PUBLIC HEARING

STATE OF NEW MEXICO

OIL CONSERVATION COMMISSION

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1220 S. Saint Francis Drive

Santa Fe, New Mexico

TRANSCRIPT OF PROCEEDINGS

April 22, 2025

VOLUME XIII

HEARD BEFORE:

HEARING OFFICER RIPLEY HARWOOD

COMMISSION MEMBERS:

GERASIMOS ROZATOS, Chair

BAYLEN LAMKIN, Member

DR. WILLIAM AMPOMAH, Member

COUNSEL TO THE COMMISSION:

MR. ZACHARY SHANDLER, ESQ.

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I N D E X

(On the record at 9:00 a.m.)

TRANSCRIPT OF PROCEEDINGS

CHAIR ROZATOS: Good morning, everybody. My name is Gerasimos Rozatos. I am the acting director for the Oil Conservation Division. I am also the acting chair for the Oil Conservation Commission. Today is April the 22nd. We are in our continuation for the consolidated cases by Goodnight Midstream and Empire New Mexico. This is a hearing that we are continuing, an evidentiary hearing. This is for Case Numbers 24123, 23614 through 17, Case Number 23775, and also Case Number 24018 through 24020, and 24025.

Before I transfer it over to the hearing officer, Mr. Hearing Officer, I wanted to bring up a scheduling issue that we're going to have for Friday. We do need to finish kind of early. I and the actual other two commissioners do have to be done by 3:00 p.m., so if we could wrap it up by 2:45 on Friday.

At the pace we're going, we're going to need that third week that we had planned in May. So obviously things will probably go out through to then. So if we can make sure that we're done by 2:45 on Friday, that we can accommodate Commissioner Ampomah, Acting Commissioner Lamkin and my schedule

as well.

HEARING OFFICER HARWOOD: All right. Perfect. Chairman Rozatos, I'll be sure to set the duck for 2:45.

CHAIR ROZATOS: Excellent. I appreciate that.

The other thing that I wanted to mention and this kind of what I reiterated yesterday, and I have reiterated this multiple times in this setting, things are getting heated, people, and we need decorum. Whether it's witness responding to attorneys, attorneys responding to witnesses, witness responding commissioners, commissioners responding to the witness, we need decorum in here.

The Hearing Officer is purposely set here to make sure that things are functioning appropriately. We need to give him all due respect. If there are objections, we stop dead in our tracks. Do not try to answer. Let the objection be heard, let the objection be ruled upon, then a statement can be made. This is normal etiquette. If this was a district court, some of these shenanigans would not have been accepted, and we all know this.

So, witnesses, make sure that you're following with decorum. Attorneys, make sure you

have the decorum and respect for the hearing officer. And everybody make sure that this is a respectful setting.

I have said this multiple times and I'm actually kind of getting tired of saying it. So please make sure that you're following through with this. This is for everybody. This disrespect is not going to be tolerated. So please make sure that you continue it.

And if I have to shut it down, we will shut it down for the day. But it will be because of your guys' respect. So please make sure that you're following through with this.

I'm off my soapbox. Mr. Hearing Officer, I transfer it over back to you.

HEARING OFFICER HARWOOD: I'll try and -- you know, I know some of this is inadvertent. It happens when witnesses understand what the question is going to be, and lawyers want to ignore the answer and move on to the next question. So I understand how that works. It's not always intentional. So I'll try and keep a closer eye out for that.

Before we proceed, let me just make sure we have a court reporter online and we're on the record.

CHAIR ROZATOS: Mr. Hearing Officer, I just wanted to add, Mr. Shandler also will be joining via us via Teams today and for the rest of the week.

HEARING OFFICER HARWOOD: Thank you, Mr. Rozatos.

Okay. I don't see a witness. Where is our witness, Mr. Rankin?

MR. RANKIN: Mr. Hearing Officer, good morning. Adam Rankin with Holland & Hart appearing for Goodnight Midstream in this case.

As we broke for the day yesterday, Dr. Davidson had completed his cross-examination by the parties and the Commission. And the question was whether or not Goodnight was going to bring him back for redirect. And upon evaluating the questions pending -- or that had been addressed, we decided not to bring Dr. Davidson back for redirect.

So with that, Mr. Hearing Officer, we would ask that he be excused.

HEARING OFFICER HARWOOD: Okay. I appreciate that. I didn't mean to be flip yesterday at the end of the day when I suggested that he had said everything he possibly could have on the subject. I think he has and did. So I appreciate the judgment call. I do see him in the back, I see

your witness, Dr. Davidson, in the back of the room now.

MR. RANKIN: He's here. On that point, Mr. Hearing Officer, if the commissioners have any additional questions for Dr. Davidson before we move on, happy to allow them to ask additional questions of Dr. Davidson.

One point of order that I do want to just point out, Commissioner Lamkin did ask a question about whether Dr. Davidson had additional analyses reflecting his petrophysical interpretation. I can just point those out to Commissioner Lamkin and he can identify them in the record, if that's acceptable.

Dr. Davidson did include additional petrophysical analyses in his direct testimony, attached as Exhibit B, and those are all the -- there's, I believe, a total of seven EMSU wells, and one of Goodnight Midstream's injection wells within the unit.

And then in his rebuttal testimony, Exhibit D-7, has an additional saltwater disposal well operated by Goodnight. So I think there's a total of nine petrophysical analyses included in his direct testimony and his rebuttal testimony.

HEARING OFFICER HARWOOD: Mr. Lamkin, is that helpful to you?

COMMISSIONER LAMKIN: That is. Thank you very much.

HEARING OFFICER HARWOOD: All right. To follow up on Mr. Rankin's offer, do either of you gentleman have additional questions or you, Chairman Rozatos, for Dr. Davidson?

CHAIR ROZATOS: I'll start off. I do not.

COMMISSIONER AMPOMAH: No, I do not.

COMMISSIONER LAMKIN: I don't either.

HEARING OFFICER HARWOOD: Before we move on to your next witness, overnight I was thinking about this. And for the record, as well as for the benefit of the parties, I want to -- it was late in the afternoon, my brain was tired. I have to listen to every question throughout the day. So toward the end of the day, this issue came up with Dr. Davidson's opinion in connection with Mr. Moander's cross-examination.

And I just want for the record and for the benefit of the parties, although you all are sophisticated players, so this is more for the record than anything else, but I wanted to make sure that my ruling was clear on that. I did not actually grant

Mr. Moander's motion to exclude that testimony.

If that testimony were presented in a court of law, it likely would have been excluded because only expert witnesses can offer opinion testimony. It's beside the point, really, that this was an undisclosed opinion because this was a question that was asked and answered.

But the point is, it was an opinion that only an expert could offer, and Dr. Davidson explained that he was not an expert in that subject matter. So in a court of law, that testimony would have been excluded and a jury would have been instructed to disregard the testimony.

Of course, this is not a court of law, and the rules of evidence do not technically and strictly apply. They're just for guidance here. And that's for a good reason. I mean, this particular setting exemplifies the reason that there is a relaxed standard. We're not here with a jury of unsophisticated laypersons listening to sophisticated experts where there's a risk of being misled. Not that I'm suggesting that Dr. Davidson was in any way attempting to do that. But the risk is not present in a situation where you have sophisticated fact-finders that are experts in their own right,

either in the a specific field or a closely related field. The risk is simply not there.

So those were the bases for my decision to not grant Mr. Moander's motion and simply allow the Commission, under the guidance of Mr. Shandler, to give that opinion such weight, if any, that they thought it might deserve.

All right. Anyway, that said, Mr. Rankin, who is your next witness?

MR. RANKIN: Mr. Hearing Officer, our next witness I'd like to call to the stand is Mr. William Knights.

HEARING OFFICER HARWOOD: I've seen you in the back of the room for a long time, Mr. Knights. Good to put a face to a name.

WILLIAM J. KNIGHTS,

having first been duly sworn, testified as follows:

DIRECT EXAMINATION

BY MR. RANKIN:

Q. Mr. Knights, will you please state your name for the record.

A. William J. Knights.

Q. By whom are you employed?

A. Netherland, Sewell & Associates. And I'm senior technical advisor, vice president.

Q. And what is your role in that capacity with Netherland, Sewell?

A. Basically due diligence on financial transactions, SEC reportings, signing reserve reports and evaluating financial transactions.

Q. And you do that based on a geologic analysis; is that right?

A. Yes. I'm primarily a geologist, but I've been there 35 years and worked with engineers closely for that entire time.

Q. Have you testified before the Commission?

A. No, I have not.

Q. Are you seeking to be qualified as an expert in petroleum geology?

A. I don't like to -- yes, I think so.

Q. Okay. And is your curriculum vitae, your resume, attached as Appendix A to direct written testimony?

A. Yes, it is.

Q. Because you haven't yet testified before the Commission, Mr. Knights, and just to give a little background for the Commission to understand your experience, will you just give a brief summary of your education first.

A. A master's degree in geology from Texas

Christian University in Fort Worth. And basically experience in the industry since 1983.

Q. So I'll move on to your experience now. So when did you obtain your master degree from TCU?

A. 1983.

Q. So with respect specifically to your experience around the Central Basin Platform and the Permian Basin, if you would, just give us a brief summary of your experience as a petroleum geologist; in particular, as it relates to conducting geologic evaluations and reserve assessments for fields in and around the Central Basin Platform.

A. I think the largest project I've worked on was the Altura acquisition, which was the acquisition of BP and Shell's CO2 projects in the Central Basin Platform at Title 23 fields, including the Hobbs North, South, Seminole, Wasson, Goldsmith. I think those were mentioned in this hearing. Then 18 other fields.

Q. All around the Central Basin Platform?

A. All in the Central Basin Platform and CO2 projects.

Q. And what exactly were you tasked with doing as part of your job responsibility?

A. It was basically due diligence, screening

the oil in place, recovery factors, things that go into the reservoir model, things that influence the financial transaction. A lot of it had to do with depth volumes curse, where the oil in place is, and reviewing the geologic inputs to the models.

Q. So do you have experience evaluating ROZ projects?

A. Every oil project I have has a component of ROZ.

Q. And as to this case, what were you asked to do in this case?

A. Review the geology, specifically relating to oil in place. And then also the communication between the injection zone and the shallower reservoirs.

Q. And as part of that assessment, were you asked to evaluate whether or not there's any potential communication between Goodnight's injection disposal zone and the overlying zones within the EMSU?

A. Yes. That was part of my task.

Q. And have you conducted, therefore, a geological study of the history of oil and water production in and around the EMSU?

A. Yes, I have.

Q. And that would be both from the Grayburg and San Andres formations?

A. Correct.

Q. Did your analysis also include the determination of whether there's any potentially economically recoverable hydrocarbons in an ROZ within the EMSU?

A. Yes.

Q. What did you look at to come to your opinions?

A. All the data provided by Empire, Goodnight, and some individual research, as I always do, through all the public data and literature.

Q. So you looked at data that was provided by Empire as part of this case?

A. Yes.

Q. And data that was provided by Goodnight as part of this case?

A. Correct.

Q. Did you also construct your own investigation looking through public records?

A. Correct. Yes.

Q. And as a result of your analysis, did you prepare a written direct rebuttal and surrebuttal testimony and exhibits that are marked as Exhibit E that provide your opinions and analyses?

A. Yes, I did.

Q. Now, before I go any further, you did prepare a revised direct testimony that was filed with the Commission, correct?

A. Yes, I did.

Q. Will you let us know what it was that you revised in that direct testimony?

A. It was a mathematical error in the calculation of hydrocarbon pore volume.

Q. And what was the error there?

A. The intervals were based on half foot, and I summed them up instead of taking the .5 foot. So it was a significant mathematical error that we corrected.

Q. And in addition to the mathematical error that you made in your direct testimony, was there another revision that you made in your direct testimony?

A. Yes. I changed a cutoff, which changed some numbers to more reflect the 20 percent cutoff that Melzer and Trentham defined as the ROZ.

Q. So originally you had used 30 percent as your cutoff?

A. Yes.

Q. Can you explain why it is that you initially used 30 percent and why you revised -- why you

originally used 30 percent and why you revised it to 20 percent?

A. Generally, I like to use a higher cutoff to kind of get a higher quality rock, an idea of kind of a sensitivity analysis. But then I realized that in this setting, being more conforming to all the other processes makes it easier to relate one oil in place to the other.

Q. So that was based on the testimony of Dr. Trentham and Mr. Melzer, correct?

A. Yes, correct.

Q. Now, you also prepared revised surrebuttal testimony that was in response to Ops Geologic rebuttal testimony that was filed with the Commission, correct?

A. Correct.

Q. What were the revisions that you made on that revised surrebuttal?

A. There's a 16,000-foot -- 16,000 number that should have been 19,000. And so I updated that.

Q. That was the only correction you made to that revised testimony?

A. Correct.

Q. Were there exhibits and figures included in your revised direct rebuttal and revised surrebuttal

testimony prepared by you and compiled on your direction and supervision?

A. Yes.

Q. Any additional corrections or changes to the testimony, figures or exhibits that were filed with the Commission?

A. No.

Q. Do you adopt the testimony in the self-affirmed direct written rebuttal and revised surrebuttal testimony that's marked as Exhibit E as your sworn testimony?

A. Yes, I do.

MR. RANKIN: Mr. Hearing Officer, I would tender Mr. Knights as an expert witness in petroleum geology.

HEARING OFFICER HARWOOD: Any objection from Empire?

MR. WEHMEYER: Without objection.

HEARING OFFICER HARWOOD: OCD?

MR. MOANDER: No objection.

HEARING OFFICER HARWOOD: Rice?

MR. BECK: No objection.

HEARING OFFICER HARWOOD: Pilot?

MR. SUAZO: No objection.

HEARING OFFICER HARWOOD: He'll be so

recognized.

MR. RANKIN: Mr. Hearing Officer, I, at this time, move the admission of Mr. Knights' revised direct testimony, his rebuttal testimony and revised surrebuttal testimony and his attached exhibits and figures that are all marked as Exhibit E.

HEARING OFFICER HARWOOD: Any objection Empire?

MR. WEHMEYER: Without objection.

HEARING OFFICER HARWOOD: OCD?

MR. MOANDER: No objection.

HEARING OFFICER HARWOOD: Rice?

MR. BECK: No objection.

HEARING OFFICER HARWOOD: Pilot?

MR. SUAZO: No objection.

HEARING OFFICER HARWOOD: They'll be admitted.

(Admitted: Goodnight Midstream Exhibit E.)

BY MR. RANKIN:

Q. Mr. Knights, have you been present for or did you listen to the summary testimony, the cross-examination, redirect testimony provided by all the witnesses that were presented during the first and second week of the testimony in this proceeding?

A. Yes.

Q. And you were here for the testimony yesterday, correct?

A. Correct.

Q. And did you prepare a summary of slides reflecting your up-to-date opinions based upon observing the testimony, the questions and the redirect, over the course of this proceeding?

A. Yes.

Q. Okay. So I'll go ahead and share my screen, Mr. Knights. And we'll walk through your slides. I'll ask you a question to prompt, and if you would just explain at high level the key takeaways of how each of these slides reflect your summary opinions for the benefit of the Commission.

So this first slide, Number 1, if you would just explain what the star is on why this is significant in terms of your overall analysis.

A. It's kind of a big picture of the San Andres and Grayburg fields in the Central Basin Platform in New Mexico. And basically shows that south of the EMSU, there's very little production.

Q. And the yellow star indicates where the EMSU is located?

A. Correct.

Q. How does this next slide here reflect on the previous slide? And explain what this shows with respect to the San Andres.

A. Well, the way the oil got into the San Andres is typically industry standard, coming from the Wolfcamp. So it's very complicated migration pathways as the oil migrates into the San Andres and Grayburg and the rest of Central Basin Platform.

The thing that's important about this is that each of these occurrences is unique and very difficult to use any one field as an analogy for another directly.

Q. And this next slide, if you would just explain how this particular slide reflects upon what you just stated about, in your opinion, the unique nature of each of these San Andres accumulations?

A. Since this trial does emphasize the San Andres, I just broke out the fields that were San Andres in the public data, showing those fields. Basically showing that the east flank of the Central Basin Platform has a high concentration of oil fields that have an indication of that as a major migration pathway and much fewer fields on the west flank where the EMSU is located, showing that that was less of a major migration pathway.

MR. RANKIN: Mr. Hearing Officer, I'm hearing some backgrounds noise. It's distracting me and it maybe distracting Mr. Knights and others. Maybe we can figure out where that's coming from before we go further.

(Pause in the proceedings.)

BY MR. RANKIN:

Q. So, Mr. Knights, I apologize because I was being distracted by the sounds of that reverberation or echo.

But maybe just quickly summarize what you just said for my benefit, explain, if not anybody else's. But explain how this slide is relevant to what you just discussed about unique accumulations in the San Andres across the basin.

A. This is restricted to the San Andres, and it basically shows that the eastern part of the Central Basin Platform is a major migration pathway, with all the fields developed and a tremendous amount of oil.

And that the western side of the Central Basin Platform was a less major migration pathway for oil.

Q. And you indicated here the location of the EMSU with the red star, correct?

A. Correct.

Q. That's on the western margin of the Central Basin Platform, correct?

A. Correct.

Q. Okay. Moving on to the next slide here, I think this is sort of a general depiction of something we've seen many times already. But if you would, just at a very high level, explain how this relates to the previous three slides we just discussed.

A. This is Trentham and Melzer's model on those migration pathways that show the Artesia pathway on the western flank of the Central Basin Platform and additional migration pathways on the east, so that migration of fluid from the west to the east and then from the north to the south.

And the lower picture shows the actual pathway of the Artesia extending down south, and even in this diagram, going all the way to the end of the eastern part of the Central Basin Platform in the Yates Field.

Q. What does this tell you about the size and interconnectedness of the San Andres across this large region?

A. This implies that it's a very, very large aquifer that has tremendous pathways for fluid migration.

Q. And tell me, just so I understand, and for the benefit of the Commission, structurally, as you go south, what is the relationship structurally as you go from the EMSU to the south along the migration pathway or that interconnected pathway?

A. For the EMSU, it's probably on a structural high, and it goes down as you go to the south. When you go further south to the Yates it gets very structurally high. And as you go to the west -- I mean, to the east, it also goes downdip.

Q. Now, zooming in a little bit here, explain what this shows with respect to the specific accumulations of oil in the San Andres within the -- across the Central Basin Platform and with the significance of this chart that you've got here.

A. So on the far left, I have the EMSU in yellow is the Grayburg production. So that's where all the production is. The yellow bars below that are the water supply wells that are all in the deeper part of the San Andres.

But I was trying to get a regional picture of what the San Andres looks like from a standpoint. So when you go to the north, to the south Hobbs fields, the dark lines that are on these are the top and base of the Grayburg from public data and just

kind of a quick analysis. And the colored ones are producing intervals that have been perfed in that field.

And so what you see as you move to the north and to the west, that there's different stratigraphic intervals that are charged with oil in each of these relative to the public Grayburg tops, but kind of pointing out that each of these accumulations is probably unique migration pathways and would be difficult to use as a direct analogy for the EMSU.

Q. You said north to the west, but did you mean north to the east?

A. North to the east. Apologize.

Q. And is this reflective in your opinion, Mr. Knights, of the unique migration pathways within and across the San Andres for oil?

A. Yes, it is.

Q. Looking at this next slide, I think you're zooming in here to the EMSU unit itself. Would you explain what this shows and how it relates to what you were just discussing about the migration pathways across the Central Basin Platform in the San Andres?

A. Correct. This was a diagram I made up early in the analysis, just trying to get my bearing on

where things were.

The green wells on the left are the water supply wells that produce no oil. And you can see that the upper perf in the 458 is maybe at 500 feet. So just a quick look says that's pretty much an aquifer.

The actual producing interval in the EMSU has an original oil-water contact between negative 325 or negative 350. On this diagram I put 350 as the producing oil-water contact, which is in my testimony.

All the wells that penetrated below the producing oil-water contact and tested oil are highlighted on this. The other thing that's highlighted on this in the red squares were our original eight wells that we did petrophysical analysis that Jim Davidson had for a time.

All the wells in orange on the right are water disposal wells, indicating to me that everything below negative 500 is an aquifer and used for either water supply or water disposal.

And the other thing to mention on this slide is, when I go through my analysis, there's a lot of discussion about San Andres nomenclature. I never want to get into that quagmire. So I just used -- by

oil-in-place analysis was based on TVD subsea depths, and those -- the three intervals that I've identified. The interval between 350 feet, the producing oil-water contact, and the highest water supply well is at 500. I called that interval a "potential ROZ."

And the other big scoping picture is, you know, of the 340, 380 million barrels of water that have been produced below the oil-water contact. There's only been 55 barrels of oil produced in all of the tests. So that comes out to a water ratio of 99.99998 percent. So that kind of goes to my initial look at the significance of the oil below the oil-water contact. You know, first plunge direct physical evidence, starting out with a very low indication of any significance of oil.

Q. So just to be clear, everything below minus 350 is included on here that's tested?

A. Correct.

Q. And all of those tests have accumulated 55 barrels of oil?

A. Correct.

Q. And over 340 million barrels of water, correct?

A. Correct.

Q. What's this next slide? And tell me a

little bit about what it shows and explain your analysis here and how it relates to your opinion.

A. So one of the things on a due diligence that you do is you look at any analyses provided and you try to do a due diligence on does it make sense with the actual physical data that you have.

I'm going to focus on just the Grayburg interval, which is between negative 100 and negative 350, so that first green line. The three petrophysical analyses here are the NuTech original, the NuTech revised and NSAI's original oil in place.

Just to start out with, I looked at it from a conventional basis. So I used a 40 percent oil saturation cutoff for net pay, and I just took all the data that was provided and said, okay, what is the net pay? And the far column on the right is the oil net pay. So the percentage of those net feet that net that hurdle of 40 percent, porosity showed that in the NuTech original, 69 percent of that would fit a conventional oil.

So typically what you look for is a relationship between that oil net pay and the production. In NuTech's revised, they did not change their methodology for the Grayburg. The reason there's a number difference is because they had some

slight changes in their tops. And in the bottom, the original NSAI model shows the same thing.

So if you look at the oil net pay, I look at that 69 percent oil net pay, and that would suggest that if everything was equal, they should have a 69 percent oil cut in that area. The actual oil cut in that area is 2 percent.

So one of the other significant things about this is most of these wells in Jim's analysis were done between 2002 and 2007. So this was probably 20 years after the water injection had occurred. So the actual state of the reservoir at that time was basically flushed from a waterflood with over 20 years, so it had a lot of fluid in there, a lot of oil extracted, and the current oil cut was 2 percent.

So the petrophysical model concerned me that these net pays in a water flush zone would indicate that there's significantly high oil saturations.

The revised has the same issue of very high oil net pay versus the standard conventional cutoffs. And when you looked at NSAI's original thing, they also kind of overestimated the oil net pay by this kind of ratio method with that. But they had it down to 18 percent oil cut, and it was 2 percent.

So in all these cases, I don't see anybody that has underestimated the oil that was in place; all basically overestimating, some dramatically.

Q. What is this analysis about the net pay in the Grayburg in the producing zone, the main pay zone of the EMSU, that NuTech's analyses show -- tell you about the reliability of their analysis in the deeper zones below minus 350 or below minus 500 feet?

A. Well, the concern is, if it doesn't relate to the actual physical data that you have evidence for when you're not calibrating to data, it's very difficult to believe in its accuracy.

And the other thing about the original NuTech model is that if you look down on the third layer, which I've entitled a transition zone between negative 500 and 700, that basically has a higher oil net pay ratio than any of the zones above it.

So just looking at the oil net pay in that interval, you would say that that is the best zone to be producing from an oil-water contact. And all of the tests that I have below the oil-water contact suggests that there's very little, if any, moveable hydrocarbons in that interval.

Q. Anything further on this slide, Mr. Knights?

A. I can talk for an hour on these slides.

Q. No, let not do that. We'll move on. So that's sort of a general review.

A. Right.

Q. Because this was looking at all NuTech's analyses. And this next slide here I think is a specific well. And just touch on, if you would, the key takeaway, because you're looking at a specific well here, how this relates to your analysis regarding NuTech.

A. Key takeaways, the producing oil-water contact in 350 is on here, so they have a test above it and a test below it. The actual recoveries are on the far right. So above the oil-water contact, they had about a 1.4 percent oil cut. But if you look at the green shaded, there's a considerable net pay, over 40 percent oil saturation.

Once you go below the oil-water contact, you still have NuTech's original significant portion of well above 40 percent oil saturation. And even their revised version, where they did change it, they still had a good portion of section above 40 percent.

And if you look at NSAI's, again, Jim has a few points. But if you look at the actual recovery on a swab, there was 100 percent oil cut.

But I think another thing to point out is, on ESP, which discussion residual oil, residual oil is relative to the current reservoir conditions, and ESP reduces the pressure at the wellbore. So that would change the reservoir characteristics, and if there was any residual oil there, you would expect it to be mobile with an ESP, at least near wellbore.

And if you look at the recoveries, it's, you know, two payrolls of oil out of 18,000, or .1 percent oil cut, indicating there's very little conventional net pay and not a significant amount of residual oil that's close to that.

Q. I think you said 18,000, but you meant 1800 barrels of water?

A. 1800 barrels, yes. Thank you.

Q. You indicated here that NuTech had a San Andres top. Explain --

A. Yeah, you know, I tried to put some reference on here, because almost everybody in this thing talks about San Andres. And San Andres is very large unit, and they basically talk about it as one amalgamated consistent zone, and it is not.

But in this interval, the producing oil-water contact at 350, you notice the top, or the aquifer, as a couple feet below that. So, there's a

lot of discussion on, "Where did this San Andres come from?" Well, based on how you pick the top, it's very close to the producing oil-water contact. So you wouldn't need much of anything to get some that have water in.

The other thing that points here is where the saturations reach zero, so those blue highlighted lines, those would be permeability barriers, in my estimation, where there's zero oil saturation and low porosity and low permeability.

But it shows that even just below the producing oil-water contact and within the Grayburg above and just below this oil-water contact, there are a significant number of these permeability barriers.

Q. Now, this next slide, this is another overview. We're moving into I believe Ops Geologic from NuTech. Explain how this relates to your analysis or assessment, diligence assessment, of Ops Geologic's petrophysical work.

A. So yes, this was the third and fourth petrophysical analysis that we received. But, again, comparing it to the data, comparing it to the Netherland, Sewell analysis, I just focussed on the -- just to get it quickly over, the red in the bottom that shows significant hydrocarbon saturations in the

high side, up to 70, 80 percent oil saturation. And even in the low side, the Ops model shows up to 60 percent oil saturation. But if you go to the core data, the direct physical evidence, there's no fluorescence, no cut, and background gas is basically background gas.

That interval combined in that whole interval, you know, 3700 barrels of water and no oil, indicates that, from a conventional standpoint, that both Ops low side and high side are, I'd say, optimistic.

Q. And what does this tell you, looking at the direct evidence? What does this tell you about the reliability of Ops Geologic's analysis?

A. That is a scenario. It's very optimistic and, in my estimation, unrealistic.

Q. Next slide here, explain what this shows. And this, again, is looking at the EMSU, a specific well, the EMSU 679. Just hit as far as the takeaway points that are important for the Commission to understand here.

A. So due diligence, looking at the direct physical evidence, on the right-hand side we have the EMSU core data, and it's an oil saturation and porosity. The main thing is, I look at, okay, here is

the actual hard physical data. What does the analysis look like?

