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3	OIL CONSERVATION COMMISSION
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7	Santa Fe, New Mexico
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10	TRANSCRIPT OF PROCEEDINGS
11	February 24, 2025
12	VOLUME II
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16	HEARD BEFORE:
17	HEARING OFFICER RIPLEY HARWOOD
18	
19	COMMISSION MEMBERS:
20	GERASIMOS ROZATOS, Chair
21	BAYLEN LAMKIN, Member
22	WILLIAM AMPOMAH, Member
23	
24	COUNSEL TO THE COMMISSION:
25	DANIEL RUBIN
	Page 1

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1	
	I N D E X
2	PAGE
3	
4	TRANSCRIPT OF PROCEEDINGS5
5	THE WITNESS
5	ROBERT FORREST LINDSAY
6	Direct Examination by Ms. Hardy11
	Cross-Examination by Mr. Rankin40
7	Cross-Examination by Mr. Moander
8	Recross-Examination by Mr. Rankin 240
U	Re-Cross-Examination By Mr. Moander243
9	
	EXAMINATION BY THE COMMISSION
10	By Commissioner Ampomah
11	By Mr. Rubin
12	ADMITTED EXHIBITS
	Empire New Mexico Exs. B, B-1 through B-34,
13	J and J-1 through J-12 and Appendix 113
1 /	Goodnight Midstream Cross Ex. 1
14	Empire Rebuttal Ex. J-13
15	
	TRANSCRIPT CERTIFICATE249
16	
17	
18 19	
20	
21	
22	
23	
24 25	
40	
	Page 4

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1 (On the record at 9:16 a.m.) 2 TRANSCRIPT OF PROCEEDINGS 3 CHAIR ROZATOS: Okay. Good morning to everyone. Happy Monday. This is the continuation of 4 5 the OCC hearing that we started up on Thursday. Today is Monday, the 24th of February. 6 7 As I've stated before, my name is 8 Gerasimos Rozatos. I am the acting director for the Oil Conservation Division. I'm also the acting chair 9 for the Oil Conservation Commission. 10 11 With me, we have the other 12 commissioners, so can we do a roll call real quickly. 13 COMMISSIONER AMPOMAH: I'm Dr. William Ampomah, a professor and professional engineer at 14 15 New Mexico Tech, designee of the Energy secretary. 16 Thank you. 17 COMMISSIONER LAMKIN: My name is Baylen Lamkin, a petroleum engineer, designee of the 18 19 commissioner of public lands. CHAIR ROZATOS: Excellent. So I would like 20 21 to bring this meeting back in order for today and for the rest of the week. We will be continuing our 22 23 hearing for consolidated case by Goodnight Midstream 24 and Empire New Mexico. It's Case Numbers 24123, 25 23614 through 17, 23775, 24018 through 24020, and

1	24025. It's an evidentiary hearing that is going to
2	be heard in front of the Commission.
3	Are all parties present? I will start
4	from the right of the room and then work my way over
5	to Mr. Rankin.
6	MR. RANKIN: Good morning, Commissioner
7	Rozatos, Commissioners. Adam Rankin appearing on
8	behalf of Goodnight Midstream and these cases.
9	CHAIR ROZATOS: Excellent. Thank you.
10	MR. PADILLA: Members of the Commission,
11	Ernest L. Padilla on behalf Empire New Mexico.
12	CHAIR ROZATOS: Bring your mic down,
13	Mr. Padilla, so we'll pick it up. Thank you.
14	MR. PADILLA: Members of the Commission,
15	Ernest L. Padilla for Empire New Mexico.
16	CHAIR ROZATOS: Thank you.
17	MS. HARDY: Good morning, Members of the
18	Commission. Dana Hardy on behalf of Empire
19	New Mexico, LLC.
20	CHAIR ROZATOS: Thank you, Ms. Hardy.
21	MS. SHAHEEN: Good morning, Commissioners,
22	everyone, Sharon Shaheen, also on behalf of Empire
23	New Mexico.
24	CHAIR ROZATOS: Thank you, Ms. Shaheen.
25	MR. WEHMEYER: Corey Wehmeyer, Santoyo
	Page 6

1	Wehmeyer, PC, here on behalf of Empire.
2	CHAIR ROZATOS: Thank you, Mr. Wehmeyer.
3	MR. BECK: Matt Beck on behalf of Rice
4	Operating Company and Permian Line Service, LLC.
5	CHAIR ROZATOS: Thank you, Mr. Beck.
6	MR. MOANDER: Thank you, Mr. Beck.
7	Chris Moander on behalf of the
8	New Mexico Oil Conservation Division.
9	CHAIR ROZATOS: Excellent. And on our
10	platform.
11	MR. SUAZO: Good morning, Commissioners.
12	Miguel Suazo with Beatty & Wozniak, appearing on
13	behalf of Pilot Water.
14	CHAIR ROZATOS: Excellent. Thank you,
15	Mr. Suazo. Anybody else on the platform?
16	Excellent. Before we start, I know
17	there were some issues that came up on Friday, so I
18	will transfer it over to Dan.
19	MR. RUBIN: Good morning, folks. Just two
20	quick preliminary matters, I believe, before we get
21	started.
22	The first is, Mr. Harwood, there was an
23	e-mail I sent out to the parties on Friday,
24	documenting the waiver of any notice issues. So
25	unless any of the parties now have something else to
	Page 7

1 state about that position, I would ask that that be 2 included in the record. You had that e-mail on 3 Friday. 4 HEARING OFFICER HARWOOD: Yes, sir. 5 MR. RUBIN: Second issue, there was a motion to reconsider filed by the Oil Conservation Division. 6 7 We had sua sponte, as they say, which means without 8 motion from the parties, struck this, the 9 supplemental rebuttal, the statement by the OCD as it appeared to be beyond the deadline. However, there 10 11 is a motion now to reconsider that ruling. 12 I will say that, as per Mr. Moander, 13 there is no objection from the parties to the motion to reconsider this filing. And I have reviewed the 14 15 filing. And unless the Commission has any questions 16 for me or wishes to go into closed session, I would 17 recommend that the motion to -- hold on, we have a little blackout. Okay. -- that the motion to 18 19 reconsider filed by OCD be granted. 20 Before I ask for a motion on that, do 21 any of the parties object to the motion to reconsider? 22 23 MR. RANKIN: No. Speaking for Goodnight 24 Midstream. 25 MS. HARDY: No, on behalf of Empire. Page 8

1 MR. RUBIN: Mr. Beck? 2 MR. BECK: No objection. MR. RUBIN: Mr. Suazo? 3 MR. SUAZO: No objections from Pilot. 4 5 MR. RUBIN: So if I could have a motion to 6 grant OCD's motion to reconsider the striking of its 7 supplemental rebuttal testimony and exhibits. 8 COMMISSIONER AMPOMAH: Mr. Chair, I move 9 that we approve the motion by OCD. CHAIR ROZATOS: I second it. 10 11 MR. RUBIN: All in favor, say aye. 12 ALL MEMBERS: Aye. 13 MR. RUBIN: Any opposed? Okay. Motion 14 passes. 15 (Motion approved.) 16 MR. RUBIN: I will now turn it back over to 17 Mr. Harwood. That's all I have. 18 HEARING OFFICER HARWOOD: Okay. Good 19 morning, everybody. So my understanding is that 20 Empire goes first. Is there anything preliminary 21 from Empire before we move straight into your witnesses? 22 MS. HARDY: No, Mr. Examiner. Thank you. 23 24 HEARING OFFICER HARWOOD: All right. Let's 25 see. I'm looking at my notes, and I'm not sure if Page 9

1 you'll be calling them in this order, but my notes 2 show that you mentioned Jack Wheeler first. Is that 3 your first witness? 4 MS. HARDY: Mr. Examiner, we've shifted 5 around our witness order to accommodate schedules. 6 HEARING OFFICER HARWOOD: Sure. 7 MS. HARDY: And our first witness is actually Dr. Robert Lindsay. 8 9 HEARING OFFICER HARWOOD: Is he here in 10 person? 11 MS. HARDY: He is here in person. 12 HEARING OFFICER HARWOOD: I'm not sure what the protocol is. Do we usually have witnesses up 13 here on the witness stand? 14 15 CHAIR ROZATOS: So, yes. Mr. Lindsay, if you'll come, please, 16 17 have a seat right here on the witness stand. And if you'll also, please, once you do come to the witness 18 19 stand, press the microphone button. It's the little 20 person with the two marks right in front of them. 21 You can turn the microphone on, please. There you 22 go. 23 HEARING OFFICER HARWOOD: Ms. Hardy. 24 MS. HARDY: Thank you. 25 Page 10

1 ROBERT FORREST LINDSAY, 2 having first been duly sworn, testified as follows: 3 DIRECT EXAMINATION BY MS. HARDY: 4 5 O. Good morning, Dr. Lindsay. 6 A. Good morning. 7 Q. Could you please state your full name for 8 the record. 9 A. It's Robert Forrest Lindsay. 10 Q. By whom are you employed, and in what 11 capacity? 12 A. I'm a consulting geologist, so I'm 13 self-employed. Q. Have you previously testified before the 14 15 Commission? 16 A. No. 17 Q. Have you provided a summary of your education, training and experience with your direct 18 19 testimony? 20 A. Yes. 21 Q. And can you please provide a brief summary 22 of your experience that is specific to the Eunice 23 Monument South Unit, which we will refer to as the 24 EMSU. 25 A. Okay. I first started working on -- at EMSU Page 11

1 in November 1988 and worked on it continuously into 2 the early 1990s, and then worked on it sporadically through the remainder of the 1990s into 2002, when I 3 retired from Chevron, and then used the data from 4 5 Eunice Monument to write a Ph.D. between 2004 and 6 2014. 7 Q. And did you obtain your Ph.D.? A. Yes, I did. 8 9 Q. In what subject? 10 A. In geology. 11 MS. HARDY: And, Commissioners, Hearing 12 Examiner, based on Dr. Lindsay's qualifications as 13 set out in his direct testimony and here today, I would request that he be qualified as an expert in 14 15 petroleum geology. HEARING OFFICER HARWOOD: Any objection, 16 17 Mr. Rankin? 18 MR. RANKIN: No objection. 19 HEARING OFFICER HARWOOD: He'll be so 20 recognized. 21 BY MS. HARDY: 22 O. Dr. Lindsay, have you provided direct and 23 rebuttal testimony and exhibits in this case? 24 A. Yes. 25 Q. Do you affirm today, under oath, that your Page 12

1	testimony is true and correct?
2	A. Yes.
3	MS. HARDY: Commissioners, I request that
4	Dr. Lindsay's direct and rebuttal testimony and
5	exhibits, which are Exhibit B, B-1 through B-34 and
6	Exhibit J and J-1 through J-12 and Appendix 1 be
7	admitted into the record.
8	HEARING OFFICER HARWOOD: Any objection,
9	Mr. Rankin?
10	MR. RANKIN: No objection.
11	HEARING OFFICER HARWOOD: They'll be so
12	admitted.
13	MS. HARDY: Thank you.
14	(Admitted: Empire New Mexico
15	Exhibits B, B-1 through B-34, J,
16	J-1 through J-12 and Appendix 1.)
17	BY MS. HARDY:
18	Q. And, Dr. Lindsay, I'm going to share my
19	screen here so we can talk about some of the
20	highlights of your testimony. Can you see that?
21	A. Yes.
22	Q. Okay. Dr. Lindsay, what does this slide
23	that's up on the screen show?
24	A. Okay. This is an index map on the left of
25	three unitized fields that are referred to as EMSU-B,
	Page 13

1 EMSU and AGU from north to south. 2 And on the right is a close-up view of 3 the EMSU, with some key cored wells shown in numbers. And two of those numbers, 679 and RR Bell Number 4, 4 5 will be shown a little bit later, as well. But it's a good reference slide so you know where they're 6 7 located. Q. And, Dr. Lindsay, as you know, these cases 8 9 are focused on the EMSU, but do you have to consider 10 the geology in the surrounding area in Eunice in your 11 evaluation? 12 A. Yes. 13 Q. And why is that? 14 A. To get the big picture. To try to 15 understand how these little unitized fields fit into 16 the context of the geology that's to the east of them 17 and to the west of them, and along strike, as well. Q. And are the EMSU 679 and RR Bell 4 wells 18 19 particularly relevant to your analysis? 20 A. Yes. Q. Okay. Let's look at your next slide here. 21 22 Can you explain what this slide shows? 23 A. Okay. On the left is a little index map 24 that shows four fields, with the orange one being EMSU. And on the right is a cross-section that's 25

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1 going right through the middle of EMSU. 2 The black vertical bars are the cored intervals that I described. And the cross-section is 3 what we call cycle-by-cycle correlation of all the 4 5 stratigraphy, with the red being dolomitized ooid 6 grainstones, that have the highest porosity and 7 permeability. 8 The orange are what are called 9 grain-dominated dolomitized packstone. The light blue being mud-dominated dolomitized packstones. And on 10 11 the right, the gray being what are called 12 dolopackstones. 13 The red have the highest reservoir 14 quality. The orange has kind of intermediate 15 reservoir quality. The blue has lower reservoir 16 quality. And the gray has the least reservoir 17 quality. And the yellow that comes through are 18 inner bedded dolomitic sandstones. And on the lower 19 20 left, that is a few little beds of fusulinid 21 dolostone. 22 Q. And, Dr. Lindsay, what is it that's important about this slide? 23 24 A. We wanted to correlate the stratigraphy from updip to downdip so we knew which layers of strata 25 Page 15

1	were laterally connected.
2	Q. Dr. Lindsay, what does this slide show,
3	please? And it's Number 4.
4	A. This is an east-west regional cross-section
5	through the Permian Basin that extends all the way to
6	El Paso, Texas.
7	And the upper diagram is what happened
8	to the west side of the Permian Basin. It tilted up
9	the late Eocene to the early Miocene. And when it
10	tilted up, it captured rain and snow and brought water
11	into the subsurface of the Permian Basin, that we
12	refer to as "meteoric recharge."
13	And this water passed these plutons that
14	created this uplift and was heated up so it became
15	hot, high-pressure, high-volume meteoric recharge.
16	That's what the top illustration shows. That was from
17	just the late Eocene to the early Miocene.
18	And then the area rifted and pulled
19	apart and destroyed that recharge area in the middle
20	to late Miocene, when the Rio Grande Rift formed. And
21	at that point, just a little bit of cool,
22	low-pressure, low-volume meteoric recharge will now
23	come into the Permian Basin.
24	And in the upper slide, it's basically
25	saying that there was a lot of high pressure that was
	Page 16

1 able to push oil out of structural closures, even if 2 those closures were 4- or 500 feet in height. The 3 amount of pressure was greater than that and could actually push oil out of the structural closure and 4 5 create what we call a "residual oil interval." That's what we initially called it. And then later, it 6 become known as "residual oil zones." 7 8 Q. And why is this slide important? 9 A. Pardon? Q. What's the relevance of this slide here, for 10 11 our purpose? 12 A. The relevance of it? 13 Q. Yes. A. Oh, this is the mechanism that created 14 15 residual oil zones in the Permian Basin. 16 Q. Including in the EMSU? 17 And then when the area rifted and A. Yes. 18 pulled apart, then some of the fields, but not all of the fields, that had residual oil were able to 19 20 backfill completely or partially or not refill at all 21 and remain a residual oil zone. 22 And in one case that we're aware of, instead of re-saturating with mobile oil, one field 23 24 actually re-saturated with gas instead of oil. 25 Q. Dr. Lindsay, what does this slide show? And

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1	this is Slide Number 5, for the record?
2	A. Yes. This is a core description that I did
3	on the RR Bell Number 4. On the left is the complete
4	core description. The coring actually started just
5	above the Grayburg in the base of the Queen Formation
6	and went through the complete Grayburg section, and
7	then extended down into the San Andres. That's the
8	left.
9	And on the right is just a close-up of
10	the San Andres part of that core description. And
11	we've cut the core description into the well log and
12	depth adjusted it so you can see what the Upper
13	San Andres looks like.
14	And the little black bars in the middle
15	show where there's oil saturation that was visible to
16	the naked eye.
17	Q. And, Dr. Lindsay, does this slide show a
18	residual oil zone in the San Andres?
19	A. Yes, yes. All of these intervals, I
20	believe, are part of the residual oil zone.
21	And when I saw the oil at the very base
22	of the cored interval, being a good exploration
23	geologist, I realized that there has to be even more
24	oil deeper. And the great question is: How much?
25	Q. Dr. Lindsay, what is shown on this slide,

