capitan. Its wellfield is located southwest of the City of Carlsbad.

Also we have the area of Happy Valley and Whites City, which Richey's report also indicates produces from the Capitan.

The Richey report also indicates that we have approximately 2340 acres being irrigated in the Carlsbad area from water being withdrawn from the Capitan in this area.

Finding --

Q. (By Ms. Kery) I was going to ask you if you could go on to Finding 2, please.

A. Finding 2 states that, "Available data indicate that the Capitan aquifer is in hydrologic communication with the Pecos River."

The information available in the literature strongly supports this.

Figure 20 -- or Exhibit E, I believe -- is shown or provided here for the Hearing Examiner, which is a copy of the US Geological Survey report by Bjorkland and Motts. This figure shows a cross-section in the immediate vicinity of the City of Carlsbad wellfield. The Pecos River is shown, and directly

beneath the Pecos River is shown an alluvium consisting of sands, clays, gravels, silts. The water table is shown in contact with the Pecos River.

Directly beneath the Pecos River and alluvium, we see that it's lying directly upon the Capitan limestone.

This figure indicates that waters within the Capitan limestone are in direct contact with the alluvium and that waters in the alluvium are in direct contact with the Pecos River.

Finding 3 states --

Q. Just one second, please, Mr. Morrison. Let me just back up in Finding 2 and look at it in conjunction with Exhibit C, the July 10th, 1985, letter from State Engineer Reynolds to Mr. Stamets. And in the next-to-the-last paragraph of that letter it's stated that, "The surface waters of all streams within the State of New Mexico regardless of the quality of the water within any given reach are designated for protection."

Would that tie into this particular finding?

A. Yes, that would tie directly into that finding. What this cross-section shows you is that the Pecos River is in contact with the Capitan Aquifer. The well site is located off to the right here.

So what this tells us is that the proposed injection site is connected to the stream. And our policy says that the surface waters in all streams in the State cannot be degraded to any extent.

Q. Thank you. You can go on to Finding 3.

A. Finding 3 states that, "Available data indicate that the Capitan aquifer at the proposed well site is in hydrologic communication with the two fresh water sources" identified in the Capitan Aquifer.

These freshwater sources are identified here on Figure 3 or -- What was it? That was part of Exhibit A.

Q. And it is Figure 3 --

A. Yes.

Q. -- of Exhibit A.

A. Also in our memorandum we provide a Figure 2, which was obtained from the 1980 study by Hiss, and it indicates that it's a tube, it can be visualized as a tube carrying water from the Guadalupe Mountains northeastward towards the Pecos River, and the flow continues on towards the injection site, and the flow continues on past the injection site, towards the freshwater zone located to the southeast of the injection site.

The fact that the Capitan is hydrologically

connected along its full length in New Mexico is clearly stated in a report prepared in cooperation with the Geological Survey. This report is State Engineer Technical Report 38 by W.L. Hiss.

On page 7 of this report it is stated in the first full paragraph, "Within New Mexico, the Capitan Aquifer varies from less than 800 to more than 2200 feet in thickness and is continuous in the subsurface from Carlsbad to Jal, New Mexico."

Figure 5 is --

Q. Excuse me, is the Hiss report that you're quoting from, Exhibit F?

A. That's correct.

Q. Okay, and that's entitled "Movement of Ground Water in Permian Guadalupian Aquifer Systems, Southeastern New Mexico and Western Texas".

A. That's correct -- I'm sorry, no, that's a different Hiss report. I'm in error.

MS. KERY: Okay.

MS. AUBREY: I'm sorry, I'm confused. Is he referring to another -- He's not referring to this exhibit?

MS. KERY: He's not referring to this one.

THE WITNESS: No.

Q. (By Ms. Kery) So why don't you clarify which

Hiss report that you're referring to, and how it relates to this finding?

A. The Hiss report that I'm referring to is not a State Engineer's exhibit. It's State Engineer Technical Report 38, which was done in 1973.

In Figure 5 of our memo, which is Exhibit 8A, shown here on the wall to the left of Figure 3, this was obtained from the Richey report, Water Resources Investigations Report 84-4077, by the US Geological Survey.