And if you go to the analysis on the left side, there's a lot of similar situations that don't exist in the core. So if you take just that upper left-hand box, above the green arrow and left of the dark line, you notice in the Ops model, we have a lot of high oil saturations in these low porosity intervals. Now, if you go back to the core data on that same section, they don't exist if the core data. And that's kind of consistent as you notice the differences in the quadrants.

The other important thing here, I think, is the aquifer, which I have defined as negative 700 and below. Those are highlighted in the dark blue. Again, let's go to the core initially and we look at core saturations in the deeper intervals. Very low oil saturations.

Now you go to the log analysis on the left side and you notice that there's significantly higher oil saturations in the analysis that doesn't correspond or contradicts the actual core data.

So, again, it kind of gives you the concept that it's highly uncertain and really unreasonable that the Ops Geologic saturations don't

match the actual physical data. So concerns in the certainty of their analysis.

Q. Next slide here, I think this, again, touches on Ops Geologic. If you would, just the key takeaway here as Ops Geologic high and low scenarios relate to your assessment of the direct evidence available in the core.

A. So this was the low side. On the left-hand side was the low side Ops model which, at least from my understanding, used the core data, uncorrected core data as their base. And they said they correlated to the uncorrected and made their petrophysical analysis.

But when I look at the uncorrected average core oil saturation, it's 14.86 percent. And if I look at their analysis, it's 30.4, almost 100 percent higher than the average core uncorrected. So the calibration there, from what I've read and understand, I saw a big discrepancy there.

The other thing on the right-hand side is a little different display. I had both their low side and high side saturations. And this is for the 679 well that had core. And as you go down the area, the red arrows are where Ops' is significantly higher than the core data.

And the other thing to note on this is

that as you get down below, say, negative 650 or so, there's a significant break-off in the core saturations, and especially at negative 700. There's very, very limited oil saturation in that interval.

Interestingly enough, in the Exxon sales package, they had their limiting factor at the lowest as a negative 700 as their estimate of their bottom of the ROZ.

The other thing that's curious is, at the bottom of the 679 core data, you see a core analysis that is SCR, so it's solid -- SHR, solid hydrocarbon residue. And Trentham in his papers discusses that when you see solid hydrocarbons, that an indication you're at the bottom of the ROZ. And there's also another core sample that's up higher that also has the SHR, solid hydrocarbon residue.

And so in these things, the other thing that's interesting if you go in the lower part, you see in the core a general decreasing in oil saturation as you go from, say, that 600 to 700. And that's also an indication that you're at the bottom of the ROZ or potential ROZ, based on both Melzer and Trentham's models.

Q. Anything more on this, Mr. Knights?

A. I could, but I...

Q. Okay. Next one, let's move on. This next one, again, is looking at a specific well. And you portrayed Ops Geologic's petrophysical analysis here in a slightly different manner. Explain your key takeaway here and how it relates to your assessment of reliability and viability of Ops Geologic's analysis?

A. And this is another well that shows the consistency in their petrophysical analysis, which I always enjoy. But it does show higher oil saturations in the lower porosity rock, preferably lower permeability.

But the other thing it shows is that the high porosity, high quality rock with high perm, there's a significant amount of rock falling in there. And I think this relates to potential recovery, that if you were going to inject CO2, if I was a CO2 molecule, where would I go? I would go the high perm, high porosity rock before I would migrate in the lower perm, low porosity rock.

And I know typically in CO2 recoveries, you use a volume of CO2 relative to the hydrocarbon pore volume. But in these cases, with the incredible amount of pore volume in the higher porosity, higher perm, I think that may be underestimating the CO2. Because you'll probably need to fill up some of that

water wet hydrocarbon pore volume before you get the CO2 to focus or be forced into the lower porosity, lower perm areas.

Q. Your takeaway from this next slide, Mr. Knights, as it relates to your discussions up to date about porosity and cutoffs and Ops Geologic's parameters?

A. Yeah, so Mr. Birkhead mentioned a number of times in his testimony that he used a 2.9 grain density for dolomite. And he basically came up with that because I'm just assuming that all of these rocks have 20 percent anhydrite in them.

And so 2.9 is above the standard 2.87 dolomite matrix. If you used a 2.87, then all of his porosities would be reduced in the dolomite section by 1.5 percent.

But I point you to Exhibit A-5, the Exxon, and you'll notice two things in this. They used a 6 percent porosity cutoff, but they also used a rogue density of 2.84 as a basic for their matrix. That 2.84 is probably a 3 and a half percent porosity drop, so if Mr. Birkhead would have used a 2.84, some of his porosities would be reduced by three and a half percent.

The Table B-1 and B-8 are the actual

core data from the 679 well. And if you look at the core pieces that were just dolomite and didn't include anything, the range was from 2.81 to 2.87. And so in some of these areas where you had a dolomite that may have been 2.82, you may have overestimated the porosity by about 5 percent.

Q. And you've got an image here. What does this show?

A. Those are just some of the rocks -- I'm a geologist, I love rocks. So on the left-hand side, you see the San Andres reservoir that had vugular porosity, and it was filled with anhydrite. And so a situation like that, if you used 2.9, you would create porosity in the dolomite and you would have no porosity in the anhydrite, when in both cases, it could be zero percent porosity in both. But that's the way that the secondary anhydrite can fill pore throats and doesn't have to be at the surface.

And then the middle one is a 13 percent, 10 millidarcy San Andres rock that is fantastic. And then the other is anhydrite, which is common in these systems. But just a picture of the real rocks.

Q. Next slide here, this is moving off of the petrophysical analysis and you're getting into your barriers to waterflow. Explain, if you would,

Mr. Knights, starting at the top, what this shows and where it came from and how it relates to your analysis about edge water --

A. Migration path?

Q. Yeah.

A. So the upper is a cross-section. This is in a 1939 paper. So these were freshly drilled wells; a lot of people paying a lot of attention to it. They broke up the reservoir into three packages, Zone A, the deepest, that probably relates to Zone 5 and 6 in Melzer -- I mean, in Lindsay's Zone B, which is separated by a low perm interval, and then Zone C, which is on the uppermost, is another flow pattern that you would have migration up the lateral pathway your fluid migration.

The other thing I've marked on here is the estimated two original oil-water contacts at 325 and 350.

And the thing that's important on here is noticing that Zone A goes below the oil-water contact interior to the field. Zone B goes to the oil-water contact slightly to the edges. And Zone C kind of expands past the oil-water contacts, but outside of the thing. So when you're looking at a structure map of the top of the San Andres or the

Grayburg, that these structures change with depth.

Q. Next, talk about how that cross-section relates to the next image below, how this relates to your analysis. And what are you showing in the next image in the same exhibit here?

A. So the simplest thing is to take the light green bounded area that says "Area of Zone A Oil." That is where the top of the Zone A goes below the oil-water contact. And going to the next one outside, the Zone B, that's where the Zone B goes below the oil-water contacts.

But I think the most interesting thing to me was, in 1939, these hatched areas are all where they had water in the field, in the middle of the field, in 1939. All these areas, if you look at this model, it says there was water encroachment within the field in 1934 that migrated in '35, '36, '37, all showing that you had water movement and migration that's entered the field.

MR. RANKIN: We may be having a microphone malfunction. It's been worn out. Can we take a quick break to see if it needs a new battery?

THE WITNESS: Was I just not close enough?

MR. RANKIN: Maybe, Mr. Knights, just make sure you're close enough so that it's picking you up

without interference.

BY MR. RANKIN:

Q. I won't ask you to restate it, but just to be clear, your testimony here is that what this early paper was showing, it was showing edge water encroachment in the middle of the field; is that correct?

A. Yes. And it's documented in that 1939 paper as "Edge Water Drive."

Q. In your opinion, Mr. Knights, does this edge water drive that was documented back in the 1930s explain the -- how does it relate to the arguments that Empire is making about these bubble maps showing unexplained water production across the field, including on the highest structure area of the field?

A. Well, primarily, the preferred path of migration along bedding planes, so along the intervals, so if you looked at the A, B and C up on top, that lateral migration along the permeability is a preferred mechanism.

MR. RANKIN: How do you feel, Mr. Hearing Officer, about the microphone?

HEARING OFFICER HARWOOD: I'm thinking there is a battery issue. Maybe you could just swap out with him and see if that improves it, Mr. Torgenson.

BY MR. RANKIN:

Q. So I think, Mr. Knights, you were explaining that, in your opinion, that the perm barriers would create preferential lateral pathways for edge water encroachment up onto the structure; is that right?

A. Yes, correct. And, you know, even those vertical perm barriers as Dr. McBeath was asking, in the 211, over 30 or 40 feet, you have permeability barriers that cause pressure separation from the reservoirs, indicating that these horizontal bedding planes, even though thin, could be very valid permeability barriers.

So another thing that comes up when you start talking about the migration paths along the bedding planes, if you go to the 1998 Love paper, he talks about conformance issues.

That conformance diagram that he used is basically in the area on the crest of the structure and they denoted that there were high perm streaks in that interval along horizontal beds where water cycled through the waterflood, and that they could cut those off by putting cement and causing those high perm streaks that were horizontal to be blocked off.

And that seems like a very simple pathway to get water from the edge water either

downdip or near these water contacts to anyplace in the actual field.

Q. How does that analysis relate, Mr. Knights, to Dr. Buchwalter's model and analysis where he could only find -- his only explanation for this water was from the San Andres? Explain what could have been differently in his model that could --

A. Well, the --

Q. -- using a varied structure to answer his problem or address his dilemma.

A. Well, very simply, Buchwalter decided, how do I get water to this well? Well, he put a vertical fracture, like this, through the 82 horizontal barriers to get the water there, when, if you look at the 1998, a very simple explanation would be a small high perm streak along a bedding plane that would bring edge water drive to anywhere in the field.

Q. But he didn't do that in his model, did he?

A. No. And he also didn't incorporate any geology, which I thought was -- since they had for petrophysical analysis. None of the porosity perms or oil in place were used in his model either.

Q. One other item here -- well, let me ask this question. Based on your analysis of this edge water drive and the structure and preferential pathways for

flow, is this sufficient to explain, in your opinion, the water bubble maps from Mr. West's testimony showing his testimony unexplained water production around the EMSU?

A. I would say it's the more reasonable assumption that that's how this water got into the area.

Q. In fact, that was the determination back in the '30s; is that right?

A. Correct.

Q. One other item here that we didn't address, so I'd like you just to touch on. You called out specifically the EMSU 239. Explain why you have that called out here and how it relates to this overall analysis.

A. Well, again, like any due diligence, what you look for is anomalies in the data and you investigate those.

So that really high water-contact bubble was basically at the 239 well. And so I looked at that well, and it was initially completed in the Queen as a gas well and in the Upper San Andres as an oil well. And that was completed in 1936 and made about 104 barrels a day. And then by 1959, it was down to about 20 barrels a day. So that indicated that that

reservoir was actually depleting, so it isolated from anything below it.

In 1973, they drilled that well down below the oil-water contact. They did not have a test. But that was 1973, and they perfed that interval.

Then in 1981 is the next, really, data point I have, is that map that shows that that well had high water.

And so it just seems, besides my original geology of I think the water came from edge water through high perm streaks along bedding planes, that even the wells that have high water could be explained easily by drilling below the oil-water contact.

The other thing about that oil-water contact is that's the only oil-water contact at 350, but in 1973, there had been a significant amount of oil produced in all these zones. So that also could impact the edge water drive coming in up above the structure in the lower zone.

Love in the 1998 paper also mentions edge water drive.

And so I think the explanations for the higher water contact, using the simplest explanation,

is the bedding plane geology edge water drive.

Q. In your investigations, did you identify any literature that identified -- that the explanation for the water production in the EMSU was from San Andres fractures coming up?

A. No, no. I saw no evidence of any fracture communication.

Q. I think when you were talking about the 239, I think you may have said that it was completed in the upper San Andres. But it is a Grayburg well.

A. I mean, Grayburg.

Q. Okay.

A. I apologize. It's a Grayburg well. Thank you for correcting that.

Q. Anything further on this slide, Mr. Knights?

A. No.

Q. Next slide here, if you would just touch on the high points, the key takeaways here, and how it relates to your assessment of the Ops Geologic parameters in their analysis.

A. Well, Ops Geologic used a -- the only thing they varied was the sensitivity and the oil saturation. Typically in the oil industry, you use permeability cutoffs to do a net pay sensitivity.

And so I just wanted to show on this

thing, if they had used a porosity or a permeability to look at the sensitivity to their oil in place, that would have been probably more valid.

The things I put on here are what they used as a baffle cutoff of 1.5 percent porosity. And then I also put on here their permeability models that show it relates to an incredibly low permeability. So the threshold for their perm barriers is unreasonable, to me.

They used a 4 percent fee effective for their actual cutoffs. And if you look at their perm, that relates to a .005 and a .01 millidarcy, which is relatively aggressive, since the typical oil industry standard is for a gas reservoir of .1 millidarcy and for an oil reservoir of 1 millidarcy.

I also put on here Jim Davidson's 7 percent fee effective using this model; that way at least have some intervals from a conventional basis above 1 millidarcy, probably a 50/50 cutoff, which is a standard way of using the cutoff.

And then one thing I always like to look at is what does a high quality reservoir look like, how much of this reservoir is high quality. And at 10 percent, that would be most of the rock above 10 percent has a greater than 1 millidarcy

permeability.

Q. Using that assessments, Mr. Knights, what does this tell you about Ops Geologic's --

A. So just, again, describing the reservoir as a critical component, especially in a tertiary recovery, so if you go from right to left, 31 percent of this rock, using a 10 percent porosity cutoff, is really high quality. So you have a third of the rock is really high quality, high porosity, good perm. And so that's where most of your recovery factor is going to come from.

If you go down to the 7 percent, you basically have another third of the reservoir that's reasonably good reservoir, probably, you know, 50, 60 percent of it is going to be higher than 1 millidarcy, 50, 60 percent is going to be lower. But that portion of your oil in place will be a lower recovery factor.

Now you go to Ops Geologic and you say, okay, 4 percent porosity, what do we get? Well, we get another third of the reservoir. So a third of the reservoir is what I could would consider poor quality, low permeability. But the Ops model, as we saw previously, that's where most of their oil is in place.

Q. Just to be clear, the color coding here

relates to your tiering across the EMSU, correct?

A. Yes. And basically, the ratios are basically the same for each one of those. But the green would be the producing Grayburg. The potential ROZ would be from negative 350, the producing oil-water contact down to 500. Negative 500, the transition zone between 500 and 700. And the aquifer is from negative 700 and below.

Q. And Goodnight's disposal operations are in what you've identified as the aquifer, right, below minus 700?

A. Correct. All their injection is below in the aquifer.

Q. Just real quick, the key takeaways here, discussing Ops Geologic's analysis and their, in your opinion, unreasonable parameters, how does this relate to your determination about barriers across the zone?

A. The little green bars on the left-hand side and the -- you almost can't see them on right-hand well, but there are, I think, two little baffles that are identified using that 1.5 percent.

But if you just go in the 7 percent, or even simpler, is if you look at Ops' permeability model on the right-hand columns, those areas that do not have any wiggles, that is below .2 millidarcies.

And if you use that .2 millidarcies, you have significant perm barriers.

The back lines I estimated at about 7 percent porosity cutoff. And if you look at those in the well to the right, you have probably a 50-foot zone that's continuous low perm. And if you just correlate that over to the well on the left, that comes out to, I don't know, probably 100 feet of continuous vertical low perm that would be a significant perm barrier by any estimation. And if you go up and down the well, you have a significant number of these small perm barriers.

But, again, looking at the 211 well, you only need a few feet of perm barrier to create pressure isolation. But all of these intervals were going to be tremendously impeding any potential vertical flow through the intervals.

Q. And, again, you've got your tiering based on mean sea level of right-hand side, right?

A. Correct. That's unambiguous depth rather than an ambiguous nomenclature name.

Q. Next slide here, again, talking about perm barriers and potential fracture pathways, what does this next exhibit show -- slide show on --

A. So this is the RR Bell San Andres core. And

basically, you can read through, but there's a number of those zones that are horizontal thin beds that are very low permeability. There's one that's .3 millidarcy, .3, .1 millidarcy. All of those would be significant barriers to vertical flow, and they are along bedding planes.

And you can see the different colors of the rocks. As you go up and down, each one of those is a separate depositional environment that's a bedding plane that goes across the EMSU. So basically, horizontal layers that are sufficiently low to be permeability barriers to vertical flow.

Q. Are you seeing any vertical fractures indicated at this --

A. And I see no vertical fractures in this section of this rock, which, in part, as far as I can tell, is the only evidence indicating fractures. But I don't see any in this well.

And then the extension of those fractures through the Grayburg and through the permeability zone are around Jim's high gamma ray spike and his anhydrites. And then getting those down to there, I don't see any evidence in this photo that there's an extensive vertical fracture network.

Q. Continuing on your discussion and also this

is about vertical fractures here, and this is from the core of the EMSU 679, I think this is from Empire's exhibit, but you made some modifications to it, explain to the Commission what you did here and how this relates to your analysis about potential fracturing and communication between the zones.

A. So the implication that fractures are going to extend 300 to 400 feet down into the San Andres using the 679 data, if you look at this one 8-foot section of core, what you can see is that there are fractures, but they're isolated to individual layers.

So you have a fractured interval, then you go above and you see a non-stained, non-fractured interval, then you see a stained interval, and then a non-fractured stained interval. So none of these fractures extend over a large vertical section.

The other thing in Lindsay's paper, if you read it, it basically says that most of or predominantly these fractures occur in karsted areas. And these karsts are layers, so it's not a large karst like Carlsbad Caverns. These are layers that are bedded. And if those are fractured, that would also indicate that you can have significant perm along a karst, but it's going to be along a bedding plane that would allow fluid to migrate along the bedding planes

up from the edge water drive or any other mechanism.

But the primary fluid migration pattern is going to be along bedding planes, and that's just standard geology.

Q. Moving on to -- well, I think this is getting into the oil-in-place analysis or some more discussion about Ops Geologic's assessment about the potential for production here. What does this show? And explain how it relates to your analysis.

A. There's a lot of discussion about San Andres, San Andres water. So I just took the Ops' San Andres structure map and on the right-hand side labeled all the wells that have drilled below the producing oil-water contact and into the San Andres.

And so I think there's nine wells that are penetrated below the producing oil-water contact and in the San Andres, by their definitions. There are also a number of wells that are very close to the producing oil-water contact.

And, again, this producing oil-water contact was designated in 1939 or so. And so post that drilling, there's been a significant amount of extraction of oil which would have helped the edge water migrate up along bedding planes into the center of the thing.

The other thing this indicates is, and goes for later on, is that we already have wells penetrating into the San Andres, and if there was any oil there, it would probably be already depleted.

Q. And, again, that's San Andres as defined by Ops Geologic, right?

A. Yes.

Q. And that's above what Empire had identified as its perm barrier, correct?

A. Correct.

Q. Next slide here, just at a high level, what does this show and how does it relate to only analysis?

A. Well, another thing that was brought up in this thing was a recovery factor. And so Tall Cotton is the only isolated CO2 recovery in an ROZ zone, so I basically had to look at it.

Basically, my analysis, using just a standard rate cum plot showed that there was 8 million barrels of oil as my estimate at ultimate recovery. The current recovery now is about 5 million barrels.

Q. Okay. And that's the basic gist of this one, key takeaway?

A. Key takeaway, my estimate of 8 million barrels is the recovery of the Tall Cotton complete at

ten-acre spacing.

Q. Next slide here, how does that relate to this analysis of the Tall Cotton Field?

A. Well, the way to get to a recovery factor is you've got to have an oil in place and a recovery. So I've got a recovery at 8 million barrels. Now I need to figure out what oil in place I'm going to use.

Basically, I came up with 126 million barrels per section. And that EOR at ten-acre spacing was 8 million, and you come up with a recovery factor of 6 percent.

Q. Okay.

A. The other -- I'm sure people will ask me questions about this.

Q. Well, if there's something you feel is important so say, you know...

A. Well, it's just that the Tall Cotton, even though it's a lesser quality rock than most of the other CO2 floods that I've reviewed, the EMSU is significantly less quality rock with respect to porosity, oil saturation in the cores and net to gross than that Tall Cotton.

So my estimate is that, you know, a range between 1 and 6 percent recovery factor would be reasonable, using the Tall Cotton as an analogy and

using Ops' net pay cutoffs as a standard.

Q. Next slide here, explain how this relates to your economic analysis of potential recovery in the EMSU, based on Ops Geologic's petrophysics.

A. So this is Ops Geologic low side cases. I used their low side case because I thought the high side case was unreasonable and not of expectations.

But what it does show is that there is a concentration of oil in place, basically just in the crest. So identified by about three or four wells.

The Upper San Andres, which has already been penetrated and produced, in that core area of about four sections, they have about 10 million barrels of oil per section. And 10 million barrels at ten acres comes out to about 156,000 barrels. And I just did, okay, on a per well basis, 1 to 6 percent recovery, would be 1,500 barrels or 9,300 barrels, which are credibly low.

And then I went to the Lower San Andres, which is a much thicker reservoir. If you look at the thickness, it's between 900 and 1,000 feet thick. Other interesting thing here is that the RR Bell, which is an older well, is kind of a unique oil-in-place calculation. If you look at that, it's at 40 million barrels per section, but all the other

wells around it are, you know, in the 20 million barrels.

And anytime you see an anomaly like that, again, you'd like to investigate it and say is there a normalization process with the petrophysics, or is there something that unusual, or is that just a single 40-acre amount of oil in place.

The other thing you notice on these maps as you extrapolate outside of this area, the oil in place significantly reduces. And if you look at some of the estimates from Empire, they used a constant oil in place across the entire unit.

But if I was going to do a pilot, if you believed these maps, I would use these areas as my pilot project. But based on the recovery factors from the Tall Cotton, I see very little evidence of economic potential recovery.

Q. Now, you mentioned Empire using a constant saturation across an area. Are you talking about their economic analysis that Mr. West presented?

A. Yes. And John McBeath's analysis, as well.

Q. Okay. And you reviewed Empire's economic analysis?

A. Briefly, yes.

Q. Okay. And did you identify that they were

using any of the data provided by any of their experts' petrophysics, geologists, in their economic analysis?

A. No, they did not.

Q. Next slide here is, I think, your last slide. Explain what this means and how it relates again to your analysis about whether or not there's potentially economic recoverable hydrocarbons?

A. Most of my analysis on this was rebutting some other analysis. But in my opinion, Jim Davidson's analysis seemed to fit the data better than anybody else's. So using his analysis, and especially since Jim created his model, but then he applied it to five other blind tests outside the EMSU, and they all corroborated the actual data, I felt very comfortable that his model was at least a reasonable representation of the oil in place in the EMSU.

If you look down at the table in the bottom, if you notice, the other tables were 10 millions barrels per section and 20 million barrels per section. Now, in the producing zone, the actual Grayburg, I have about 21 million barrels in the Grayburg on a per section basis.

But as you go below that, the potential residual oil zone, which is the 150 feet below the

producing oil-water contact, I have about 9 million barrels per section.

Now, if you get down to the transition zone, between 500 and 700, I've got about 5, 6 million barrels in place. And even if you use the most exaggerated recovery factors, that becomes insignificant relative to economics. And anything below negative 700 where Goodnight is injecting, it's just minuscule. Significantly insignificant to any concept of economic recovery.

Q. Mr. Knights, you testified at the beginning that you had experience conducting evaluations, assessments for more than two dozen CO2 fields across the Central Basin Platform, right?

A. Correct.

Q. How does this proposed project here in the EMSU relate to what you've seen and you've assessed in terms of CO2 recovery or potential for an actual project, relative to your experience across the Central Basin Platform?

A. It would be significantly below the quality of reservoirs that I've evaluated previously.

Q. Have you seen anything in your analysis that would -- does this compare in any way to anything you've seen in your analyses of CO2 recovery projects?

A. No. This is a unique animal. Like I mentioned before, all these things are unique animals and you have to take it from the data that you have and evaluate it.

But in my opinion, there's significant physical data to suggest that Jim's petrophysical analysis is probably the most accurate of all.

And the other thing I can say is I don't think anybody has underestimated the oil in place. So I think there's another case that could be lower than Jim's.

Q. What is your opinion -- when you refer to "Jim," you're referring to Dr. Davidson, correct?

A. Yes. I apologize. Dr. Davidson and I work in the same office, so I'm very familiar with him.

Q. Okay. What's your opinion about whether Empire's producing zone and Goodnight Midstream's disposal zone are in communication?

A. There's absolutely no evidence that there's any communication. And there's significant evidence that says there's a significant number of permeability barriers between the Goodnight injection zone and all of the shallow producing zones and the potential ROZ zones that are above, say, you know, Jim's gamma ray spike at about negative 500.

So my overall concept is between negative 500 and up is unique, separate. There's some oil saturation up there that somebody might be able to go after. And then from 700 down, it is a complete, separate, isolated reservoir that has unique characteristics. And those two won't interfere with each other at all.

Q. What's your opinion about whether Goodnight's injections impair Empire's ability to develop recoverable hydrocarbons?

MR. WEHMEYER: Object. This is outside the scope of any of his filed testimony.

HEARING OFFICER HARWOOD: Mr. Rankin.

MR. RANKIN: Mr. Hearing Officer, Mr. Knights has testified that the scope of his testimony is to evaluate the geology, whether there's any recoverable hydrocarbons and whether there's any communication between those zones that would affect recovery. That is exactly what his scope of testimony is.

HEARING OFFICER HARWOOD: I'll allow it. Overruled.

BY MR. RANKIN:

Q. Mr. Knights, what's your opinion about whether Goodnight's injection is impairing Empire's

ability to develop recoverable hydrocarbons in Goodnight's disposal interval in the EMSU.

A. It would have no impact, in my opinion.

Q. What's your opinion about whether Empire can develop a potential ROZ in the shallower EMSU intervals while Goodnight continues to dispose of produced water into its disposal zone?

A. I think that very -- correct. Could you repeat the question?

Q. What's your opinion about whether Empire can potentially develop an ROZ in the shallower EMSU intervals while Goodnight continues to dispose of produced water into its disposal zone?

A. Yes. I think -- is that the shortest answer?

Q. In other words, in your opinion --

A. They're completely isolated and separated. And any activity above negative 500 or above negative 700 and below 700 are going to be completely isolated.

Q. Based on everything you reviewed and everything you've heard, do you believe there's any basis to suspend Goodnight's injection operations?

A. Not, I do not.

MR. WEHMEYER: Objection. This is absolutely outside of anything the witness would have

personal knowledge on, and it's speculation in terms of what the Commission should do.

HEARING OFFICER HARWOOD: That will be for the Commission to decide. Sustained.

MR. RANKIN: Very well.

BY MR. RANKIN:

Q. Mr. Knights, you've heard some discussion during Empire's testimony from their witness that more data is required in order to make a determination on the potential for ROZ development in the EMSU.

What's your opinion about whether or not more data is required to make that determination?

A. I believe there's plenty of data here to make a decision. I think the -- well, I mean, if somebody will ask me, I'll...

Q. Okay. So your bottom line takeaway is that there's plenty of data to make a decision about whether there's a potential ROZ or whether there's injection impacting any potential recoverable hydrocarbons, correct?

A. Correct.

Q. Let me ask you this, Mr. Knights. What's your bottom line takeaway opinion about what Empire is proposing to do here and what Goodnight has been doing and whether -- what's your bottom line analysis about

those two things?