1	which is Exhibit B-26?
2	A. Okay. This is just a close-up again of the
3	RR Bell Number 4, showing the oil-stained intervals in
4	that core description, from top, just below the top of
5	San Andres, to the base of the cored interval.
6	Q. Dr. Lindsay, what's shown on this slide,
7	which is Number 7?
8	A. Oh, yes. This is the on the left is a
9	box-by-box photograph of the EMSU 679 core. And on
10	the right is box-by-box photographs of the RR Bell
11	Number 4.
12	And on the lower left of each of these
13	illustrations is the top of the cored interval. And
14	on the upper right, is the base of the cored interval.
15	And when you look at this, there will be
16	a plain light photograph of the core, and then next to
17	it will be the same box with the ultraviolet light
18	photographs.
19	And we've shown where, if we just look
20	at the left to begin with, you can see where the
21	base of and so you start in the lower left and you
22	go up to the top to go down the section. And you can
23	see the base of the Grayburg.
24	And the remainder of the core, where we
25	have that yellow line, is all of the San Andres that
	Page 19

1 was cored in this particular well. And the core was 2 oriented down to 36 feet within the San Andres, with the idea being doing a fracture study besides doing a 3 core description of both the Grayburg and the 4 5 San Andres. 6 Then on the right is basically the same 7 thing, with the lower left being the top of the core 8 and the upper right being the base of the cored 9 interval. And, again, we're showing what is in the Gravburg and what is in the San Andres. 10 11 And in both examples, if you look at 12 very last box of core, whether it's in the 679 or in 13 the RR Bell Number 4, you'll see the oil stain right at the base of both of these cores. 14 15 So that told us that there's oil 16 saturations deeper into the San Andres. 17 O. Dr. Lindsay, how can you tell -- well, what color is the oil staining for the --18 19 A. It will be a gold color, a brown to gold color. And there will be lots of pieces that will be 20 21 creamy color. And those creamy color pieces is where 22 the core was completely cleaned of all the oil, and 23 that is where the porosity and permeability was 24 measured. And then the brown intervals in the 25 Page 20

1 plain light view is where -- the unclean pieces. So 2 you can see the oil stain in the San Andres. 3 Q. And, Dr. Lindsay, can you explain what's shown on this slide? 4 5 A. This is just a close-up of a core on the left from the EMSU 679, which we actually have right 6 7 This particular box. And it's showing the here. 8 cleaned intervals and the porosity and permeability associated with that. And then the oil-stained 9 10 intervals on the left, you can see how much oil stain 11 is there. And this is in the San Andres. 12 And on the left, this particular core is 13 available. I brought it here. And we have it just 14 sitting here on the floor, if you would care to look 15 at it. 16 Then on the right is the RR Bell, just a 17 representative sample from it, showing some of the 18 porosity and permeability data there. And both the 19 plain light on the left and the UV light on the right. 20 And then on both of these cores, we're showing the oil saturation and water saturation 21 22 associated with these. Q. And, Dr. Lindsay, is the box in front of 23 you --24 A. Yes, this box is the box that's on the left. 25 Page 21

1 And you can see the oil stain in the core, and you can 2 also the see the cleaned intervals. And we actually made a thin section, as well, from this piece right 3 here. And all the blue is the porosity. 4 So in that case, the porosity is just 5 about 15 percent. It's 14.9 percent, with 19 6 7 millidarcies of permeability, and 38.4 percent oil 8 saturation, and 28.4 percent of water saturation. 9 HEARING OFFICER HARWOOD: If the witness wanted to move around and stand up and show us stuff 10 11 on that exhibit, he's welcome to do so. It's up to 12 you. 13 MS. HARDY: Would the commissioners like him 14 to do that? 15 THE WITNESS: I can do that. 16 CHAIR ROZATOS: Whatever is best for the 17 witness. I know I can see. 18 I don't know, Dr. Ampomah, can you see? 19 HEARING OFFICER HARWOOD: Can you gentlemen 20 see it okay? 21 CHAIR ROZATOS: He sees it that way, so I 22 think we're okay, Doctor. 23 HEARING OFFICER HARWOOD: Okay. Great. 24 BY MS. HARDY: 25 Q. Dr. Lindsay, is it your opinion that the Page 22

1	cores show oil staining through the San Andres?
2	A. Yes. And where we have core, yes, we see an
3	oil stain in the San Andres. And we know what
4	percentage is there with the core analysis.
5	Q. Can you smell the oil in the cores?
6	A. Oh, yes. Yes, you can smell it. And this
7	was an old core. This was taken in 1990, and you can
8	still smell the oil saturation. Just pick up any one.
9	Yeah.
10	So that core has been out for 35 years.
11	This was taken in 1990. Yeah. Okay. Great.
12	Perfect. Okay.
13	Q. Dr. Lindsay, can you please explain what's
14	shown on your next couple of slides. And these are
15	Numbers 9 through 12, for the record.
16	A. This is the core analysis for the EMSU 679,
17	the core that we just showed. And in this particular
18	illustration, it's showing where the top of the
19	San Andres is located. And the green column is the
20	oil saturation foot by foot from the San Andres down.
21	And this next slide is the continuation
22	of that. And, again, just the green interval is
23	showing the oil saturations associated with that core.
24	And then here's the lower part with the oil saturation
25	shown as well.

1 Q. Dr. Lindsay, what is the range of oil 2 saturations shown on this analysis? 3 A. I think the highest I recall seeing was up about 38 percent, and the lowest was just, like, 4 1 percent, just about 1 percent. There's quite a 5 6 range in here. 7 Q. And in your opinion, are the numbers lower 8 than you would find in the actual core? 9 A. These are the lowest possible numbers, because when you're coring these -- well, any well, 10 11 you have to be able to -- when you're coring through 12 it, you have to lift the cuttings up to the surface. 13 And so these cores have basically been super flushed and so these are the lowest oil saturations you're 14 15 going to see in these cores. 16 There's actually been some work done 17 that actually shows, in another field, with an SVE paper, what the residual oil zone in that particular 18 19 field looked like, with respect to conventional core, 20 and then sponge coring, and pressure coring. And it 21 showed a significant difference. 22 Basically, in this field is the Seminole 23 San Andres, and it was some work done by Hess and 24 published in an SVE paper. When they looked at their 25 residual oil zone, they saw that if they had an

1 interval that had about 18 percent oil saturation via 2 a conventional core, when they looked at a similar interval to that with a sponge core, they would see 3 24 percent oil saturation instead. And then when they 4 5 went in and pressure cored, they found that the oil saturation in the residual oil zone was 32 percent. 6 7 So there's about a 14 percent rise when 8 you compare a conventional core analysis to a sponge 9 core analysis to a pressure core analysis. So what we're showing here are the 10 11 lowest readings. And they could be 14 percent higher 12 if that data applies in EMSU in the San Andres. 13 Q. And, Dr. Lindsay, do these saturations reported here in this report show a residual oil zone? 14 15 A. Yes, yes. Basically, the way I've been kind 16 of trained to understand what a residual oil zone 17 would look like is, in a conventional core analysis 18 would be anything with 20 percent or greater percent oil would be considered a residual oil zone. 19 20 Q. And were you working on the EMSU at Chevron 21 when this report was done? 22 A. Yes. Yes. Q. Dr. Lindsay, what does this exhibit, which 23 is J-3, show? 24 25 A. Okay. This is actually two cores on the Page 25

1 left, so you can see the complete Grayburg interval, 2 the upper part of -- on the left, the upper part is 3 from EMSU 649. It is continuously cored from the top of the Grayburg down to the -- not quite to the base 4 5 of the Grayburg. And then an offsetting well, the EMSU 679, cored, the lower part of the Grayburg down 6 through the San Andres, into the upper part of the 7 8 San Andres.

9 And the upper part of the 679 was 10 oriented, so we could do a fracture study, and the 11 oriented core in the EMSU extended -- in 679, extended 12 down to 36 feet into the San Andres. So we actually 13 did a fracture study in the San Andres as well.

And on the right, that's just a close-up of the cored interval in the San Andres, and it's showing the interval that was oriented in the San Andres where we did a fracture study.

And then beneath that, the remainder of the core was not oriented, but we described it all. And, again, you can see the black bars were we saw visible oil saturation.

And the surprising thing was, when we looked at the UV light data, right at the very base of the cored interval, at the bottom of the core in the San Andres, we actually saw the UV light oil stain in

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1 the base of the core.

Q. Dr. Lindsay, what's shown on this slide,which is marked as Exhibit B-2?

A. Okay. On the left is a regional map, and it 4 5 has been put together, of the San Andres showing porosity fairways, where, when the west side of the 6 Permian Basin was tilted up into the air and water 7 8 charged into the subsurface into the San Andres, the 9 pathways, the porous pathways that the water took regionally from the west, entering into the 10 11 subsurface, into the Permian Basin, and on the 12 right -- and so as the water charged through, it could 13 follow the porosity and it could also follow through fractures and faults, as well. 14

And so on the left, I've created what I call a fracture halo map, where you might have a small fault in the middle, and then when that fault moved a little bit, you created a series of fractures around that fault.

And all these fractures are three dimensionally interconnected. That's the key. It's hard to show that in a flat 2D view. But all of those fractures are interconnected.

Q. And, Dr. Lindsay, why is this informationimportant with respect the EMSU?

1 A. Because when Eunice Monument, when the 2 structure formed, that was in the Cretaceous into the early Tertiary, during the Laramide orogeny. And all 3 the carbonate in Eunice Monument, whether it was a 4 5 grainstone or a grain-domed impact stone or a 6 mud-domed impact stone or a wackestone, or even the carbonate inside of sandstones was all dolomitized. 7 8 And that creates a much more brittle rock. 9 And when the Eunice Monument structure 10 formed and flexed and created an asymmetric anticline, 11 the dolomite, being brittle, fractured. 12 And this is just a little cartoon to 13 kind of shown what a fracture halo would look like. 14 Q. And what is shown on your next slide, which 15 is Exhibit J-4? 16 A. This is the fracture study of just the upper 17 36 feet of the San Andres in EMSU 679. And in that 36 feet, we measured 129 vertical fractures. And this 18 study was not done by a company like Core Lab. This 19 20 was done in-house by myself. 21 And you can see trends to these vertical 22 fractures, and you can see numbers here, it says 2, 4, 6, 8, 10. And that tells you how many fractures were 23 24 found at each 10-degree increment in this slide. 25 And you tend to see that most of the Page 28

1 fractures tend to go northeast to southwest, with some 2 going northwest to southeast, but at a lesser number. Q. And what about Exhibit J-5? 3 A. And this is the fractures that were 1 to 4 5 3 feet in length; we call them large fractures. And this is just showing their trend. And there seems to 6 7 be a very strong trend that's kind of 8 east-northeasterly to west-southwesterly. 9 O. And what about Exhibit J-6? A. Pardon? 10 11 Q. And what does this Exhibit J-6 show? 12 A. Oh, this next one? Okay. This is the small fractures that we 13 14 found. So these are little fractures that are just a 15 few inches in length. There's 109 of them in that 16 36-foot interval. And, again, you tend to see this 17 stronger trend of fractures, and these are all vertical fractures that trending northeast to 18 19 southwest, with a lesser trend northwest to southeast. 20 And then another trend that's kind of more east-west 21 oriented. 22 Q. And, Dr. Lindsay, do the fractures allow for the communication of fluids between the San Andres and 23 24 the Grayburg? 25 Once you get a fracture the width of a A. Yes. Page 29

1	sheet of paper, you're at infinite permeability. And
2	a lot of these fractures we found were actually
3	solution-widened, and they're much wider. We'll
4	actually show an example here in just a little.
5	Q. Is that this slide, Exhibit J
6	A. It's this slide here. These are some of
7	these small fractures that are solution-widened. And
8	to the naked eye, you wouldn't think that they're all
9	interconnected, but they actually are.
10	And instead of being the width of a
11	sheet of paper, they've been solution-enhanced by
12	late-stage fluid. This meteoric water that charged
13	through has actually solution-widened these fractures.
14	And they're all interconnected, because
15	the oil has gotten into all of these. So they're oil
16	stained as well.
17	Q. And does this confirm what was shown in your
18	fracture study?
19	A. Yes, yes, and that's there a fracture halo.
20	And it's really hard to see that when you're only
21	looking at 4-inch width of core.
22	Q. Dr. Lindsay, what is shown on Exhibit B-21?
23	A. This is showing two things. It's showing a
24	water chemistry study that was does in Eunice
25	Monument, and it's showing the structure at Eunice
	Page 30

Monument, as well.

1

2	The Eunice Monument structure is a
3	double-humped asymmetric anticline. And it's
4	double-humped because beneath it, the basement is
5	broken into smaller blocks, and they're differentially
б	moving, creating this odd looking double-humped shape
7	to the structure. And when that structure moved,
8	that's when all the fractures were created.
9	And then we did a water chemistry study
10	in-house, and this was when I was with Chevron. And
11	we found three different water chemistries. We found
12	connate water that had about 120,000 ppm total
13	dissolved solids and was barium rich.
14	And then we found edge water that was
15	being sucked in by a pressure drop in the reservoir
16	that was less than 10,000 ppm and it was sulfate poor.
17	And this was coming from the Goat Seep Aquifer, which
18	is downdip to the west of the western unit boundary,
19	just a couple miles.
20	And then bottom water in the San Andres
21	was found to be less than 10,000 ppm, as well. But in
22	this case, it was found to be sulfate rich.
23	And so we realized that we had three
24	different water chemistries in the reservoir: connate
25	water, edge water, and bottom water.

1 And so once we got this information, we 2 had made this illustration before showing what the structure looked like. We then superimposed on it the 3 water chemistry, and that's why we've got these little 4 5 letters in here saying E for edge, B for bottom, and C 6 connate. And then we added that into the 7 illustration. 8 Q. And, Dr. Lindsay, just to be clear, did you 9 prepare this illustration based on the Chevron data at 10 the time you were at Chevron? 11 A. Yes, yes. As soon we got the water 12 chemistry data, we went and superimposed it on the 13 structure map, because then it made a lot of sense, 14 what we were seeing. 15 O. And does this information show the water was 16 migrating from San Andres to the Grayburg before the 17 waterflood? 18 A. What it's actually showing here, it's just showing where the bottom water is. It's not showing 19 20 that the water is moving up out of the San Andres into 21 the Grayburg. But it is showing the edge water moving into the Grayburg. And that's via a pressure drop. 22 23 It's being basically sucked in a couple miles. 24 Q. And what is the impact of injection on the chemistry of the water? 25

1	A. Say that again.
2	Q. What is the impact of injecting into the
3	reservoir on the water chemistry?
4	A. Oh. Well, we're using the bottom water.
5	That's the source for the injection water in EMSU, in
6	the Grayburg. It was easy to get to. It's just
7	directly beneath the Grayburg Reservoir. And so it is
8	being used as the fluids in the waterflood, to
9	physically push from the injection wells to the
10	producing wells.
11	Q. And what is showing on your next slide,
12	Exhibit B-28?
13	A. This is showing where the edge water is
14	coming from, on the bottom, with a 3D seismic
15	cross-section here. It's shot east-west, right
16	through EMSU. And the top illustration is basically
17	that same area, only it's from the unitization
18	hearing, when EMSU was being unitized.
19	And the color on the far left is showing
20	where the Goat Seep Aquifer is located. And it's just
21	downdip a couple miles from EMSU. And then you can
22	see where EMSU is located on here, in the upper slide.
23	And then, on the right, you start to see
24	all this yellow and orange, which is a stratigraphic
25	trap that is creating the lateral stratigraphic trap

1 in Eunice Monument.

2	Then the bottom illustration is
3	basically showing what you we can actually image
4	and see the Goat Seep Reef on the far left. And the
5	arrows, the top set of arrows, is showing the top of
6	the Grayburg. And the bottom set of arrows is showing
7	the base of the Grayburg and top of the San Andres.
8	And so water is being sucked from the
9	Goat Seep through the Grayburg updip into EMSU and
10	coming in as edge water.
11	Q. Dr. Lindsay, by analyzing the water
12	chemistry, can you determine where water is moving
13	within a reservoir?
14	A. Yes, yes. Because we have these three
15	different water chemistries, you can identify edge
16	water from bottom water from connate water. And
17	that's the beauty of that water chemistry study.
18	Q. And in your opinion, does the water
19	chemistry show that water was moving from the
20	San Andres into the Grayburg?
21	A. Oh, yeah. When I was working in Hobbs
22	full-time on EMSU, it was common knowledge that bottom
23	water was being pulled up through what we call the
24	little water plumes vertically into the Grayburg. And
25	there was one example, EMSU 887, where there was a

1 plume of water around this particular well, and we 2 happened to core that well, and we actually oriented 3 that particular core so we could do a fracture study 4 on it.