This report shows the thickness of the Capitan Aquifer. The report was released in 1984. Figure 5 shows that the Aquifer is continuous, that it has no barriers to flow, and it shows that the thickness varies greatly from less than 800 feet to more than 2200 feet.

Based upon this information, I think it's pretty clear that the Capitan Aquifer is continuous, so there's no restrictions to flow along its course within New Mexico.

Finding 4 states that the Applicant's conclusion that the impact of brine inject would be practically undetectable could not be verified by us.

The Applicant's results have been discussed previously and are provided in a series of figures in

which the impacts are not clearly shown. We're shown contour lines, we're shown shaded figures. We found these very hard to interpolate.

The scales have been selected such that only extremely large changes in TDS can be identified. The Applicant may be correct that the impacts are practically undetectable, simply because of the way the results are being provided.

In a meeting with the Applicant and the consultant, we requested that the impacts be provided to us in terms of how many parts per million is going to be -- is going to show up in the Pecos River or the freshwater zones. We didn't ask for more contours. We found that these were very difficult to use in determining what the actual impact would be upon the Pecos River and the other freshwater zones.

Finding 5 indicates that a number of uncertainties exist in the modeling investigation. Because of these uncertainties and a general lack of information on the Capitan system, we are unable to render an opinion which quantifies the impacts due to the brine injection.

Groundwater moves through the Capitan Aquifer in a system of solution cavities and fractures. Flow in such a system is very complex and very difficult to

describe.

In addition to having a complex system, we also have very limited data. Mr. Wallace indicated that he was aware of one or two aquifer tests. The aquifer tests give us an indicator of what the Aquifer parameters are. Those aquifer parameters are required in the model to get a realistic representation of what might happen.

In our 1985 investigation by Deborah Hathaway, she identified only seven aquifer tests for the Capitan Aquifer. This is a relatively few aquifer tests for such a large area.

The combination of having a very complex geologic system in which we have flow in fractures and solution channels, and which we have a difficult time describing the extent, size and connectivity between them, and the great limitation of data makes it very difficult to obtain a realistic model.

We identified and have discussed a number of uncertainties in the specific comments presented in Exhibit A.

We indicated in that exhibit that Mr. Wallace does make some conservative assumptions in his modeling.

We also indicate that there are other aspects

of the model which may not be very conservative.

Typically what Mr. Wallace does is, he'll make a conservative assumption with respect to one freshwater zone or the Pecos River, but this is not a conservative assumption with respect to the other area. Most of our comments were with this respect.

Mr. Wallace made the statement that quite a lot of speculation has been made about the flow regime. We certainly agree. Because of the data limitations, we have to do a lot of speculation. We have to make a lot of assumptions, and when we make assumptions, we enter uncertainty.

Finding 6 states that --

Q. Let me just back up for a minute. Can you just briefly explain why an aquifer test is useful in defining or figuring out the qualities of a particular aquifer?

A. Previously, Mr. Wallace explained the input parameters which he used. These were hydraulic conductivity, porosity, the storage coefficient.

These are all parameters which are obtained through aquifer tests.

The fewer the aquifer tests, the less information you have on the parameters. You have to go to textbooks values, or you have to go through an

evaluation of what the geology is and come up with some other means of coming up with the aquifer parameters.

Model calibration is also a means of coming up with the aquifer parameter distribution, but calibration was not used in this example.

Q. And how would you have calibrated a model such as this?

A. Our calibration is performed by trying to reproduce the heads which you've observed.

There's two types of calibrations:

Steady-state calibration, in which you try to reproduce the head distribution you've had before wells have started to pump.

Or, there's a transient calibration in which you try to reproduce the historical water level declines that you've observed.

The model tries to reproduce what you observed. You change the modeling parameters such that your predicted heads compare reasonably well with your observed heads. When you reach that, your model is calibrated and you can use the model for predictive purposes.

In this situation, the model has not been calibrated.

Q. And is it common practice in hydrology to

calibrate models?

A. It's a practice which is often used but is not used all the time. Mr. Wallace indicated when there's data limitations, calibration may not be possible.

In other situations, time may be a problem, or the issues which need to be addressed may be such that calibration is not necessary.