A. Well, I think there's two isolated -- different, separate, isolated reservoir potential, and one is an aquifer that is incredibly large and unusual. And one is shallow and isolated and has, in my opinion, maybe a marginal amount of oil in place to be attacked from an economic standpoint.

Q. You said that the San Andres is very large, correct?

A. Yes. I think one of the most interesting things is that it's actually under-pressured, so .38 psi per foot. And the amount of withdrawal of fluid and the amount of injecting fluid, with seemingly no indication of pressure buildups, indicates that it's just a tremendously large reservoir.

And it goes back to Melzer and Trentham's theories about how this water was placed and how the migration paths happened and where they did. And matches with the larger scope things that we see in the Central Basin Platform on where the oil is.

Q. And just explain, if you would, how that relates to your bottom line opinion. I mean, the size of the reservoir and the pressures, how does that relate to your ultimate conclusions here?

A. The concept of fluid migration, especially

vertically, would need a pressure differential and a reason to go up. And when you have a significantly large reservoir that's under-pressured and with the withdrawal rates and injection rates showing it has incredibly high permeability, there's no reason for the water to go up at all.

MR. RANKIN: Thank you very much, Mr. Knights.

Mr. Hearing Officer, I have no further questions of Mr. Knights and make him available for cross-examination.

HEARING OFFICER HARWOOD: All right. It's 10:24. We'll call it 10:25 to make the math easier. Let's come back at 10:40. We'll take our mid-morning break.

(Recess held from 10:24 to 10:40 a.m.)

HEARING OFFICER HARWOOD: Mr. Wehmeyer, cross-examination?

MR. WEHMEYER: Thank you.

CROSS-EXAMINATION

BY MR. WEHMEYER:

Q. We've never met before, and didn't get a chance to visit at the deposition. That was somebody else, yeah?

A. Correct.

Q. Similar to my visit with Dr. Davidson, what I want to kind of talk a little bit about some of the data relied on, some of your methods and ultimate conclusions.

And before getting into that, I wanted to talk about some of the process that brought you here. I'm going to try to share my screen.

And in terms of your original report, do you remember authoring a report on or about August 26, 2024?

A. Yes.

Q. And if we get down to your signature page, you signed that report?

A. Correct.

Q. That was under penalty of perjury?

A. I would assume so.

Q. And, in fact, you also stamped numerous of your reports with your geology seal?

A. Correct.

Q. When you put the stamp on the report -- do you remember, did you a stamp this one?

A. I don't know. Is it on there?

Q. I don't know if I lost it on the watermark with the copy job. I've seen it on others. I just don't know if I lost it.

A. I do not know.

Q. What's the significance when you stamp those reports?

A. It's just a professional geologic stamp, license. I'm a licensed petroleum geologist.

Q. Basically, that the work conforms with the standards associated with your license?

A. Yes.

Q. Now, Mr. Rankin covered at the start of your testimony some of these changes you made. And I just want to make sure the commissioners have a handle on how drastic these changes were that you made.

The first which you said you were working in the wrong foot increments in interpreting Dr. Davidson's work; is that right?

A. Correct.

Q. And so will you explain to the commissioners what your error was when you signed your first report under penalty of perjury with respect to that half-foot increment?

A. I summed the hydrocarbon pore volumes, and I assumed that it was 1 foot, but it was -- that wasn't me, was it?

Q. No, sir.

HEARING OFFICER HARWOOD: Thank you, Sheila

for cutting that person off.

A. Could you rephrase the question.

Q. Yes, sir. With respect to the half-foot increment that you erred on in the first place, will you tell the Commission how you made that error.

A. It was a list of hydrocarbon pore volumes and I summed them up, but it was for half-foot, so I needed to multiply it by.5. And it was -- the file was labeled -- it confused me.

Q. So with respect to your opening testimony, you rendered opinions as a geologist about hydrocarbons in place here. Yes?

A. Correct.

Q. Tell the commissioners by way of order of magnitude how this changed those oil-in-place estimates.

A. 100 percent.

Q. So you swore under penalty of perjury, you think you actually stamped this thing with your geology seal, with Netherland, Sewell letterhead -- and you can tell the Commission Netherland, Sewell letterhead is on here. Yeah?

A. Correct.

Q. And you said: These are my opinions. These are the reasonable opinions based on my work.

And you were literally off in terms of the hydrocarbons before this Commission by a factor of 100 percent?

A. Correct.

Q. Okay. How did the error come to your attention?

A. I'm not really sure.

Q. And that wasn't the only change. After Mr. Padilla took your deposition -- and Mr. Padilla, he's not a geologist, is he?

A. I don't know.

Q. Okay. Mr. Padilla takes your deposition and you make another big change to your opinions, don't you?

A. Relative being -- a change from 30 percent cutoff to the 20 percent saturation cutoff.

Q. Tell the commissioners in terms of order of magnitude on the saturation cutoffs, how does that affect the volumes of hydrocarbon here, oil in place?

A. I don't know. But it added oil in place.

Q. A significant amount, doesn't it?

A. I don't really remember. Maybe 20, 25 percent.

Q. Okay. So you're off by a multiple of 100 percent because you didn't know the correct foot

increments. And then you're off by another 20 to 30 percent because of the cutoff percentage?

A. Yes.

Q. How did that error come to your attention?

A. That wasn't an error. That was a --

Q. Interpretation?

A. I used 30 percent in my original, more of what I expect the oil in place to be. But then I realized that everybody else was using 20 percent, and so I thought, well, just for relative purposes, I should join the bandwagon and use 20 percent water saturation cutoff.

Q. The water saturation, I mean, that's a big variable in input into all of these formulated arrived at oil in place?

A. Yes. One of the primary cutoffs.

Q. And scientific method you used for making a deviation from what you swore to in the first place to what you swore to and sealed in the second place was you, quote, unquote, wanted to join the crowd?

A. Yes. To make it easier for comparable reasons.

Q. One of the slides that Mr. Rankin visited -- first, with respect to the core in 679, did you ever physically look at that core?

A. No. I had pictures.

Q. Well, I guess if you didn't physically look at the core, you also never went in and described the core. Do I have that right?

A. Correct.

Q. I thought I had Mr. Rankin's presentation already pulled up to avoid wasting your time. I didn't, so let me get to it. Actually, it threw me off. It was titled "Trial Exhibits." I did have it. This is not trial exhibits, it's the presentation, but I've got it. All right.

A. Everybody makes a mistake.

Q. We're in the presentation that you just went through, and I want to focus on this core. So we know you didn't look at the core. We know you didn't describe the 679 core. In building a facies model, which is what Dr. Davidson used -- yes?

A. I believe he did.

Q. -- wouldn't it be really important to actually look at the core and study the core and describe the core as part of building that facies model?

A. Not necessarily.

Q. You also didn't use the RR Bell core at all as part of the analysis, did you?

A. In my analysis?

Q. In Dr. Davidson's analysis, which, again, you rely on his analysis in terms of building oil-in-place numbers, right?

A. Yes, his petrophysical analysis.

Q. Would using the RR Bell core have been important to that if you're going to rely on a facies model?

A. I really don't know.

Q. With respect to the facies model, in terms of rock facies, that would be a geologist that would assist with identifying and selecting rock facies. Yes?

A. It would be helpful to be a geologist.

Q. Did you assist Dr. Davidson in his rock facies selection?

A. No.

Q. Dr. Davidson, is he a geologist?

A. Not by degree, no.

Q. Why didn't you help Dr. Davidson with the rock facies selection if you're a geologist or actually a geologist that's been designated as an expert in this case?

A. Because Jim is an expert petrophysicist, and one of his main jobs is describing rocks from their

petrophysical characteristics, which are not always visual but actually quantitative.

Q. As we talk about reliability of testimony, I want to focus in on this EMSU 679 core. Did you add the purple arrows that go up and down?

A. The blue and green arrows, I added. And the depths at the bottom, I added.

Q. So 4230, 4232?

A. Yes.

Q. And the descriptions there to the side of the blue arrows, when it says, "Non-Fractured, Non-Oil Stained," did you add that?

A. Yes.

Q. And so in your testimony with Mr. Rankin, what you were explaining is that you have oil-stained intervals that you can see the staining, and then you have an interval next to it that's not oil-sustained?

A. Correct.

Q. And just for the commissioners, as we assess qualifications and reliability of testimony, how were these cores prepared?

A. I would assume standard procedures.

Q. Can you describe those standard procedures?

A. Not specifically.

Q. Now, if we just take -- let's take this one

as an example. Can you see my cursor? I'm at 4236.

A. Yes.

Q. Do you see the blue arrow?

A. Yes.

Q. And then there's a green arrow immediately below it. You added both of those?

A. Correct.

Q. And you saw fit to add the verbiage "Non-Fractured, Non-Oil Stained," to the one below it?

A. Correct.

Q. Explain to the commissioners what's important about that distinction between the stained above and the non-oil-stained below, according to you?

A. It shows stratigraphic variation over limited intervals of about a foot to half a foot, that you can have stratigraphic variations in a horizontal sense.

Q. Can you explain, as a matter of geology, how on earth it could be that you could have this very -- you would agree this is very highly oil-stained right here where I'm indicating at the bottom of the green arrow?

A. Correct.

Q. And then just immediately touching it, there would be no oil staining whatsoever?

A. Correct.

Q. Just explain, as a geologist, now that happens, so that the commissioners understand.

A. Well, there's probably a permeability separation, a depositional separation. It could be an unconformity, that fluid properties migrating through one does not migrate through the other. And it also indicates that there's lateral migration and not vertical migration.

Q. As a scientist, are you familiar with the term that Dr. Davidson used after coming back from the break and visiting with counsel, called a "preponderance of the evidence"?

MR. RANKIN: Objection.

BY MR. WEHMEYER:

Q. Is "preponderance of the evidence" --

MR. RANKIN: Characterization. Objection.

HEARING OFFICER HARWOOD: Rephrase. Leave out the "after visiting with counsel."

BY MR. WEHMEYER:

Q. So you were in here when we were on this issue of barriers and I said: Are you going to sit here for Netherland, Sewell and tell these commissioners that there's a barrier?

And he said no.

Do you remember that?

A. I remember that diatribe. I'm not really sure I understand what the conclusions were.

Q. And then we came back from lunch and he started speaking of a preponderance standard. Do you remember that?

A. I don't remember those exact words.

Q. Does preponderance have any scientific meaning? Sounds kind of like a legal thing. Does preponderance have any meaning in your science world?

A. I mean, it means -- to me, it means a lot.

Q. Okay.

A. I have more than just a piece of data.

Q. And we may have just missed. Is that a scientific term, that you're aware of?

A. Scientific? I don't know if I have a scientific dictionary, but not a defined scientific term.

Q. As you've worked with Dr. Davidson over the last 15, 20 years, have ever heard him use the phrase or term "preponderance"?

A. I don't know.

Q. Well, let's pick your -- I asked why, as we look at this 4236 -- and, again, after all the work and the many written statements in the case that

you've signed, there's been at least five different signed statements by you, right?

A. I think -- yeah. One revised, one revised and a sur. Five.

Q. Plus a sworn deposition?

A. So is that six?

Q. I wouldn't count the deposition. But you did that, too.

A. Okay.

Q. So after all of those, Mr. Rankin and you selected 24 slides here, give or take, to come and tell the story. And this was one of them, right?

A. Yes.

Q. And I asked how on earth do you explain that, and you said -- you gave the commissioners how you would explain the difference between how you can have oil staining immediately above and non-oil stain immediately below, right?

A. Yes. I'm not sure I understand that question.

Q. Yeah. I asked how, as a matter of science, do you explain this highly oil-stained core, and then immediately below it, there's no staining at all. And then you gave the commissioners under oath here an explanation, according to you as a geologist, how that

happens.

A. How it could happen, yes.

Q. And is that to the standard of whatever certainty you would hold yourself to and Netherland, Sewell to as part of your work in the case?

A. I believe that's a good explanation of how that could occur.

Q. It's not just a wild guess. You chose 24 slides. This is one you thought was most important. I asked how on earth does this happen from what you decided was an important slide. You gave the commissioners your answer, and you're standing by that and that's the degree of rigor that you, as an expert, bring to it. Yes?

A. I'm still not sure I understand the question.

Q. Is this a part of a full diameter core analysis?

A. This is probably half-slabbed core.

Q. So with respect to core analysis, with respect to each foot, are they going to actually pull that core out and clean it before measuring porosity and permeability?

A. I would probably say in some cases, they do, in some cases, they don't.

Q. And then there's going to be a smaller piece from the thick side of the slabbed core that's crushed to acquire oil and water saturation?

A. Correct.

Q. And the cleaning of the core, that's going to be done before the core is slabbed, correct?

A. Before the core is slabbed?

Q. Yes. The cleaning of the core to measure porosity and permeability is going to happen before the core is slabbed. Do you understand that that is part of the Core Labs process on full diameter core analysis?

A. I would defer to my petrophysical expert on that. He understands.

Q. And then only after all that is the slab going to be photographed and described? Or you don't know?

A. That could be a procedure.

Q. So following --

A. Sounds reasonable.

Q. So following full diameter core analysis, the core will have been stripped of all appearance of non-oil-stained core in each foot and a piece of core that is oil-stained and then you get the photographs.

In terms of the procedure that came for

these photographs to be, you have no idea, do you?

A. Typically, they're not cleaned before they do the core analysis.

Q. Dr. Lindsay shot through the roof when he saw this slide from you. Do you understand the explanation for how two pieces of core that are touching each other and one is heavily oiled-stained and other one is not, is that it has literally been cleaned out as part of this procedure? That literally all of the oil that was in that slab, that looked just like the one above it --

MR. RANKIN: Objection, Mr. Wehmeyer is testifying.

HEARING OFFICER HARWOOD: Overruled.

A. So yes, that could be an explanation for that as well.

Q. Wouldn't that be a more likely -- I'm not a geologist. But just looking at this thing, wouldn't that seem to make more sense, as a matter of science, when you see something that heavily oil-stained immediately above the one that is not?

A. Yes. I think that would be reasonable.

Q. Why before coming in here and giving the Commission these opinions, did you not do the work to be able to speak authoritatively and clearly on

important issues like this?

A. I guess I could have done more rigorous detail, but the specifics I was trying to get to here was that the fractures do not extend across vertical.

Q. Well, as we talk about fractures, again, so to help orient the commissioners, this core is about 3 inches in diameter, give or take, 3 and a half inches?

A. Okay.

Q. So as we get this core, even if it went all the way down to the Grayburg, you're only getting to look at 3 inches. And so if a fracture is apparent here and doesn't work perfectly vertically straight through the entire core, it's going to meander outside of the 3 inches in diameter and you're got going to see the continuous nature; isn't that right?

A. Correct.

Q. And so as you talk about noncontinuous fractures, that they're observed in shorter intervals, there's no way to view one fracture that's going to go perfectly straight up in the core, is there?

A. Correct.

Q. Now, just while we're on the slide, and I'm jumping around a bit, but fracture studies, did you perform any fracture studies here?

A. No.

Q. Did you perform any frac gradient studies?

A. No.

Q. And so if the commissioners wanted to know with respect to these fractures -- and we can agree that there's fractures in this core, right?

A. Correct.

Q. And because you showed a different slide -- I'm now working off of your Slide 18. That doesn't show a lot of fractures. That was one of the reasons you chose this one?

A. No. I chose this one because it had some stratigraphic variability and permeability variability.

Q. Obviously, whether we're talking RR Bell or the 679, we can certainly find plenty of sections in that core that has extensive fractures in it, can't we?

A. I do not know. I didn't look at all the core.

Q. And I guess the discussion about fractures, was that really to the ends of Mr. Rankin's questions over this idea of impermeable barriers or baffles of barriers to flow?

A. Could you restate that question?

Q. Yeah, just why we're talking about fractures.

A. Why we're talking about -- is that a question or --

Q. Yes, sir. And I appreciate you asking me to rephrase.

The reason that we're talking about fractures and core is because this is part of your story on the testimony that pertains to communication between the Grayburg and the San Andres?

A. Correct.

Q. And so did you review Bob Lindsay's fracture study that he prepared?

A. Yes.

Q. And he's also now prepared one for the RR Bell core. Would you like to see that one?

A. Not really.

Q. But I'm trying to understand in terms of the baffles, what were your parameters for setting a baffle flag? Or did you set the baffle flag or are those Dr. Davidson's over on the --

A. Those are Dr. Davidson's.

Q. Did you come up within any baffle flags?

A. The only baffle flags are on one of my other slides here, where I represented two wells, using a

sensitivity of where I would create some baffles in those two logs.

Q. And what were your standards for those baffles?

A. Well, they're two visual things. One using Dr. Birkhead's permeability estimate of less than .2 millidarcies. And then I also used a 7 percent porosity as an analogy for things that are less than 1 millidarcy perm.

Q. You've seen Mr. Birkhead's slides. There are certainly places in the core that have very low porosity but very high permeability.

A. Low porosity and high permeability?

Q. Yes.

A. Yes.

Q. That is the characteristic of the rock in this area. You will find places that have low porosity, high permeability?

A. Yes. The lower the porosity, the least likely it is to have high perm.

Q. However, as it comes to bear here on what was actually observed and measured in the core, that is not the case in a great many places. There are plenty of places with low porosity that have very high permeability?

A. Plenty of -- I didn't do a statistical analysis on that.

Q. So in terms of talking about barriers to flow or baffles to flow, you have not done a study looking at in instances of low porosity, what the permeability looks like; is that true?

A. No. I've looked at all the porosity perm plots, so I've looked at all that data.

Q. So now I'm just going to illustrate -- can you see in -- this is a slide that I think you either showed the exact slide or some variation of it, right?

A. Yeah. I understand it, though.

Q. To orient the commissioners, the purple dots are core measurements out of the 679. The lighter green is North Monument. Blue is the 458. And the other shade of green is the Bell. Correct?

A. Was that to me, correct?

Q. Yes.

A. Yes.

Q. And so with respect to your baffle cutoff, you were looking at 7 percent porosity?

A. That was one of my estimates, and the other was .02 millidarcy from Dr. Birkhead's work.

Q. .02 or .2?

A. .02.

Q. And so if it was less than 7 percent porosity, did you give consideration to permeability, or did you call that a baffle?

A. No. I just said that that was perm barriers, potential perm barriers.

Q. Something with less than 7 percent porosity you called a potential perm barrier?

A. Correct.

Q. That was the only standard?

A. No. Also the .02 millidarcy from Dr. Birkhead's work.

Q. So would it have to be less than 7 percent porosity and also less than .2 millidarcy in permeability?

A. No.

Q. So if it was nearly under 7 percent porosity, that was enough to trip a flag for you to call it a perm barrier?

A. Yeah, a potential perm barrier.

Q. Irrespective of what the permeability would be below that 7 percent?

A. Correct.

Q. Where in science would you find that 7 percent porosity would be a perm barrier? Where can I read that as a matter of industry standard or

acceptance?

A. Now, that is -- literature, I'm not sure. But 7 percent is basically that 50/50. Half of those are above 1 millidarcy and half of them are below 1 millidarcy. So it gets you a likelihood that that is maybe not more than likely, but a reasonable vertical perm barrier.

Q. Okay. And so if -- and I'm not being a smart aleck with this. But other than taking your say-so, if the commissioners wanted to know where does this standard of less than 7 percent porosity somehow become a perm barrier, what is that?

A. It would go back to the porosity perm plot, and you look at the plot and you look at 7 percent porosity and you look at the distribution of permeabilities within there. You do have a few points that are very, very high permeability, but you have a significant portion of those that are lower permeability.

So when you put those barriers up, if you have a significant number of -- there's a 50/50 chance that that's a perm barrier, and you have enough of those, it becomes a preponderance of the evidence.

Q. And I'm just trying to understand this. Because you didn't give consideration to permeability

on your 7 percent porosity cutoff for making a barrier. And I hear you're cutting it two ways. You were cutting it at Mr. Birkhead's .2 millidarcy on perm --

A. .02.

Q. .02. -- or you would cut it at anything under 7 percent porosity, right?

A. Yes. Those are two reasonable definitions of -- the .02 is probably highly likely. The 7 percent is probably reasonably likely.

Q. But wouldn't you want to know what the -- if you're cutting this off as 7 porosity, wouldn't you want to know, based on these particular rock properties, what permeability looks like in that rock?

A. Well, the problem with using actual permeability is you need a core data. And for 99.9 percent of the rock when you're making these analyses, you're not going to have core data. So you're going to have to use some statistical analysis to determine more than likely or less than likely what the perm of that rock would be if you did not have core data.

And if you look at this graph, you can see very few points at 7 percent porosity are in the high permeability. So it's very unlikely that you'll

have a 7 percent or lower porosity that has a high permeability, but you will have some.

Q. Well, help me. And this is me being a lawyer and not an engineer or a scientist. I'm seeing the 7 percent, your cutoff -- am I indicating correctly on this X axis with the cursor where your cutoff would be?

A. Yes.

Q. Am I at the right increment over here at the far left, this .02 millidarcy?

A. Yes.

Q. As you talk about core, aren't all of the data plots that I'm circling here instances that would be over .02 millidarcy of permeability but less than 7 percent porosity that were actually measured in these four different cores?

A. Correct.

Q. And obviously, if you have those types of millidarcy of permeability, fluid will flow, won't it?

A. Not necessarily.

Q. Why not?

A. Well, the 1 millidarcy is a standard traditional cutoff for oil fluid flow. And so anything below that is probably more than likely going to be a barrier to fluid flow.

Q. We'll take that in two pieces. Let's just start first with the one that you just offered here. So that the commissioners aren't mislead, that would be in conventional mobile oil type environment. Yes?

A. Correct.

Q. So if we're looking below -- so you said you set your baffle flag at 7 percent porosity. Based on actual measured core data, if we use the 1, you can tell the commissioners that there's piles of plots here that have over 1 millidarcy of permeability measured at less than 7 percent porosity, true?

A. Correct.

Q. And according to you, over 1 millidarcy, we should all be expecting fluid to flow at that permeability, right?

A. Yes, in a horizontal perspective.

Q. What if we add CO2 and we're no longer speaking in a conventional world? You understand this whole proceeding that week three of this is over Empire going in with CO2?

A. Correct.

Q. I only ask, this is being a little bit smart aleck, because we've spent a lot of time talking about mobile oil in conventional world. And in terms of mobile oil, you understand Empire is not expecting to

get mobile oil in the San Andres? We're on the same page with that?

A. Correct.

Q. If you apply CO2, the 1 millidarcy of permeability that you spoke to in the conventional world, that comes down significantly, doesn't it?

A. Correct.

Q. How far down would that come?

A. I do not know.

Q. Would .1 at least be a reasonable estimate?

A. .1 for a gas reservoir would be about what Dr. Davidson assumed was a 7 percent porosity cutoff.

Q. I'm talking about permeability now. I'm sorry, we may have missed.

If you're adding CO2 can you now expect fluid to flow at .1 millidarcy of permeability?

A. Gas to flow at .1 millidarcy.

Q. At what point would you have oil flow?

A. Somewhere between -- less than 1 millidarcy, I would assume, if it's got a gas component.

Q. How about water?

A. Water, probably around that 1 millidarcy, plus or minus.

Q. Have you done that work?

A. No.

Q. You're guessing at this?

A. No. I am making a professional judgment.

Q. Okay. But just as we put this plot into perspective, you would set your baffle flag -- you did set your baffle flag over here at 7 percent porosity. And so now I'm asking -- in a CO2 world, you talked about one, and I showed you where we've got plotted core in four different cores in the San Andres and Grayburg that have plots that are well over 1. If we add CO2, we get even more of these data points that would then fall into fluid --

A. Some mobility, yes.

Q. With respect to permeability barriers, if we come back to your -- what I'm trying to figure out is -- were you here during the opening remarks by Mr. Rankin, the very first day? We came in on a Thursday and there was opening argument. Do you remember that?

A. I probably don't remember it specifically, but I think I was here.

Q. You were here, yeah. And Mr. Rankin said that his experts were not given any guidance on where the analysis was supposed to end up or where the conclusions were to lie. He wanted them to come and make an objective assessment. Do you remember him

mentioning that in opening arguments one way or the other?

A. To that effect, yeah. I would assume that that was...

Q. I want to look back at your original report. I think this is the one before the correction, and this is no gotcha with the correction or not, but this was the very first one you signed. Can you read that? What was the second charge that you were given as part of your work here? Can you read Number 2 to the commissioners?

A. Evaluate and confirm the presence of geologic barriers isolating the San Andres Formation from the overlying Grayburg Formation.

Q. Why were you not engaged to just evaluate the potential presence of barriers? Why were you engaged to actually confirm the presence of geologic barriers?

A. That is what it states there, but my analysis, if it did not find barriers, that would have been my analysis.

Q. Is the reason that you were retained to confirm the presence of barriers that Goodnight had already drilled and was injecting saltwater into Empire's oil unit?

A. Could you rephrase that?

Q. At the time that you were hired to confirm barriers, was the reason they were asking you to confirm, as opposed to evaluate whether they existed at all, because they were already injecting into the oil unit?

A. At the time, I did not know. And although it does say "confirm the presence of geologic barriers," I interpreted that to be confirm or unconfirm or deny.

Q. Can you tell the commissioners about an instance in which you would have been hired before this to confirm geologic barriers?

A. No.

Q. So if the commissioners want to know how often you go around, as a Netherland, Sewell expert, confirming the presence of geologic barriers, this would have been the first time you were hired to do that?

A. It was the first time there was something written that said that in a bullet point. But confirming permeability barriers is basically what I do for a living, determining net pay and what is a barrier, what is a reservoir, what is non-reservoir, what is quality of rock, what is poor quality of rock,

what is reasonable quality of rock.

Q. So just coming back here to confirming the presence of these baffles, in your reports, and I can show you examples, but you use the phrase "potential barriers to flow." You know that you have hedging language throughout these reports that do not say Netherland, Sewell is saying there is, in fact, a barrier. It says that there might potentially be a barrier?

A. Correct.

Q. Is that the testimony of Netherland, Sewell in this case today?

MR. RANKIN: Objection. Netherland, Sewell is not testifying. Mr. Knights is testifying.

HEARING OFFICER HARWOOD: Well, he's an agent. I'll allow it allow. Overruled.

A. Can you repeat the question.

Q. I'm just trying to see if you're sticking with the reports or if we need another revision.

Is it the testimony of Netherland, Sewell, through you, as its agent, that there is a potential barrier?

A. Yes.

Q. Is it the testimony of you, as Netherland, Sewell's agent, that there is, in fact, a barrier?

A. There are many barriers between the 350 and the 700 feet that I kind of evaluated.

Q. Is it the testimony of Netherland, Sewell -- and Netherland, Sewell is the entity actually engaged here to work, right?

A. Correct.

Q. Is it testimony of Netherland, Sewell that there is, in fact, across the entirety of the EMSU an impermeable barrier that prohibits the flow of any fluid from the San Andres into the Grayburg? Yes or no?

A. Could you repeat that again? I got to get all these.

Q. That's okay. The goal is to get this as accurate at possible, and I appreciate you asking me to break it down and clarify. I'll strike that.

As we visit concretely here on this project, let me start with the first question, is it the testimony of Netherland, Sewell, or you as its agent, that there is a potential barrier to flow between the Lower San Andres and the Grayburg?

A. Yes, from --

MR. RANKIN: Objection. Form.

THE WITNESS: Oh, sorry.

HEARING OFFICER HARWOOD: Overruled.