And when we looked at the core with this plume all around it, we saw that it was highly fractured. So it was a perfect place to do a fracture study to understand how the water was getting up out of the San Andres up into the Grayburg via all of these fractures that we saw.

Q. Dr. Lindsay, what is shown on this slide,Number 21?

A. South of EMSU, this is Arrowhead Grayburg Unit. This is a unitization map that was made. And by this point in time -- this was in 1992, when this field was being unitized. And by this point in time, we started to realize how important it was to kind of understand where some of this bottom water coming out of the San Andres was coming up into the Grayburg.

20 So when this map was made, the purple 21 areas, that say bottom water, or "B Wtr," those are 22 the places in AGU where we found bottom water, meaning 23 San Andres water coming up into the Grayburg.

And then the rest of the map, we were mapping where edge water was come into this particular

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1 field. And it was coming in through four little
2 18-inch grainstones, and so we mapped out each one of
3 those so the engineers knew where to stay away from
4 edge water.

5 Because originally, they kind of -- they 6 didn't want to unitize the western third of the field 7 because it produced water. And we had looked at cores 8 enough there and described them well enough, that we 9 realized there were just four 18-inch grainstones that 10 had most of this edge water coming into the reservoir.

And so we mapped them out and said, "Well, the total thickness is 285 feet thick. Do you want to abandon the western third of the field because of just 6 feet of grainstones, these dolomitized grainstones?" And we said, "Just stay away from them. And if you do that, then you can produce all the rest of that strata."

And they said, "Okay."

18

19This was a very handy map. But we20showed bottom water besides edge water and where it21was coming in.

Q. Dr. Lindsay, before we get to your conclusions, I just wanted to confirm for the record that all the slides that we've shown are included with your direct or rebuttal testimony.
1 A. Yes. 2 Q. Okay. Thank you. And can you please summarize your conclusions here for the Commission. 3 A. The first conclusion is that there's a 4 5 residual oil zone in the San Andres. We've seen it in 6 core. We know it's there. We just kind of don't know 7 how much is there. 8 And the second thing is, we use these 9 cores -- when we can cross the San Andres and we can find the top of the San Andres in core, that really 10 11 helps us in our correlations through non-cored wells, 12 just looking at well logs. And that helps us 13 tremendously. That's kind of the second bullet point. And it's also showing us where the high is, the 14 15 structural high in EMSU is compared to Goodnight's 16 salt water disposal wells. 17 And then the third thing is in EMSU 679, the fracture study showed that there was fractures 18 and what the orientations were like in both the 19 Grayburg and in the San Andres. 20 21 Q. And, Dr. Lindsay, before I go to the next slide, is it correct that Empire's other witnesses 22 23 have quantified the residual oil zone in the San Andres? 24 25 A. Say that again.

1	Q. I think you said just a minute ago that
2	there is a residual oil zone in the San Andres, but
3	you're not sure how much.
4	A. Oh, yes.
5	Q. And Empire's other witness quantified it?
б	A. Oh, yes. They'll explain that in more
7	detail. I just saw it in these cores up in the upper
8	part of the San Andres.
9	So we know it's there and it goes right
10	to the base of the cores, so we know it has to go
11	deeper.
12	Q. And let's go on through the slide.
13	A. Okay. Yeah. Another issue is this
14	high-salinity water that is being not injected into
15	the San Andres. It's going to pressure up and it's
16	going to come up through these fractures and it's
17	going to come into the Grayburg Reservoir. And that's
18	going to create problems with the existing waterflood
19	operations, by having these plumes of water come up
20	into that Grayburg, as more pressure is created by
21	putting more water into the ground.
22	And then, because it's a high-salinity,
23	heavier-fluid, this injection water is going to
24	eventually, with time, work its way back down, off
25	structure, to the west side of the field. And it's
	Page 38

going to contaminate someday the Goat Seep Aquifer,
 which is a source of low-salinity water in the
 Chihuahuan Desert. And you don't want that to happen.
 You simply don't want that to happen.

And then there's this ROZ in the 5 San Andres that we've been discussing. The water 6 7 chemistry tells us that it's sulfate rich. And so if 8 you're injecting the high-salinity produced water and 9 if it has any free ions of calcium or sodium or 10 potassium or barium, they are going to mix with the 11 sulfate and they're going to create scale. And that's 12 going to precipitate in the reservoir in this residual 13 oil zone, and it's going to start to reduce reservoir 14 potential. It's basically going to cement up the ROZ. 15 And that's a problem.

And in my 48 years working in the petroleum business, the thing that surprises me about this is that a company that has no working interest in EMSU is allowed to inject this high-salinity produced water into the unitized interval. I've never, ever seen that before. Ever. And to me, that kind of -that defies why the unit was even made.

MS. HARDY: Those are all my direct
examination questions for Dr. Lindsay. He's
available for cross-examination and questions from

1 the commissioners. Thank you. 2 HEARING OFFICER HARWOOD: Commissioners 3 first or parties? 4 Mr. Rankin, I suspect you may have some 5 questions. 6 MR. RANKIN: Thank you very much, Mr. Harwood. I do have some questions and I will 7 8 work my way through them. 9 CROSS-EXAMINATION BY MR. RANKIN: 10 11 Q. Good morning, Dr. Lindsay. How are you 12 today? 13 A. Morning. O. You and I had a chance to converse in 14 15 January over your direct testimony that you presented 16 in this case, and it was a pleasure to get to meet you 17 at that time. I want to just kind of touch on a few 18 19 things as I walk through your testimony and 20 presentation this morning. And as I do, I'll ask you 21 to bear with me. Okay? I understand from your summary here that 22 you have an undergraduate degree in geology from 23 24 Webster State College; is that right? 25 A. Yes.

1	Q. And then you obtained your master of science
2	degree in geology from BYU?
3	A. Yes.
4	Q. And then you went on to get your Ph.D. in
5	geology from University of Aberdeen in Scotland,
6	right?
7	A. Yes.
8	Q. And that was in 2014?
9	A. Yes.
10	Q. And the Ph.D. was awarded based on a
11	dissertation that you prepared that was focused on the
12	Grayburg Formation, correct?
13	A. Yes.
14	Q. And that evaluation or study you did looked
15	at the Grayburg across the shelf into the Central
16	Basin Platform, correct?
17	A. Yes.
18	Q. And it included the EMSU as part of the
19	overall study, correct?
20	A. Yes.
21	Q. How many fields within that area was
22	included in your study?
23	A. It was EMSU-B, EMSU and AGU for right around
24	EMSU. And then, to the east, was McElroy Field, which
25	is on the east side of the Central Basin Platform,
	Page 41

1 towards the south edge.

2	And then I included work in two mountain
3	ranges, the Apache Mountains, where there's an
4	equivalent to the Grayburg called the Munn Formation,
5	the Lower Munn Formation. And then, in the Guadalupe
б	Mountains, we measured multiple sections, lots of
7	sections for years, so we could use those to guide us
8	in our work, working on EMSU.
9	And then on the Northwest Shelf, we went
10	to the type section of the Grayburg and described a
11	core that is about 1.9 miles just downdip of the type
12	section of the Grayburg.
13	The original type section was not cored.
14	It was described via cuttings. So we found a nearby
15	core and described it as well.
16	And so we tied from the mountain ranges,
17	to the west, to the type section, to EMSU, to McElroy.
18	Q. It's a large area, right?
19	A. Yes, yes. Regional.
20	Q. How many miles across?
21	A. It was over 200 miles.
22	Q. Right. And the focus was on the Grayburg
23	right?
24	A. Pardon me?
25	Q. The focus was on understanding the Grayburg?
	Page 42

1	A. On the Grayburg, yes.
2	Q. And then going back into time, you started
3	with Gulf after your master's degree back in 1976,
4	right?
5	A. Yes.
6	Q. And you were with Gulf up through 1985, when
7	Gulf and Chevron merged; is that correct?
8	A. That is correct.
9	Q. And upon the merger with Chevron, remind me
10	where you went when Chevron moved. Prior to that
11	merger with Chevron, where were you working for Gulf?
12	A. I was working at the lab in Houston.
13	Q. So once Chevron merged with Gulf, where did
14	you go then? Where were you assigned?
15	A. I was assigned to Denver, to work on
16	mid-continent exploration.
17	Q. How long were you in Denver?
18	A. From 1985 to November of 1988.
19	Q. Okay. And so then after 1988 now, just
20	as a reminder, your understanding is that the EMSU was
21	unitized in 1984; is that correct?
22	A. Yes.
23	Q. So in 1988, where did you go from there?
24	A. Well, I was then transferred from Denver to
25	Hobbs, New Mexico, to work full-time on EMSU.
	Page 43

1	Q. Was that a shock to your system, to go from
2	Denver to Hobbs?
3	A. No, not really, because I was raised in a
4	small farming town. So it kind of felt like I was
5	going home. Only I wasn't in northern Utah, I was in
6	southeastern New Mexico. It was kind of nice.
7	Q. So that's when you first came to work on the
8	EMSU, when you were transferred to Hobbs?
9	A. Say that again.
10	Q. That's when you started working on the EMSU,
11	when
12	A. Yes. Late November 1988.
13	Q. Okay. And what were your responsibilities
14	when you were assigned to work on the EMSU?
15	A. It was to describe the cores that were
16	taken. And so the idea was to come in and identify
17	where the cores were and start describing them.
18	And so the very first set that we
19	started to work on was right through the middle of the
20	reservoir so we could cleave EMSU in half. That's
21	kind of like the old Roman divide and conquer. So we
22	could get a good look-see east-west, right through the
23	middle of the field. Then the idea was to go the
24	north and quarter it, and go to the south and try to
25	quarter it.

1 Q. And those cores that you were taking at that 2 time, they were all limited to the Grayburg, correct? A. Yes. 3 Q. And so you were hired, and your role at 4 5 Chevron at that time was essentially to help 6 characterize the Grayburg Reservoir? To do a reservoir characterization 7 A. Yeah. and to connect all the strata together. Because the 8 9 fields had been unitized into what's called Zone 1, Zone 2, Zone 3, Zone 4, Zone 5 and Zone 6, from top to 10 11 bottom, now the idea was to correlate in more detail. 12 Q. I'm going to ask you about that, because I 13 think your description of the cycling was very fascinating, and I want to understand that a little 14 15 bit better. But we'll get to that once we get to your 16 exhibits. 17 So then you stayed with Chevron all the way up until approximately 2002; is that right? 18 A. Yeah. Till 2002, about September 14th or 19 20 somewhere around there. Q. Okay. And then at that point, you moved 21 22 over to work with Saudi Aramco, correct? 23 A. Yes. 24 Q. And you finished your career at Saudi Aramco 25 in 2015?

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1 A. I started there in 2002 and worked there 2 till December 4th of 2015. 3 Q. And then you hung a shingle and are now an independent consultant, correct? 4 5 A. Pardon? 6 Q. You hung a shingle and you're now an 7 independent consultant, correct? 8 A. Oh, since then, yes. Since I left Aramco, 9 yes. I'm just a consulting geologist now. O. Give me a sense for the kind of things 10 11 you've been doing as a consulting geologist. What 12 fields have you worked on and what kind of consulting 13 have you done? A. Well, I've done a few different things, 14 15 because I started to work on things I wanted to do 16 when I didn't have time to do them, when I was working 17 full-time. So I've been doing some of that kind of 18 work. 19 I went back to one field that I worked 20 on and asked permission to look at some cores to 21 identify a mobility-of-finds issue and shared that 22 data with the company, with Chevron. That was kind of 23 fun to do. But I started to consult with different 24 companies. I worked on a ROZ core for one particular 25 Page 46

company in Midland in the San Andres. And then I
 worked on unconventional cores for another company,
 describing Woodford core, Barnett core and Wolfcamp
 core.

5 And then I've started to, with a friend of mine, put together a very large core workshop, 6 7 where we're trying to -- next year, in 2026, the West 8 Texas Geological Society is going to turn 100 years 9 old. And the idea was to go back, 100 years back, and look at some of the original field discoveries that 10 11 were made in the Permian Basin. And so we're 12 looking -- we've been looking for old field 13 discoveries from 1920 to 1930 and up to about 1934.

And we have identified 22 fields for this core workshop. And we've found 17 cores from some of those fields so people can see what the fields looked like that started up the Permian Basin, what made it tick right off the get-go. So I've been doing that.

And then I've been teaching some classes at my old alma mater, at BYU, free of charge. I'm trying to give back for them being kind enough to let me go to graduate school there and get a nice job. So I would go there and teach stuff of for free. Then I've helped a couple of students,

one working on a master's degree, on an unconventional reservoir on the Barnett. I helped him get his master's degree. And then I helped another fellow work on his Ph.D. at Texas Tech, and I was on his committee. And he happened to be in one of my classes at BYU when he was a master's student. So it was kind of fun to help him out, too.

Q. Going back to your time at Chevron in Hobbs, when you were working at the EMSU, you were there from 10 1988 to 2002, during that time, did Chevron ever do 11 any in-house analyses on the prospectivity of the 12 San Andres, at the time you were there?

13 A. Yeah. That's where we saw the EMSU 679 and described it, and the -- let's see, I think I did the 14 15 RR Bell-- well, I think both of those, we actually did 16 those a little bit later when we -- because the office moved in 1990 to Midland. And so I think we were 17 18 doing the description work on those two San Andres 19 cores in Midland. And before that, we were working on 20 the Grayburg cores in EMSU.

Q. What's your understanding for when the EMSU679 well was drilled?

A. Pardon?

23

Q. What's your understanding for about when the 679 well was drilled?

1	A. Was drilled?
2	Q. Mm-hmm.
3	A. Well, they wanted to get a good look at
4	they wanted to see the fractures and understand them
5	and see if that might have any impact on production.
6	Because at first, the waterflood wasn't working really
7	well in the EMSU, and they wanted to see what the
8	fracture trend looked like.
9	And so 679, part of it was oriented, and
10	part of that orientation went down into the
11	San Andres. And we tended to just focus at first just
12	on the fractures in the Grayburg, because they were
13	highly focused on the Grayburg.
14	Then there was another core, orienting
15	core, taken in EMSU-B, the 887. And then we realized
16	that was really valuable, so we went down, when AGU
17	was being unitized, and got two more oriented cores in
18	AGU so we understood what the fractures looked like.
19	Q. My question was, though, what was your
20	understanding of when the 679 was cored and drilled?
21	A. When it was cored?
22	Q. Mm-hmm.
23	A. That was in 1990.
24	Q. 1990. Okay.
25	A. Yeah.
	Page 49

1 Q. Earlier during your summary presentation, 2 you mentioned the EMSU-B of EMSU-B-887. That was one 3 of the wells you were discussing in which a fracture 4 study had been done, correct? 5 A. Yes. 6 Q. And I think at the time of your testimony, 7 you referred to it as the EMSU 887. But it's actually 8 a well that was drilled and cored in the EMSU-B, to 9 the northwest of the EMSU, correct? A. The only oriented core in EMSU-B is 887. 10 11 Q. Right. My point is, though, it's not in the 12 EMSU, correct? 13 A. No. It's just north of it. It's right on 14 trend. All that separates the two is a line. 15 O. Understood. But my point is that it was not 16 in the EMSU, correct? 17 A. That's correct, yeah. It's literally the next well out of EMSU into EMSU-B. 18 19 Q. As a result of Chevron's coring of the EMSU 20 679, did they pursue any further the San Andres during 21 your time there? 22 A. To do what with the San Andres? 23 Q. Did they pursue the San Andres? 24 A. No, not that -- no. Q. Did Chevron ever attempt to produce the 25 Page 50

1 San Andres and any of its wells during the time that 2 you were with them, with Chevron? A. Not that I can recall, but that wasn't part 3 of my job. My job was focusing on putting the 4 5 architecture of the Grayburg together. So they may have been, they may not have been. But that wasn't 6 7 part of my job. 8 Q. What specifically did Empire ask you to do 9 in preparing your opinions and testimony for this 10 case? 11 A. Oh, just to give an overview of the EMSU, of 12 the kind of work that I've done in the past. Yeah. 13 Q. And you were seeking to be qualified today as an expert in -- you have been qualified as an 14 15 expert in reservoir characterization; is that right? 16 A. Yes. Yes. 17 Q. Now, at the time you prepared your direct testimony that you submitted in August of 2024, did 18 19 you review any of Empire's testimony or exhibits from any of its previous submissions to the Division? 20 21 A. Say that again. I'm getting old, hard of 22 hearing. 23 Q. Am speaking too soft? A. You might put the mic a little closer. 24 25 Q. Okay. So, at the time you prepared your Page 51