In other situations, a model is not necessary at all. The State Engineer, as an example, often can administer certain areas without any model predictions.

The Rio Grande is one example. If we have a well being proposed very close to the river, we don't rely upon model predictions; we rely upon the worst-case estimate that that well is going to affect the river immediately.

That policy is very similar to the policy that we see here: We don't rely upon a model; we rely upon a worst-case estimate that, yes indeed, because you're connected you will affect freshwater sources.

Q. Thank you. You can go on to the next finding. I believe it's number 5.

A. Finding 6 states that, "The consultants' study results suggest the possibility that the hydraulic gradient may be reversed in the vicinity of

the Pecos River which may eventually degrade the freshwater sources in the Capitan near the City of Carlsbad."

I'd like to direct your attention to Figure 4 of our April 7th, 1993, memorandum. It's a map from Hiss's 1980 study, and the 1980 study is an exhibit, Exhibit --

MS. AUBREY: -- F.

MS. KERY: -- F.

THE WITNESS: -- F, okay, thank you.

As can be see from Figure 4, Exhibit F, the surface of the -- potentiometric surface, the elevation of the head, it's almost flat in the vicinity of Lake Avalon, and this relatively low hydraulic gradient extends eastward toward the Eddy County/Lea County line, and the proposed injection site is located to the east of this county line.

Mr. Wallace was correct that we have a submarine canyon near that county line, and that's acting as a partial restriction to flow, and that's sort of -- It's damming up the water, so we have a flat aquifer right in through there.

If we look at Figure D9 now, I believe --

Q. (By Ms. Kery) This is D9 from --

THE WITNESS: -- of -- I'm sorry.

MS. KERY: -- Exhibit 8.

MS. AUBREY: -- Exhibit 8.

THE WITNESS: -- Exhibit 8 of the Applicant, entitled -- It's the report entitled *Capitan Groundwater Studies*. I believe you want to look at Figure D9 [*sic*]. We can look at, say, Figure (b). This figure shows the head increase or water-level rise due to the injection activity.

The -- Lake Avalon is located at the very far left-hand portion of this figure, and the steep spike that you see in the middle of the figure -- Excuse me, Mr. Hearing Examiner, do you see that figure?

EXAMINER STOGNER: Yes, I do.

THE WITNESS: Okay. The steep spike is the location of the injection well.

What this figure tells us is that the model which -- the model scenario number one predicts a head rise all the way to Lake Avalon. This was for scenario one.

If we look at scenario two, which is Figure D11 of this same exhibit, scenario two also predicts that the proposed injection will cause head rises all the way from the injection well, all the way to Lake Avalon.

Going back to Figure 4, when we superimpose

this head rise on this flat surface, what that tells us is that we have a potential for causing the hydraulic gradient to be reversed.

Right now we believe the groundwater is moving from the Pecos River towards the east. The surface is very flat, and so we have a fairly small amount of head rise. This could induce changes in the flow of groundwater.

In the draft study that we reviewed, we determined that the head rise was about one foot for every mile from the river. Looking at these figures, it looks like the results are somewhat different, about a half a foot per mile.

Based upon the head change which Mr. Wallace computes and the information which Mr. Hiss gives us on the elevation of the heads in the area, the proposed injection may induce saline water towards the freshwater zone near the Pecos River. This inducement of saline water may also affect the stream flows in the Pecos River.

Finding 7 states, "In the process of evaluating the consultants' investigation, we identified two other studies which quantified impacts on the Pecos valley due to withdrawals of Capitan water."

This finding is discussed in detail in our specific comment 4 of Exhibit A, in our April 7th memorandum.

In the mid-1960s a consultant report was prepared which revealed that the use of Capitan water in Texas could cause significant depletions of freshwater resources in the Pecos Valley and New Mexico.

Mr. P.D. Akin, formerly the Chief of Hydrology in the State Engineer's Office, prepared an evaluation of the report and advised the State Engineer that any new developments in the Capitan in New Mexico would be expected to affect the freshwater supplies in the Pecos valley.

Shortly after this evaluation was performed by Mr. Akin, the region was declared as the Capitan Underground Water Basin, so existing rights could be protected.