BY MR. WEHMEYER:

Q. Is it the testimony of you and Netherland, Sewell here to this New Mexico Oil Conservation Commission that there is, in fact, an impermeable barrier all the way across the EMSU that prohibits the flow of fluid from the San Andres into the Grayburg? Yes or no?

MR. RANKIN: Objection. Foundation. He's talking about formation nomenclature that Mr. Knights did not address in his testimony. So I think the question needs to be specified so he understands the question.

HEARING OFFICER HARWOOD: Overruled.

A. With a caveat. Can I put a caveat in yes or no or say it's gray? I don't know.

Q. Is it gray?

A. Well, the specific statement you made, is there a barrier, one barrier across the entirety of the EMSU, I would say I have not identified one single barrier, but many individual barriers.

Q. With respect to what you're saying, "many individual barriers," is it the testimony of you, for Netherland, Sewell here to this New Mexico Oil Conservation Commission that taking the many barriers that they prohibit -- that it is an impermeable

barrier that does, in fact, prohibit any fluid migration from the San Andres into the Grayburg?

A. I would say significantly inhibits.

Q. Can you help me with the difference between significantly inhibits and completely stops?

A. I'm not 100 percent sure, but the preponderance of the evidence that I've reviewed indicates that there is more likely strong indications of permeability barrier between fluid flow from the Goodnight injection zones and the Empire shallow production and the shallower potential ROZ.

MR. WEHMEYER: I'd object to the nonresponsive and ask that that be stricken. And this is to the ends of -- I'm not going to fuss with him or fight over it with him on decorum, but I do need the answer to the specific question I'm asking.

HEARING OFFICER HARWOOD: Well, reask it then. I'm not going to strike the answer.

BY MR. WEHMEYER:

Q. The question is, if you'll focus on --

A. Yeah, I'm...

Q. -- what is the difference between significantly inhibits and completely stops?

A. The degree of certainty.

Q. You're saying that that is -- a degree of

certainty is what differentiates those two things?

A. Yes.

Q. Have you opined anywhere on a degree of certainty as to "significantly inhibits"?

A. No.

Q. And if Mr. Rankin comes back after the break, you're not going to be able to put a percentage on that, are you?

A. No.

Q. Now, as a geologist, I thought I heard Mr. Rankin's objection a moment ago that you don't know where the San Andres is. You didn't pick any tops of the San Andres, did you?

A. No.

Q. Well, you're laughing. Help me with that. Why are you laughing on a question when we've got 21 witnesses in this thing, and the Commission has got to make a decision, and I ask the geologist, "Did you pick the top of the San Andres" and you laughed? Tell me why that one is a funny one?

A. You have a number of geologists picking the top of the San Andres at various places. You didn't need another one to put another estimate on there.

The problem with the San Andres is it's just not a defined interval. So it's basically to the

winds of whoever is picking it, for whatever reason they're picking, where they are picking it. And I didn't want to get into that quagmire.

Q. Well, maybe we are going to get to that person, but we've deposed everything that moves, and I haven't seen it yet.

Who is the Goodnight witness that is going to get on the stand and tell the Commission that they picked the top of the San Andres?

A. I would assume that would be Preston McGuire, I think.

Q. Did he pick them or did he rely on hearsay from someone that is no longer with the company?

A. I do not know. Again, I tried to stay away from that.

Q. Do you know where the Lovington Sand is?

A. I never really looked for it. The nomenclature was new to me.

Q. In terms of if the commissioners want to know where the top of the San Andres is -- strike that.

If the commissioners want to know, according to Mr. Knights, where the Upper San Andres, is that any analysis you performed? Could you all tell them where the Upper San Andres is?

A. No.

Q. If they wanted to know where the Lower San Andres is, as the geologist here, could you tell them where the Lower San Andres is?

A. No.

Q. If they wanted to know where the Lovington Sand is, you couldn't tell them where the Lovington Sand is?

A. No.

Q. Now, in terms of the -- as we continue this barriers to flow, we saw at Number 2 here in your report that your task was to confirm the presence of geologic barriers isolating the San Andres Formation from the overlying Grayburg Formation. I read that correctly?

A. Yes, you did.

Q. You heard your counsel's objection earlier that you didn't know where the San Andres was, right?

A. Correct.

Q. So how did you confirm the presence of geologic barriers isolating the San Andres Formation from the overlying Grayburg Formation if you didn't even pick the tops, you don't know where it is, you don't know where the Lovington is, you don't know where Upper San Andres is or the Lower San Andres is?

A. I defined my own internal nomenclature.

Q. Will you help the commissioners with what your methodology was to pick the -- was it just the 7 percent porosity cutoff, as you went about work here as a geologist? Was that it?

A. No.

Q. What then was your methodology? Move now not from data but the we're moving over to methodology. What was your methodology to confirm a barrier?

A. Trying to look at preponderance of data and defining where reservoirs are. And so the two reservoirs that I've defined that people variously call whatever name they want to, are the Goodnight injection zone, which is significantly below a negative 700 feet and it was defined by permeability fluid flow, water supply wells and injection wells, that had a unique characteristic from a reservoir quality perspective.

And then I had the additional information on the Grayburg producing oil-water contact that has significantly different reservoir characteristics.

And then I had the petrophysical analysis that analyzed below the producing oil-water

contact and that negative 700, which I considered aquifer below that and found numerous amounts of indications of permeability barriers, horizontal permeability barriers.

And I didn't see any evidence of any indication of communication between those two separate reservoirs. And nomenclature was not in my -- I just -- I think that just confuses things.

Q. Then why did you use it in the very first paragraph of what you wrote?

A. When you're first tasked for a performance, you're given all kinds of directives and people are trying to say how they view the reservoir. They view it as Grayburg San Andres, the actual unit was named Grayburg San Andres. I think it ill defined originally, and I think the definition of San Andres, in my opinion, should have developed over the history of the -- with the new data, indicating that there are different reservoirs within the San Andres.

And much like the Grayburg has 82 separate parasequences that have different permeabilities of perm barriers between those, the San Andres is likely having a similar set of stratigraphic barriers and reservoirs that have different qualities throughout the whole thing.

And I just did not get into the -- what you call San Andres, what Preston would call San Andres, what Adam would call San Andres, what anybody in the room would call San Andres. I just didn't think that was important to my oil in place or the definition of reservoir isolation between one and the other.

Q. So if you we just come back to what you say your charge was, so that we've got this in one place for later in closing argument, evaluate and confirm the presence of geologic barriers isolating the San Andres Formation from the overlying Grayburg Formation.

It would be your testimony to the Commission that you don't have an opinion on that because you don't know where each of those formations are?

MR. RANKIN: Objection. Foundation, form.

A. Yes, I don't have any testimony.

HEARING OFFICER HARWOOD: Overruled.

And, Doctor, when these objections come up, you have to wait. Okay?

THE WITNESS: I apologize.

A. Am I supposed to answer now? I was asking for the question again.

Q. I'm sorry, I just didn't understand. I'm not fussing with you. And I appreciate the --

A. I don't mind.

Q. Yeah, I appreciate you doing that.

If the commissioners want to know whether you have confirmed the presence of geologic barriers isolating the San Andres Formation from the overlying Grayburg Formation, you would tell them that you don't have any testimony on that, do you?

A. It's depending on whose personal interpretation of the San Andres.

As specific depth intervals that are unambiguous at negative 700 between the producing oil-water contact at negative 350 and negative 700, I believe there is a number of permeability barriers that -- potential permeability barriers that are identified in that interval.

And various geologists would call that San Andres Grayburg. I wanted to be very specific, and there's no ambiguity in where I pick these. I have TVD subsea depth and an X, Y. It is not in the interpretation of anybody's what I'm going to call it.

Q. You used a new phrase now. This one is actually in your report. What is, quote, potential permeability barrier?

A. "Potential" is word we use because we are not 100 percent sure.

Q. And in terms of putting a probability percentage on it, we visited earlier, even if we give you a break over lunch, you're not going to be able to give us a percentage on how sure you are or not, are you?

A. No. It's more than likely, likely. And the issue with geology and interpretation is, you're actually interpreting every half foot for thousands and thousands of feet. So you really do have to have a preponderance of data or a most likely case.

Because if you're trying to be certain and 100 percent certain, then you almost can never make a financial decision or a decision at all if you want 100 percent certainty.

Q. Well, no, I asked what is a potential permeability barrier. You said it's something not 100 percent sure. I asked can you put a percentage on it. And your answer is you cannot put a percentage on it; is that correct?

A. I can, but I won't.

Q. I'll take that. And even if we take a lunch, you're not going to come in and all of a sudden have an answer after visiting with counsel, are you?

A. Not without -- but if I go to sleep, I may have a different interpretation, as that's where I do most of my thinking.

Q. While you're asleep?

A. It's amazing. I wake up in the morning and go, "Oh, my gosh."

Q. Okay. So as we come back to your methodology here to get to potential permeability barriers, did you review literature?

A. Specifically for the perm barriers, I mean, I attempted to review when people say they want literature basis. I did look, but there's very little literature on permeability barriers.

Q. Well, the -- with respect to the EMSU here, you know, Dr. Lindsay has written a Ph.D. discussing that water is migrating from the San Andres up into the Grayburg.

MR. RANKIN: Objection. Mischaracterizes the testimony of Dr. Lindsay and his Ph.D. thesis.

HEARING OFFICER HARWOOD: Rephrase.

BY MR. WEHMEYER:

Q. Have you read Dr. Lindsay's work on water migration the San Andres into the Grayburg?

A. First part, yes. Second part, no.

Q. Does Dr. Lindsay opine that water is finding

its way up into the Grayburg from the San Andres?

A. I did not get that from reading his testimony or looking at his figures.

Q. What about hearing his testimony here in the proceeding?

A. If he stated that, I would probably disagree with that interpretation.

Q. Did you read the Chevron paper that spoke to water migration?

MR. RANKIN: Objection. Foundation and form.

HEARING OFFICER HARWOOD: Overruled.

A. I'd have to see which specific Chevron discussion that you're talking about.

Q. As the expert here, you can't -- after we've seen the Chevron paper flashed 20 times, you can't -- you have no idea what Chevron paper I'm talking --

MR. RANKIN: Mr. Hearing Officer, there's several Chevron papers.

HEARING OFFICER HARWOOD: I'm sorry, what was that? I heard what you said, there are several Chevron papers.

In fairness to the witness, can you identify the paper you're talking about, Mr. Wehmeyer?

BY MR. WEHMEYER:

Q. Any Chevron paper.

A. Could you rephrase the question?

Q. Do you recall seeing in this courtroom any Chevron paper in which Chevron discussed migration of fluids from the San Andres into the Grayburg?

A. Again, I have seen a lot of data. I'm not sure which ones were Chevron. But if you could show me, I would gladly make a statement.

Q. I'm actually going to move over to -- what about pressure data, the 211 well with the RFT measurements that were taken of that well back against the Technical Committee Report, initial pressure measured up in the Grayburg? Have you done any kind of studies based on the pressure data, on pressures, to identify whether there's depletion occurring?

A. Define "study." I've reviewed data and observed data and analyzed it mentally that shows that there's pressure barriers.

Q. My question is pressure depletion in the San Andres as a result --

A. Same.

Q. And I'm specifically talking about the RFT measurements in the 211 well. And I can show you the slide.

A. I think I have the slide in my mind. But I think you said San Andres first, or Grayburg?

Q. The measurements were in -- the RFT tool was measured throughout the Grayburg into the San Andres. The initial pressure reading was out of the Grayburg in the Technical Committee Report.

A. Again, I'm not sure whose San Andres you're talking about. But I'm familiar with the depths and the pressure variations that indicated permeability barriers between them.

Q. This is a slide that you're familiar with?

A. Yeah, I've seen that.

Q. So in the 211 well, all of the little bullseyes, those are measurements off the RFT tool in 1986, which would go down into the San Andres, correct?

A. By someone's definition of San Andres, yes.

Q. And do you see that there's a 282 psi depletion that's reflected here off of what would be anticipated pressure off of the Technical Committee Report original pressure reading?

A. The initial pressure reading in the San Andres?

Q. In the Grayburg.

A. In the -- I'm confused. That pressure, that

1527, is, by this, in the San Andres.

Q. That would have been predicted in terms of where it should have been based on the pressure gradients.

A. Predicted from? Do you know what the pressure gradient was in the San Andres at 3700 feet? I can't ask questions. I'm just kind of --

Q. I'm just trying to figure out with your work here as a geologist, if you're talking about barriers, did you do any of your own geological work here or engineering work to look at pressure depletion to see if there's pressure depletion between the Grayburg and the San Andres? Yes or no?

A. I don't think I had any pressure data in what some people call the San Andres.

Q. We were talking about literature. Have you seen any literature that says there's an impermeable barrier across the EMSU that would isolate the San Andres from the Grayburg?

A. Literature that says specifically perm barriers across the entire EMSU, no.

Q. Okay. So if the Commission wanted to know after 100 years of oil and gas development out here whether anybody has written that there is a potential permeability barrier across the EMSU, you haven't seen

that, have you?

A. Correct.

Q. Have you seen any literature that would report bedded anhydrite all the way across the EMSU?

A. No.

Q. If anhydrite is bedded, what did does "bedded" mean?

A. It means it's a horizontal layer.

Q. How thick does it need to be?

A. Does it need to be for what?

Q. To be able to call it "bedded anhydrite."

A. I don't know. A couple inches, half foot.

Q. And so here, if bedded anhydrite is a couple inches -- again, you haven't done any kind of a fracture gradient analysis in terms of what would cause existing fractures to expand or widen or actually break through that rock, have you?

A. No.

Q. If fluid does migrate from the San Andres that Goodnight's injecting -- are you with me so far?

A. Yes. An assumption.

Q. -- if the potential baffle doesn't keep that water down there -- are you with me so far?

A. If and if. Yes.

Q. -- would you agree that that would interfere

with Empire's oil and gas operations in the Grayburg?

A. May I ask a clarifying question?

Q. Sure.

A. "Interfere," what does that mean?

Q. Make more expensive. Cause the loss of oil. Cause less oil to be recovered. Or is the answer I don't know?

A. I don't know.

Q. And the reason I ask that is because counsel asked you -- do you remember, like, the last three questions he had of you were about whether Goodnight's operations are having an effect on Empire? Right?

A. Sure.

Q. I'm going to step sideways here for just a second. In terms of evaluating an ROZ project, you said you've been involved as a consultant assisting clients in evaluation an ROZ project?

A. Yes.

Q. And if we come here to the EMSU and we hypothetically play out that Empire approaches you to ask you about an ROZ in the San Andres -- are you with me so far?

A. Which San Andres?

Q. All of the San Andres Formation.

A. All of them.

Q. Let's do the entire San Andres that's in the unit that the Commission formed in 1984. Then are we on the same page?

A. I think so, but -- yeah, sure. I'll try.

Q. You know right this second that Goodnight is injecting into Empire's earlier established oil unit, right?

A. I know the depths that they're injecting into.

Q. Are you familiar with any other instance, have you ever seen that in your career, where a commercial saltwater operator is injecting into somebody's designated unit?

A. Not that I'm familiar with, no.

Q. This would be the first one?

A. That I've seen, yes.

Q. So coming back to this, if Empire approaches you and says, "I'm looking at an ROZ development. Maybe it costs $1.2 billion, and I'm going to do the entire San Andres" -- are you with me so far?

A. I think so, yes.

Q. -- and that's not a hypothetical in terms of -- you heard Mr. West actually sit up here and testify that Empire's intention, Phil Mulacek, they do everything big, they're going to go all the way down

to the top of the -- to the top of the Glorieta. Did you hear Mr. West's testimony?

A. I heard that.

Q. -- would you tell them this is a concern, that there is vast amounts of saltwater being injected into the interval that you want to conduct your tertiary operation in?

A. Would that be a concern of mine?

Q. Yes.

A. To them?

Q. Yes.

A. No.

Q. Why?

A. Because if the alleged resource is in the San Andres and it is residual, it's not going to be moved by injection of fluid.

Q. Isn't it going to make a CO2 program different -- injecting that fluid is going to change pressures. It's going to cause more expensive use of CO2. Once oil becomes mobile after the CO2 invades those pore spaces, it can be washed out of the recovery wells. All of these are potential lost hydrocarbon in this hypothetical, aren't they?

A. I would assume that might be an impact.

Q. And so, again, coming back to your advice to

Empire who approaches you in light of this saltwater injection, you can tell this Commission that any investor, be it a bank that's lending -- you represent banks making decisions on whether to lend, right?

A. Yes.

Q. Operators making decisions on whether to drill?

A. Yes.

Q. Working interest owners making decisions over whether to elect to participate on an AFE, to participate in a project?

A. Correct.

Q. You are absolutely going to tell them that this saltwater injection is a concern, aren't you?

A. I don't know, really.

Q. Now, in terms of the baffles, were you able to map a single baffle that went all the way across the EMSU? Were you able to correlate that in your logs, a baffle that you could -- if you started 2 inches over here and you could follow it all the way over?

A. I did not map.

Q. And that's actually a question, in and of itself. I didn't find a single map you created in this entire case. Did you create one single map

through three statements, two of them you revise, and a deposition, and you being a geologist, is there one map you actually made here?

A. Well, the maps in my presentation were basically data posted at individual wells. But I did not contour a map around the EMSU.

Q. I know you took Ops Geologic's maps and contours, right?

A. Yes. I reviewed --

Q. Other than just adding some numbers to maps that other geologists made, you didn't make a single map here, did you?

A. Correct.

Q. And this is truly not a smart aleck question, but don't geologists, like Love creating -- isn't, like, the first thing you're doing is you're looking at the actual core and you're making maps?

A. Well, in the due diligence process, making maps, much like picking San Andres tops, kind of confuses the issue. I have enough maps and things to basically do diligence on and see if they're accurate, see if they make sense, and use their information.

Because a lot of times when I'm reviewing something, the other people have spent a lot more time looking at the environment, geologists, and

basically, I just want to confirm, validate and use whatever data I can from other experts.

Q. So the other experts here, you said they spent a lot more time doing the evaluation?

A. Correct.

Q. You didn't rely on any of Dr. Davidson's maps, did you?

A. I don't know if he made maps.

Q. I didn't see one. So to state it differently, you're not aware of a single map that Netherland, Sewell made here, are you?

A. Correct.

Q. And so if we just come back to the work, you like to rely on all the other work because they've done more work. That was your testimony a moment ago?

A. Correct.

Q. Here, that would be NuTech and Ops Geologic, wouldn't it be?

A. That was the data that I reviewed from a validation standpoint, yes.

Q. Now, as we continue to talk about the mapping, you were not able to map -- did you even try to map a particular baffle that would have gone across the EMSU, whether it's 2 inches thick or 400 feet thick?

A. No, I did not.

Q. And you can tell the Commission, though, based on looking at these logs, there is not going to be one single baffle that goes all the way across, is there?

A. I cannot say there is not.

Q. After all of your work here, if there was one to be found, do you think your work would have found that baffle?

A. Not necessarily.

Q. So I guess just...

A. I'm trying to answer it.

Q. No, no, I appreciate your cooperation. None of this is a fuss with you. I'm just trying to get my head around how, if you're the barrier guy and you're the geologist and you have all of these logs and we're talking about baffles or barriers, if there was one, why you didn't map it to bring it in here and show the commissioners?

A. Why I didn't map it. I guess the number of logs and the data that we have, even if we could map it between the points, there would be a lot of extrapolation where you don't have data or don't have quality data to actually have a high degree of confidence in the data.

Q. So basically what you're saying is, if you were going to try to map a baffle or a barrier that would go all the way across, there's too much uncertainty in your data to be able to do that and come in here and give an opinion to these commissioners?

A. For a single barrier, yes.

Q. Now, help me. If I'm understanding your report correctly, I didn't see that you really tied this back to logs or core at all. In terms of the idea of a baffle or barrier, it looked to me like you left geology and went to engineering and said that you observed mud losses. Is that fair?

A. That's probably fair.

Q. So if the Commission wants to know on this baffle or barrier testimony, is this geology or is this, like what you said in your report, you know, really what I saw documented were mud losses and so that's where my opinion lands, it would be fair to say this is more of an engineering mud loss type of opinion for these commissioners?

A. Yes. Integrating the geology and the engineering, I came to my professional opinion.

MR. WEHMEYER: May I approach to just show a demonstrative?

HEARING OFFICER HARWOOD: Approach the witness?

MR. WEHMEYER: I'm trying to honor decorum. Before I leave my place at Bar, I want to make sure I have permission to go get that board.

HEARING OFFICER HARWOOD: Sure. That's fine.

Do you need to move, Mr. Rankin, to see what Mr. Wehmeyer is pointing out? Feel free to do so.

BY MR. WEHMEYER:

Q. So I'm just going to kind of lay out what we've got. Can you see the black? Do you see the black line?

MR. RANKIN: Mr. Wehmeyer, just let me know what images we're looking at so I can understand what they are.

BY MR. WEHMEYER:

Q. We've got the SWD wells on here and we have numerous of the other deeper wells that -- conventional wells that have been drilled. And what we've got is a map by Ops Geologic, top of the Lower San Andres.

We've got purple. They've mapped in the purple, the mud losses. Because we've heard all about

the mud losses and how we know this is happening, right? You've heard that in here and we've read that 1,000 times, right?

A. Correct.

Q. Purple is the mud losses in the various wells that have been reported. Red is Ops Geologic's top of the San Andres. This brown is the Lovington Sand. Black is the Lower San Andres.

So are we oriented now in terms of -- I think really the easiest way is if you focus in on purple being those mud losses and the red being Ops Geologic's top of San Andres, and blue Goodnight's, what Preston McGuire got from somebody else. Blue would be the Goodnight top of San Andres.

A. Okay.

Q. Are you with me so far? Have you tired to, like, actually correlate this? As we talk about, well, it's explained by the loss of mud during drilling, have you tried to map where the loss of mud happened in relation to anybody's top of San Andres?

A. No. Just TVD subsea absolute value.

Q. And you can tell the commissioners here that purple is the loss of the drilling fluid that is all -- there is zero correlation between where fluid was lost and anybody -- the Lovington Sand, the top of

the San Andres, either side's top of the San Andres -- if you've got opinions about mud losses having some relevance here, can you explain to the Commission how that is based on the actual data?

A. Why there is mud loss?

Q. Yes. How does the mud loss, with the variable depths that this happened -- tell the Commission anything about whether there's communication between the San Andres and the Grayburg.

A. Again, I -- the tops, San Andres Grayburg, I think between negative 350 and negative 700, I've got significant indications of multiple permeability barriers that may not individually go across the entire EMSU. But individual reservoirs, even in the loss circulation, can be stratigraphically isolated.

Q. They might be stratigraphically isolated or they might not be, right?

A. They -- sure.

Q. And with respect to stratigraphic isolation, you've heard testimony about the baffles. You're not disputing as a matter of geology that there can be baffles within that might change pressures in isolated intervals, but that wouldn't extend across the EMSU, are you?

A. That wouldn't?

Q. Correct.

A. Could you state that again? I'm not sure --

Q. You're not disputing that in a particular well, there can be isolated areas of baffles that would not be extensive across the entire 14-acre EMSU?

A. Yes, that could be correct.

Q. And, again, I've heard so much about the mud. I told the guy, I said, "I've got to see it on one" -- "just show me, where is the mud happening so I can get my head around this."

Can you explain to the commissioners, if they go back and read your witness statements and it says, "I have opinions about potential flow barriers based on where mud was lost," by reference to this correlation or comparison across the log section, can you show them how that testimony is supported?

A. How it is -- I'm a little confused on the question.

Q. Yeah. And I -- on some days, I'm an okay lawyer. I'm a terrible geologist and engineer, I can tell you that. So help me if I'm just asking the bad question and I need to ask it differently.

But if the idea of your baffles are explained as a matter of engineering, which is what we just covered before I stood up here.

I said: If it's geology, let's see it mapped.

You said: I don't have that.

I said: Is it really more engineering?

You said: Yes, it's the mud losses.

I'm showing you the mud losses. I'm showing you what someone at Goodnight at some point in time felt was the top of San Andres, what Ops Geologic has mapped as the top of San Andres. And I've even put the Lower San Andres on here, too, and I've even given you the Lovington Sand.

Can you tell the commissioners, in your own testimony, how on earth does this support the idea that there is an impermeable barrier across the EMSU that would isolate injection from the Grayburg?

A. At one specific -- I'm not sure.

HEARING OFFICER HARWOOD: This would be a good place to break for lunch?

MR. RANKIN: Mr. Wehmeyer, I can't see it from where I'm sitting. Ms. Hardy, perhaps you guys can send us a copy of what we're looking at, because I just can't tell what we're looking at from this distance. And I wouldn't mind being able to look at it so I can prepare for redirect.

MR. WEHMEYER: Sure. And I should have

pointed this out. If this helps, A, it's over here on the very far -- so that there's no cherry-picking, A is on the very far western edge. A minus is over here at the southeast. We have some data points way out here east.

So as you track these, I will send the answer key --

MR. RANKIN: Mr. Hearing Officer, I'm not asking for Mr. Wehmeyer to testify. I'm just asking him to share the document with me so I can see it.

HEARING OFFICER HARWOOD: Why don't you guys do that over lunch.

Chairman Rozatos, what time is your pleasure for the Commission to be back?

CHAIR ROZATOS: Let's return back at 1:15. I think it will be a perfect time. And that will give them some time to also exchange information.

HEARING OFFICER HARWOOD: We'll break for lunch and be back at 115. Thank you.

(Lunch recess held from
12:01 to 1:19 p.m.)

HEARING OFFICER HARWOOD: All right. Let's see, where were we. Cross-examination, Mr. Wehmeyer.

MR. WEHMEYER: Thank you.

BY MR. WEHMEYER:

Q. When we left off at the break we were visiting on these various logs with the plots. I'm going to try to bring this up. The coloring is better electronically.

And what we've done here by way of demonstrative is attempt to show across the EMSU the alleged mud losses against Goodnight's top of San Andres, Empire's top of San Andres. We've also mapped here the Lovington Sand in brown.

So, again, to just orient here by way of the colors, the purple is the mud losses and drilling that are reported. The purple along the bottom, can you see that?

A. Yeah.

Q. You're welcome to refer to the hard copy. I don't think I can zoom in on this. I'm going to try.

A. I think the one that you previously mentioned was the loss circulation zones.

Q. Yes, that was the purple, is what I'm getting at.

A. You called that purple.

Q. In terms of actually doing your work here, did you ever actually go in and plot well by well where the alleged circulation loses occurred?

A. I did have that in spreadsheet form and

reviewed the drilling reports to see where those occurred.

Q. With respect to the Andre Dawson, do you see that would have actually occurred above everybody's pick of the San Andres?

A. Yes.

Q. Again, just in terms of the idea that any barrier, if it's based on mud losses, would be isolating injection in the Lower San Andres and the Grayburg, in light of the Andre Dawson well there with the mud loss, alleged loss circulation, can you explain how that would work as a barrier in that location?

A. Yeah. Loss circulation is where you have a change in the reservoir, the pressure differential, indicating that you have a barrier on top and a barrier on bottom. And specifically in the Dawson well, that was a very minor volume of loss circulation. And later on, they had some significant loss in variation down in where most of the other wells also lost their circulation.

So I think each one of these loss circulations, the top of those is a distinct permeability barrier from everything above it.

Q. But, again, in terms -- have you made any

effort to go back and look at the actual logs against the loss circulation to try to make a correlation or distinction there?

A. Very minor. It wasn't blatantly obvious that there was a large porosity differential. But the pressure and the loss of a significant amount of fluid indicates that it is actually a significant permeability barrier.