1	direct testimony and filed it in August of 2024
2	A. Yes.
3	Q had you reviewed any of Empire's
4	testimony and exhibits from any of its previous
5	submissions to the Division?
6	A. No.
7	Q. Had you reviewed any of Empire's exhibits or
8	testimony that were filed with your testimony in
9	August of 2024?
10	A. No, I don't think I did. No.
11	Q. Did you review any of Goodnight's previous
12	submissions to the Division or Commission that were
13	presented to the Division prior to this case?
14	A. Yes. When you mean for, like, rebuttal?
15	Is that what you mean?
16	Q. No. Prior to this case because Empire
17	and Goodnight have been in previous disputes. Do you
18	understand that? There are other cases that went
19	before the Division between Empire and Goodnight. Do
20	you understand that?
21	A. Explain that again just a little bit. I'm a
22	little confused here.
23	Q. Sure. So prior to this case that's
24	currently before this Commission, do you understand
25	the Empire and Goodnight have been in previous
	Page 52

1 disputes that went to hearing before the Commission? 2 I didn't know anything about this till A. No. I was contacted about this case. 3 Q. So at the time of your direct testimony that 4 5 you filed in August 2024, had you reviewed any of the 6 information, opinions, analyses that Goodnight had presented to the Division in any of the prior cases? 7 8 A. Oh, just what I rebutted. Just that. 9 That's all. Q. But nothing in any of the prior cases? You 10 11 hadn't reviewed any of the testimony in any of the 12 prior cases that Goodnight had prepared? 13 A. All I did was, if somebody had written stuff up, I read through that, line by line by line to see 14 15 if I agreed or disagreed with what had been said. And 16 then I wrote up some notes and sent it to Empire. 17 Q. Sure. Understood. I guess what I'm getting at is that prior to your review of the information and 18 19 testimony that was submitted by Goodnight in these 20 cases, you had not reviewed any of the earlier testimony or exhibits that Goodnight had submitted to 21 22 the Division, correct? 23 A. I don't think so, no. 24 Q. Okay. Now, as part of your testimony and your analysis, you have not yourself conducted a study 25 Page 53

1 or an analysis of whether residual oil or ROZ 2 hydrocarbons are economically recoverable from the San Andres and the EMSU, correct? 3 4 A. No, no. 5 Q. And Empire did not provide you with any 6 economic data to support such an analysis, correct? 7 A. Say that again. 8 Q. Empire did not provide you with any data to 9 support such as an analysis, correct? A. No. 10 11 Q. Because an economic analysis was not within 12 your scope, correct? 13 A. No, not really. No. 14 0. Okay. 15 A. Because there you have to get oil-in-place 16 numbers, and that requires a lot of work, enormous 17 amount of work. 18 Q. Have you previously provided any expert 19 testimony on whether a ROZ could be economic? 20 A. Say that again. 21 Q. Have you ever previously provided testimony 22 on whether a ROZ might be economic? 23 A. You mean the ROZ we're talking about in the 24 San Andres? 25 Q. Actually, no. Any ROZ. Page 54

1	A. No.
2	Q. Okay. Have you ever been part of a project
3	to develop a ROZ?
4	A. What?
5	Q. Have you ever been part of a project to
6	develop a ROZ?
7	A. I just helped out by describing the core for
8	this one client, yes.
9	Q. And in this case, you've not been asked by
10	Empire to conduct an analysis on whether a ROZ in the
11	EMSU is technically recoverable, correct?
12	A. No.
13	Q. Because your expertise is just in
14	characterizing the rock, not in whether the oil can be
15	extracted, correct?
16	A. Yes.
17	Q. And so you have no opinion about what the
18	recovery factors or how much oil, if any, might be
19	recovered from the San Andres in the area that you've
20	identified as a potential ROZ?
21	A. No. Because there's not enough data right
22	now.
23	HEARING OFFICER HARWOOD: Mr. Rankin, it's
24	almost 10:30. We should probably take a ten-minute
25	break.
	Page 55

1 MR. RANKIN: Now is a great time. 2 CHAIR ROZATOS: Let's do that. We'll be back at 10:40. 3 (Recess held from 10:29 to 10:40 a.m.) 4 HEARING OFFICER HARWOOD: Let's go back on 5 6 the record, please. 7 MR. RANKIN: May I proceed? 8 HEARING OFFICER HARWOOD: One moment, 9 please. The Commission members, during the break, would like to have a better idea of who Empire's 10 11 witnesses are going to be for the rest of the day, 12 after Dr. Lindsay. Can you help us out with that? 13 Do you have a witness order, Ms. Hardy? MS. HARDY: Yes. Our next witnesses are 14 15 Ryan Bailey and Scott Birkhead after Dr. Lindsay. 16 HEARING OFFICER HARWOOD: And is that it for 17 the day? 18 MS. HARDY: I think it depends on how far we 19 get. 20 MR. RANKIN: I quess it would be helpful, 21 Mr. Hearing Officer, to know. Because, you know, I 22 guess based on the prehearing statement, we 23 understood they were going to be in a different 24 order. And in going forward, that certainly would be 25 helpful. I know the Commission probably is reviewing

1 testimony based on the order that was described. And 2 if it's going to be different going forward, I think we'd like to know. 3 HEARING OFFICER HARWOOD: Yeah, I think 4 5 that's only fair. And, you know, over the lunch hour, maybe you could give Mr. Rankin and the other 6 parties a better idea of who is coming up next over 7 8 the next few days. 9 MS. HARDY: Sure. Happy to do that. 10 HEARING OFFICER HARWOOD: So for now, Ryan 11 Bailey and Scott Birkhead are your next witnesses? 12 MS. HARDY: Yes. And then Jim Buchwalter. 13 HEARING OFFICER HARWOOD: Okay. So you have somebody else. All right. Great. 14 15 Anything further, Mr. Rubin, before we 16 turn this back over to Mr. Rankin? 17 MR. RUBIN: Nothing further, Mr. Harwood. HEARING OFFICER HARWOOD: All right, 18 19 Mr. Rankin. The floor is yours. 20 MR. RANKIN: Thank you, Mr. Hearing Officer. 21 CROSS-EXAMINATION (continued) BY MR. RANKIN: 22 23 Q. So, Dr. Lindsay, I think I was just getting ready to get into the testimony. Can you hear me 24 better now? 25

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1	A. Yes.
2	Q. Okay. I'm going to try my best to enunciate
3	and have a little more diction and project.
4	A. Okay. Thank you.
5	Q. Now, Dr. Lindsay, you had been retained by
6	Empire to provide testimony earlier in these cases,
7	back in 2023, correct?
8	A. That's correct.
9	Q. Okay. And you had prepared written
10	testimony that was filed with the Division, Oil
11	Conservation Division, initially back for a hearing in
12	November of 2023, correct?
13	A. Yes.
14	Q. Now I'm going to put on my screen that
15	testimony, because I just want to make sure I have the
16	right I have a couple questions for just about what
17	changed and why. Okay?
18	A. Okay.
19	Q. Let me know when you can see the screen in
20	front of you.
21	A. I see it.
22	Q. Now, just to confirm, I have on the screen
23	here what I understand is your original testimony from
24	November 2023 that was filed with the Division. And
25	I'll go down to the signature page just so you can
	Page 58

1	confirm that's the date that you submitted this
2	testimony and that this is that testimony.
3	Do you see your signature dated October
4	2023?
5	A. Yes.
6	Q. So this was your original testimony that you
7	submitted to the Division in these cases, correct?
8	A. Yes.
9	Q. Okay. Very similar testimony that you
10	submitted back in 2023. I'm not going to ask you to
11	go through all the changes and differences today,
12	okay, but I want to just point out a few things so
13	that I understand better and maybe the Commission
14	does, too, about what changed.
15	Here on the second page of your 2023
16	testimony, I've highlighted a couple passages that I
17	want to just talk about.
18	Here you described, under your heading
19	A, "The proposed SWD wells would inject into
20	San Andres Formation which contains a residual oil
21	zone."
22	Did I read that correctly?
23	A. Yes.
24	Q. And the SWD wells you're referring to here
25	are Goodnight's wells, correct?
	Page 59

1	A. That's correct.
2	Q. And you go on to explain that while looking
3	at cores and characterizing the Grayburg and
4	San Andres reservoirs, it was discovered that the
5	San Andres contains a residual oil zone, correct?
6	A. That's correct.
7	Q. Now, I understood that what Chevron was
8	doing was not characterizing the San Andres but was
9	characterizing the Grayburg; isn't that true?
10	A. That's true.
11	Q. Now, here, below that first entry I read
12	under Paragraph 6, you go on to say that, "San Andres
13	Reservoir at EMSU contains oil-saturated porosity down
14	section to depths of minus 719 feet (subsea) to
15	potentially minus 750 feet (subsea) and is a residual
16	oil zone."
17	Did I read that correctly?
18	A. Yes.
19	Q. Okay. Now, I'm going to switch over to your
20	2024 testimony. Okay? This also is marked Exhibit B.
21	And you'll see I have your signature page here, which
22	indicates that you signed and submitted this testimony
23	on August 13, 2024, correct?
24	A. Yes.
25	Q. And I'll go back up to the top of this
	Page 60

testimony just to see that -- in fact, this is the new 1 2 one because it has all these other cases in it, right? 3 A. Okay. Q. I'm going to skip through some of the 4 5 initial stuff, but you'll see I'm going to get to an 6 entry here in this testimony that's very similar to 7 the one we were just reviewing, from 2023. 8 And again, it has a heading that says, 9 "The proposed SWD wells would inject into San Andres Formation which contains a residual oil zone," right? 10 11 A. Yes. 12 Q. Now, here, again, similar entry, but under 13 the first bullet, it says, "The Upper San Andres Reservoir at EMSU contains oil-saturated porosity down 14 15 section to depths of minus 719 (subsea) to minus 750 16 (subsea), " and you go on to say, "and potentially 17 deeper and is a residual oil zone." Did I read that correctly? 18 19 A. Yes. 20 Q. Now, during your deposition back in January, 21 you explained to me that the reason you made this 22 change, and the change was that you added the language "and potentially deeper," right, deeper than minus 23 24 750? 25 A. Yes. Page 61

1	Q. And the reason you made that change to that
2	portion of your testimony was because you went back
3	and locked again at the core and took pictures of it
4	and saw visible oil staining below minus 750, correct?
5	A. Well, at the base of the core.
6	Q. How deep is the base of the core subsea?
7	A. We would have to go back and look at that.
8	Q. Okay.
9	A. That's Plates 1 and 2.
10	Q. Okay, yeah. Off the top of your head, you
11	don't recall?
12	A. Not off the top of my head. But being a
13	good exploration geologist, when you see oil
14	saturation at a base of a core, that tells you it must
15	be going deeper.
16	Q. Okay.
17	A. That's why that statement is in there.
18	Q. Very well. But off the top of your head,
19	you don't know how deep it was? I mean, it's about
20	760 feet, or what, is the base subsea?
21	A. We'd have to go back and look at that. But
22	it's on both cores, the 679 and the RR Bell, both of
23	them.
24	Q. Do you recall what plate or figure it was in
25	your exhibits that have the images?
	Page 62

1	A. Well, it would be Plate 1 and Plate 2. So
2	they would probably be at the end. Because these are
3	figures.
4	Q. I guess we can just do it off the core
5	report, too, couldn't we?
6	A. We could do
7	Q. That doesn't have th subsea depth, does it?
8	A. No, it doesn't. No. Yeah. Oh, boy, now
9	we'd have to zoom in and look at the let's see if
10	we can get over and go down.
11	You'll still end up with just the now
12	there's minus right right go back to the
13	left. Go back to the left just a little.
14	There's minus 750 right there. Okay?
15	And that's a 10-foot box of core. So if you go down,
16	so there's 10. So that would be minus 760, 61, 62.
17	Q. So the base of the San Andres I'm sorry,
18	the EMSU 679 core is minus 762 subsea, correct?
19	A. That would appear to be the answer.
20	Q. So when I zoom back out, and just to keep
21	this in everybody's mind, and at some point I'll come
22	back and refer to this core report, but it's in your
23	tables, I think, B-1 through B-8, is that correct, for
24	the EMSU 679?
25	A. Mm-hmm.
	Page 63

1 Q. So this is the core report for the EMSU 679, 2 and it doesn't have subsea depths, but it does have 3 the measured depths --4 A. That's correct. 5 0. -- on this column? 6 Okay. So that measured depth of 4357 is 7 going to be equivalent to minus 762 subsea, correct? 8 A. That should be. 9 Q. Okay. Any reason to think it's not? 10 A. No. 11 Q. Okay. So you agree with me it would be 12 minus 762, right? 13 A. It should be, yes. 14 Q. Why wouldn't it be? 15 A. Pardon me? 16 Q. Why wouldn't it be? 17 A. Well, we've got that listed on the plate. 18 And we never do subsea in core analysis. We never 19 show that. We show the measured depth. Okay? And we 20 never, ever put subsea values in the core analysis. 21 Q. So the base of the core is minus 762, 22 correct? 23 A. That's what it should be, yeah. 24 Q. Okay. And is there any reason to believe that the core report would have left any footages off 25 Page 64

1	the core report?
2	A. They always show the missing intervals.
3	Q. So there's nothing missing from this core
4	report, agree?
5	A. It should be.
6	Q. It should be what?
7	A. It should be complete.
8	Q. But sitting here today, you have no reason
9	to believe that this core report is incomplete?
10	A. Yes.
11	Q. Yes what? You have no reason to believe
12	that it's not incomplete? You agree that it's not
13	incomplete?
14	A. No, it's not incomplete.
15	Q. Okay. Thank you.
16	So going back to my questions, you went
17	back and reviewed the core, took pictures of it, saw
18	visible oil staining below minus 750 subsea, right?
19	A. Yes.
20	Q. And that's why you came back and updated,
21	revised your 2023 testimony, to include this
22	additional language that says "and potentially
23	deeper," correct?
24	A. That's correct.
25	Q. Now, I guess my question to you is, so based
	Page 65

1	on that, then, based on visual inspection of the core,
2	you did amend or update this statement, right?
3	A. Yes.
4	Q. But all that information was available to
5	you at the time of your 2023 testimony, correct?
6	A. Yes.
7	Q. Okay.
8	A. Oh, no. No, it wasn't. Because I don't
9	I can't recall between the first statement and this
10	one when we took the pictures of the core. And when
11	we took the pictures of the core is when I saw the oil
12	saturation at the base of the core.
13	Q. I guess my point, though, is that that core
14	was there, and you knew where it was and you could go
15	review it as part of your preparation of your 2023
16	testimony, correct?
17	A. No.
18	Q. Why not?
19	A. Because it was at the Bureau of Economic
20	Geology, and I had to contact them and ask them
21	permission to get the core to look at. And so it was
22	not available to me.
23	Q. You asked for permission and they gave you
24	permission to view it between the 2023 and 2024?
25	A. Yes, somewhere in there. And that's when we
	Page 66

1 wanted to go and take photographs of it, so you could see visual oil saturation in the plain light views and 2 3 UV light oil saturation views, as well. And so we took it over to Core Lab after I got permission to 4 5 look at it. 6 And when we got the photos back is when 7 I noticed in one of the cores, what you really 8 couldn't see with your eyes that well showed up with 9 UV light. And we realized right at the base of both cores we had oil saturation. 10 11 Q. My point is, though, Dr. Lindsay, is that in 12 order to get access to the core, you just had to ask 13 for it, right? 14 A. I had to ask permission, yeah. 15 O. And you could have done that leading up to 16 in preparation of your 2023 testimony, correct? 17 A. I could have, yes. 18 Q. Now, your amendment or your update to your 19 2024 testimony was not based on your review of the 20 core report, correct? 21 A. Oh, this amendment? 22 Q. Right. A. It was by seeing the oil saturation in the 23 24 core photos. Then I went back and looked at --25 Q. Right. But you had the core report, as Page 67

-	
T	well, back at the time of your 2023 testimony,
2	correct?
3	A. Yeah, I did. Yeah.
4	Q. And that core report provides your oil
5	saturations as measured in the core, correct?
6	A. That's correct, yeah.
7	Q. Now, looking at this header here, "The
8	proposed SWD wells would inject into San Andres
9	Formation which contains a residual oil zone," that
10	sounds very definitive, right?
11	A. Mm-hmm.
12	Q. But your deposition with me, you testified
13	that in your opinion the Upper San Andres in the EMSU
14	has a potential ROZ. Do you agree?
15	A. Yes.
16	Q. So is it your opinion that there's a
17	potential ROZ in the Upper San Andres?
18	A. Yes.
19	Q. But during your deposition with me in
20	January, you testified that it's your opinion that
21	there's a confirmed ROZ in the Grayburg within the
22	EMSU, correct?
23	A. Yes.
24	Q. Okay.
25	A. And that's totally different than the
	Page 68