Mr. Akin used calculations to make his findings to the State Engineer. These calculations were probably analytical models.

MS. AUBREY: I'm sorry, I didn't hear that. Probably?

THE WITNESS: Were most likely analytical groundwater flow models to make the estimate that

distant diversions in Texas would have impacts on the Pecos valley.

The second report which we identified was a 1985 State Engineer study performed by Deborah Hathaway. Ms. Hathaway developed a calibrated numerical groundwater flow model of the Capitan Aquifer.

The results of her study indicate significant impact to the Pecos Valley due to wells producing from the Capitan in Texas and New Mexico.

The purpose of this study was to be used in litigation with the State of Texas. We were concerned that we were having shortfalls on the Pecos system, and we could not explain why we were having those shortfalls. We were not delivering the required quantities on the stream system.

We evaluated the entire stream system, and the -- This area was one area which was identified as a possible reason of why we were having shortfalls on the stream. We've got pumpages in New Mexico and Texas which are affecting the Pecos system at the Carlsbad area.

In our meeting previously, Mr. Wallace asked if we had any studies which quantified water quality impacts. This study does not quantify water quality

impacts, and so I did not mention it.

The other reason was, this study was used in litigation, and I was not sure that this was public information. Once our attorney indicated that it was public information, we felt that we could refer to it in the study.

This concludes my review of the findings.

Q. (By Ms. Kery) Could you please describe how injection of brine into the Capitan Reef may degrade the freshwater zones in the Capitan Aquifer?

A. I've already touched upon this already, and I'll summarize.

Since the saline zone is hydrologically connected to the freshwater zones and the Pecos River, the potential exists that if you inject water into this area, it will degrade the freshwater zones.

For the freshwater zone near the Pecos River, I've discussed Figure 4 of Hiss's study and also the head calculations presented by Mr. Wallace. These indicate that you have a fairly flat surface and that small changes in head may reverse the groundwater flow.

We're not concerned that -- as Mr. Wallace states, that we're injecting an ink dropper into a waterfall and this ink is going to travel upstream to the Pecos River.

Our primary concern with respect to the Pecos River is that we may cause a backup of flow, we may cause head rises in this area that's relatively flat such that some migration of saline water may occur towards the river and the freshwater sources.

Our other concern is that we have a lot of groundwater use now from the Capitan in this area.

For the freshwater zone located southeast of the proposed injection site, the water quality impacts are a potential problem because the freshwater zone is downgradient from the injection site. Obviously, the injected brine is going to flow downgradient, and the freshwater zone is located downgradient. We don't need a model to tell us that probably some influence of the injection will occur on this freshwater zone.

Also, one thing that drives the gradient is the difference between the elevation of the head in the freshwater zone and the head or the water table elevation at the injection site.

As we inject water -- We're injecting water into a confined aquifer that's under pressure. When we inject water, we're going to increase the head. This increased head is going to increase the hydraulic gradient.

Also, I believe that Mr. Hiss's 1980 report,

he indicates that the heads in the Capitan have been influenced by existing development in the area. So you could have a possibility that the heads in the area could also be altered due to existing development. We could have increased gradients as a result to existing wells.

The increased gradient will cause more saline flow from the injection, to flow faster towards the freshwater zone located to the southeast.

We believe that the primary source of the freshwater zone located southeast of the injection well is primarily groundwater recharge from the Glass Mountains.

We also agree with Mr. Wallace that some water is probably being induced from the San Andres and Artesia -- or, I'm sorry, the other systems in that area.

Q. I'd like to refer to Exhibit -- OCD/SEO Exhibit B. That's an April 7th, 1993, letter to Mr. Van Ryan from Eluid Martinez, the State Engineer.

A. I'm sorry, one second. Yes.

Q. Do you have that in front of you?

What were the conclusions reached by the State Engineer in this letter on the issue of whether saline injection should be allowed in the Capitan

Aquifer?

A. He concludes that the Capitan Aquifer contains designated freshwater supplies and that any degradation of any portion of the Aquifer could eventually degrade the entire aquifer and/or the Pecos River.