Q. And, again, I'm just trying to understand. Can you talk us through, with this data on -- well, strike that. The first question is, have you gone well by well where Goodnight alleges circulation losses and tried to correlate that to the porosity and permeability interpretations of Netherland, Sewell to somehow tie those together?

A. Yes. I looked at that.

Q. Did you create any actual work product as part of that effort?

A. No.

Q. So if the Commission wanted to see that rock product, that doesn't exist. True?

A. Not in my testimony, no.

Q. You talked about secondary authorities earlier. As we talked about the producing oil-water contact, as I understand it, you had some critiques of

Dr. Buchwalter's material balance simulation?

A. Yes.

Q. And what's --

A. Disagreements.

Q. Let's talk about the producing oil-water contact. Are you aware that the producing oil-water contact actually was lowered from 350 feet to about 500 -- strike that. Are you aware that the producing oil-water contact lowered from 300 feet to about 540, 550 feet?

A. I don't understand. I mean -- yeah, you'll have to explain a little more.

Q. Do you know this within the Grayburg, the producing oil-water contact actually lowered with production, that it moved deeper subsea?

A. In the EMSU?

Q. Yes.

A. No.

Q. If the producing oil-water contact lowers by 200-plus feet, what would that do to the water in the Grayburg?

A. I'm not sure I understand the question. If --

Q. If the producing oil-water contact lowers through production of the Grayburg -- are you with me

so far?

A. I don't understand that concept, where that would happen.

Q. In terms of the producing oil-water contact.

A. So you had an oil-water contact?

Q. Yes.

A. And you produced oil?

Q. And it goes down.

A. And it goes down?

Q. Yes.

A. Yeah, I'm not sure how that physically happens. Ask a question.

Q. And I'm probably asking the question incorrectly here. Are you aware of the oil-water contact in the EMSU ever lowering?

A. No.

Q. If it did lower, what would that do to water in the Grayburg?

A. I don't know how to answer that.

Q. So just looking at this Chevron paper from 1989, EMSU Grayburg estimated oil-water contact at 550 subsea. Where is your producing oil-water contact based on your work?

A. 350.

Q. So that would be off by 200 feet from what

Chevron is writing about in 1989, correct?

A. Yeah. I have seen no evidence at all of a producing oil-water contact below 350 feet TVD subsea.

Q. So the additional drilling of new wells after the '80s couldn't lower that oil-water contact?

A. I don't see how that would physically be possible. I believe in gravity.

Q. With respect to the secondary authorities we were visiting on earlier, the 1996 Chevron paper that I mentioned, was this part of anything you reviewed in your literature search in terms of trying to identify literature that would have spoken to communication between the San Andres and the Grayburg?

A. I don't believe I reviewed this. Is this an exhibit?

Q. Exhibit I-7. You've never seen this before?

A. I've seen the exhibit, but reviewing the paper, I'm not sure.

Q. Okay. According to you, this is not literature that would indicate that there was communication between the San Andres and the Grayburg at EMSU?

A. I would have to remember this. I would have to reread that and come to a conclusion.

Q. You haven't done that as part of your

barrier work in this case?

A. I may have reviewed this. But I definitely didn't come to a conclusion that there was any communication between the San Andres and the Grayburg.

Q. Here's another Chevron paper. A portion of the water production is probably attributable to communications of Zones 4 and 5 with the Lower Grayburg and San Andres aquifers. Although siliclastics between each zone generally prevent vertical communication in some localized areas of the field, they do not act as permeability barriers. When the barriers break down in the Lower Grayburg members, the prolific San Andres aquifer can influx into the oil productive horizons, resulting in large volumes of water production.

Did you read this as part of your literature search before coming in with barrier opinions?

A. I did read this, yes.

Q. Why does this not satisfy you that authors had already written about communication?

A. This was represented in the AGU, not the EMSU.

Q. It actually comes out of the Technical Committee Report from 1983, yes, on the EMSU?

A. I do not -- I see the Technical Committee Report of the Arrowhead Grayburg Lea unit on this.

Q. Can you explain as a matter of geology why communication would occur between the Grayburg in the San Andres and the AGU but not in the EMSU?

A. It's a different geologic setting.

Q. With respect to the critiques of Dr. Buchwalter's model, isn't it the position of Goodnight and its experts that Dr. Buchwalter should have mapped the entire east half of New Mexico and about half of Texas, too, as part of the simulation?

A. I have no clue.

Q. In terms of the critiques of Dr. Buchwalter and how big his simulation model should have expanded geographically is not something you've looked at?

A. I've reviewed his model and have some criticisms of it. I don't know that that specific thing represents my opinion.

Q. As we continue to talk about literature, I asked you earlier about Ph.D.s and papers written by Dr. Lindsay. Here, he's talking on the Arrowhead Grayburg. And do you see the areas where he indicates bottom water?

A. Yes. I see where he picks that out.

Q. Was this part of your literature search?

A. I did review this.

Q. And this isn't good enough for you to indicate, as a matter of geology, that there would be communication between the Grayburg and the San Andres?

A. Absolutely not.

Q. Were you in here for Dr. Lindsay's testimony?

A. Yes.

Q. An additional paper written by Dr. Lindsay: Evidence of communication between San Andres and the Grayburg here, and a few well locations in Arrowhead. There was a problem with the Upper San Andres Formation bottom water production that ascended up into the Grayburg strata via vertical plumes of water along swarms of narrow, short space, fractures.

And then at Page 1004: These plumes of vertically oriented Upper San Andres Formation bottom water only affected small areas in the unit and in most cases, only affected one well, though mapped as though it was affecting a larger area.

Similar vertically oriented plumes of Upper San Andres Formation water were also encountered in individual wells further north in Eunice Monument South Unit, EMSU, and EMSU-B.

Was this part of your literature search?

A. Yes.

Q. And this wasn't good enough for you either?

A. I had a different explanation that I think is more reasonably geologically based.

Q. From Dr. Lindsay?

A. Correct.

Q. I'm going to try to get over to your slide presentation now. Actually, I shall show this real quick before we leave this.

We've also prepared a demonstrative from an aerial perspective plotting the Goodnight top of San Andres against the Empire top of San Andres against the pressure losses. Have you done any work like this to try to compare where the tops against where are the alleged loss circulation events?

A. No.

Q. In terms of the geology here, I'm at your Slide 2 -- and actually, I just want the Commission to know what work you did versus didn't do.

Here at Slide 1, you did not create this, did you? This was somebody else?

A. I pushed the buttons to create that, yes.

Q. Where did you get this?

A. This was created out of Drilling Info, or now Enverus.

Q. That was a map from Drilling Info?

A. Yes.

Q. The second slide with the geology, you didn't create this either?

A. No.

Q. In terms of the idea of migration pathways, if this was really a migration pathway, how could oil have gotten into these little tiny pores with low permeability? If this was a failed migration pathway, how did that oil saturate long enough to get into these little tiny pores in incredibly low permeability situations?

A. Well, the alleged hydrocarbon that might be in those pores, I'm not sure I can explain how that got there. But the migration pathways of oil generated from the Wolfcamp and migrating through the entire system is very complicated, so...

Q. Did any of the oil in the Grayburg come from the Wolfcamp, or you don't know?

A. I would assume that that also came from the Wolfcamp.

Q. Would it have passed through the San Andres, or you don't know?

A. I'm assuming it would have passed through the Grayburg in horizontal migration paths.

Q. No, my question is, how does it get from the Wolfcamp to the Grayburg? Did it go through the San Andres?

A. Complicated migration paths. I do not believe it had to go through the San Andres.

Q. No, my question here is a matter of scientific probability. Did it go through the San Andres?

A. The oil that's in the Grayburg, I don't believe so.

Q. Can you explain to the Commission how, with scientific probability, the oil got from the Wolfcamp to the Grayburg, or you don't know?

A. I do not know.

Q. I'll move over to your rebuttal. Actually, this is the original testimony.

I have a question at Slide 5. As we talk about geology, did you do any rock outcrop work in this case? Did you look at any rock outcrops?

A. No.

Q. You know that Dr. Lindsay and Dr. Trentham both have done rock outcrop studies as part of studying this area?

A. Yes.

Q. Now, wouldn't evaluation of the rock outcrop

study be useful to identifying the rock facies within the facies model here in the EMSU that Dr. Davidson used?

A. I did not do anything with facies, and none of my analysis had facies.

Q. You know that Dr. Davidson did, right?

A. Correct.

Q. And in terms of all of the petrophysical analysis that you used then to calculate oil in place, that all came from Dr. Davidson in his facies model?

A. Correct.

Q. Doesn't that give you concern, as a geologist, that your work is derivative and 100 percent relying upon what was done by Dr. Davidson, and he didn't look at any outcrop and didn't actually study the core, describe the core before putting together a model that was 100 percent predicated on facies?

A. What was the question there?

Q. With you relying on that data, and, again, all of your outputs -- so the Commission understands, if we move and now start talking about oil in place, 100 percent of your work is dependent on the petrophysical work done by Dr. Davidson. True?

A. I reviewed Dr. Davidson's and everyone

else's petrophysical analysis, so I incorporated all of that data. And trying to validate data, I think -- actual physical data contradicts most of those petrophysical analyses except Dr. Davidson's. So in validating his model, his facies model, however he interpreted it, seemed to match the actual physical data. So I think I validated Dr. Davidson's model as being the most accurate of any of the ones that I was presented.

Q. Matched what actual data?

A. The core data.

Q. But you didn't describe or study the core, and you never looked at either it -- and you didn't look at the RR Bell core at all, did you?

A. No. What you do is you correlate to the actual quantitative data, the measurements form the core data, the oil saturations and the porosities, much like the other petrophysical analyses either should have done or tried to do.

Q. But if you're working off of a -- if you've chosen at the petrophysical level to base all of your work off of a facies model, the geology is all the more important in terms of actually looking and describing the core and studying rock outcrops, so that you know what rock do I actually have in this

particular environment?

A. I would say no. The actual validation of the petrophysical model is comparing it to the actual physical data that you have. And if it doesn't match that, you can't use it. And if it does match it, that's a more valid analysis.

Q. What physical data did you have in the 679 well beneath the core?

A. We had none.

Q. Now, coming back, I just want to make sure we've got this in the bumpers. With respect to your work, now you mentioned that you looked at NuTech and you looked at Ops Geologic. But in terms of your calculation of original oil in place that you've offered testimony, written and verbal, to this Commission over, that was all derivatives off of what Dr. Davidson did?

A. Correct.

Q. So I understand that you now say: Well, I looked and criticized Ops Geologic, I looked and I criticized NuTech.

But so there's no vagueness here, if Dr. Davidson's work, petrophysical work, is wrong, then your oil-in-place values are incorrect. True?

A. Well, I would say all of interpretations of

anything aren't wrong. It's a most likely realistic case, and there could be sensitivities around there. But like anything, making a statement of 100 percent factual, this is the actual answer, I can't say that.

But I can say from my professional opinion, that Dr. Davidson's is the most reliable, most likely case of oil in place in the EMSU within the depth intervals that I evaluated.

Q. I've forgotten my question now, but I don't think that was an answer to it. I'm just trying to take this down into pieces so we understand.

So you're saying all of the petrophysical work by everybody is wrong, right? You're saying, it's a matter of how wrong?

A. I'm saying that I looked at all the analyses and I compared it to the actual physical data, and there was a large discrepancy in most of the analyses. The one that was closest to, which I also said that I think he may have overestimated oil in place also, was Dr. Davidson's. So I used that as an indication of the oil in place and the potential recoveries of the oil in these intervals.

Q. Well, you were off by a factor of 100 percent, just because you didn't know how to read the data, right?

MR. RANKIN: Objections. Badgering the witness.

HEARING OFFICER HARWOOD: It's argumentative. Rephrase or withdraw.

BY MR. WEHMEYER:

Q. I mean, it's a real question. When you talk about it's a matter of, you know, who's accurate, who is not accurate, and that you've somehow looked at all this and you're the final say on it. I mean, literally, in terms of the data you looked at, you swore under oath to this Commission and put your seal on an opinion that you've said is off by over 100 percent?

A. Correct.

MR. RANKIN: Objection. Mr. Knights testified that he identified and corrected the record.

HEARING OFFICER HARWOOD: It has been asked and answered.

BY MR. WEHMEYER:

Q. Let me try to see if I have these steps right on what happened.

Do you remember you came up with the original saturation of 30 percent, was what you wanted to use?

A. 30 percent cutoff, yes.

Q. And that was back when you were off by the factor -- just in timing on these errors, that was when you were off by 100 percent because you misread the intervals?

A. Yes. The paper submitted was 100 percent wrong.

Q. And we visited before the break on why did you change it, and you said: Well, I did what everybody else, the rest of the club was doing. I think was the phrase you had.

Is the real reason you moved the 30 percent to 20 percent is because you had already had the volumes crammed down so low, when you realized the 100 percent mistake, you had to chop it in half, and then the 30 percent was an effort to just add some volumes back so that you didn't get laughed out of this hearing?

MR. RANKIN: Objection. Argumentative.

HEARING OFFICER HARWOOD: It is argumentative. I'll sustain it.

BY MR. WEHMEYER:

Q. Was part of the reason that you went from 20 percent saturation to 30 percent saturation because now you realize, oh, no, I have to chop my oil in half

because I read the depth interval wrong?

A. No.

Q. But, again, just before we leave this, so that the Commission understands, all of your outputs that you did not amalgamate from NuTech and Ops Geologic and Dr. Davidson, and take the best of the three, you threw out Ops Geologic, you threw out NuTech, all of your work is a 100 percent derivative of what Dr. Davidson did?

A. Correct.

Q. And you know he chose the facies model. He had all sorts of different models he could have adopted. He chose the facies model?

A. I believe so, yes.

Q. Rock facies is a concept of geology. This is lithology. This is something that's happening 4400 feet beneath the surface of the Earth?

A. Correct.

Q. So I'm just asking you, as a geologist, where all of your work and your oil-in-place volumes is dependent on Dr. Davidson, and he chose a facies model, and he didn't describe the core, he didn't look at the core, he did use the RR Bell core, he didn't do a rock outcrop study, that doesn't give you concern?

A. Not at all. Basically, when you look at an

analysis, you don't decide how they did it. But you validate it on the results. And Jim Davidson matched the core better on five offset the wells that he blind tested and corroborated the information on each of those other fields.

I really enjoyed the Seminole one, where he showed that the swept zone has been CO2 flooded for 40 years, still had between 15 and 25 percent residual oil zone saturation, indicating that a residual oil saturation matched his volume metric estimates.

And I think all those validation points pointed to Dr. Davidson as the most accurate analysis that I had at the time.

Q. You talked about sensitivities a moment ago. Did you run a sensitivities analysis?

A. In my summary, I've done sensitivity analyses in my head basically using the net pay scenarios that I use for the 4, 7 and 10 percent porosity. And I showed percentage-wise how that would have affected the oil in place in the EMSU and also how it broke down the reservoir quality on how much was really high quality, medium quality and low quality. And so I ran those scenarios.

Q. So the question is, did you run or perform here a sensitivity analysis that you would put the

Netherland, Sewell stamp on as a sensitivity analysis? Yes or no?

A. I ran -- well, yes.

Q. Where do we find that in your papers?

A. The slide that has the Ops permeability, the different porosity cutoffs, those variations.

Q. Where you reported Ops' volumes?

A. Correct. Their net pay analysis. That was based on a porosity cutoff, which, in fact, all four of the -- or five of the petrophysical analyses had a very similar porosity. And so using that, I didn't feel I had to do a separate porosity net pay analysis for each of the things.

But those percentages were probably equivalent for each of the sensitivities. So we had 30 percent of rock and very high quality greater than 10 percent. We had another third of the rock that's medium at 1 millidarcy and above. And then you had another third using the Ops Geologic model at about 4 percent porosity. By their porosity calculations, that was basically another third of the rock.

Q. And I truly don't know this. Did you discuss sensitivity analysis anywhere in here, or is this something you said you did in your head?

A. I did not have a writing of a sensitivity

analysis.

Q. So if the commissioners want to see a sensitivity analysis, they're not going to find that in any of your written statement, are they?

A. They can look at the net pay analysis that I had in my summary comments that shows that I had a 4 and a half, 7 and 10 percent as different levels of quality of rock defined in the reservoir.

Q. With respect to that sensitivity analysis that you now testified to that you performed, you said Ops Geologic was part of that analysis?

A. Part of the analysis?

Q. Of the sensitivity -- their 4 percent porosity would be part of your sensitivity analysis?

A. Yes. I showed what their volume differences would have been from a net pay consideration using different porosity cutoffs. Because they had a tendency to just use saturation as a cutoff. As an industry standard, the most common use of net pay scenarios is to use a permeability related to a porosity cutoff to define reservoir quality.

Q. Even in an instance here, where porosity and permeability do not directly track with one another and there's variability in porosity with permeability?

A. Correct.

Q. Now, with respect to Ops Geologic on the sensitivity analysis, ultimately, does that land at their volumes? When you say you performed a sensitivity in your head --

A. Their maps were their 100 percent volumes.

Q. Okay.

A. And if I used a 7 percent, that would be reduced by another 32 percent. And if I used 10 percent, that would be reduced by another 30 percent.

So, basically, on the Ops Geologic model, I have a third of their rock is very high quality, high porosity; a third of their rock is medium, and basically that was Jim Davidson's cutoff that he used; and then Ops Geologic has another third of their oil in place in the low porosity that is relatively lower quality, low porosity, based on a porosity cutoff. And that's where most of their oil is, in the low porosity.

Q. And so I'm just trying to get back to -- as you talk about the sensitivity analysis that you said you ran in your head, is Ops Geologic then in that analysis -- I mean, you just testified, you said: That's part of my sensitivity. Right?

A. Correct.

Q. Would that be the high case?

A. It would be an unrealistically high case, yes.

Q. But you said you used that for your sensitivity analysis here. Correct?

A. I used that as a porosity to get to a net pay distribution. I'm not sure of the question.

Q. And so to the extent that you're -- in a sensitivity analysis, would Ops Geologic then be your high case?

A. No.

Q. What would be your high case in the sensitivity?

A. At the moment, it would be some kind of distribution around Dr. Davidson's oil in place.

Q. Where would we see that in either your handouts or your written testimony?

A. You do not have that.

Q. So I'm just trying to take this in pieces. On the sensitivity, what I have in my mind as an lawyer, not a scientist, there's going to be a high case and a low case, right?

A. Yes.

Q. And a middle case?

A. Yes.

Q. I asked you: Did you run a sensitivity?

And you eventually said you did.

And I said: What is your sensitivity?

And you said: Ops Geologic and Dr. Davidson.

I mean, is it that simple?

A. No, it's not that simple.

Q. What would, then, be the high case in your sensitivity that you ran?

A. There's just not enough data to be comfortable with a high side case. I mean, right now, the most likely case is Dr. Davidson's and some semblance of distribution around that. Right now, if I had to do it off the top of my head, I'd say 10 percent up and 10 percent down.

Q. You said off of Dr. Davidson's, and I'm not going to continue to beat the horse about the facies model, but did you actually discuss in your original testimony, actually, your original testimony, a 4 percent porosity cutoff?

A. Could you ask that question again?

Q. Did you originally start this project at a 4 percent cutoff, 4 percent porosity?

A. I don't understand did I start the process. I was using whatever was provided to me. So Ops used, I think, 4 percent effective porosity as their cutoff.

Jim Davidson used a 7 percent effective porosity for his cutoff. To tell you the truth, I don't remember what NuTech used.

Q. So I'm in your rebuttal report, and I'm going to try to zoom in, because I want you to explain what this is and why this is.

Do you see the paragraph that begins, "In NSAI's analysis of oil saturation"?

A. Yes.

Q. So NSAI, that's you and your company, right?

A. Yes.

Q. NSAI, that would also be Dr. Davidson, right?

A. Correct.

Q. "We used a consistent porosity cutoff of 4 percent to evaluate the reasonableness of the three petrophysical models to conduct an empirical analysis."

Why did you use a 4 percent porosity cutoff?

A. For consistency. So I was doing a variation on oil saturation. And so if I used a consistent oil saturation but an inconsistent porosity, all these petrophysical analyses couldn't be compared appropriately.

So I took all the lowest porosity that somebody used as 4 percent on Ops. I said, okay, let's just use that as a common porosity cutoff so that I am just looking at the variability of saturations.

Q. I'm now moving over to your original report. As we come back to this concept of facies, which is what Dr. Davidson's work is based off of, there was a lot of discussion yesterday on shallow water environment versus deep water environment.

You say here, "Oil entered the San Andres Aquifer and migrated through a complicated porosity system to create several isolated reservoirs with varying compositions of salinity and hydrocarbon saturations. These include both mobile oil and productive fields across the CBP and residual oil scattered along the migration pathways."

I'm actually at the wrong spot. Sorry about that. Here we go. This is what I wanted to focus on. And for reference, this is out of your revised original report. "The EMSU is located along the northwestern edge of the CBP, as shown in Figure 1. The unit is composed of the producing Grayburg Reservoir and the underlying San Andres Aquifer."

And, again, in the testimony, we've had

great difficulty today on -- you said you don't know what San Andres is, you don't know what Grayburg is. But when the commissioners go back and read these reports, they're going to see that you speak of San Andres and Grayburg all over the place, don't you?

A. Probably it's inconsistent. My definition of San Andres, I tried to be consistent at relating it to the Goodnight injection interval, which some of the people call the Lower San Andres.

Q. If I take the tops off of the various logs here and just ask you to show the Commission, I have some logs that don't have tops on them, to show them where, according to you, in that particular log the San Andres is versus the Grayburg, would you be able to do that?

A. Not particularly well. Or I could do it as inconsistently as everybody else. But what I could do is define the top of the Lower San Andres, where the Goodnight injection level is, at basically some of the tops of the major loss circulation zones. Because I think that is a definitive indication of a significantly different reservoir quality in size and component that is isolated and separate and different from shallower reservoirs.

Q. I'm just showing you off of the plot here

that's at Figure 4 that the loss circulation zones are all over the place. You are not going to testify that wherever there's a loss circulation zone, that that becomes the San Andres and Grayburg, are you?

A. No. It's a perm barrier and it creates separate reservoirs.

Q. My question was, San Andres versus Grayburg, you said you would go to where the mud losses are, you're not telling the OCC that it's your geology opinion that you would pick San Andres Formation from Grayburg Formation based on wherever the mud loss occurred, is it?

A. Again, anyone that uses a formation as a nomenclature, it's very arbitrary. I use depths and reservoir quality.

And the reservoir quality in the Lower San Andres is distinctly determined by, number one, the loss circulation zone, but then, again, the water supply wells that show it has a tremendous permeability and a large, significantly large, aquifer. And then the water injection that shows a significant amount of water that's injected at very high permeabilities with very little pressure changes, which also indicates it's a very large aquifer.

Q. Would you agree with me that the San Andres

and the Grayburg are all in the EMSU -- those are both in the EMSU, right?

A. They are both, yes.

Q. And the unit interval is all of the Grayburg and all of the San Andres, correct?

A. I think so, yes.

Q. So coming back to Page 5 of your original report, "These formations were deposited in typical marine and restricted-marine environments, with most of the EMSU deposition occurring in a predominantly shallow-water carbonate ramp environment." I read that correctly?

A. Correct.

Q. Is that still your opinion?

A. Yes. It's a little indistinctive because it doesn't supply the actual depths. But for the significant other shallow waters in the Grayburg, actually the producing interval.

Q. So if we just took one of these logs as an example, take that one, where is the Upper San Andres and where is the Lower San Andres?

A. Well, from the preponderance of data, I would suggest that the top is somewhere equivalent to the large loss circulations that we have across this in probably eight of the eleven wells. So probably

somewhere there.

Q. If you're picking off of the loss circulation intervals, you can tell the Commission that the depth of formation is going to change by hundreds of feet, isn't it?

A. I don't think so. I think most of them are around negative 700 feet at the top of where the major loss circulation and injection zones are. Both of those indicate that it's a large aquifer from a permeability standpoint and uniquely different than any of the overlying Grayburg or the Upper San Andres reservoirs above that Jim Davidson's either high gamma ray or that negative 500 or negative 700 feet, which I define as kind of demilitarized zone, that I think most of the perm barriers within that separate the two reservoirs, and everything above negative 500 is completely separate and just --

Q. So your testimony is that the loss events are happening at 700 feet subsea?

A. Approximately that depth. Maybe a little different.

Q. I have this plotted here at subsea. And based on the actual data, I'd like you now to explain -- and here, I'll give you the legend. The green is going to be mud loss depth. Can you help me

with how this would look like 700 feet subsea?

So we have the EMSU 628. That one is at 139 feet. We have the Ernie Banks. That one is at 970 feet.

A. What are the three numbers?

Q. We have the EMSU 713. That's at 933 feet.

I'm just trying to understand where -- how are you saying these all happened at 700 feet subsea?

MR. RANKIN: Mr. Hearing Officer, I'm confused by what I'm seeing on the screen. I don't know what these numbers are or where they came from, who created this document.

So I guess I would object to it being used for cross-examination because I don't know what any of these numbers are or where they came from.

HEARING OFFICER HARWOOD: More foundation, Mr. Wehmeyer.

BY MR. WEHMEYER:

Q. Have you ever tried to actually place on a map or a plat well by well where the actual subsea depths are in each of the wells that are under study here, the loss circulation?

A. The loss circulation zone on a map?

Q. Yeah.

A. I believe I have.

Q. So, again, you're the one that started with 700 subsea feet. If the data is that in the EMSU 628, the loss occurred at 1,039 feet, we can agree that that is not 700 feet, right?

A. Correct.

Q. If the SWD N 11-1, the loss circulation was at 1,051 subsea, that is not 700 feet, is it?

A. Correct.

Q. In the EMSU 713, if it happens at 932 subsea, that's not 700 feet, is it?

A. Yes. If, yes.

Q. In the Ernie Banks SWD, if it is lost at 970, that's not 700 feet, is it?

A. Correct.

Q. If in the 1028 it happens at 1,013, that's not 700 feet, is it?

A. Correct.

Q. In the Nolan Ryan, if it's 1,043, that's not 700 feet, is it?

A. They're all below 700 feet.

Q. So, again, the idea that we would choose the place of loss of circulation, what happened to define San Andres versus Grayburg, in terms of being able to correlate that across this field, there's no way to do

that, is there?

A. You wouldn't use one piece of data to define a reservoir.

Q. So you would agree that if you're picking tops off of just circulation loss, that would not be a valid scientific basis or engineering basis to pick?

A. That data only, no.

Q. Now, coming back to your paper. So we're back to your paper here at Page 5, "These formations were deposited in typical marine and restricted-marine environments, with most of the EMSU deposition occurring in a predominantly shallow-water carbonate ramp environment."

First, do you stand by that testimony that EMSU is predominantly shallow water?

A. Yes.

Q. Have you done any work here to show where shallow water would transition, if at all, to deep water?

A. No.

Q. So the best we have is that after your geology work, the EMSU is predominantly shallow water? And if the Commission wanted to know anywhere not shallow water, nothing you have an opinion on or anything you've done as a matter of geology. True?

A. Predominantly, yes.

Q. Now, tell the Commission about the importance of being in a -- the EMSU and San Andres being in a shallow water environment. What does that mean about rock type?

A. It's very variable and generally thinner deposits.

Q. You would expect less mud in that environment, wouldn't you?

A. Yes.

Q. You would expect more oil in that environment, wouldn't you, in a high energy -- in a higher energy shallow water environment as compared to low energy deep water environment?