1	San Andres ROZ.
2	Q. Okay.
3	A. We're talking about two different animals.
4	Q. I want to explore that with you today.
5	We'll get there.
6	Now, when we were discussing the
7	different animals, okay, the two different ROZs, we
8	discussed that, in your opinion, the Grayburg ROZ in
9	the EMSU stops at the base of what you identify as
10	Grayburg Formation, agree?
11	A. Yes.
12	Q. Okay.
13	A. Yes.
14	Q. And your testimony was in your deposition
15	that there's another potential ROZ in the Upper
16	San Andres, right?
17	A. Yes.
18	Q. And your opinion is that there's a composite
19	sequence boundary. And it's in that beautiful chart
20	you did with all the cycling within the Grayburg. You
21	testified that there's a composite sequence boundary
22	at the base of the Grayburg, correct?
23	A. Yes. That sits on top of the San Andres.
24	Q. And there's another composite sequence
25	boundary at the top of the Upper San Andres, correct?
	Page 69

1	A. It's the same boundary.
2	Q. Okay.
3	A. The base of the Grayburg and the top of the
4	San Andres is the same composite sequence boundary.
5	Q. Okay. Just to be clear, so you're saying
6	I understood from your testimony in the deposition
7	that there was a composite sequence boundary at the
8	top of the Grayburg?
9	A. At the top of the Grayburg, yes.
10	Q. Let me rephrase. That there was a composite
11	sequence boundary at the base of the Grayburg and
12	another one, meaning underlying that, within the top
13	of the San Andres?
14	A. They're the same.
15	Q. They're the same. Okay.
16	A. They're the same, yeah.
17	Q. Now, if you would, just explain what a
18	composite sequence boundary is, if you would.
19	A. It's when you have a larger drop in sea
20	level. That's the simple answer.
21	Q. And what happens when you have a large drop
22	in sea level to the sediments when that occurs?
23	A. Being carbonates, when you have it's not
24	only a larger drop in sea level, it's over a longer
25	time, too. And so you have plenty of time for
	Page 70

1 rainwater to start to dissolve into the carbonate. 2 And you start to etch it and you start to dissolve it. 3 And ultimately, you start to karstify the rock if you have enough time and enough water. 4 5 Now, this was in a desert setting, so it was a slow process. But you can ultimately start to 6 7 make sinkholes, and collapse breccias will fill into 8 those sinkholes. And that's precisely what we see 9 when we describe the EMSU 679. Q. So when you and I were discussing this topic 10 11 during your deposition, we talked about that composite 12 sequence boundary, and you told me that it's generally 13 reflective of a lower permeability and lower porosity interval, correct? 14 15 A. Yes. 16 Q. Okay. And generally, it serves as a barrier to flow, correct? 17 18 A. It can serve as a barrier. 19 O. Okay. 20 A. But it might not be laterally continuous. 21 Q. Thank you. Now, the other topic, as we were 22 discussing, these two different ROZs, that one that you believe is confirmed to exist in the Grayburg, and 23 24 then another that is potentially in the Upper San Andres, at the time you and I were discussing this 25

1	back in January during your deposition, I asked you if
2	you were aware of any circumstance where there was a
3	ROZ across a low-perm or no-perm boundary or composite
4	sequence boundary. Do you remember that question?
5	A. Hmm.
6	Q. And you told me that you're not aware of
7	any?
8	A. Say that again. Explain that.
9	Q. I asked you during your deposition if you
10	were aware of any other circumstance, any circumstance
11	where there was a ROZ across a low-perm or no-perm
12	boundary.
13	A. Okay. So you're referring to the top as the
14	San Andres. Okay. I
15	Q. I'm referring to your testimony is that
16	there's a confirmed ROZ in the Grayburg.
17	A. Yes.
18	Q. There's a composite sequence boundary that
19	separates the Lower Grayburg from the Upper
20	San Andres, correct?
21	A. Correct.
22	Q. And your testimony is that there's a
23	potential ROZ in the Upper San Andres, correct?
24	A. Yes.
25	Q. And I'm asking you, do you recall your
	Page 72
1 testimony in the deposition that you said that you're 2 not aware of any other ROZ where there is a ROZ that 3 goes across a composite sequence boundary? 4 A. Oh, you mean that you're communicating? 5 Q. No, I'm asking are you aware of any other 6 circumstance where there's a ROZ above and below a 7 composite sequence boundary? 8 A. Not off the top of my head. 9 0. Okay. A. There could be. 10 11 Q. There could be, I quess. But I asked you 12 that question back in January and you said you weren't 13 aware of one. And now, here we are in February, and 14 you're still not aware of one, correct? 15 A. Yeah, yeah. To the best of my knowledge, 16 yes. 17 Q. And at the time when we talked about a ROZ, and I think you kind of touched on this in your 18 19 opening summary, I asked you what your definition of a 20 ROZ is, and you told me that basically, it's a residual oil zone, it's anything that has oil 21 saturations greater than 20 percent and up to about 22 40 percent or until you get to the point where you 23 have mobile oil. Agree? 24 25 A. Yes.

Page 73

1	Q. And just out of curiosity, do you have any
2	sense for what oil saturations are required to achieve
3	mobile oil in the EMSU?
4	A. No.
5	Q. Have you ever studied that?
6	A. No.
7	Q. So you're not sure, as you sit here today,
8	and you haven't looked at it, what oil saturations
9	would result in mobile oil?
10	A. No.
11	Q. Okay. And you and I talked about this, and
12	I think you you told me in your at the time
13	you're not aware of any ROZ projects that are pursued
14	ROZ zones with average oil saturations below
15	20 percent, right?
16	A. Yes.
17	Q. And that's still true today?
18	A. Should be, yes.
19	Q. Okay. And potentially commercial ROZs, one
20	with a baseline or a lower baseline, a lower threshold
21	at the base of the ROZ of 20 percent oil saturation up
22	to around the point of mobile oil, right?
23	A. Yes. Yes.
24	Q. And just to understand conceptually how
25	these ROZs look, generally, when you go from the top
	Page 74

1 of the ROZ, top of the interval, where it may be 2 defined as a ROZ, you go from higher oil saturations down to lower oil saturations, correct? 3 4 A. That is correct. 5 Q. And then in the upper part of the residual oil zone, some of the oil is going to be mobile 6 7 generally; is that right? 8 A. Yes. It's how you define the word "mobile." 9 Yes. O. How do you define the word "mobile"? 10 11 A. Well, I would first say that some of these 12 ROZs actually have a little bit of mobile oil in them 13 that has actually migrated back into them, and that's 14 why you get slightly higher oil saturations at the top 15 compared to the bottom. 16 And so when you come in and you try to 17 do these long horizontals and produce them, that's how you get some of the mobile oil out, because there's a 18 little bit of mobile oil in to begin with. Just a 19 20 little, not much. But that's just my perspective and 21 my interpretation. 22 O. I want to talk a little bit more about the concept of how these ROZs are created. And you gave a 23 24 little bit of preview of it in your summary, and I want to get into it some more because I find it 25

1	fascinating. Okay?
2	And I'm going to put up on my screen and
3	I'm going to stop well, let's see. We talked about
4	this during your deposition. This was a document that
5	you produced to Goodnight, Dr. Lindsay, as I
6	believe actually it was the only document you produced
7	to us as a document that you referenced or relied on
8	in preparation of your initial direct testimony. Do
9	you recall that?
10	A. Mm-hmm.
11	Q. So this was the sole document that was
12	produced to us that you had reviewed or had referenced
13	or relied on in the preparation of your direct
14	testimony. And I thought it was very fascinating and
15	I want to just kind of talk through it with you here.
16	This was, I understand, an abstract from
17	a talk that you gave in 2024 at the American
18	Association of Petroleum Geologists annual meeting in
19	Houston, correct?
20	A. That's correct.
21	Q. And the first part of the abstract is an
22	overview of the process that the literature refers to
23	as "Mother Nature's Waterflood," correct?
24	A. That's correct.
25	Q. And it explains the sort of the tectonic

1	mechanism that you discussed in your opening that
2	allowed for Mother Nature's Waterflood, or this
3	meteoric atmospheric water, to flush through the
4	various formations downdip, sweeping oil out of the
5	formations, right?
6	A. Yeah. Out of the structural closures.
7	Q. And then it also explains the source of the
8	water, right?
9	A. Yes.
10	Q. And that would be atmospheric or what's
11	called "meteoric water"?
12	A. Yes.
13	Q. And then at some point, after multiple pore
14	volumes, I guess, if you would maybe just I use
15	that term, but if you would explain what a pore volume
16	is?
17	A. If you look at, say, like, original oil in
18	place, there's a pore volume of oil. Okay? So if
19	you're sweeping something, you're putting that much
20	pore volume through the rock.
21	Q. Okay.
22	A. Okay? And then the catch is: How many pore
23	volumes swept through the rock between 40 million and
24	16 million years ago? That's an enormous amount of
25	fluid.

1	Q. Yeah. And I think Mr. Melzer, who is here,
2	and some of the other experts, you know, discussed
3	ROZ, given an assessment of dozens and dozens of
4	multiple pore volumes that swept through both the
5	Grayburg and the San Andres during that period,
б	correct?
7	A. Yes.
8	Q. Okay. And that's the process that moved the
9	oil out of those formations downdip, down in the south
10	and east of the Permian Basin, Delaware Basin and
11	basically into Texas in the eastern side of the
12	Central Basin Platform, correct?
13	A. Yeah. We don't know how far it got pushed,
14	but it got pushed out of the closures.
15	Q. And that wasn't just the Grayburg and
16	San Andres. It was any formation that had porosity
17	and permeability, right?
18	A. That's correct.
19	Q. And I think in the slide that you presented
20	in your summary, you had the Guadalupian and
21	Leonardian formations all were included in that sweep,
22	right?
23	A. What was shown was that the pathways was
24	just the San Andres, when you look at Map 2, that one
25	illustration.

1	Q. I'm referring to this one.
2	A. Oh, the cross-section here.
3	Q. Because I think you're showing here that
4	across the Delaware Basin that you have Guadalupian,
5	Leonardian and the Wolfcampian; Pennsylvanian even, I
6	think.
7	A. You have the opportunity to do that because
8	there was a study done in a field called "Indian
9	Basin" where they found it was swept down into the
10	Pennsylvania, and they assumed it was by Mother
11	Nature's Waterflood. And they had pretty good data to
12	prove that.
13	Q. So just to orient ourselves here, we're
14	looking at a cross-section from west to east, I
15	presume looking north?
16	A. No. This is east-west oh, I'm looking
17	north, that's correct.
18	Q. Okay. So I see west on the left and
19	A. And east on the right.
20	Q. Okay.
21	A. Yes.
22	Q. Okay. And the middle is the Central Basin
23	Platform, right?
24	A. Yep.
25	Q. And approximately, based on that, the EMSU
	Page 79

1 would be located just on the sort of margin of the 2 Central Basin Platform, correct? 3 A. Yes. Yes. In the Guadalupian. Q. In the Guadalupian. Okay. And what's 4 5 interesting about the EMSU in this particular location 6 is it's on the shelf margin, right? 7 A. Yeah. You've got to move that over. 8 Q. To the right or to the left? 9 A. To the right. Q. Yeah, it's a little bit more to the right, 10 11 you think? 12 A. Yes. 13 Q. Okay. But it's still on that ramp, that --14 A. It's right on the margin. 15 Q. So forgive me for my non-geologic location, 16 but I was trying to -- so that's in the approximate 17 location of the EMSU, correct? 18 A. That's correct. 19 Q. And when we get into your cycling, I think I 20 want you to explore with me a little bit about how the 21 fact that it's on this margin shelf makes the EMSU a 22 complex system, okay, that you spent a lot of time 23 exploring? 24 A. Mm-hmm. 25 Q. So you told me that the Guadalupian includes Page 80

1 the San Andres and the Grayburg, right? A. The San Andres is actually in the upper part 2 3 of the Leonardian. The Grayburg is in the Guadalupian. 4 5 Q. Just to reiterate, any formation that had porosity along the west of the Delaware Basin then, 6 7 had water entry into it, correct? 8 A. It could have, yes. 9 Q. And the Mother Nature's Waterflood, as we 10 call it, is what swept all that mobile oil out of 11 those zones, wherever it was, including the structural 12 traps, including out of the Grayburg and the 13 San Andres, right? 14 A. Mm-hmm. 15 O. Okay. Now, that process continued, as you 16 describe in this abstract, and as you did in your 17 summary, until the Rio Grande Rift essentially 18 interrupted the hydraulic dynamic, right? 19 A. Yes. It destroyed it. 20 Q. And so that hydraulic head that was pushing 21 all that water downdip and sweep oil, was essentially 22 terminated, right? 23 A. That's correct. 24 Q. Now, what I thought was fascinating is that, as a result of that termination and the loss of that 25 Page 81

1 hydraulic head, as you describe, some of that water 2 that had been previously swept and migrated back and 3 partially re-saturated some of the formations that had 4 previously been swept, right? 5 A. Yes. It wasn't the water. It was the oil. 6 O. I'm sorry. The water was backfilled and 7 partially re-saturated some of those formation that 8 had been swept, right? 9 A. Well, the water pushed it out. Then the 10 head of energy went away and so the oil could migrate 11 back into the trap, if it hadn't been pushed past a 12 regional spill point. 13 Q. And in this situation here, I think we 14 discussed during your deposition, that you told me 15 that the Grayburg had partially re-saturated with 16 mobile oil in the EMSU, correct? 17 A. That's correct. 18 Q. But not in the San Andres, right? A. And the San Andres did not. Right. 19 20 O. Now, in the abstract you write that this 21 explains why ROZ plays exist in the Permian Basin, 22 right? 23 A. Yes. Q. And what do you mean by -- when you say 24 "exists," you mean that's the process of re-saturation 25 Page 82

1 that explain why ROZ plays exist in the Permian Basin, 2 correct? 3 A. Well, there's the ability to re-saturate just a little bit with mobile oil, and that just helps 4 5 you out. And that's why you have a change of higher oil saturation in the top of a ROZ to a lower oil 6 7 saturation at the base. 8 Q. Right. Now --9 A. Otherwise, it would all be the same. 10 Q. If it had been completely saturated, right? 11 A. If it was swept and uniformly pushed out, it 12 should be the same. 13 Q. That assumption is based -- that's based on 14 the assumption that there was complete oil saturation 15 prior to Mother Nature's Waterflood, correct? 16 A. Yes. 17 Q. Now, so then I think we talked about this, and this gets into the mobile oil. We discussed this 18 19 during your deposition, that a lot of ROZs probably 20 were re-saturated, this is your saying, with some 21 mobile oil, so that when you pump them off with water 22 to lower the pressure. You would get some production, you get some mobile oil coming out of that residual 23 24 oil zone, correct? 25 A. Yes. Page 83

1	Q. Now, because generally, otherwise, right,
2	residual oil zone wouldn't move, it wouldn't be mobile
3	at in situ conditions within the reservoir because
4	it's become essentially immobile, right?
5	A. Most likely.
6	Q. Most likely?
7	A. Most likely.
8	Q. And that process
9	A. That's a very fine line.
10	Q. I'm sorry. Very fine line.
11	A. That's a very fine line.
12	Q. And you haven't looked at, you're not aware,
13	you can't tell me what at what oil saturation oil
14	will become mobile, right?
15	A. No.
16	Q. Okay. Now, the reason that oil is not
17	mobile or not often mobile in the residual oil zone is
18	because it had been swept so many times with multiple
19	or dozen pore volumes of water, right?
20	A. Yes.
21	Q. And that water strips the oil from the pores
22	and the rocks and overcomes the Van Der Waals forces,
23	and whatever else is holding the oil in place, and
24	moves it down out of the structural traps, right?
25	A. Yes.