The State Engineer recommends that the Capitan Aquifer and the Pecos River be protected from contamination by not permitting saline injection into the Capitan Aquifer.

Q. And you've testified that the Hydrology Section could not verify the Applicant's modeling results because of the way the results were presented, and you also indicated that some uncertainties exist in the modeling investigation, and there may be some assumptions which may not be conservative.

Is this correct? Did you make these statements?

A. Yes, that is.

Q. Okay. If these problems could be corrected in the modeling investigation, would the State Engineer have a different recommendation concerning this matter?

A. No, the State Engineer would not have a different opinion. Although it may be possible to resolve many of the problems in the modeling

investigation, there will still be large modeling uncertainties because of the vast complexity of the Capitan system and the significant data limitations at the present time.

I would -- Based upon available information, we feel that there is more -- I forget the term Mr. Wallace used. He said there was no practical connection. But based upon available information, we feel that there's a very good connection between the injection site and the freshwater zones.

Mr. Hiss's 1980 report -- which again I forget the exhibit number. Exhibit F, was it?

Q. That's correct.

A. In the last section of Mr. Hiss's 1980 report, in the section on "Influence of Exploitation of Ground Water and Petroleum Resources", in the second-to-the-last paragraph it is stated, "The shape of the regional potentiometric surface representative of the hydraulic head in the Capitan aquifer east of the Pecos River at Carlsbad has been changed significantly in response to withdrawal of both ground water and petroleum during the past 50 years. The westward movement of saline water from the Capitan aquifer in Eddy County east of Carlsbad into the Pecos River has been greatly diminished or eliminated by a reduction in

hydraulic head."

Conversely, we feel that if you inject the reverse can happen. Instead of pumping, you're now injecting. You can cause the reverse situation.

We feel that there's significant evidence that indicates that a good possibility exists that freshwater sources will be degraded due to injection activity in the Capitan Aquifer.

The basis of the State Engineer's recommendation is the fact that the saline zone in the Capitan is connected to the freshwater sources in the Capitan Aquifer and the Pecos River.

Because of this hydrologic connection, any injection of brine into the Capitan could eventually degrade the freshwater sources in the Capitan Aquifer and the Pecos River. We feel that there's a large majority of information which supports that such an impact could occur, and that's the reason for his recommendation.

MS. KERY: I have no further questions.

EXAMINER STOGNER: Thank you, Ms. Kery.

Do you feel that --

MS. AUBREY: Mr. Stogner, I --

MS. KERY: Excuse me, I'd like to move the admission of OCD/SEO Exhibits A, B, C, D, E and F.

MS. AUBREY: I have no objection.

EXAMINER STOGNER: Exhibits A through F are admitted into evidence at this time.

MS. KERY: Thank you.

MS. AUBREY: Mr. Stogner, may I have a few minutes before I begin my cross?

EXAMINER STOGNER: Let's take a five-minute recess.

(Thereupon, evening recess was taken at 7:05 p.m.)

* * *

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 10693, heard by me on 6 May 1993.

, Examiner
Oil Conservation Division

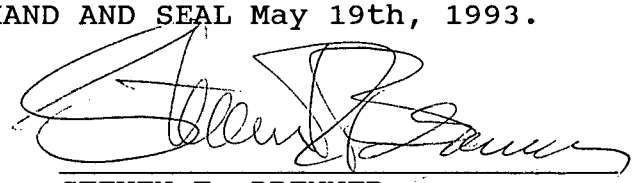
CERTIFICATE OF REPORTER

STATE OF NEW MEXICO)
) ss.
COUNTY OF SANTA FE)

I, Steven T. Brenner, Certified Court Reporter and Notary Public, HEREBY CERTIFY that the foregoing transcript of proceedings before the Oil Conservation Division was reported by me; that I transcribed my notes; and that the foregoing is a true and accurate record of the proceedings.

I FURTHER CERTIFY that I am not a relative or employee of any of the parties or attorneys involved in this matter and that I have no personal interest in the final disposition of this matter.

WITNESS MY HAND AND SEAL May 19th, 1993.



STEVEN T. BRENNER
CCR No. 7

My commission expires: October 14, 1994