A. There would be -- yeah, there would be higher porosity.

Q. Which, in this instance, would equate to more oil in place?

A. Yes, above the oil-water contact, it should.

Q. Now, as we visit on rock facies, if you're shallow water, you would be more grain dominated and less mud dominated, wouldn't you?

A. You would be more likely to be more grain dominated versus mud dominated.

Q. Now, we've talked about how much depth we

have of 679 core in the EMSU. If we're below that, and you're talking about rock properties off of the log, you're going to need a spectral gamma, aren't you?

A. Spectral gamma is very useful.

Q. Because that's the only way that you're going to be able to tell am I looking at thorium, is this gamma reacting to potassium, is it reacting to uranium. Yes?

A. Yes.

Q. In this instance, did you have any spectral gamma whatsoever within the EMSU boundaries?

A. Not within the boundaries of the EMSU.

Q. And so, again, coming back to your work being based off of Dr. Davidson's, does it give you concern as a geologist that a facies model was developed in a shallow water environment in which rock typing was picked without having any spectral gamma to differentiate out of uranium, thorium or potassium?

A. Well, we did have spectral gamma rays in nearby offset wells to the southeast and to the north that were used in my evaluation to indicate that those were actually uranium. And I think extrapolating that over the EMSU is a reasonable geologic assumption.

Q. How far away were those wells?

A. I'd say maybe two, three miles.

Q. Would the rock outcrop study be more valuable?

A. A hundred miles away, no.

Q. As we talk about uncertainty in this particular instance, would you give me that in terms of picking rock types here, in the absence of core, in the absence of spectral gamma, that certainly reasonable folks could disagree over one level of rock quality picked? For example, moving from a wackestone to a mud dominated packstone or a mud dominated packstone to a grain dominated packstone, that there could at least be one facies of rock change reasonable uncertainty there that you could move?

A. I guarantee that some people would call things differently, much like the nomenclature of the top of the San Andres.

Q. I'm not fussing with you, but is that a yes?

A. Yes.

Q. And in this instance, if all you did was move over Dr. Davidson's rock facies and assume a level of one better rock type -- are you with me so far in the assumption?

A. Mm-hmm.

Q. -- that you then move to oil saturations

that look very similar to the ones prepared by Ops Geologic and NuTech, don't you?

A. I'm not sure that's the case. But if it would be the case, then those would contradict the actual core data in the rest of the model. So I would go to Jim Davidson and say, "This model is not working."

Q. If you'll listen to my question.

A. Okay. Sorry.

Q. We've already covered that you can agree that reasonable minds, reasonable science minds, could disagree here about one level of rock type. There's at least that amount of uncertainty here, according to you.

A. Okay. I'll go with that assumption.

Q. And here, if you move Dr. Davidson's rock type over by just one level, do you know how closely that would compare to what Ops Geologic did?

A. No.

Q. Would you expect it to look very similar to what Ops Geologic did?

A. No.

Q. Why?

A. Because the oil in place numbers were dramatically higher than I would have expected

relative to the core data.

Q. Well, you mention core, and we know we don't have core deep into the Lower San Andres.

A. Right.

Q. But with respect to the core, you understand that Ops Geologic actually made corrections to eliminate certain of the core plots because it would have led to an unreasonable n value?

A. I think I'm aware of that, yes.

Q. And in terms of just fussing with Ops Geologic, if we looked at the n value -- I understand that Dr. Davidson wouldn't agree he'd arrived at an n value. But some of his plots were all the way over to 10 on his n value. If you looked at his analysis and where it fell on the plots --

MR. RANKIN: Objection. Mr. Wehmeyer is testifying.

HEARING OFFICER HARWOOD: Let's hear the end of the question first.

Mr. Wehmeyer, in the interest of maybe saving time, how about rephrasing it?

MR. WEHMEYER: Absolutely. And I think we're on the same page. I apologize for the long question. I'll strike that.

BY MR. WEHMEYER:

Q. So the question is, I understand that Dr. Davidson didn't use an Archie's equation, right?

A. Mm-hmm.

Q. So he didn't do m and n values, did he?

A. No.

Q. Ops Geologic chose a modified Archie's equation, with a variable m and n. Yes?

A. Correct.

Q. Have you seen that done in the petrophysical world?

A. Yes.

Q. So in terms of them varying m and n on a modified Archie's, this is not something crazy?

A. No.

Q. Scott Birkhead isn't a nut? This is something that's --

A. Shortcut.

Q. Okay. Now, with Dr. Davidson's work, even though he didn't use an m and n, you can't determine what the m and the n would be off of his plots and work, can you?

A. Dr. Davidson couldn't.

Q. And, in fact, some of those n values reach all the way to 10, don't they?

A. I do not know, but that would not surprise

me.

Q. Which would be even higher than the n value used by Ops Geologic, which got to about 9 in certain places?

A. I assume that's correct.

Q. Did you do a study of the critical water saturation, basically a look at how much water can even move if the Netherland, Sewell analysis is correct?

A. I did not do a study, no.

Q. So in terms of telling the Commission about what percentage of your water saturations would be critical or irreducible, that's not something you've done, not something --

A. No.

Q. -- you would be able to talk about?

A. Well, I mean, I'm exposed to residual oil saturations and residual water saturations just in the industry, but not specifically here.

Q. So if they wanted to know, based on the majority of Dr. Davidson's rock typing, how much of that water -- and those water saturations, they go up over -- they immediately go to 92 percent, don't they?

A. Yes.

Q. And so just by choosing that rock type and

that facies model, you can't get more than 8 percent oil into the model simply as a matter of rock typing; isn't that right?

A. That's probably correct.

Q. So you pick the rock type. So just based on rock type -- and, again, no spectral, no core, we know we've got -- you've looked at -- at least 92 percent immediately has to be water?

MR. RANKIN: Objection. Mischaracterizing the testimony. Mr. Knights testified that they did have spectral and they did use spectral in their analysis.

HEARING OFFICER HARWOOD: Overruled.

BY MR. WEHMEYER:

Q. Do you want me to reask it?

A. Yes, please.

Q. Yeah, no, it's an interruption. I totally get it.

So you've looked enough at Dr. Davidson's facies model. You know that based on the rock type he selects for the majority of the Lower San Andres reservoir formation, that just by the rock type, it only allows a maximum of 8 percent oil in because it's going to put at least 92 percent saturation into it, isn't it?

MR. RANKIN: Objection. Mischaracterizes the testimony of Dr. Davidson.

HEARING OFFICER HARWOOD: Overruled.

A. Looking at that Sc chart, some of those curves, where they hit the very high resistivity index, I think those lower values to the right may be in that 7 to 8 percent. So if that was the lithology that was defined, then that would be a maximum saturation.

Q. Right. And the people that define lithology would be geologists, right?

A. Correct.

Q. And Dr. Davidson is not a geologist?

A. Well, I would amend that. Geologist petrophysicist. Because petrophysicists distinctly do more lithology work than I do.

Q. Did he do any lithology work here?

A. Using log characteristics, yes.

Q. Log characteristics off of triple combo, which really -- again, just in terms of keeping credibility with this Commission, doesn't it all just come back to his gamma ray reading? If the gamma ray spikes, he says this is non-reservoir?

A. That was a significant data input into his analysis, yes.

Q. So as soon as the gamma ray spikes, it immediately becomes non-reservoir, and practical matter, just making this simple, at that point you're going to have 92 percent plus water saturation, you can't put in more than 8 percent oil. True?

A. On some of those curves, that is correct.

Q. As we talk about some of those curves, the majority of the rock in the Lower San Andres that he's chosen would be wackestone or worse?

MR. RANKIN: Objection. Mischaracterizes the evidence. Dr. Davidson testified that he didn't use wackestone in his model.

HEARING OFFICER HARWOOD: Do you have more foundation? Maybe something to show him or refer him to specifically?

MR. WEHMEYER: Mr. Knights and I are on the same page. He knows where these rock types end up.

BY MR. WEHMEYER:

Q. You know where the -- you've looked at the facies model in terms of what rock -- you want to know as a geologist, what rocks is Dr. Davidson giving me here? Right?

A. Well, basically, I don't really care what rocks they are. I look at the results of the analysis. And I compare it to the actual hard-core

data that I have and see if that makes sense or seems reasonable.

Q. What hard-core data did you have in the EMSU?

A. For the EMSU, the 679 core data. And in the Grayburg, I had a lot of production data.

Q. Now, the Grayburg, that was produced conventionally.

A. Correct.

Q. No --

MR. RANKIN: Mr. Hearing Officer, Mr. Knights was cut off. He was answering a question and Mr. Wehmeyer cut him off.

HEARING OFFICER HARWOOD: Okay. I'm sorry I missed that.

MR. WEHMEYER: Well, I'm happy for him --

BY MR. WEHMEYER:

Q. I didn't mean to cut you off. Go ahead.

A. I don't actually remember what I was talking about.

HEARING OFFICER HARWOOD: Stop. Let's not get into the same situation we got into yesterday. Remember, it's a radio transmission. Guys, give each other time. Okay?

BY MR. WEHMEYER:

Q. I've enjoyed our visit. I think you and I are on the same page more frequently than Mr. Rankin.

So as we come back to -- I said hey, look, you're the geologist, you do this work. First thing you're going to want to know is: What rocks is my petrophysicist giving me? Fair?

A. I would ask Jim what rocks are there.

Q. And what did he tell you?

A. As you know, Jim can be pretty loquacious. So it was long diatribes of why these rocks are what I've determined them to be. And I was enjoying my conversations and learned something every time I talked to him.

Q. Did you ever get an answer on what rocks are these?

A. The ones that were in his model. And he actually never output a model of this foot is this rock type.

Q. Okay. So if the Commission wants to know -- and I'm not being a wise guy with it, I promise. If the Commission want to know, when I went to go do my oil-in-place estimations, I asked Dr. Davidson, "What kind of rock do I have here?" do you know? Yes or no?

A. Not by foot. But basically the deeper water a little more on the mud side than the grainstone

side.

Q. Where did he call deeper water?

A. Deeper water is probably throughout the system, but predominantly lower in the Spraberry was deep water and shallower above the -- in the Upper San Andres, you know, above that gamma ray, that was primarily lower.

Q. I think we just moved southeast quite a bit. Not Spraberry. San Andres?

A. Oh, did I say Spraberry?

Q. Yeah. That's okay.

A. San Andres.

Q. And so the rock types, the best you -- well, let me take it in two pieces.

First, would you agree that whatever rock type was the predominant rock in his facies model, you're a little bit unclear on that right now as you sit in this chair?

A. Correct. On a foot-by-foot basis, yes.

Q. And not being a wise guy, but it is a little odd that the geologist would be asking the educated engineer, "What type of rocks are these?" as opposed to you doing the work on the front end to assist the petrophysicist with, "This is the lithology that you should expect in this particular environment. This is

deep water, this is shallow water. This is what we need to be looking at from outcrop"?

A. Not at all.

Q. Now, you said you checked what he did against -- I don't want to misquote you -- direct data or the --

A. Direct physical evidence.

Q. Direct?

A. Physical evidence.

Q. Direct physical evidence. How did you check his Lower San Andres? What direct physical evidence did you have? Was that just Grayburg?

A. That's a good question. Yes, the only direct physical evidence we have in the Lower San Andres is the reservoir quality by the saltwater supply wells and the injection wells, indicating permeability, reservoir quality and reservoir dimensions.

Q. But, again, this isn't rock type. This is just going to be a gamma log?

A. Correct.

Q. Which comes back to, as I talked about, couldn't we all agree here amongst reasonable people that the rock facies could be off by a level of one?

A. Okay.

Q. Now, returning to just the water saturations, because I want to keep the forest in view here, the majority of the rock that Dr. Davidson's model selected was mud dominated packstone or worse, right?

A. Potentially. I'm not sure.

Q. Well, you've seen the plots on the graph, right?

A. Yeah.

Q. And, you know that by making that selection, even if you moved over to mud dominated packstone, you have 80 percent water saturation right off the bat, don't you?

A. Yes. High water saturations.

Q. And which to the other side of 1 minus equation, means you could maximum have maybe 20 percent residual oil zone, right?

A. Correct.

Q. Through just the facies selection?

A. Correct.

Q. And then in the modeling that you all selected, if there was not at least 20 percent oil saturation, zero credit for oil was then put into your model, correct?

A. The net pays, yes, would have been zero.

Q. So it really gets this simple if you're looking at this from the Netherland, Sewell approach: Dr. Davidson makes his facies picks for the majority of the Lower San Andres.

A. Mm-hmm.

Q. And based on those facies picks, you have to start with 80 percent water, or even more water, and based on that facies pick, you cannot put enough oil in to get past the 20 percent threshold for your model to give that oil any credit for oil in place?

A. Correct.

Q. I want to talk a little bit about the 20 percent threshold. You've seen literature, you've heard testimony from Steve Melzer, Dr. Trentham about ROZs.

A. Correct. Yes.

Q. And 20 percent is what they've spoken to as an acceptable threshold to get started at for an ROZ project?

A. As I understand it, it's the low side. You need --

Q. But it is an oil saturation -- and I'm so sorry. You go ahead.

A. And so you need at least 20 percent to make it reasonably viable. And that has to do with the

residual oil saturations that are common in these rocks.

Q. And, again, just to keep this simple for my simple brain, this is not you have to start at 40 percent and you produce it down to 20 percent residual oil and you stop? Based on their literature and their work on ROZs, 20 percent would be an acceptable place -- that's a lot of oil down there -- 20 percent would be an acceptable place to start?

A. To start as a minimum?

Q. Yes.

A. If I had less than that, I wouldn't even consider it.

Q. Yes?

A. Yes.

Q. Okay. So your model literally kicks out all of the residual oil that Dr. Trentham and Steve Melzer would start an ROZ project at, doesn't it?

A. Yes.

Q. And, again, in terms of the rock facies that's selected, in terms of moving from grain dominated packstone over to a mud dominated packstone, that comes down very much to shallow water environment versus deep water environment, correct?

A. Yes, it does.

Q. And here, I asked you as the geologist, do you have any opinions to share, could we go well by well, depth by depth, and you tell where is shallow water environment, where is deep water environment, that's nothing you've done as a geologist, nothing you have opinions on, true?

A. I mean, I could have opinions if I reviewed something specifically.

Q. You haven't done it to date?

A. I have not done it, no.

Q. Additionally, all rock with less than 7 percent porosity, all of that oil is kicked out of the Netherland, Sewell model, isn't it?

A. Correct.

Q. And so you understand that in ROZ development, oftentimes you will find some of your highest oil saturations in some of your lower porosity rock, right?

A. I don't know if I agree with that.

Q. Do you have a position one way or the other?

A. In the better reservoirs, the higher oil saturation is in the higher quality rock. You get better recovery factor. But in some reservoirs, I could imagine that you would have more of the oil in the low permeability rock because it hasn't moved and

won't move.

Q. Under typical conventional environment, right?

A. Correct.

Q. Coming back to Mother Nature's waterflood. You heard Dr. Lindsay testify in here that as water pushes through here, mobile oil is going to be pushed out. What we have left is residual oil that clings to pore throats and, you know, pore volume, with the water on the inside, waiting to be released through something that can reduce the viscosity, such CO2?

A. Yes.

Q. So this comes back to -- you understand that Scott Birkhead has testified here that what he's actually observed in core and what he's modeled is that, oftentimes, the higher saturations of oil occurs in the lower porosity environments, true?

A. So yes.

Q. But, again, just in terms of keeping the big picture here for the commissioners, if it's below 7 percent porosity, we never get those volumes in your model. Those are all kicked out, right?

A. Correct.

Q. You would agree with me, because we're not dealing in conventional environment here, and this

whole fuss is over tertiary, that through the injection of CO2, it is then possible to reduce the viscosity to recover the oil from these type pore throats and vary these pore volumes, true?

A. Yes, that is the concept.

Q. In terms of oil wet versus mixed wet, there's been a lot of discussion about that. Is this an oil wet environment or a mixed wet, or might it be something in between?

A. I think it might be somewhere in between.

Q. If you move from an oil wet environment over to a mixed wet environment -- are you with me on the assumption? -- what would that do to your modeling?

A. I'm not sure. I would defer to Dr. Davidson on that.

Q. But before you came in and testified on volumes, you didn't ask him, "Did you model this off of oil wet versus mixed wet?"

A. No.

Q. But that certainly would change the volumes, wouldn't it?

A. I would defer to Dr. Davidson.

Q. We're going to go back to your slide show.

While we're talking about ROZs some of the recipe or the Cookbook of ROZs, you're looking for

things, no one is expecting mobile oil in a ROZ development; we can all agree on that?

A. Correct.

Q. There's pages of testimony that I've read from the Goodnight witnesses about: Golly, we've produced a gazillion barrels of water here, and we have very little oil that's come up with it. Right?

MR. RANKIN: Objection. Mischaracterization of the system.

HEARING OFFICER HARWOOD: Yeah, I don't remember "golly" being in any of the technical reports. Rephrase.

MR. WEHMEYER: It's all my simple mind can appreciate.

BY MR. WEHMEYER:

Q. Have you read the other witness statements in the case?

A. Yes.

Q. Has there been a lot of paper spent on: We've produced a whole lot of water, but we have very little oil?

A. Yes.

Q. And for an ROZ development such as this one, if you're advising a client, you would tell him that's exactly what you'd expect, right?

A. No, I don't think so. I think the ESP, the changing of the reservoirs would anticipate -- be a significant indication that there was a significant ROZ there.

So the concept that we don't produce any oil so there must be oil there, is -- I don't think that's a positive statement.

Q. I'm taking the opposite side of it. If somebody says, "I produced a lot of water and I don't have oil" --

A. Yeah.

Q. -- if they're here talking to you on the ROZ, you'd say, "That's normal. You would expect that"?

A. Yes.

Q. And we can go log by log, but to the commissioner's cherry-picking comment, we can go into actual logs and we can look at the mud logger's report, and in the Lower San Andres -- are you with me on what we're -- deep in the San Andres.

A. Deep in it.

Q. We can find gas shows, we can find oil fluorescence, we can find odor. Those aspects of Dr. Trentham's recipe and Cookbook are present in many of these logs, aren't they?

A. In many of the logs, in some instances, yes.

Q. And additionally, off the top of my head, I know it's the 660 and I think it's the 658, Mr. Rankin will correct me on it, those wells were tested with an ESP and an electric submersible pump, and those did, in the Lower San Andres, produce oil along with the saltwater? There was mobile oil?

A. There was some mobile oil, yes.

Q. And just the way oil works in the pore space and in those pore throats, if you're getting mobile oil, you know there has to be residual oil left behind?

A. Correct. Yes.

Q. And we may be able to work pretty quickly through this from here. In terms of just economics -- you with me so far? -- I see in your papers that you kind of wave your hand over and go, this is not economic to fiddle with. Fair?

A. Yes.

Q. But you haven't actually run any economic assessments here. You have haven't looked CapEx, OpEx, revenue anticipated?

A. Just on a screen basis.

Q. Did something happen in your head that you woke up with, said, "Yeah, I looked at it"?

A. I'm not sure.

Q. Where would I see the work? If the Commission wants to see an economic assessment, says you're going to be the economics guy, where in your papers do we see the economic assessment, other than your say-so?

A. It would be the last two slides in my summary slide deck.

Q. You've analyzed CapEx and OpEx?

A. I generally use the data that I'm given. So I used the Tall Cotton data, from there.

Q. Let's talk about Tall Cotton. In terms of a recoverability factor, you haven't seen any EMSU, have you?

A. No.

Q. Is that something you'd want to see?

A. At this moment, no.

Q. How about even oil compositional analysis? Ignore miscibility, just API of the oil.

A. No.

Q. Okay. Now, Tall Cotton, might it have been that oil was overstated in the first instance?

A. Yes.

Q. And with respect to Tall Cotton, you've heard the testimony about they actually fracked in --

they were trying to -- they didn't want to wait. Kinder Morgan wanted the juice out of the squeeze faster. And so they fracked into the injector wells. Do you remember that testimony?

A. I remember the testimony, but I have no confirmation that that's actually what happened.

Q. That's an interesting point in itself. So in terms of what happened at Tall Cotton by way of the recoverability of the residual oil, you don't know what happened as a technical matter, do you?

A. I know the direct physical evidence is the performance and the rate cum plot is 5 million barrels of data over 15 years, and a decline curve that gives me whatever happened in this instance that's an estimated oil recovery that would accomplish from that development.

Q. Just looking at this -- and I know you're not an engineer, but looking at the graph on the bottom right, when you see a curve like that, would you expect that there was something from a technical engineering perspective that happened to that production?

A. Something happened to the production, yes.

Q. That it would be different than and not explained by somehow the oil just couldn't be -- the

EOR was no longer effective?

A. I really don't know exactly what that is. But I would suggest there's plenty of plausible explanations.

Q. One of them being that they fracked the injector wells?

A. That would be something that might affect it.

Q. Why would you supply the Commission with this slide? As we talk about it, you've only offered 24 slides and it's important to get things right. Why would you give the Commission testimony about Tall Cotton being a good analogy here without actually digging in to understand, from a technical perspective, what happened out there?

A. Well, I don't think that data is available publicly. So to this public data, this is the only ROZ-isolated interval that I could even attempt to get somewhat close to a recovery factor.

So I thought it was important to at least look at that data and come up with at least a screening perspective on what that recovery would be.

Q. This slide, you showed just for record reference. We're looking at your Slide 13. Are you with me there?

A. Correct.

Q. I'm not sure anybody knows -- what is Goodnight's position as to what Ops Geologic's average grain density was? Is the point of this fussing with what you think Ops Geologic's grain density is?

A. No. They have a ternary diagram that he suggested it was 2.9 for the dolomite end.

I think if you're talking about his grain density, that would be the amalgamation of how much percentage of dolomite, how much percentage of sandstone, how much percentage of the other mineral interests. And you get an average main grain density of that.

The only thing I was suggesting here is that he used 2.9 with a constant 20 percent anhydrite to get that up from the typical 2.87 grain density that would normally use for the dolomite component in his analysis.

Q. I just don't want the Commission to be left with any misimpressions. For example, on EMSU 679 core average matrix 2.83, is that grams over cubic centimeters?

A. Correct.

Q. And you think Ops Geologic -- well, let me stop at that. That's an average, isn't it, 2.83 grams

per cubic centimeter? Is that an average of what was measured in core?

A. Where? I'm not quite sure.

Q. Here, I can highlight it.

A. Oh, yes. Okay.

Q. That's an average over the whole core, right?

A. Yes.

Q. Is Exxon a client of yours?

A. No.

Q. Exxon, they were at about 2.84 grains per cubic centimeter?

A. Correct.

Q. What do you think Ops Geologic's average is?

A. I do not know.

Q. If you went back and averaged it and it was 2.835, could we all agree that that is incredibly reasonable and right in line with core and what Exxon came to?

A. It's still -- I think the 2.9 is a little high relative to the industry standards. So I would use a 2.87 there, recalculate his, see what a thing -- I think it would reduce his 2.83 to maybe -- I don't know.

Q. But the core average is 2.83. Exxon came up

with 2.84. If Ops geologic's average was not 2.9, whatever you speculate on, was 2.835, you would agree that that's at least in line with core and in line with what Exxon came up with?

A. Yes.

Q. What was the average grain density of Dr. Davidson's model?

A. I believe his dolomite density was 2.87. But I would defer to Dr. Davidson.

Q. Higher than the average in core, higher than Exxon and higher than what Ops Geologic came up with, correct?

A. Yeah, if that is correct, if that's what he used.

Q. And we're just popping through these things to clean up and make sure I covered.

The Zone B water on this Slide 14 --

A. Mm-hmm.

Q. -- so that the Commission is clear, those arrows are not in this publication, are they?

A. Correct.

Q. You said there's an influx of Zone B water with the arrows off to the right?

A. The paper defined edge water drive, and this is an indication that the high water contacts were

about where the reservoir went below the contacts.

Q. Where did the paper define edge water drive as coming from?

A. Downdip.

Q. Is there anything in the paper that says water is entering in from the east?

A. No. That's an observation from this map.

Q. An observation from -- you put the arrows on the -- the only thing on the map are the arrows that you added that would indicate water is coming from the east.

A. Well, all the hatched areas are water that was present in there in 1934, '35, '36 and '37.

Q. On what basis would you say that water came from the east?

A. Because it's right on the eastern edge of the map.

Q. And is this the Grayburg that is being spoken of here?

A. This is Grayburg.

Q. Have you not heard -- again, you're the geologist. Have you not heard the extensive testimony in here that the Grayburg pinches off to the east and that there's no water moving in or out from the east?

A. I've heard that it does get tighter and it

pinches out to the east.

Q. And in terms of literature saying here at EMSU water is entering from the east, have you seen any such literature in the Grayburg?

A. No.

Q. And, again, so the Commission is aware, you put the arrows coming in from the east, and the reason you put the arrows coming in from the east was because you found these little shaded spots in this diagram?

A. Correct.

Q. When was that paper written?

A. 1939.

Q. So we've got over 80 years -- I'm trying to do -- I've heard an engineer one time say, "I never do public math." I thought that was kind of probably a good thing.

But over 80 years since the paper, the paper doesn't say the water is coming in from the east. But you've cited the paper here and you put the arrows on -- and the geology. I guess I should ask that first. Geology says the water is not coming in from the east, right?

A. No, this is an observation.

Q. And, again, so that the Commission understands, before you put the arrows on here and

brought it and swore to it, the observation you formed give them the methodology you used in getting to that observation?

A. Yes.

Q. I'm sorry. Let me re-ask it.

Data, methods, conclusions. If they want to know what the methodology you used to say water is entering into the Grayburg from the east, tell them your methodology?

A. Reviewing this document and seeing that the eastern flank had some anomalous early water.

Q. Moving to the cartoon, or whatever you want to call it, above it, so that the Commission is not misled, the perm barriers were not in this publication, were they?

A. No. I highlighted those.

Q. And neither was the little dotted line? I'm trying to follow this dotted line. Do you see if they wanted to --

A. Yes.

Q. That's not in the paper. That's something you added, right?

A. Correct.

Q. And perm barrier, is this where you used a 7 percent porosity to define this perm barrier?

A. No. They have little marks there.
Q. Well, I want to ask you about the little marks, to make sure we're talking the same thing. Are these the little marks you're talking about?
A. Yes.
Q. Can you help the Commission with where they would find the little marks that close the top of what you call the perm barrier?
A. Close to the top of the perm barrier?
Q. For it to be a barrier, it has to close on the top, right?
A. No. The perm barrier can be any layers in there. It's not the entire -- you don't need an entire thickness. All you need is some --
Q. Let's take it in pieces. First, I said the little dot -- the tiny dotted line, that wasn't on the original, you added that?
A. Correct.
Q. And the colored perm barriers, that wasn't on the original document. You added that?
A. Correct.
Q. And so then I asked: Did you use your 7 percent porosity cutoff for this perm barrier? You said no?
A. No.

Q. You said you did it based on the little lines that they drew, right? Yes?

A. Yes.

Q. And so then I asked: Are these the little lines?

And I'm indicating here there's lines that go along -- are you with me? Those are the lines you're speaking of?

A. Yes.

Q. But the lines never close -- literally at the top of what you've called a perm barrier, there are no lines. If that was your methodology, how did you decide to call that a perm barrier and to effectively put in lines where the author of the cartoon chose not to?

A. For simplicity and geologic interpretation to close the polygon.

Q. But the author of this that was trying to communicate something through the writing, can we agree that they intentionally did not close the top of what you've now called a perm barrier?