1 O. And all that's left then is the oil that is 2 actually very well trapped to the rock and is unable 3 to be swept, or poor quality rock, right? A. Yeah. It's residual. 4 Q. Generally, after a residual oil process, 5 such as that, the oil that's remaining is in the 6 7 poorest quality rock, the lowest porosity, lowest 8 permeability rock? 9 A. It could be, yes. It says even some of the 10 porous rock, too. 11 Q. Some of the what rock? 12 A. In some of porous rocks. 13 Q. Some of the porous rocks? A. Yeah. 14 15 Q. Even though it was swept by multiple pore 16 volumes? 17 A. Mm-hmm. 18 Q. How would it stay in those porous rocks? 19 A. It just didn't have enough time to push it all out. Depends on the wettability of the rock. If 20 21 it's oil wet, there's going to be a film around the pores, and there would be a little bit of oil left. 22 23 Q. My understanding is, Dr. Lindsay, that as a 24 result of Mother Nature's Waterflood, generally the 25 wettability changed from -- if it existed before as Page 85

1	water wet, it would generally change to oil wet. Is
2	that your understanding as well?
3	A. We haven't done enough work to know that.
4	Okay? So I can't answer that question.
5	Q. You haven't looked at that as part of your
6	testimony today?
7	A. No.
8	Q. Okay. So we talked a little bit previously
9	in your deposition about generally how and where these
10	ROZs were. I'm trying to see if we have a good image,
11	map view of how Mother Nature's Waterflood swept. And
12	I don't know that it's in your testimony.
13	A. Well, you have that one map right there
14	before you of the San Andres.
15	Q. This one here?
16	A. No.
17	Q. This one?
18	A. It's that right there.
19	Q. I guess we can use this. So it's a little
20	hard to see, and I'm going to ask your this is
21	Exhibit B-2 of your testimony, correct?
22	A. Mm-hmm.
23	Q. This shows the approximate location of the
24	city of Hobbs, right?
25	A. Yeah. That's the Hobbs Field, yes.
	Page 86

1 Q. And just to the southwest, but approximately 2 where my cursor is, is that approximately where the 3 EMSU is? 4 A. Yes. That whole area right there. 5 O. You're identifying here on this map the different fairways. And this Artesia Fairway, which I 6 think is two arrows, is essentially where Mother 7 Nature's Waterflood would have passed through the 8 9 San Andres and the Grayburg, correct? 10 A. Yes. 11 Q. So it would have -- it followed this pathway 12 down, along through the San Andres, pushing water out 13 of the EMSU, down south, like, as you said, we don't 14 know exactly how far. 15 A. Yes. 16 Q. But potentially down all the way down into Texas. And sometimes, I think there were these things 17 called liniments that pushed some of the oil across 18 19 the Central Basin Platform into the Midland Basin, 20 correct? A. That, I don't know. 21 22 Q. But that was the general pathway that Mother Nature's Waterflood followed, pushing all this water 23 24 out of these zones, correct? 25 A. It followed regional porosity, yes.

1 Q. And Mr. Melzer and Dr. Trentham spent a lot 2 of time evaluating what those porosities and permeabilities were in the fairways, correct? 3 4 A. Yes. That's their map. 5 Q. That's their map. And when we get to their 6 testimony, we'll get into that. 7 Now, I asked you about this, and I asked 8 you whether or not, based on your experience and 9 review, whether you're aware of any ROZ developments, 10 commercial, pilot, any kind of ROZ development, that's 11 on the west side of the Central Basin Platform and the 12 fairway that we just discussed. 13 A. On the Central Basin Platform? 14 O. To the west of it. 15 A. To the west. So that would include the 16 Northwest Shelf? 17 Q. I'm excluding the Northwest Shelf. 18 A. Okay. I'm not aware of any. 19 Q. In fact, all the ROZ developments, 20 commercial, pilot, or otherwise, are either on the 21 Northwest Shelf, up here, or just above the Central 22 Basin Platform, or on the eastern edge of the Central 23 Basin Platform to the middle third of the Central 24 Basin Platform, correct? 25 A. It would be over, like, around Seminole and

1 other areas along there. Q. Right. In fact, that's where all the major 2 3 ROZ developments are located, correct? A. Well, and further north. 4 Q. And further north, along the Northwestern 5 Shelf, right? 6 A. Yes. 7 O. Now, going back to your abstract here that 8 9 we were discussing, you divide the ROZs between an 10 upper and a lower ROZ, correct? 11 A. Yes. 12 Q. And in this abstract, you describe that the 13 upper ROZs all have higher oil saturations, correct? A. Yes. 14 15 Q. And those, as you described in your 16 abstract, those are potentially productive, right? A. Yes. 17 Q. And then you say the lower ROZ just remains 18 19 a ROZ, right? 20 A. Yes. 21 Q. And in your abstract you say that evidence 22 for these two reservoirs being completely swept of 23 mobile oil is from this detailed reservoir 24 characterization that you discuss in this abstract. 25 And, really, in this case, we're focused on two

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1	fields, the EMSU and the what was the other?
2	McElroy Field, right?
3	A. Yes.
4	Q. And the McElroy Field was also the subject
5	of was included in your Ph.D. dissertation?
6	A. That's correct.
7	Q. And as I scroll up, you give a long list of
8	the types of data and the reservoir characterizations
9	that you did that helped you to identify the Grayburg
10	as a potential ROZ, correct?
11	A. Yes.
12	Q. And all these data points and reservoir
13	traits were all limited to the Grayburg, correct?
14	A. That's correct.
15	Q. Okay. Now, I want to talk a little bit
16	about what Goodnight has identified as a permeability
17	barrier that separates its disposal zone in the
18	San Andres from everything above it. Okay?
19	At the time you prepared your direct
20	written testimony back in August of 2024, you did not
21	evaluate where Goodnight had identified a permeability
22	barrier in its wells, correct?
23	A. State that again.
24	Q. At the time you prepared your direct written
25	testimony in August 2024, you did not evaluate where
	Page 90

1	Goodnight identified a permeability barrier in its
2	wells, correct?
3	A. I think that's correct.
4	Q. When you and I discussed it at your
5	testimony in your deposition, you confirmed that you
6	had no looked at it when you prepared your testimony?
7	A. Okay.
8	Q. Right? Do you agree?
9	A. That's yeah. Yeah.
10	Q. Okay. Now, Empire did not ask you, as part
11	of your analysis and opinion, to look at that,
12	correct?
13	A. I don't recall them asking me that, no.
14	Q. Okay. And you did not discuss the location
15	of Goodnight's permeability barrier with any of
16	Empire's other experts before submitting your August
17	2024 testimony?
18	A. No, I think we talked about that.
19	Q. Who did you talk about it with?
20	A. It was with some of the other staff members.
21	Q. Okay. But you did not yourself evaluate
22	where Goodnight had identified a perm barrier in its
23	wells or across the San Andres, correct?
24	A. Let's see. I have to think about that.
25	Because you kind of

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1	Q. Go ahead.
2	A. We thought when I was first doing my
3	work, I thought there might be a barrier there. But
4	then the more closer you start to look at the
5	database, where you have a little bit of data, you
6	find out those tight spots, less porous spots, come
7	and go.
8	Q. Where?
9	A. That's the top of the San Andres.
10	Q. What you define as the San Andres, correct?
11	A. Which is the San Andres.
12	Q. I know. But in terms of where Goodnight had
13	picked a perm barrier, you did not evaluate where that
14	is located, correct?
15	A. No, because I kind of couldn't find one, to
16	tell you the truth.
17	Q. But you didn't look at their testimony or
18	their analyses or their experts
19	A. No.
20	Q to decide
21	A. No.
22	Q where they're putting it, right?
23	A. No.
24	Q. And Empire didn't ask you to do that, did
25	they?
	Page 92

1	A. No.
2	Q. Okay. At the time of your August 2024
3	testimony, you had not evaluated the San Andres top
4	picks used by any of the other saltwater disposal
5	operators in and around the EMSU, right?
6	A. No.
7	Q. And at the time of your 2024 testimony, you
8	also did not evaluate all the different picks that
9	Empire had picked for the top of the San Andres across
10	all its wells in its structure maps, right?
11	A. No.
12	Q. Sticking on the same topic, I'm going back
13	to your testimony from '24, Exhibit B, and I'm going
14	to the header labeled "F."
15	And here you say that, "Documentation
16	shows there is not an effective seal between the
17	overlying Grayburg producing zone and the underlying
18	San Andres." And then it says in parenthesis, "(Can
19	be found on is SPE papers)," correct?
20	A. Mm-hmm.
21	Q. Now, the phase in parenthesis, "(Can be
22	found in SPE papers)," that's not your testimony, is
23	it?
24	A. No.
25	Q. Mr. Jack Wheeler with Empire added that to
	Page 93

1	your testimony, correct?
2	A. I think so, yes.
3	Q. And you do not adopt that statement as part
4	of your testimony, correct?
5	A. Yes.
6	Q. Because you told me during your deposition
7	that you don't have any SPE papers to show that,
8	correct?
9	A. That's correct. But then I did get an SPE
10	paper later.
11	Q. Which is that?
12	A. It's on a Seminole San Andres Unit.
13	Q. Who's the author?
14	A. There's a series of authors with Hess.
15	Q. Was that included in the any of documents
16	that you reviewed, referenced or relied on that you
17	provided to Goodnight?
18	A. No. It was more recent.
19	Q. When did you become aware of this paper?
20	A. About a month or two ago.
21	Q. Who brought it to your attention?
22	A. A friend of mine, Bob Trentham.
23	Q. So if I ask you for it during the break, is
24	that something you can provide to me?
25	A. I can give that to you, yes. I'll have the
	Dage 94

1	attorney give it to you.
2	Q. But as you sit here, you don't know who the
3	authors are or when it was published?
4	A. I have it my backpack. I could print it off
5	and you could have a copy.
6	Q. Just so everybody's aware, because I think
7	it would be helpful, the place where we're talking
8	about here, so we're some distance to the southwest of
9	Hobbs with the EMSU, but the Seminole San Andres Unit
10	is over here, on the northern part, portion of the
11	Central Basin Platform, correct?
12	A. Mm-hmm.
13	Q. So that's the location you're talking about?
14	A. Yes.
15	Q. Okay.
16	A. You know, now that you brought it up, on
17	that SPE paper that you want a copy of it, that's the
18	paper where they compared the residual oil zone, the
19	conventional core, sponge core, and pressure core.
20	Great piece of work.
21	And they found that if you're at
22	18 percent with a conventional core, a sponge core
23	would find 24 percent instead, and a pressure core
24	would find 32 percent. So all these numbers that I've
25	shown for my core analysis is conventional. And

1	that's basically saying there's far more oil there,
2	it's just been swept out by the coring process.
3	Q. While we're on that topic, okay, since you
4	brought it up, I'm going to just take a small
5	diversion in my examination to ask you about that.
б	Now, we're talking about two very
7	different locations, the Seminole San Andres Unit,
8	which is up on the northeastern part of the Central
9	Basin Platform?
10	A. Yeah. The northeast corner.
11	Q. Okay. And then we're talking about the
12	EMSU, which is on the southwest kind of margin of
13	A. The northwest corner.
14	Q the northwest corner of the Central Basin
15	Platform. Okay. Now, have you yourself done any
16	analysis or evaluation of the effect of the
17	conventional core and bleeding off of oil saturation
18	from that coring process?
19	A. It's a standards thing to know that when
20	you're coring, you have to have a big head of energy
21	to lift the cuttings all the way to the surface. So
22	you're probably a thousand pounds of extra pressure
23	that's sweeping through the core and pushing all this
24	oil out. Then when you pull the core to the surface,
25	more oil goes out on top of that.

1 And so the saturations you're looking at 2 are pretty darn low compared to what they used to be. Q. Understood. And I think nobody would argue 3 that there's going to be some bleed, right, from 4 5 conventional? 6 A. Right. And that's the beauty of the work that was done in the Seminole. 7 8 O. So my question of you is specifically asking 9 your background and experience. Have you yourself done any evaluations, assessments, studies about loss 10 11 of oil from conventional core? 12 A. No. We just know that it happens. O. Okay. So based on that, are you aware, 13 would you agree with me, that the gravity of the oil, 14 15 the viscosity, how much dissolved gas may be in the 16 oil, all those sorts of factors would influence how 17 much oil may be bled or lost from a conventional core? 18 A. Yes. Q. Of course, right? 19 20 A. Yes. O. So to evaluate bleed or loss from the 21 22 conventional core, would you agree that it's important to understand what those other factors are and what 23 24 the nature of the oil is at question? 25 A. Yes.

1 Q. Okay. All right. We got distracted a 2 little bit. I was trying to get into this section here with the header F. And we talked a little bit 3 about this header and the statement about these SPE 4 5 papers. 6 Do you know, Dr. Lindsay, if the SPE 7 paper you're referring to about these conventional 8 cores in the SSAU, do you know if those are the papers 9 that Mr. Wheeler was thinking about when he inserted 10 that in your testimony? 11 A. I have no idea. 12 Q. Okay. Now, during your deposition with me, 13 then again during your summary, and then your written 14 testimony, you talked about that it was common 15 knowledge while you were working at Chevron that there 16 were water plumes extending up out of the San Andres into the Grayburg, correct? 17 A. That's correct. 18 19 Q. Okay. And I think you told me, and I don't 20 recall if it was stated in your summary, but you told 21 me during your deposition that no one had mapped them, 22 right? 23 A. At EMSU, yes. 24 O. Right. Okay. 25 A. There was one map by a quy named Tracy Love Page 98

1 in an SPE paper where he showed higher water 2 saturations versus lower water saturations on a well-by-well basis, and had an illustration. 3 4 Q. Do you happen to recall, was that a 1998 SPE 5 paper? A. Somewhere around there. I can't remember. 6 No, I think it was -- well, I'm not sure of the date 7 8 on it. But it was Love and McCarty. 9 Q. Is this the paper, Dr. Lindsay? A. Let's see. Let me look at it. Yeah, it 10 11 might be. There should be a map in there, if you scroll down. There should be a little map of this 12 13 field. Yeah, there it is. Q. This is the map you're thinking about? 14 15 A. Yeah. 16 Q. And this is the map that, in your 17 recollection and your understanding, shows wells that 18 have a higher water cut? 19 A. Yes. Q. And your understanding is this map reflects 20 21 pluming of San Andres water under the Grayburg? 22 A. Potential pluming, yes. 23 Q. Okay. 24 A. But that's about the only one. Because it 25 was such a well-known fact that no one made a map. Page 99

1 And then years later, Tracy and Andrew put this map 2 together that may show where the plumes are. 3 Q. So if I look at this map, I'm going to just go down and I'm going to highlight -- I've highlighted 4 5 here what the title of this figure is, and it says, 6 "Wells that have symptoms of poor reservoir 7 performance are marked by a large circle." 8 So your understanding is that the wells 9 with these big circles are the wells where there are higher water cut, correct? 10 11 A. There should be, yes. 12 Q. Okay. And I'll scroll back up, because I 13 think they discuss this figure up here in the paper. 14 And just to be, clear, just for MR. RANKIN: 15 the benefit of the commissioners, I'm going to ask 16 that this paper, because I don't think it's already 17 in evidence, I'm going to ask that this paper be marked as Goodnight Cross Exhibit Number 1. Okay? 18 I haven't yet marked it, but I will do 19 20 so and I'll submit it for the record. But I haven't 21 yet introduced it as an exhibit. 22 HEARING OFFICER HARWOOD: Does Empire object? 23 24 MS. HARDY: No, no objection. 25 MR. MOANDER: No objection from OCD. Page 100

1 CHAIR ROZATOS: Objections from Pilot or 2 Rice? 3 MR. SUAZO: No objection from Pilot. HEARING OFFICER HARWOOD: Hearing nothing 4 5 from Rice, I'm assuming no one objects. It'll be 6 admitted. 7 (Admitted: Goodnight Midstream 8 Cross Exhibit 1.) 9 BY MR. RANKIN: Q. And so this paper is titled, "Problem 10 11 Diagnosis, Treatment Design and Implementation Process 12 Improves Waterflood Conformance." 13 Did I get that right? 14 A. Mm-hmm. 15 Q. And the lead author here is Mr. Tracy Love, 16 with Chevron, followed by Andrew McCarty of Chevron, 17 and then some other folks, right? 18 A. Yes. 19 Q. And basically, without getting into the 20 detail here, this paper is a summary of the issues 21 identified by Chevron when they first initiated the 22 waterflood through EMSU, problems with conformance, 23 fast cycling, the water breakthroughs, permeability 24 streaks, that sort of thing. Do you recall that in 25 this paper?

1	A. That's correct.
2	Q. And they describe the numerous challenges
3	that they had in developing this waterflood,
4	especially from the initiation of the flood, right?
5	So part of the challenge here that
6	Mr. Love was trying to review in this paper was to
7	explain what those problems were and then how to try
8	to resolve them. Is that your understanding?
9	A. Yes.
10	Q. Okay.
11	A. This follows up on earlier work that I
12	did
13	Q. Right.
14	A with respect to conformance.
15	Q. Right.
16	A. They followed up on this, yeah.
17	Q. Yeah, the cycling of the I don't know,
18	how many, 82 different cycle series? How many were
19	there in the Grayburg?
20	A. Oh, you mean the little cycles of
21	deposition?
22	Q. Yeah.
23	A. It was about 88.
24	Q. So 88 different cycles of deposition. And
25	each one of those, is it representative of a sea-level
	Page 102

1	withdrawal?
2	A. Rise and fall.
3	Q. Rise and fall. So during the period of
4	deposition that comprises the Grayburg and
5	San Andres or actually, just the Grayburg, right,
6	there are more than 88 different cycles of sea-level
7	rise and fall?
8	A. There's 88 that I could count, if I remember
9	correctly.
10	Q. And that results in a very complex
11	reservoir. Agreed?
12	A. Yes.
13	Q. Okay. And part of the challenge of this
14	waterflood was understanding the complexity from one
15	zone to the next?
16	A. Yes.
17	Q. And even within those zones that you
18	identified to me, Zones 1 through 6, there are highly
19	variable permeability streaks within each of those
20	zones, correct?
21	A. Yes. We identified which ones were the
22	bigger problems. That's why we did the conformance
23	work.
24	Q. Right. Some of them were bigger problems
25	that others, right?
	Page 103

1	A. Yes.
2	Q. But so there was high variability in the
3	horizontal permeability, but also in the vertical
4	permeability, too, within the Grayburg, right?
5	A. There seems to be if you're looking at
6	matrix permeability, there's more with respect to
7	horizontal than vertical. Okay?
8	Q. There's more permeability horizontally? You
9	mean
10	A. It's more problems.
11	Q. More problems.
12	A. Higher. Now, you have these vertical
13	fractures, and they're little hairline features.
14	Okay? And they're solution-widened a little bit. A
15	lot of those, we just had to kind they will have
16	the most permeability. Okay? And that's what makes
17	the plumes that come up.
18	But then there's these horizontal layers
19	that have high permeability, too, where you can take
20	water from here and go through like that. Very quick.
21	Very quick.
22	And so this conformance work that this
23	paper is talking about, and what I was trying to do,
24	was trying to solve these problems, not these
25	problems.

1	Q. Right.
2	A. Okay?
3	Q. Understood. And that's all within the
4	Grayburg, right?
5	A. Yes.
6	Q. Okay. So just an overview, okay, of what
7	this paper is all about, and as we discussed
8	previously when you showed the map, where there's some
9	wells where there are particular problems, I think
10	this particular paper was focused, in particular, on a
11	certain area that he calls the "conformance diamond."
12	It's here in Figure 8.
13	And it's a diamond of a number of
14	patterns, waterflood patterns, that were particularly
15	troubling, as I understand. Is that correct?
16	A. I don't know if that was the worst spot. We
17	worked on a spot that I thought was worse than this.
18	But that's just life.
19	Q. By my understanding is that that conformance
20	diamond is within this area with the greatest
21	collection of these enlarged circles. Right?
22	A. Okay.
23	Q. So going back up to this section here where
24	Mr. Love describes what the figure represents, he goes
25	on to describe, he says, "Conformance problems were
	Page 105

1	observed even the entire field " and then he sites to
T	observed over the entire field, " and then he cites to
2	that Figure 7, right?
3	A. Okay.
4	Q. And he says, "The focus that I referred to
5	as the conformance diamond was defined as a pilot area
6	for the conformance improvement work."
7	And then he cites to Figure 8, which is
8	that conformance diamond showing the different
9	waterflood patterns that he was evaluating, right?
10	A. Mm-hmm.
11	MS. HARDY: I'm sorry, I have an objection
12	to Mr. Rankin really testifying and reading the
13	article, I think.
14	MR. RANKIN: It speaks for itself. I'm just
15	giving a summary. If Dr. Lindsay disagrees with my
16	characterization, I think he can tell me.
17	A. Well, I'll just tell you this, that I think
18	Tracy and Andrew were making something very simple
19	much more complicated.
20	If we can go back to the map that shows
21	the field, the worst spot was up in the northwest
22	corner, where there was a well that injected water,
23	800 barrels a day, on vacuum. Never built a pound of
24	pressure year after year. And we went in and found
25	that it was connected from north to south to the

1 nearest producing well. 2 And all we had to do was once we 3 realized the path, is just go in and squeeze it off. That's all we had to do. And it's very simple kind of 4 5 work. And what they're doing is they're kind of making it a little bit too complicated. 6 7 Q. Looking at this map, Dr. Lindsay, do you know roughly where Goodnight's existing saltwater 8 9 disposal wells are? 10 A. I just have a rough idea. 11 Q. What's your rough idea? 12 A. To the south, in the southern part. 13 Q. Down in this area here? 14 A. Yes. 15 O. Okay. So just going back to Mr. Love's 16 description of this figure, he says, "It was verified during the reservoir characterization" -- that would 17 18 have been your work, right, Dr. Lindsay? A. Mm-hmm. 19 20 Q. -- "that the conformance diamond contained natural fractures, injection into a gas cap, and 21 22 areally extensive permeability streaks, all of which caused the characteristics illustrated in Figs. 4-6." 23 24 So 4 through 6 are right above here, and I think what we're looking at here is a plot of 25 Page 107

1	water-to-oil ratio, WOR right?
2	A. Mm-hmm.
3	Q on the Y axis, against cumulative
4	production over time, correct?
5	A. Mm-hmm.
6	Q. And what we see is, where the water
7	injection begins, we see water-to-oil ratio go high,
8	right?
9	A. Mm-hmm.
10	Q. And that's not what you want to see in a
11	waterflood, right?
12	A. No.
13	Q. Figure 5 is a diagnostic plot for a
14	production well in direct communication with an
15	injection well. Again, on the Y axis, we have
16	production, which is rates or barrels per day, and the
17	X axis, we have cumulative
18	A. That's Figure 6.
19	Q. You're right. That's what I meant to say,
20	Figure 6.
21	We have production rates, barrels per
22	day, on the Y, and then cumulative liquid production
23	on the X axis, correct?
24	A. Mm-hmm.
25	Q. And again, we see where waterflood begins
	Page 108
1 and the circles are water and the diamonds there are 2 And so we see the circles go up, meaning water oil. 3 production goes up, and oil production drops, right? 4 A. Yeah. 5 O. Okay. And then figure 6, is, again, another 6 plot showing production and injection rates on the Y axis for water, oil and water injection, so water 7 8 production, oil production, water injection. And on 9 the X axis, we have cumulative production days. So a time on the X in production, and injection on the Y. 10 11 And we see when water injection 12 commences, we see oil production drop and water 13 production kind of continue up a pace, correct? 14 A. Mm-hmm. 15 O. Okay. So those are the problems that he's 16 referring to that were occurring in the field that 17 they were trying to figure out. 18 Next sentence here, he says, 19 "Furthermore, these problems were isolated to Zones 1 and 2 in the conformance diamond. 20 The overall goal for the conformance diamond was to increase water 21 22 production and decrease water cycling, " correct? 23 A. Mm-hmm. 24 Q. So what he's telling me here is that the 25 problems that they've identified in 1998 that you're Page 109

1 referring to here is isolated to just Zones 1 and 2. 2 And I'm going to go over to your Exhibit B, and I'm going to pull up your cycling 3 image, as soon as I can find it. This is that 4 5 intricate cross-section that shows us, essentially, the EMSU an the Grayburg, correct? 6 And so I think we're looking from west 7 8 to east, and we don't quite see this pronounced here, 9 but essentially, this is the double-humped anticline 10 that you were referring to in your summary? 11 A. This is stratigraphically on here. 12 Q. Okay. So it's not as pronounced as the 13 structure? 14 A. They're separate illustrations. 15 O. Understood. 16 A. Okay? 17 Q. Understood. But nevertheless, I mean, my point simply is that you can still see the double-hump 18 anticline, correct? 19 20 A. No. That's an anticline that was growing 21 during deposition. 22 O. Okay. 23 A. That was during Grayburg time. That has 24 nothing to do with the Laramide orogeny and making the big double hump asymmetric anticline. 25 Page 110

1	Q. Okay. Understood. So, my point here,
2	though, was just to orient ourselves to where Zones 1
3	and 2 are, where the problems with conformance were
4	identified in Mr. Love's paper.
5	A. Mm-hmm.
6	Q. And on the right-hand side of this
7	stratigraphic cross-section, we see that the Zones 1
8	and 2 are the uppermost zones in the Grayburg,
9	correct?
10	A. Mm-hmm.
11	Q. So in this paper that we're reviewing from
12	1998, the problems that were identified and the high
13	water volumes that were identified in this Figure 7,
14	were all limited to Zones 1 and 2, based on this
15	paper, correct?
16	A. Yes, for that area.
17	Q. Okay. And in this paper, Dr. Lindsay, is
18	there any discussion of San Andres pluming into the
19	Grayburg?
20	A. Gee, I haven't read this for let's see,
21	when was this published?
22	Q. 1998.
23	A. Yes. I got it in about 2000 or 2004. I
24	haven't read it since then. So I'm not sure if they
25	were talking about pluming. Because pluming was
	Page 111

1 fairly uniformly understood, that we had lots of 2 little plumes. And those are just vertical plumes 3 that basically go up around one well. Okay? So what they're trying to do is solve a 4 5 problem between multiple wells that's horizontally 6 oriented in high permeability dolograinstones. That's 7 the problem they're trying to solve. They're not 8 trying to solve vertical plumes. 9 Q. I understood this paper was addressing all the problems that they were having in the EMSU, that 10 11 they were not getting good conformance, to solve those 12 problems. 13 A. From what I understand of this paper, they 14 were trying to get the horizontal connectivity under 15 control. 16 That's what we were trying to do before 17 they did this paper, up in the northwest corner. And we were looking at the base of Zone 1, where there was 18 a dolograinstone that in one area that it had 2.2 19 20 darcies of permeability, and in another area, it had about 750 millidarcies of permeability, and just a 21 22 little bit of it was 5 feet thick. 23 That was the problem, because you're 24 taking all the injected fluid through 5 feet and it's not going up in any other intervals, it's not going 25 Page 112

down in other intervals. You're wasting all this time and money cycling water through a dinky little 5-foot interval. So the whole idea was to isolate it and force the fluid to go laterally in other directions, in that little 5-foot bed, but then also go up into other beds of strata, up and below.

7 That's the whole idea with conformance
8 work, and that's what these guys were trying to do as
9 well. So it had nothing to do with vertical plumes.

Q. Dr. Lindsay, in your deposition to me and earlier today, I was asking about whether or not you had any maps showing vertical pluming, and you identified Mr. Tracy as having prepared maps that were representative of vertical pluming.

And in your deposition, you told me that he had written an SPE paper identifying the issues that reflected high water cuts for wells as a result of vertical pluming.

And I'm asking you -- you know, I've looked at this paper and I've looked for other papers that address it. This particular paper, Mr. Love was trying to evaluate impacts that were causing problems in the Grayburg waterflood, and he does not address or identify any discussion of vertical pluming of the San Andres or the Grayburg.

1 A. No. 2 MS. HARDY: I object to the question. HEARING OFFICER HARWOOD: Overruled. 3 4 BY MR. RANKIN: 5 Q. Do you agree that he does not address any vertical pluming into the Grayburg? 6 7 MS. HARDY: Dr. Lindsay, you can wait until 8 there's a ruling on my objection, please. 9 HEARING OFFICER HARWOOD: It's overruled. A. They were chasing horizontal permeability 10 11 problems. Not vertical. Okay? 12 Q. Dr. Lindsay, you told me, just before I 13 pulled up this exhibit, that this exhibit, this paper, was going to address vertical pluming into the 14 15 Grayburg. Do you remember that? 16 A. No, I just said that there was a map that 17 would show where there's higher water production, and that might be where the plumes are. 18 19 Q. And in this paper, what Mr. Love is saying 20 is that those higher water-cut values are a result of 21 poor conformance within Zones 1 and 2. Do you 22 disagree with that? 23 A. It could and it might not be. 24 Q. Okay. Very good. 25 MR. RANKIN: Mr. Hearing Officer, we're Page 114

1 about four minutes before noon, I think before we get 2 into any other testimony, I think it might be a good 3 time just to go ahead and take a break here. My stomach tells me it is, so I wondered if anybody else 4 would like to take a short break. 5 6 HEARING OFFICER HARWOOD: Why don't we --7 I'm sure lunch is on people's minds. So why don't we qo ahead -- you're reading my mind, Mr. Rankin. Why 8 9 don't we go ahead and break for lunch. Is an hour enough time for everybody? 10 11 CHAIR ROZATOS: Let's give an hour and 15. HEARING OFFICER HARWOOD: And hour and 15. 12 13 Okay. Let's be back at 1:15. And, Madam Court Reporter, we are going 14 15 to be off the record for lunch. (Lunch recess was held from 11:58 a.m. 16 17 to 1:16 p.m.) HEARING OFFICER HARWOOD: Let's go back on 18 19 the record. 20 Mr. Rankin, are you ready to proceed? 21 MR. RANKIN: Just a moment, Mr. Hearing 22 Officer. I'm just getting connected to the wifi. 23 HEARING OFFICER HARWOOD: Oh, one other thing. You have a habit of saying "Mm-hmm." Just 24 25 for the record, if you can try to remember to say Page 115

1	"Yes" or "No." I think the court reporter is
2	probably getting it down, but it's less ambiguous.
3	THE WITNESS: Okay. Thank you.
4	CROSS-EXAMINATION (Cont'd)
5	BY MR. RANKIN:
б	Q. Good afternoon, Dr. Lindsay. I'm going to
7	pick up on a new topic from where we left off before
8	lunch. I'm going to talk with you a bit more about
9	your opinions, position on Goat Seep. And I'm going
10	to go back to your Exhibit B, which is your February
11	2024 testimony. And I'm going to go down to the
12	section of your testimony where you address potential
13	contamination into the Goat Seep from the San Andres.
14	A. Yeah. Thank you.
15	Q. Let me share my screen so you can see what
16	I'm talking about. Let me know when you can see my
17	screen, Dr. Lindsay.
18	A. I see it.
19	Q. This is under the subheading E, and you say
20	here, "It is more likely than not that Goodnight's
21	injection of high-salinity water into the San Andres
22	would contaminate the Goat Seep low salinity aquifer
23	attached to the Eunice Monument and Arrowhead fields
24	due to its greater density and increased pressure as
25	more water is injected."

1	Did I read that correctly?
2	A. Yes.
3	Q. Okay. Now, your opinion that Goodnight's
4	injection is more likely than not going to contaminate
5	the Goat Seep is based on your understanding that the
6	Goat Seep has a total dissolved solid concentration of
7	less than 10,000 milligrams per liter or parts per
8	million, correct?
9	A. Yes. And that it's connected to Eunice
10	Monument pressure-wise. So that means porosity in the
11	Goat Seep and porosity in the Grayburg are connected.
12	Q. Right. But my point is that, yeah, your
13	statement and your opinion is that the Goat Seep has
14	less than 10,000 parts per million TDS, right?
15	A. That's correct.
16	Q. In your statement opinion that the Goat Seep
17	has less than 10,000 parts per million, it's based on
18	your personal communications with Mr. Alden Carpenter
19	at Chevron, right?
20	A. Yeah. Well, just not me. The whole office.
21	Q. Right.
22	A. He came from La Habra, California, where the
23	office was that he worked in, to our office in
24	Midland, and presented all the data. And so everybody
25	working on EMSU, EMSU-B and AGU were all in
	Page 117

1	attendance, and anybody else that wanted to be there.
2	So it's a fairly large group, just not me.
3	Q. Just not you. I guess my point, though, is
4	that your statement, your testimony today about the
5	water quality in the Goat Seep, is based on that
6	presentation that Mr. Carpenter made to Chevron?
7	A. Yes.
8	Q. And you were in attendance?
9	A. Yes.
10	Q. And you took notes on that presentation, and
11	that's those notes. And your recollection of that
12	meeting and presentation is the basis for your
13	testimony that the Goat Seep has less than 10,000
14	parts per million?
15	A. That's correct.
16	Q. But you haven't yourself conducted an
17	independent investigation of the water quality in the
18	Goat Seep, correct?
19	A. No, no. That was Alden's job. He was a
20	geochemist.
21	Q. And you've not reviewed any other
22	geochemistry or chemistry data for the Goat Seep as
23	part of your analysis or opinion today, correct, other
24	than Mr. Carpenter's presentation to you?
25	A. There was one other fellow that wrote a
	Page 118

1	Ph.D. on it, and his name was Hiss. And I've listened
2	to some of what he had to say. But that's all.
3	Q. Okay. Yeah, we're going to talk about Hiss
4	a lot at some point during this hearing, for sure.
5	So your recollection is that Hiss had
6	some data showing that the Goat Seep had somewhat
7	lower TDS then; is that right?
8	A. Mm-hmm.
9	Q. Below 10,000 TDS?
10	A. Yes.
11	Q. Okay. So the two points are Mr. Carpenter
12	and Hiss?
13	A. Yes.
14	Q. But you haven't presented any data as part
15	of your testimony today on Hiss, have you?
16	A. No.
17	Q. And you haven't cited to that. This the
18	first I'm hearing that you're relying on his for that
19	statement?
20	A. No, no, I didn't use any Hiss data.
21	Q. Right.
22	A. I just heard what he had to say.
23	Q. Just so it's clear for the record, you
24	didn't reference Hiss in any other parts of your
25	testimony, right?