A. Yes.

Q. Okay. So then on what scientific basis did you have to close it and then come in here and testify to the Commission about it?

A. I did make a big assumption that the perm barrier on the east and west and the bottom have a top somewhere.

MR. WEHMEYER: I think I'm at a place that I may be able to pass the witness, but I would like just two minutes to visit with my clients, if I could ask for the afternoon break now. But if that doesn't please the Commission, I'm happy to proceed.

HEARING OFFICER HARWOOD: Chairman Rozatos, it is 2:50 p.m. What's your thinking?

CHAIR ROZATOS: Yeah, we need to take a break, let's take a break now. And we can come back.

HEARING OFFICER HARWOOD: All right. Is 10 minutes enough?

MR. WEHMEYER: That's perfect. Thank you.

HEARING OFFICER HARWOOD: Let's come back at 3:00.

(Recess held from 2:51 to 3:00 p.m.)

HEARING OFFICER HARWOOD: Mr. Wehmeyer.

MR. WEHMEYER: Thank you. On behalf of Empire, we pass the witness.

THE HEARING OFFICER: All right.

Mr. Moander, I believe you'd be next.

MR. MOANDER: Yes, Mr. Hearing Officer. OCD does not have questions for this witness, and we'll

pass the witness.

HEARING OFFICER HARWOOD: All right. Rice operating, Mr. Beck?

MR. BECK: Just a couple of questions.

CROSS-EXAMINATION

BY MR. BECK:

Q. Mr. Knights, if I think you said that if Empire came to you, told you that they were going to drill down to the bottom of the San Andres and spend 1.2-or-something-billion dollars on doing it, you would voice them a concern about the injection going on at the bottom of the San Andres, right?

A. I would give them one of many concerns, but that would be a minor one.

Q. And what are those other concerns?

A. The actual presence, the volume of the presence. The thickness of the San Andres is a negative. You can't CO2 flood an individual zone. You have to flood the entire section. Some of the perm barriers in there may also be an issue. I think the karsting that is evident from the loss drilling circulation and the amount of fluid -- water withdrawal from the water supply wells. And the ability to inject, indicating that it's a significantly large volume of -- pore volume of water

that is in the system that they would have to overcome to get to those -- the alleged oil in the smaller porosity throats trying to get that CO2 to contact that oil. I think those would be my major concerns.

Q. And what if they came to you and said, "Okay. Well, given those concerns, we're just going to exploit the CO2 tertiary recovery, the potential ROZ above negative 700 subsea"?

A. Yeah, I think negative 500 would probably be my estimate of where the current -- if I was -- if I was going to reclaim a unit, I would say negative 500 would be the base of the productive oil unit and the potential ROZs. And that anything developed up there would be isolated and separate from the deeper reservoir that's currently being injected from Goodnight.

Q. And so when you say that it's isolated, I was a little bit confused about there was seemed to be a lot of discussion on whether there was there -- there was one significant barrier in the EMSU, permeability barrier, whether there were multiples.

At a base level, it sounds like you're of the opinion that there's no communication above that permeability barrier and below, right?

A. Correct.

Q. Now, explain me how that is if there's not just one single permeability barrier that you've found?

A. Well, there's evidence that there's a number of tight streaks in there that it may be thinned and laterally extensive. It's difficult to actually map it across the whole unit. But those tight streaks are perm barriers, but there's also other vertical impediments to vertical flow.

So if you have a fluid trying to move up through this stratigraphic column and it hits a high perm streak, it's not going to go up, it's going to go laterally across there. And so there are indications of a lot of low perm barriers, but there are also some layers and including -- he pointed out there's some loss circulation zones a little higher in the section. All those would be impediments to vertical fluid migration up into the above reservoirs.

Q. And I think you went through this with Mr. Wehmeyer, but you, in part of your work, you advise banks on investing in new discovery projects of oil like this?

A. Yes.

Q. And you do that for working interest owners, I think you said?

A. Working interest owners, companies, new developments, new business ventures, private equity firms due diligence, screening of projects before someone goes to the next level of is this worth kicking the tires.

Q. And if one of those clients came in and asked you for the EMSU, is there a permeability barrier in communication between the disposal zone and the potential ROZ above it, what would you tell them?

A. I'd say there's plenty of evidence that I've seen that indicates that there's no communication between those two and those are isolated and separate reservoirs.

MR. BECK: All right. Thank you.

Pass the witness.

HEARING OFFICER HARWOOD: Thank you, Mr. Beck.

Mr. Suazo, Pilot Water Solutions?

MR. SUAZO: No questions from Pilot, Mr. Examiner.

THE HEARING OFFICER: All right. Then we come to the Commission. Anybody want to volunteer? I put Dr. Ampomah in the hot seat yesterday first. I can do that again.

CHAIR ROZATOS: I'll start.

HEARING OFFICER HARWOOD: All right.

CHAIR ROZATOS: I'll start. I don't have any questions.

THE HEARING OFFICER: That makes it easy.

CHAIR ROZATOS: Yes.

THE HEARING OFFICER: All right. Well, I don't see any volunteers, so I'm just going to pick on Mr. Lamkin first.

Do you have any questions, Mr. Lamkin, for Mr. Knights?

COMMISSIONER LAMKIN: I do have a couple questions.

EXAMINATION

BY COMMISSIONER LAMKIN:

Q. Good afternoon, Mr. Knights. Thank you for your testimony.

So with regard to the correlation of the wells that had anomalous water production volumes, did you look into whether or not those wells were perforated across the bedding planes that you hypothesized are the conduits to fluid flow?

A. Yes.

Q. Was that in one of your figures, or is that in your testimony somewhere?

A. In the testimony. I think it's in my

rebuttal testimony on Page 5. I discussed that 239 well in pretty specific detail on where it was perfed and where it was drilled deeper.

Q. Was that the only well that you analyzed?

A. That's the only well that I went into detail on.

Q. Was that the only well that you found was perforated across that bedding plane?

A. That was the only one I investigated, since that was the largest anomalous thing that most people pointed to.

Q. Okay. Other than potential communication, vertical communication between the San Andres and the Grayburg, can you think of any other possible explanation as to why you would see a pressure reduction in the San Andres prior to oil being produced from that zone?

A. I think the only one would be the production, early production in the San Andres of (audio glitch) waterflooding actually started in -- or being pervasive in the Central Base Platform.

Q. Was there any consideration made to a poroelastic effect causing a pressure drawdown in the San Andres from the removal of reservoir fluids in the Grayburg formation?

A. No, I did not consider that.

COMMISSIONER LAMKIN: I think that's all my questions. Thank you.

THE HEARING OFFICER: Thank you, Mr. Lamkin.

Dr. Ampomah.

EXAMINATION

BY COMMISSIONER AMPOMAH:

Q. Thank you, Mr. Knights, for your testimony. I do have a couple of questions for you. If we can have your slides up, that would be much useful to me.

Now, my first question to you is, Mr. West talked about Empire using 18 percent recovery factor based on Seminole as an analogous to, let's say, the EMSU. Can you comment on that 18 percent?

A. I think, basically, the reservoir quality of the EMSU is significantly less than the Seminole and I don't think that's a very good analogy at all. Seminole is a relatively good quality reservoir with a lot of the oil in the higher porosity intervals. And I think the Tall Cotton analysis that I did, although very cursory, is probably more in line with what I would expect in the EMSU.

Q. So, there was a discussion on the Tall Cotton. And, you know, I just want to know, let's

say -- you just look at the Tall Cotton. Apart from -- well, let me put it this way. Are there any technical difficulties that they faced, you know, that contributed to, let's say, less recovery from the Tall Cotton, or it's just purely based on geology?

A. Basically, there could be technical issues that I'm unaware of. But I use the actual physical data of the production and its trend currently.

Q. But you also listened to Steve Melzer talking about all the technical issues, even they did not listen to him, you know. So he talked about actual technical issues that really resulted in that failure. Did you incorporate that into your analysis?

A. No, I didn't. Most of the stories of things that go wrong, there's always stories, but I try to look back at the actual data and say, "Well, okay, this is the data. If you can explain it, I'd love to see it. Can you show me that data," and then I'd make adjustments.

But in this case, it was a screening, and I think it's -- you know, anything on the technical issues that may have caused that to be a lower recovery, I did not incorporate.

Q. So the Seminole did have -- does the Seminole have a main pay zone and then the ROZ?

A. Correct.

Q. Is it not analogous to the EMSU, based on even your testimony and that of Dr. Davidson's testimony?

A. Do I think that's a good analogy?

Q. Yeah?

A. No. It's higher quality rock.

Q. Now, let's talk about rock quality. So I know that there are different ways that we can come up with the rock quality. Especially even if we do -- we can also utilize the portal sizes, which has been more or less established in the industry.

So why did you or your team not really do more detail analysis, especially when you are referring to the reservoir quality?

A. Yeah. I guess there could have been more detailed work done, but I think the -- yeah, just do not do that.

Q. So the actual reservoir quality analysis that Dr. Davidson worked on, would you agree that probably it's extreme?

A. Extreme low? High?

Q. Okay. So if you look at the profile that he used, the RI, and then the saturation, and he tried to more or less use the -- that plot to more or less

illustrate that the EMSU or San Andres is more or less oil wet. So I'm saying that if you look at that plot superimposed with the saturations, is it not really extreme, especially when, at some point -- if you pick this facies model, then you are more on less saying probably the oil -- the water saturation is going to have to start from 80 percent or 90 percent.

Was that on extreme?

A. It is dependent on the actual lithology that you interpret. And I think Dr. Davidson used the core data in the upper San Andres to build that model and take that down from the log characteristics. So I think it's a case -- I'm not sure if it's an extreme case.

Q. Can we go to Slide Number 2 on your presentation. You know, I know there was a discussion on this one. Can you tell the Commission that it is your testimony that there was a migration of the oil, one is the Wolfcamp being the source rock for the Grayburg and the San Andres? Is that your testimony?

A. Correct. Yes.

Q. I'll ask you the same question. Can you explain to the Commission how this migration pathway happens? When you say complex, it's complicated, I don't really understand. So how complicated, how

complex it is?

A. My description of complex is basically looking at the different accumulations in the San Andres throughout the Central Basin Platform. They're in different areas and different types of accumulations.

And in some areas where you may expect to find oil, you don't. In some areas, it's just unusual where the oil is. And I can't really explain how it got there. And there's not a simple path. So that's what my complex issues is. I don't understand how the oil got there.

Q. And based on your testimony, you talk about the San Andres being so extensive throughout the EMSU and even beyond; is that correct?

A. Correct. And I guess the Lower San Andres. Because there's an Upper San Andres and a Lower San Andres. And so a lot of my difficulty with the nomenclature is people say "San Andres" and it's not specific. So for the large aquifer, I'm discussing the Lower San Andres that is where the Goodnight is injecting.

Q. So, in the unitization documentation, was it specified Lower and Upper San Andres, or it was Grayburg and San Andres?

A. Yeah, it was Grayburg and San Andres.

Q. So, do you have any objection when Empire says that the unitization zone is right from the Grayburg to the bottom of the San Andres?

A. No. I think that's an accurate description of the unit.

Q. Now, another question that I had, you know, we've been going back and forth on this. You have a lot of experience. You've helped a lot of companies, you know, in these types of litigations.

Have you ever seen any external company that do not have any producing, let's say, interest in the unitization zone, being allowed to bring in water from different sources to inject? Have you seen that before?

A. No.

Q. Why do you believe that there has never been a precedent for that?

A. I do not know. But I think in this situation that there would be a distinct physical geologic reason why they both can coexist.

Q. Let's move to Slide Number 4. So you said that you classified the San Andres as a -- whether upper or lower, or let's say the lower, okay, as a large aquifer.

A. Yes.

Q. Large aquifer. How do you determine the boundary?

A. That is a very good question, because I think one of the most surprising things in going through this is understanding that the San Andres is under pressured at about .38 or so psi per foot. And, again, complexity, I don't really know how to explain that. But the amount of water that was withdrawn in the early days and the amount of water that was injected and the very limited changes in pressures would all point to just a very large aquifer that, you know, taking out 340 million barrels and having limited pressure drop would portend to a very large tank being that 340 million barrels was a very small component of that.

Q. Can we go to the slide where you showed -- you actually marked the perm barriers, the one that you did yourself --

A. Yes.

Q. -- that opposing counsel was going back and forth with you on? Right there, this one.

So which zone are we in on the top figure?

A. That's all the Grayburg. So that is the

producing intervals in the Grayburg. That was discovered in 1928, I think. But this paper was 1939 after they had drilled, you know, 450 or so wells. And it was basically an amalgamation of the data at that time.

Q. And based on your discussion, were you more or less using this as analogous potential barriers that could be seen in the San Andres?

A. These were all barriers that are in the Grayburg, so these are not in the San Andres.

Q. So, when you talk about the barriers, the perm barriers, that exist in the San Andres, is it analogous to what we see in here?

A. A little. I believe there's intervals, and in my TVD depth between, say, 500 and 700 TVD subsea, that there's a lot of petrophysical events, that there's multiple perm barriers, both very, very extremely low and very moderately low. But a number of those barriers in amalgamation, I think, is an incredibly strong barrier to vertical fluid flow.

Q. And do we have an extensive mapping based on the log data, how this would look like?

A. I have not done that mapping, no.

Q. So, I'm thinking about how -- let's say we have perm barriers within the area where we are

injecting, and then we are saying that it is a large aquifer. I'm trying to figure out, you know, if there are barriers in there, you know, why are we saying it is a large aquifer? I'm trying to just understand that.

A. Well, the large aquifer comes from the pressures. I think the last analysis I saw was that in a small area, there was 39 million barrels of oil injected, the pressure gradient --

Q. Water injected? No.

A. Water injected. This is a water disposal in the Lower San Andres. And the average pressure for those five wells had a pressure gradient of .381, and after 39 million barrels were injected into that over about a year and a half, the pressure gradient was tested in all five of those wells, and the average was .383.

So that's 39 million barrels and a very -- if you calculate that at the .002 gradient at the depth of 5,000 feet, that comes to about a .25 psi per million barrels injected. And so that's one of my big indications of -- you know, when I talk about direct evidence, I think the biggest direct evidence is material balance of pressures and volumes.

And that really tells you a lot about

the actual reservoir size, but as you were mentioning, you know, the actual boundaries, that is very difficult. Especially if you have these limited pressure variations with that kind of volume being injected in there.

Q. So is there an expert from Goodnight who is going to really discuss to the Commission the pressure situation? Is there someone that is going to testify on that?

A. Yes. I'm --

Q. So, I'm not going to bother you with that. I'm not going to bother you with that.

A. I've been exposed to it, but I am not the expert on the pressures. But it was very important in my testimony and my understanding of the reservoirs.

Q. Okay. Can we go to Slide Number 5, or even probably Slide Number 6 would be helpful. Slide Number 6, yeah. Let's go to 6.

So here, you're showing us the locations, you know, in the oil zone and then also within the San Andres, where we do have the water supply wells and then also the injection wells that are ongoing right on the east side. Where is the proposed new injections from Goodnight? Where is it going to be?

A. I would like to make a correction here. This is basically an alphabetical order. It's not a location order. So just from right to left was just the well numbers in order. So it's not -- logistically, that's not west to east. It's just a diagram.

So I was trying -- what I was trying to present with this was all of the critical data and critical wells that have tests or indications of fluid mobility in all of the zones. So all of the red wells in the middle or either petrophysics or the only wells that tested something below the producing oil-water contact. So sorry about that. I didn't make that clear before.

Q. Okay. Okay. Now we talked about the perm barriers. So I also confirmed the testimony from Dr. Davidson that there are anhydrites that causes those perm barriers.

A. Yes. His interpretation was anhydrites are low permeability, low porosity intervals.

Q. So when he was testifying, it sounded like he doesn't have any concrete evidence?

A. Direct core data, I don't think he has in that interval.

Q. What about mud logs?

A. Mud logs, I think there were a few to go through there, but I don't know if there was. I'd defer to Dr. Davidson.

Q. And then he also testified that it was not continuous. Is that fair?

A. Yeah, he could not -- I don't think he could correlate, you know, one interval across the entire area.

Q. Now, are these perm barriers something that has been established, you know, in the Permian or, let's say, in the EMSU as well established perm barriers, isolated formation that has been well established that there are perm barriers here that more or less serve as a cap rock.

A. I think the only detailed information is from the Seminole and the Hobbs units in their CO2 applications. They went through and had detailed studies and said that there was no communication throughout the San Andres from the deeper zone.

But I don't think there's any, you know, confirmation, literature that states this is a consistent perm barrier across the Central Basin Platform.

Q. And I thought you said you don't want to use the Seminole as analogous field to the EMS?

A. Exactly. And those are the only two that I know that have had deeper studies on that communication between deeper. But, again, not a very good analogy.

Q. So let me ask you. Has there been any discussion about the perm barrier issues between Goodnight and Empire?

A. I don't believe -- I'd have to defer to -- I mean, I wasn't in the communications there.

Q. And has there been any communication from Empire based on even all the testimony that you've listened to about any perm barrier?

A. I don't think -- I have not been familiar with any communications between anybody at Empire.

Q. So, you know, you're tasking the Commission to really make a tough decision here where you're providing as expert testimony that there exists a perm barrier that separates out Goodnight's injection zone from where you believe the ROZ could be.

Now, if I ask you right now, where is the Grayburg, is it extensive in the EMSU, I'm sure you're going to say yes.

A. Yes.

Q. Right? If I ask you about the Lower San Andres, you say it's extensive, right?

A. Correct.

Q. If I ask you about the Upper San Andres, you can really pinpoint that and say right here is there, right? Why can't we have the same for the perm barrier? We need right evidence, you know, stronger evidence that could be mapped.

A. I think that's a good question. It could be you could do some geologic considerations and make a map that would support it, but I think all the current data that I've reviewed doesn't suggest that there's any communication between the two. And I think the pressure differences and just the reservoir characteristic, the dramatic differences between the Lower San Andres and the Grayburg in that Upper San Andres, I think are sufficient to basically make that statement. In my opinion, that's strong indications of a barrier.

Q. So, that one we're talking about time, t is equal to 2024, right? But Goodnight is proposing to inject huge volumes of water. And, you know, I don't want to go into the pressure discussion with you. I prefer to wait so we can get into that. But you've seen these baffles, and based on your testimony, it's not extensive?

A. Well, the individual baffles are not

extensive, but the preponderance of significant numbers of them in all the wells that we looked at, I think amalgamated the preponderance of them since there's significant perm barriers as a group.

Q. Yeah, but that is essentially based on some of the logs that you looked at. But there's no well-documented evidence, more or less, and there is no core to support that claim.

A. Okay.

Q. And even Dr. Davidson and yourself, you're saying that we don't need any further data, the Commission has enough data to make decisions. Do you still stand by that?

A. I think for the injection in the lower thing, that there's no pressure buildups, no indication of vertical migration, that there's no evidence that I think that has any influence on the shallower reservoirs above.

Q. So is there someone from Goodnight who is going to tell us about Goodnight's injection and their perceived impact on existing operations?

A. Yes.

Q. Okay. Can we go to Slide Number 7. Thank you.

You know, and, let's say, majority of

the experts, almost everybody has a lot of experience in the industry, right? So you are presenting your portion, NuTech presented their portion, and Scott also did the same thing.

Now, my question to you is, as you've shown us this, even from the original one, the revised one, and then even your original one and all of that, first question is, do you see any evidence of oil in the San Andres?

A. No -- well, the only -- in some of the cores, there was some staining. But from a significant portion, continuous saturations that is kind of required for an ROZ, no.

Q. Well, if we look at the EMSU 679, I mean, it is well established that there is oil, at least based on that EMSU 679. And then also the RR Bell well, it is established that there is at least some oil in place.

A. There is some oil. And I think most of the analysis went to the significance of that oil and its aerial extent or its vertical extent.

Q. So assuming that NuTech, Ops Geologic, they overestimated the oil in place, what about the core?

A. The core? For which?

Q. Okay. Let me rephrase my question.

Assuming that NuTech, Ops Geologic and even Dr. Davidson, you know, they've all interpreted -- Scott also did the same, Dr. Birkhead. So they've done all of this and there is a contention with regards to which one is correct, which one is correct, my question is, what is the core saying?

A. Well, the core correlates best with Dr. Davidson's.

Q. I want to show you, this one will be Scott's rebuttal. So he compared EMSU 679 compared to that of Goodnight's and Empire.

COMMISSIONER AMPOMAH: So I want to approach the witness and show him to refresh the memory.

BY COMMISSIONER AMPOMAH:

Q. So in here, we are looking at the EMSU 679 that do have actual evidence of the core. Now you're saying that it is only Dr. Davidson's analysis that matched the core, let's say, to your satisfaction.

What you see on Track 9 and Track 10, is it not a good match?

A. 9 and 10? I think if you look --

Q. Yeah, let's go to where the spot is. Yeah, right there.

A. Yeah, so there are areas that there are significant differences between the saturations

from -- and this is Ops', correct, Ops' petrophysics?

Q. Yeah. Dr. Buchwalter.

A. It is.

Q. Yeah. He's comparing all the different analyses that were done.

A. So there's certain intervals in there that are significantly overestimated from the SO, especially as you get lower. And I think I brought up that in my testimony, that, you know, if this is an ROZ, then the depths, the last, I don't know, 50 to 100 feet indicate that there's a lowering of oil saturation in the cores, which might suggest the base of an ROZ.

Q. So, have you seen any testimony where Empire has estimated, based on the core, or even if Goodnight have done that, based on the core, the actual core, what is the average saturation within the San Andres?

A. You know, I didn't do the San Andres nomenclature, so I just did TVD subsea depths. So I have not done what is the oil saturation in the San Andres in this core.

Q. Can we bring back the slides one more time?

A. Does this have a San Andres top on that? So there, in the lower part of the San Andres?

Q. Yes.

A. Or what is -- there's two San Andres picks? This is basically a good example of the difficulty of having different people pick San Andres top, because it makes a significant difference on what you're going to do for the average saturation.

And basically all my analysis was done on a TVD subsea base, so I didn't get into that nomenclature. But I did see that degradation in oil saturations as you go deeper.

Q. Yeah, let's go to Slide Number 8 on your presentation. So on Slide Number 8, I'm just focusing on the analysis that Dr. Davidson worked on. Do we see any oil saturation?

A. There are a few intervals that are about 40 percent, but most of them are below 20 percent.

Q. But we gain 20 percent and 40 percent or, let's say, below -- above 20 percent. Do you see significant saturations?

A. Only above the producing oil-water contact.

Q. But what about the below the producing oil-water contact?

A. Very limited.

Q. Do we see, or it is not?

A. Well, I guess numerically, I would say there's maybe 50 feet out of 250, or maybe 10 to

20 percent of the rock is above 40 percent. I don't know, rough estimate.

Q. Yeah, let's go to --

A. But not a lot.

Q. Can I proceed?

A. Yes.

Q. Okay. So based on Dr. Davidson's testimony, he testified to the Commission that he believes that there is an ROZ on the Upper San Andres. Do you believe that or not?

A. Not from this well.

Q. So generally, and this is just an example, so he testified to the Commission that he believes that there is an established ROZ in the Upper San Andres. Is that your testimony or you, more or less, probably have a problem with that?

A. Again, he's using the San Andres terminology. I know between negative 350 and negative 500, I have a potential ROZ, but not a definitive. And if I was looking at this well, I would say that this wouldn't be a strong indication of an ROZ.

Q. Yeah, then let's look at Slide Number 10. These are all core data, which I like. Is this showing any oil saturation or no oil saturation within the San Andres?

A. Again, I'm not sure the depth of whose San Andres top, but yeah, I would have to re-jigger this for whoever's San Andres top I'm trying to use.

But the big picture on this is that the core data saturations and the profile versus porosity versus the same theme in the analysis doesn't appear to be -- appears to be contradictory a little.

Q. You know, let's say from my point of view, Goodnight is giving us different estimations of, let's say, oil saturation, Empire is doing the same. So if we can stick to the core, because the core is the real evidence that we all have here, let's say, all the models that have been done trying to fit to the core and based on that, try to predict how it's going to be on the other ones. So I just want to look at the core and just look at the core and see what it's saying?

A. Yes.

Q. You know, we can just debate about the oil estimations here and there. But what is the core showing us?

So on this particular slide, you have a potential ROZ, you do have a transition zone and then you have the aquifer. So I'm asking you, looking at the core, the EMSU 679 core data, do we see any evidence of oil saturation?

A. Yes. There is oil saturation in the core.

Q. Okay. Let's go to Slide Number 11. So I asked you whether you've calculated the average saturation in the core. You said you've not done that.

A. I guess this gives the average saturation in the core. So if I did say that, I was in error.

Q. Okay. So let's focus on the first track. Is this one the actual core or the corrected core?

A. The actual, not corrected.

Q. So how was the 14.8786 calculated?

A. There's the arithmetic average of the core values.

Q. Without any cutoffs or the core values?

A. Yes.

Q. Did the Empire do the same analysis?

A. I don't remember.

Q. So, it would be good for the Commission to know, based on the existing core data, what is the actual average saturation that we are seeing in the core. You know, I can cross-check. I'm pretty sure some of Empire's experts probably might have presented that. So, that is something that would be very, very helpful to the Commission. At least you've presented something here, but I don't know how it -- created

this. But these are real data that we do have.

So, it would be good for the Commission to know what is the actual average oil saturation within, let's say, the Upper San Andres, the Lower San Andres. That would be very, very helpful to us.

A. I don't believe we have any core data in the Lower San Andres.

Q. So when you put your marker right in there and you say it's an aquifer, where is that?

A. That? That's a negative 700 TVD subsea.

Q. So where is that?

A. Depending on which geologist you talk to, it could be various places.

Q. I mean, so what should I take? I mean, the Commission, what should we take?

A. In my opinion, basically 700 and below, there's no evidence of hydrocarbons and a lot of evidence of significant water. Above that, above 500, I think you have some evidence, higher evidence of oil in place in the core and in the log analysis. And in between 500 and 700 feet, it's like a -- what I call a transition zone, but very little oil in place, probably doesn't look like an ROZ to me, but...

Q. But sir, so this one is just a type log. I mean, how are you going to -- isn't your testimony --

I know there was a backup for that? Isn't it your testimony to the Commission that right within the San Andres minus 700 across is all -- is your testimony that across 700 on all wells is an aquifer? Isn't that your testimony?

A. Yes. Below that subsea depth I believe is all on aquifer, yes.

Q. But I thought there was back and forth where you identified that barrier, you said below that was when you were getting all the mud losses.

A. Yes.

Q. I mean, it was a little bit -- it was so curious to me that -- you know, I've worked with a lot of petrophysicists, a lot of geologists, and only God knows how long it takes them to all come to a conclusion on where the tops are? So it's a little bit surprising to me that the senior geologist, you said you depended on the petrophysicist to get you the tops. Is that not surprising?

A. No. As I mentioned before, the quagmire of where you pick the top, if I waited for a geologist to come up with a specific top and define it, I would be waiting for my analysis.

But using the subsea depths, which is -- a lot in the CO2 work, you do pore volume out of our

pore volume depth migration. So I think the critical part is what is your volume of oil versus depth. And so I basically -- it hurt some people, but I just took the TVD subsea depth and -- waiting for someone to have a definitive definition of what the San Andres top is.

Q. So is it your testimony that the average core saturation within, let's say, depending on how you call it, but the San Andres is 14.86 percent? That is your testimony?

A. For this, for the core interval, that's the total interval.

Q. So it's your testimony that your original oil saturation is 14.86?

A. Part of that's in the Grayburg, though, I believe, by most people's definition.

Q. So I just want to know, you've looked at the data, you've provided this to the Commission, the 14.86, is it within the San Andres? Or where is it?

A. It is the complete data set, and I guess if you gave me specific tops, we could calculate the average porosity. Each person is going to have a different top, but I think the important thing here is, as you get lower in this section, the oil saturation in the core goes significantly lower.

So at that negative 700 TVD subsea in this well, there's a significant shift in the oil saturations to be much lower.

Q. Yeah, I was trying to do a little bit of math where I would just use oil-in-place calculation formula to try and get some numbers here.

Now, so you estimated 14.86, and I really wanted to understand, is it a good number for the Commission to calculate, let's say, roughly how much oil is going to be in place based on the core?

A. I think it all depends on what your tops are. I think the way I would do it was, I'd stick to my intervals of 350 to 500, 500 to 700, and 700 below, and I'd have the core average oil saturations for those intervals and then it would match up with all my analysis.

Q. Yeah, I thought that was what you were trying to show the Commission, that, see, these are all the core points that we have, but the average saturation is 14.86. I thought that is what you wanted the Commission to take out from here.

A. Yeah, most of the analysis was -- I believe this was from a rebuttal, so it was basically do due diligence on the other petrophysical analysis and saying, okay, does it match core, which one do I agree

with, which one do I think is the best representation of the core data?

And so this wasn't specifically done for an oil-in-place calculation, but I'm very supportive of your questions and the information that would be helpful to you.

Q. Yeah, so if you look at Mr. McBeath's economic analysis that he presented to the Commission, he used 10 percent also. So I was just curious, if the core is telling you 14.86, why then even use 10 percent, you know, estimating to say that there is no economic value?

A. I think it would depend on the depth interval that you were evaluating. And I don't remember exactly the depth interval that John was evaluating.

Q. Now, so there was a lot of testimony, especially with the Empire experts, they talk about the core data should be the minimum value. But it sounds like Dr. Davidson does have a different opinion even where he wants to apply a correction factor to even that data. Can you try to explain to the Commission, you know, both ends?

A. Well, the core data oil saturation does need a correction, and Dr. Davidson used one, I think it

was 1.22, but it looks like the other experts in this case used a much larger correction.

And so that difference between 1.22 and -- I really don't have the numbers on the top of my head, but it was significantly more correction. And I think one of the issues that I had with that is that down in the Lower San Andres, that's going to be lower in the section, and if it is a residual oil, you'd use a lower B sub o, since it has already been flushed. And I think that kind of, just in a ballpark, would indicate that you need a lower, you know, expansion factor to have your uplift.

And I think Dr. Davidson did a pretty rigorous calculation and came up with his range of 1.22 up to 1.26, I think. And I think that's a most likely reasonable -- I mean, you could have some variations around there, which I think he did, but he just used one number.

Q. And did that correction factor increase the saturation or --

A. Yes.

Q. -- decrease the saturation?

A. No. Increase. Increased by about 22 percent.

Q. Okay. So how much weight do you put on the

analysis, Empire's experts' analysis and Dr. Davidson's analysis and then also the core?

A. I go back to the core as being my hard, distinct physical evidence, and so I tried to compare all the analysis back to that core data. And Dr. Davidson seems to be, in my opinion, the best correlation with the actual core data.

Q. So is Goodnight going to provide the Commission what they believe the average oil saturation is within the Upper San Andres and then the Lower San Andres?

A. Yes. I could do that if someone would agree on the San Andres top.

Q. I mean --

A. But I can do it from a depth interval. I feel very comfortable that's where.

Q. Now, I think Goodnight does have the tops, right?

A. Yes.

Q. So, when you say that, depending on the top, I mean, you as the chief geologist understands, you know, making a case for Goodnight? So, Goodnight does have a top or you don't have a top?

A. No, I do believe Goodnight has an interpreted top.

Q. So Goodnight can provide the commission their top, and then also let's say the average oil saturation within that, both for the Upper and the Lower. And I'm hoping that Empire should provide the Commission with the same data.

A. Excellent.

Q. And we do -- I don't know if the Commission, we do have the actual core data or not in terms of the numbers. But it would be good for us to also look at it and do our own calculations with that as well.

A. Excellent.

Q. Slide Number 14. Okay. We've already talked about it. You said this one was in the Grayburg, so I appreciate that.

Now, there has been a lot of discussions about Dr. Buchwalter. Now, the more I listened to Goodnight's experts, the more I get more comfortable with the work that he did.

So, is it your testimony that within the San Andres, there are high streak permeability bugs cast within the San Andres?

A. Within the lower San Andres, yes.

Q. Now, tell the Commission why you are opposing to what Dr. Buchwalter did when he put that permeability within the San Andres as part of his

simulation?

A. I'm not sure I -- not sure I disagreed with the -- I mean, I think the reservoir model, what I disagreed with is the geology he puts into it and the oil in place.

The permeabilities, you know, the distribution of permeabilities maybe, the magnitude. You know, I didn't really have that much of an opinion on the actual permeabilities.

Q. So Dr. Davidson and then yourself presented different theories as to how he could have gotten the water into the Grayburg, you know, for the wells that were producing more water.

A. Yes.

Q. So you have all the theories that could be a possible solution. Why did Goodnight not present that in a model to the Commission?

A. I do not know.

Q. So let me follow up on that and ask if Goodnight had all the input data that Dr. Buchwalter used in his model? I'm asking if you know if Goodnight got all the input data that went into Dr. Buchwalter modeling.

A. Did we get all the data? I'd have to default to, I think, John McBeath. But I don't think

we -- I think there was a hard time getting all the actual data out of the model and the data that supported the input parameters.

Q. So I just want to reiterate this point again. Were there any anhydrites identified in the RR Bell Number 4 well and then also the EMSU 679 that had a core? Are there any established or any documented anhydrites that were found in any of the core?

A. I think I recognized some anhydrites initials by some of the cores, but I didn't -- I don't remember seeing a significant bedded anhydrite interval.

Q. Let's go to Slide Number 24. Thank you. So, here you're showing Tier 2 and then Tier 1. And the bottom, I presume, is it oil or water saturation?

A. That is oil saturation.

Q. So here, when you see a producing zone, which formation are we talking about?

A. The green symbols at negative 350 are Grayburg. And if you use Ops' model, some of the San Andres.

Q. Okay. So here, do we see, so assuming you're saying that the green is all Grayburg, producing zone --

A. Yes.

Q. -- and then the blue will be the potential ROZ, which will be based on your nomenclature, that will be the Upper San Andres.

A. Correct.

Q. And then you have the Lower San Andres and then, let's say, the aquifer zone, more or less becoming the transition zone and then the water aquifer?

A. Correct.

Q. Okay. Do we see any oil saturation within the Tier 2 and then Tier 1?

A. In which interval?

Q. All of them, just -- or you can just focus on the residual zone and then also the transition zone.

A. Yeah, the potential ROZ, there is some Tier 1 and I'd say a significant amount of Tier 2.

Q. And then I saw that maybe this one is different, but the one that I reviewed earlier on, it sounded like it had a total oil in place there. I think there were three.

A. Yeah, there were three columns.

Q. Yeah, what -- did you change your testimony, or...

A. No, I just shortened it so it would fit on that half of the graph.

Q. Yeah, because the one that I reviewed, it sounds like you were showing over 200 million for the potential residual zone. Is that a correct number?

A. Yes. So what I did to get to that number was extrapolated the averages for the wells across the entire EMSU. And basically, I don't think that's a realistic way of doing it, but I wanted to be -- originally, I was just trying to match what other people did by, okay, how do I compare my oil in place to theirs? Well, they extrapolated it over the entire interval, so I did also.

But I think the critical issue on recovery is the concentration of oil. You know, if you have, you know, one barrel of oil in 100 feet or one barrel of oil in 1,000 feet, the higher concentration is much more valuable, you get a higher recovery factor.

So I think the critical issue that I'm trying to focus on here is the oil concentration in MBO per section.

Q. Yeah, but -- so based on your analysis, I saw over 250 million barrels. So are you saying that Empire should not go for it?

A. Well, if it was equally distributed over the entire area by just extrapolating the data points, that's the number you get to.

But I think a better way of analyzing it is to look at the concentration in a section area. And if you were to do a pilot, you'd pick a section, and this is the average oil in place in that section.

So I think it's a much easier reference if you're going to go to that next step of trying to determine how economic it would be to recover. Because you can do a pilot in a square mile area and come up with a spacing, you know, how many wells are in it, you know how much oil you're recovering, rather than having a large volume of 250 million barrels over 11,000 acres and, you know, ten-acre spacing, you know, you'd need a thousand wells. This way you can get a more functional economic unit to kind of evaluate your --

Q. You know, you talked about the San Andres being under pressure. And I promise I'm not going to go much detail with you on that, but, you know, coming to that conclusion, did you incorporate the supply water wells, the withdrawals from those wells into your analysis?

A. Well, there were two points. I think there

was a 1959 study that was introduced a little earlier that had about a .38 something. And then just some recent data that I think was supplied to the Commission that showed this local area where Goodnight has injected a number and came up to 3.83 as a current.

And so 1959 to current, having almost identical pressures, I guess that kind of incorporates the ups and downs of supply, injection and withdrawals in the region.

Q. In one of your slides, I saw that you had a perm barrier that you put in. I saw that in one of your slides --

A. Yes. I t was --

Q. -- a yellow region mapped as a perm barrier. Do you remember something like that?

A. I think there were a number. There was one in the 746 well and then my cross-section with two wells that I was trying to do a sensitivity analysis on. I forget which one it would be.

Q. Yeah, that'll be on Page 24 of your -- of 32 total pages?

A. Yes.

MR. RANKIN: Is it in Mr. Knights' testimony, Dr. Ampomah?

A. In the summary slides.

Q. Labeled as now Goodnight Number 8 testimony, Exhibit E. E.

A. Yeah.

Q. There was two wells with a cross-section where we do have a perm barrier, a permeability barrier.

A. Page 32?

Q. 24 out of 32. Yeah, right there.

A. Oh, okay. This is an older one.

Q. Oh, there's another one. Is another one -- can you talk to it, or --

A. Yeah. I can talk to any of it.

Q. So, I want to know, is your perm barrier the same as that picked by Dr. Davidson?

A. I'm not 100 percent sure. This was an early well, and these are actually the two wells that had spectral gamma rays. And you were asking earlier how far those were away, and I guess there's three miles -- maybe a little more than three miles away.

But yes, that perm barrier is -- I think the better slide to do is in my summary slides. I think it's probably halfway through, maybe Page 12.

Q. Yeah, probably. Let me just ask a general question. The depend barrier that you picked, they're

the same as the ones that the Division picked, or it's different?

A. Different. There are sensitivities in perm barriers, and so what I was trying to show in that cross-section is Ops' perm barriers or barriers that were based on a 1.5 percent porosity, which I thought was very low. And then I just tried to use a more reasonable, most likely, you know, 50 percent perm barrier, or not at 7 percent porosity. And then I also used the .02 perm that Dr. Birkhead had determined, and used that.

And if you use all -- any of those situations, you can get a significant number of perm barriers throughout the entire section.

Q. So is it your testimony that your perm barrier was strictly based on porosity permeability cutoff, and Dr. Davidson perm barriers were based on anhydrites?

A. Correct.

Q. So which one should the Commission take?

A. My guess is both are probably --

Q. Anything --

A. Together, there's just a lot of perm barriers.

Q. So is there a cross-section that shows

entirely -- so if you look at this cross-section in Figure 4 that we are seeing right now, can you also have the same cross-section showing the Commission how you picked your barrier throughout the EMSU the same for Dr. Davidson?

A. Yes, we could do that. I don't think I have.

Q. Now, let me ask you. So these series of questions were based on the cross. I just want to clarify some few things.

Did Goodnight already have their own perm barrier before you -- prior to your work?

A. I do not know.

Q. Did you review the application to the Division?

A. I guess, briefly.

Q. So there was no baseline for you to compare your work to?

A. No, no. I'm basically totally independent.

Q. Then when they say that confirm barriers, what were they referring to in your scope of work?

A. I'm not really sure what they were confirming to. But in my -- I took that as review the perm barrier and tell me what you believe.

Q. Review the perm barrier and tell me what you

believe. What perm barrier? If it's not there --

A. Correct.

Q. -- what perm barrier?

A. Well, semantics. But, basically, I was going to look for the communication between those two, and I think they believe there was a perm barrier in there, so I think they said, "Confirm this perm barrier."

And basically in my line of business, people tell you a lot of things, but you basically go back to the data, put your professional opinion on it to tell them. A lot of times, it's not what they want to hear. But in my line of work, it's just you have to have, you know, your best effort at getting to the right answer.

Q. So you made a comment as part of the cross, you said San Andres is not a defined interval. Do you remember something like that?

A. Mm-hmm.

Q. But Empire believes that they've characterized, they've described the San Andres. So you know, I'm just trying to understand in terms of you saying that the San Andres is not well defined, so why should we agree with your interpretation?

A. Basically, mine is a reservoir

characterization, so I look at the oil -- the potential reservoir. So I look at pore volume, permeability and isolation of intervals and zones that can be just exploited economically.

And if you have multiple reservoirs in -- you know, one of the big things we have is for many big companies that are in the same reservoir, they all have different nomenclature for different tops and different intervals. And I don't really care what they call it. I'm going to pick -- this is an interval that I think is a boundary here, a boundary here, and this is a separate interval. And then they can call it anything they want, but all I need to do is decide what the reservoir characteristics are in those individual zones.

And so I apologize that it's very difficult, this nomenclature thing. It's more of a legal issue than a reservoir characterization.

Q. So you also made mention of potential barrier.

A. Yes.

Q. You recall that? Does that mean that we don't have enough data to confirm that?

A. I generally don't like to make affirmative statements of 100 percent certainty on really

anything, because in the oil business, you realize that things can happen and you look at the preponderance of data, all the data you evaluated, and it suggests there's a perm barrier there.

And I would say, you know, on an individual basis it's a potential perm barrier. But when I have a preponderance of a significant number of potential perm barriers, then it becomes more likely that there's a significant barrier to fluid migration.

Q. So, sir, you made a good point here. You said that you don't normally -- you want to attach uncertainty to your estimations; your don't want to really tie yourself to a particular, let's say, decision or something like that?

A. Yeah.

Q. Now, I've reviewed all the -- you showed us clearly all the wells that you performed petrophysical analysis on. Let's say Dr. Davidson did that. I've also reviewed all the work that Ops Geologic did, that NuTech did. It's all based on uncertainty, right? So why should the Commission not give Empire the opportunity to go and explore based on the uncertainties that we are seeing here?

A. Well, I think some of it's precedence. And from my look at the reservoirs, I think the certainty,

the alleged resources that are proposed for the lower San Andres, I think Jim Davidson's analysis, in my opinion, is more accurate and indicates that there is little to no significant oil in the lower San Andres.

And then it also comes down to, just in general, the New Mexico oil and gas industry in, itself. This water disposal -- you know, there's about 1,700 horizontal wells completed a year in the in the Delaware Basin, and that comes out to about 70,000 barrels a month of new production at a water-oil ratio of 3 to 1. That's going to be around 210,000 barrels a month that New Mexico is going to have to find a place to put that water. And in a long term, that's just a month. So if you can extrapolate that out, very big numbers.

But the other thing is just the precedence of using the San Andres as a water supply and a water injection zone is just an industry common practice. And I think this reservoir is unique in this under pressure, which I'm still fascinated by how that came to be or -- but it does seem to be there.

But I think the best thing for the New Mexico State is to have these people both coexist. If I was asked by Empire what I would consider them doing, I'd say, you know, "Your most oil in place, no

matter whose petrophysical analysis you're looking at, is in the Grayburg. And you already have some infrastructure there, you have the oil in place and that's probably your most economic chance. And if you go down to the 350 to 500 foot interval, there is some indications. I believe, that Jim Davidson's petrophysical analysis says there's very high risk. But if you believe your petrophysical analysis, then that 150 feet may be the next best thing to do."

But I think jumping down into the Lower San Andres, well, I think there's significant evidence that the alleged resources down there may not exist at all. I think there's plenty of activity that they could do above there.

I guess that's my general feel of just reviewing the reservoir quality, the oil in place, the certainty of the other evaluations that we've looked at. I think the preponderance of actual physical evidence I think supports my conclusion and Jim Davidson's petrophysical analysis.

Q. So are you saying that based on the data, based on the evidence that is available, that is your opinion, right?

A. Correct.

Q. But so, the Commission, you've not shown us

any evidence that there's an isolation between the Lower San Andres and then the Upper San Andres. You cannot -- you don't have the physical evidence to show the Commission that this is the barrier that we believe that there is no communication between the Upper San Andres and then the Lower San Andres. Is there any literature supporting that, any reference supporting that?

A. I don't know of any literature that states that.

Q. And then your opponent is saying there's no barrier.

A. Yeah. I don't quite understand that conclusion.

Q. You know, but you've not shown us a cross-section, no literature showing that there's a clear barrier between the Lower San Andres and then the Upper San Andres. So what evidence, what preponderance of evidence, have you shown to the Commission that we've mapped up this as a barrier, so this is our suggestion that let Empire focus on the Upper and there will be no communication from the Lower?

A. Is this -- interesting the way this legal process works in the rebuttal versus the just do my

work and present a case.

So I spent a lot of time rebutting some what I think are very unrealistic data use or saying there is communication between there. I really don't see any evidence. And just the geologic system here, I don't think there's any realistic way there's any communication between the two.

But you're correct that as a distinctive literature map, definitive map, I do not have that. I've not created one. And I can see how that would be helpful to the Commission.

Q. You know, I've listened to all the testimony, and I'm looking forward to dialogue with Larry Lake, Professor Larry Lake, you know.

Let's say -- and I don't want to get into the pressure issue with you, but --

A. Interesting discussion, though.

Q. Yeah. You know, let's say when you look at, let's say, the production history, what is withdrawn, what is, let's say, put in, your are right, there is clear evidence that there is no communication. Right?

But what about that huge volume of water that has been proposed? Have you forecast into the future -- you've even -- based on your own testimony, you're telling the Commission that they are karsts,

you know, there are perm barriers, you know, there are some karsts in there.

So is that also not a risk if the Commission allows a huge volume of water to be injected, even though now we do not have the evidence that there is a communication?

A. Well, again, I'd come back to the -- the strongest evidence is material balance, which is volumes and pressures. And I think monitoring pressures would be a valid way of making sure that there isn't a pressure increase. And when you see one, then you can react.

Currently, the way I see this now is that there's a reaction before the evidence shows that there's communications. But I think monitoring the pressure and allowing the current state, and if you allowed four more permitted wells to inject a lot more oil [sic], you'd get to an answer much quicker, the pressure monitoring. And it'd be very interesting.

Because just .383 over a large -- I just -- it amazes me how little pressure variation for the volumes of water that were both extracted and input. I just -- it's just amazing. But it's just a unique situation, and I do believe that they can attack their most valuable asset and send in, and

Goodnight can help the oil industry produce all the oil they want.

Q. Well, but Mr. Wheeler was saying if Goodnight moved two miles away from the operations, they are not going to contest. So it's not like they are shutting you off. They provided options. Why not take it?

A. I do not know. That's out of my purview. Is that correct?

Q. You know, when you talk about there's no evidence that there's communication, I mean, the question that I will ask you is, if you see that bubble map that was shown to the Commission and you see excessive water production, the question I have for you is, how did the operator solve that problem to have effective material balance communication?

A. I do not know.

Q. So then it's still -- but so the person who owns all the data is saying there is a communication. And you're saying that you don't know, but, I mean, so then -- and you did not provide any theory or any model showing a different way as to how water can get -- higher production can get through these wells. There's not been any evidence, no models from Goodnight to establish that other than we don't know

what went on.

A. Well, I agree we did not have a reservoir model. But I think the 1939 paper that showed water at the crest of the structure in 1934, '35, '36 and '37 indicated that it was there.

And the perm barriers, basically the migration paths that Dr. Lindsay shows, they're all around bedding planes. So that is the preferred mechanism for migration of all oil; it's laterally, it's not vertical. The perm barriers that are used to identify perm barriers are horizontal permeability.

And so, generally, vertical permeability is a magnitude smaller, so using that as a perm barrier, I think would be maybe conservative. But I think, just to geologic mechanisms of layered beds, migration along bedding paths, and also in Dr. Lindsay's fracture analysis, he described that the predominant amount of fractures were in the karsted intervals.

And the karsted intervals are relatively thin. In the 679 well, they were between 1 and 3 feet, and there was one that was about 10 foot thick. But that's the limit of those karsts. And if most of the fractures are in those karsts, that would be a lateral fracture pattern that would increase the

permeability horizontally, which, in my opinion, is the way all the water got into those wells.

And I think if you actually look at the volumes, you take it out over the years and the cums, the excessive water volumes, I think I estimated about 300 barrels a day. So it may have been a large volume, but it was over a long period. So the actual excessive values, I think from a total perspective are not quite as dramatic as I expected from looking at that big map with a mesh.

Q. You know, you made a comment during the cross and I thought that was interesting. You said something to the effect of Empire and its consultant did a significant amount of work, and your responsibility was to review it and critique that, instead of doing independent work to support the case.

I mean, can you comment on that statement?

A. That's primarily my job, is to evaluate, QC and when needed, do the evaluation myself, but that's a secondary step.

Jim Davidson, or Dr. Davidson, is a petrophysicist. You know, he's been there about 20 years. But I find him incredibly, incredibly intelligent, and most of his work turns out to be

correct. Although criticized as -- you know, we, as a company, occasionally are being criticized for being conservative, but we really are trying to present the most realistic case from the data that we see.

Q. Yeah, and even if you look at Dr. Davidson's work, you know, I'm not criticizing his work, you know, same as, let's say, the consultants from Empire, all different strategies, but I do see some similarities in their work.

A. I agree.

Q. And that is the core, right? So that is where I want to focus on. I mean, these higher volumes, I had my questions, you know, I went back and forth with the experts, you know, with some of these higher saturations and all of that.

But I think the real evidence is the core. And I feel like all these analyses, they are more or less in agreement with the core, some way, somehow. Do you believe that?

A. To some degree.

Q. Okay, okay. Now, is it your opinion that oil-water contact is static?

A. No.

Q. But I thought Empire's counsel was going back and forth with you on that, and it sounded like

you feel like it has to be a constant number that hasn't changed.

A. No. But I did disagree that producing oil and the contact going down would be inappropriate.

Q. But you believe that oil-water contact is not static?

A. It goes up. Gravity.

Q. Oil-water contact --

A. The water goes up. I may have misunderstood the question as it was directed, but the statement I heard was the oil-water contact effort production went down. And because he was talking about negative 350 and negative 550 --

MR. WEHMEYER: I can probably clarify the confusion I created. Based on the publication that we showed that slide, they wrote that it was an error on the original one and that it was actually at 540, 550 subsea, which is what Dr. -- so the early one was an error, the lower one was accurate, and that's been written on.

COMMISSIONER AMPOMAH: Okay. Thank you. I appreciate that clarification.

BY COMMISSIONER AMPOMAH:

Q. Now, has anyone from Goodnight done total analysis on how the proposed saltwater injection in

combination with the existing saltwater injection are going to have, you know, considering the barriers that has been discussed?

A. The alleged perm barriers?

Q. I'm not going to say that. Is there someone going to discuss that in more detail, you know, to the Commission that you know?

A. I'm not sure. You know, I would assume so.

COMMISSIONER AMPOMAH: Okay. I think I'll end here. Thank you so much for your time.

THE WITNESS: Thank you.

MR. SHANDLER: Mr. Hearing Officer, can I have two questions to follow up? I'm over here on the left.

HEARING OFFICER HARWOOD: I'm not used to looking over there. Sure, absolutely? Go for it, Mr. Shandler.

EXAMINATION

BY MR. SHANDLER:

Q. All right. So both parties are in the same unit. If the Commission decides it's a tie and wants to divide it up, what is the number where the new division should be in the sandbox?

A. Was that a question to them?

Q. That is a question.

A. I would do negative 500 and negative 700. That interval would be like the demilitarized zone, and we monitor it very distinctly to see if there's any evidence that there's any vertical movement up and down from there.

Q. And so there are existing permits that Goodnight has, would they be -- the existing permits, are they in the DMZ zone already?

A. I'm not even sure where they're located.

Q. And the proposed ones, are they in the DMZ zone?

A. I don't -- you mean, perfed within the negative 700 to negative 500 TVD subsea depths?

Q. Yes.

A. I don't think they are, but...

Q. I guess, will there be a witness who will explain historically why the existing Goodnight wells were chosen at that number, where they were drilled?

A. I guess the location, I'm not sure. The depth at which they were completed was the understanding of the reservoir and the karsting below that negative 700, approximately, depths.

Q. So there was already previous work figured out why these existing wells were drilled to a specific depth?

A. I believe so.
Q. And that will be presented?
A. Yes.
MR. SHANDLER: Thank you.
THE WITNESS: Is that appropriate?
HEARING OFFICER HARWOOD: Thank you, Mr. Shandler.
So this brings us to redirect examination. Is there any possibility, remote possibility, that we might finish this witness today?
MR. RANKIN: No.
HEARING OFFICER HARWOOD: No?
MR. RANKIN: No.
HEARING OFFICER HARWOOD: Hope springs eternal. All right.
Let me ask you, Mr. Rozatos, I mean, we still have almost 25 minutes, shall we use it? Or what are your thoughts, Mr. Chairman?
CHAIR ROZATOS: Mr. Rankin, would you be able to have a good stopping point in 25 minutes, or would you just prefer to start first thing in the morning?
MR. RANKIN: I don't have my mind how I'm going to segregate out the questions. I'm just going to walk through my notes. So I don't have a distinct

stopping point in my mind.

I could start and do a few minutes and we could break, or if everyone's -- you know, we could start in the morning. I'm fine either way.

CHAIR ROZATOS: For the sake of continuity, then, maybe we should just start first thing in the morning. That will allow you to gather your thoughts, it will allow the witness to have a break as well. And I mean, it's only 25 minutes, so it's not like we're wasting that much time for today.

HEARING OFFICER HARWOOD: All right. That's great. And along the lines of hope springing eternal, if you gather your thoughts and get organized overnight, maybe a cross-examination will be shorter.

THE WITNESS: It's a good chance.

HEARING OFFICER HARWOOD: All right. Great. All right. Then if there's nothing further, we'll be off the record for the day and we'll see everybody again tomorrow at 9:00. Thank you.

CHAIR ROZATOS: Thank you, everyone.

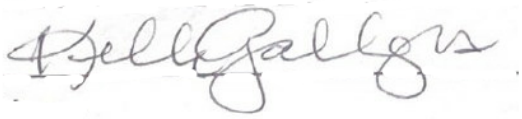
(Proceedings adjourned at 4:33 p.m.)

AFFIRMATION OF COMPLETION OF TRANSCRIPT

I, Kelli Gallegos, DO HEREBY AFFIRM that on April 22, 2025, a hearing of the New Mexico Oil Conservation Commission was taken before me via video conference.

I FURTHER AFFIRM that I did report in stenographic shorthand the proceedings as set forth herein, and the foregoing is a true and correct transcript of the proceedings to the best of my ability.

I FURTHER AFFIRM that I am neither employed by nor related to any of the parties in this matter and that I have no interest in the final disposition of this matter.

May 9, 2025 

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