1	A. No.
2	Q. Okay. So, now, on this water issue, okay,
3	about Goat Seep, I'm going to go down to your
4	Exhibit B-21. Okay? And I think this cross-section
5	was shown as part of your summary and testimony,
6	correct?
7	A. Yes.
8	Q. Okay. Only it was just the cross-section
9	that was shown and not the caption to the right,
10	right?
11	A. I think the caption was in there, too.
12	Q. Was it? Okay.
13	A. Yes, he's in there.
14	Q. So this cross-section, I guess I'll call it
15	a stylized cross-section, of the EMSU, as I've seen
16	from your summary, the written testimony shows the
17	three categories or types of water that were
18	identified by Mr. Carpenter in the EMSU, right?
19	A. Yes.
20	Q. And we have the edge water, which is coming
21	up from downdip from the west, which is the Goat Seep.
22	But it's symbolized here with a little E, correct?
23	A. Yes.
24	Q. And then we have the bottom water, which
25	you've identified with a B, which is in the Upper
	Page 120

1	San Andres, and that is lower TDS and sulfate rich,
2	right?
3	A. Yes.
4	Q. And I neglected to say that the edge water
5	is also lower TDS and sulfate poor. Correct?
6	A. Yes.
7	Q. And then you got up here, with a C is the
8	connate water, right?
9	A. Yes.
10	Q. Okay. And this representation that you
11	depict here was done as a result of Mr. Carpenter's
12	analysis, right?
13	A. That's correct.
14	Q. Okay. And I'm going to ask you about the
15	chemistries as we walk through this, and I may come
16	back to it later. But right now, I'm going to ask
17	about the encroachment of the edge water.
18	When we spoke about this exhibit during
19	your deposition, I understand your testimony to be
20	that Chevron was able to actually measure the
21	encroachment of this edge water up into the structure.
22	You can actually see it in the pressure readings,
23	right?
24	A. Mm-hmm.
25	Q. You could see the pressure wave
	Page 121

1	A. Yes.
2	0 of this water encroaching, right?
3	A. Yes.
4	Q. And you're able to measure that water coming
5	up all the way to the top and across the crestal zone
6	of the double-humped anticline, right?
7	A. Yes.
8	Q. And the vertical offset here is something on
9	the order of, you know, about 300 feet, correct?
10	A. Yes. Depending on where you start, it gets
11	up to minus 350. And as you go back into the
12	reservoir, it'll be down about minus 600. So that's
13	the interval.
14	Q. Yeah.
15	A. And then it thins out as you go up into the
16	east.
17	Q. To the east.
18	A. It becomes center.
19	Q. And so, based on Carpenter's study, right,
20	he was able to clearly identify, based on the water
21	chemistry, a clear signal of Goat Seep water coming
22	up, correct?
23	A. Yes.
24	Q. But at the same time, I understand that it
25	was common knowledge that there was all this pluming
	Page 122

1 of San Andres water coming up from fractures through the crestal high and other locations throughout the 2 3 San Andres into the Grayburg. How was it possible that Mr. Carpenter 4 5 was able to obtain a clear signal of sulfate-poor 6 water in the Grayburg from the Goat Seep encroachment 7 if, in fact, there was all this water coming up, 8 pluming, from the San Andres? 9 A. Well, the plumes are just little water-well 10 plumes coming up like this, like my finger. So if get 11 away from those, you can get a good sample of the edge 12 water. 13 Q. Okay. And if that were the case, if water 14 is coming up from the San Andres continuously, prior 15 even to the waterflood being commenced, wouldn't that 16 pluming of water disrupt the pressure front and 17 interrupt the encroachment of Goat Seep water updip? 18 A. Yes. Q. Okay. But that's not what Mr. Carpenter 19 20 saw, was it? A. This is where he got his data and 21 22 re-superimposed it on the structure. 23 Q. Okay. 24 A. Okay? 25 Q. At the time of your August 2024 testimony, Page 123

1	and then again when I deposed you in January of this
2	year, you were not aware that the EMSU has a produced
3	water disposal well that was injecting into the
4	San Andres, correct?
5	A. Yes.
б	Q. Okay. And you had been working at Chevron
7	since 1988, but you were unaware that Chevron had,
8	itself, and XTO after and Empire after them, operated
9	a saltwater disposal well that was injecting into the
10	San Andres within the EMSU?
11	A. No. That was an engineer's job, not mine.
12	Okay?
13	Q. Yeah. And you didn't evaluate that or
14	Empire didn't inform you of that as part of your
15	preparation for testimony?
16	A. That's correct.
17	Q. And until your deposition in January of
18	2025, you'd not conducted an independent investigation
19	of the potential impacts of that saltwater disposal
20	well that's in the middle of the EMSU on the EMSU,
21	correct?
22	A. No, I didn't. I didn't do anything like
23	that. My job is reservoir characterization. Okay?
24	Q. I understand.
25	A. Not engineering and disposal and water.
	Page 124

Let's get that perfectly clear. Okay?
Q. Yeah, yeah. Understood.
On the same point, just to make sure I
understand, okay, the EMSU was a waterflood, right?
A. Yes.
Q. And it had six water-supply wells. Do you
understand that it had six water-supply wells that
were providing water for waterflood operations?
A. Yes. I knew there was quite a few, yes.
Q. And you understand that there were within
the interior boundaries of the EMSU?
A. Yes.
Q. And you understand that they were completed
and producing water from the San Andres, correct?
A. Yes.
Q. Okay. But at the time of your testimony
that you submitted in August of 2024 and your
deposition with me in January of this year, you had
not evaluated and you were unaware of where those
wells were actually completed in the San Andres,
correct?
A. Yes. That wasn't my job.
Q. Okay.
A. My job was to describe cores and correlate
the stratigraphy inside of the Grayburg Reservoir.
Page 125

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1	Q. I understand.
2	A. Not to know where perforated intervals were
3	in the San Andres. That's an engineer's job.
4	Q. I guess, though, Dr. Lindsay, you know, this
5	issue before the Commission is a fairly complex issue,
6	and it's not just it's not just understanding the
7	stratigraphy, but it's also understanding what's in
8	it, right?
9	A. Yes.
10	Q. And you're telling the Commission that
11	there's a ROZ down through the San Andres. And I
12	would think part of reservoir characterization would
13	be to understand what the history of the reservoir is
14	or was. Is that a fair assumption?
15	A. Yes.
16	Q. And part of understanding the history of the
17	reservoir is to understand how it was treated, were
18	there disposal wells and where they were located and
19	what the volumes were that were disposed, were there
20	water-production wells and where were they located,
21	where were they completed and what zones and how much
22	water do they produce. That seems to be the question.
23	A. That has nothing to do with the reservoir.
24	My focus was on the reservoir and how the plumbing
25	system, how it was connected. Okay? Not where water
	Page 126

1 was being disposed of or where water was being taken 2 out of the San Andres for the waterflood. That was the reservoir engineer's job. My job was to focus on 3 the architecture of the reservoir? Okay? 4 5 Q. And when you're talking about the reservoir, you're talking about the Grayburg? 6 7 A. Grayburg. Q. Now, moving on from that topic, let's talk 8 9 about water chemistry. I'm going to go back to your Exhibit B. 10 11 Well, before I do that, I do have a 12 question, I guess. Go back to that question. Go back to that exhibit. 13 14 Earlier, when we were talking about the 15 boundary between the Grayburg and the San Andres in I 16 think it's your Exhibit 1, actually, where you show 17 the many layers and different cycles within the Grayburg, I think you stated here, too, that there is 18 19 a composite sequence boundary between the bottom of 20 the Grayburg and the top of the Upper San Andres, 21 right? 22 A. Yes. 23 Q. And the reason that you're seeing this 24 edge-water encroachment that follows the structure and stays along the base of the Grayburg is because that 25 Page 127

1 composite sequence boundary is low porosity, low 2 permeability, right? A. It's either that, or you have better 3 permeability and porosity in the Grayburg. And the 4 5 water follows the pathway of least resistance. Okay? So it's probably coming up through porosity in the 6 7 Grayburg. Okay? 8 9 And there tends to be maybe a little 10 less porosity towards the base of the Grayburg, maybe 11 at the top of the San Andres. But it's following the 12 pathway of least resistance, and that's going to be 13 through porosity in the Grayburg. Q. And so in carbonate systems, when we have 14 15 horizontal bedding and plane bedding, you're telling 16 me that water is generally going to follow the 17 horizontal bedding because, in this case, it's the path of least resistance? 18 19 A. Yes. And there's more permeability 20 horizontally than there is vertically, unless you run into fractures. And then the fractures will overwhelm 21 22 the horizontal permeability. 23 Q. Okay. But here, based on Mr. Carpenter's analysis of the water chemistry and the pressure front 24 that you're seeing, there's no indication of 25 Page 128

1	San Andres coming up into the Grayburg?
2	A. Not with this data, yeah. All we wanted to
3	do was show the three different water chemistries and
4	where they were located.
5	Q. Okay.
6	A. That's all. Nothing about plumes.
7	Q. On the point about water chemistry, just to
8	be clear, when you prepared this testimony, Exhibit B,
9	in August of 2024, you did not independently review
10	any other chemistry data other than the notes that you
11	took from Mr. Carpenter's presentation, right?
12	A. That's correct. Though there was one other
13	water chemistry study by another independent fellow a
14	few years later that got a few samples from Eunice
15	Monument, as well. And that was actually published in
16	ABG, in their bulletin.
17	Q. Do you recall the author of that paper?
18	A. I can't recall off the top of my head. I
19	understand he's passed away.
20	Q. Okay. Was that a paper that you included in
21	your references
22	A. No.
23	Q or cited to in your testimony?
24	A. No.
25	Q. Was it a paper that addressed the Grayburg
	Page 129

1 or did it address the San Andres?

A. It was looking at the water chemistry in
Eunice Monument and anywhere else where he could get
some data.

Q. I want to talk a little bit more about the sulfate enrichment question. In your direct testimony and in your summary, and we just talked about it, one of the key assumptions, as I understand from your testimony, is that the San Andres tends to be sulfate enriched, whereas the Goat Seep tends to be sulfate poor, correct?

12

A. That's correct.

Q. And because of that, if you were to take water samples, as Mr. Carpenter did, he was able to discern, he believes, the difference between the two sources, right?

17

23

A. That's correct.

Q. Okay. Now, as we discussed earlier today and reviewed in your earlier testimony, and as part of your presentation earlier, both the San Andres and Grayburg in the EMSU were swept by Mother Nature's Waterflood, correct?

A. Yes.

Q. And in your direct testimony here, I've
highlighted a portion of your testimony where you say,

1 "Dissolution of evaporite strata" -- which is calcium 2 sulfate, right? A. Yes. 3 Q. -- "added sulfate to low salinity San Andres 4 5 water as it recharged into the subsurface." 6 Did I say that correctly? 7 A. That's right. 8 Q. And then the next bullet, you say, "Through time recharging meteoric water delivered low salinity 9 water (less than 10,000 parts per million) containing 10 11 sulfate into the San Andres residual zone (ROZ) and 12 EMSU-B, EMSU and AGU, " correct? 13 A. That's correct. Q. Now, my understanding is that evaporites 14 15 are anhydrites -- or rather, anhydrites are 16 evaporites, correct? 17 A. That's correct. Q. And anhydrites are in the Grayburg in the 18 19 EMSU, correct? A. No. 20 21 O. No? A. No. They're updip of the EMSU. So, there's 22 23 a little bit of anhydrite cement, but there's no 24 bedded anhydrites in the EMSU. 25 Q. What's that based on? Page 131

1	A. Core studies.
2	Q. Core studies?
3	A. Yeah. The rocks never lie. The rocks never
4	lie. So we look there and we see what's really there.
5	And we look really close and make a lot of thin
6	sections so we can look inside the pore system in
7	great detail.
8	We do not see bedded anhydrites inside
9	the EMSU. It is updip, and that's what makes the
10	stratigraphic trap.
11	Q. But isn't the EMSU a stratigraphic trap?
12	Oh, I see. You're saying stratigraphic trap
13	A. Yes, only evaporites.
14	Q. Got it.
15	A. That's what makes the lateral stratigraphic
16	trap.
17	Q. I understand. So you're saying there are no
18	anhydrites in the EMSU?
19	A. There's no dense of anhydrite in the EMSU.
20	There are evaporite cements in the EMSU. But there's
21	no bedded anhydrite.
22	Q. Okay. What kind of evaporites are in the
23	Grayburg?
24	A. I thought I just answered that. It's
25	anhydrite.
	Page 132

1 Q. In the Grayburg? 2 A. Yes. It's anhydrite cement. 3 O. Okay. 4 A. Okay? 5 Q. Are there evaporites in the EMSU in the Grayburg, or are they all just --6 7 A. Now, are you talking about bedded anhydrite? 8 There's none. There's anhydrite cement in EMSU. It's 9 a small percentage, a few percent, but it's there. But it's just cement. 10 11 Q. So the distinction you're making is when you 12 say "bedded anhydrite," you're talking thicker 13 deposits of anhydrites? 14 A. A bed, a layer. A layer however thick. 15 Okay? There's none in EMSU in the Grayburg. 16 Q. How are anhydrites formed? 17 A. By evaporation of sea water. 18 Q. But I thought when we went through this 19 before, when we talked about this 88-layer 20 stratigraphic representation of the EMSU, that there 21 were 88 different sequences of sea water, ocean-level 22 changes, correct? 23 A. That's correct. 24 Q. And every time we had a sea-level change, where the sea level receded off that shelf, we had 25 Page 133

1 evaporites form, correct? 2 A. Not necessarily. Why don't you go to the other illustration that shows the regional 3 cross-section and the 3D seismic, and I'll show you 4 5 right where the evaporites are, the bedded evaporites. 6 Q. Is this the one? 7 It's the one with the seismic. A. No. 8 Q. This is not the one you're talking about? A. No, it's not this. Go to the one with the 9 seismic. 10 11 Q. I'm not sure which exhibit it is, but I'll 12 keep scrolling till we find it. 13 A. All the orange on the right, which is updip 14 to the east, the orange layers are bedded evaporites. 15 The yellow are nonporous sandstone, dolomitic 16 sandstones. 17 And if you look above where it says "EMSU," and come down, there's where the reservoir is 18 19 located. So there's no bedded anhydrite in EMSU. 20 There's just cement. 21 Q. But there are some anhydrites -- there's 22 cemented anhydrites in the EMSU and the Grayburg? 23 A. There's no cemented anhydrite. That infers 24 a layer of strata. It's just cement, maybe 5 percent, 25 and the rest is dolomite. That's all.

1 Q. Now, we discussed that meteoric water swept 2 the Grayburg, correct? A. That's correct. 3 Q. And if I go Exhibit B-1, I think you had a 4 5 nice image of the entire basin subject to the Mother 6 Nature's Waterflood. 7 A. Oh, yeah, this is where you're getting it to the west, and it's coming downdip and into the basin. 8 And it really doesn't go into the basinal facies. 9 Ιt 10 sweeps around through the shelf margin where all the 11 porosity is located. 12 So if you go to that other map, that 13 kind of had a blue color to it, then you'll see the 14 pathways. 15 O. Yeah. I understood. So the overview map, 16 which is this one, kind of shows you --17 A. This one right here. 18 Q. Yeah. -- the direction of flow. 19 A. And that's for the San Andres. O. Okay. Now here, though, in the image at the 20 21 bottom, where you show -- this is after termination, right, of the flooding process? 22 23 A. Yeah. As you lose your pressure and then 24 you destroy the recharge area. 25 Q. And this image, you show that subsequent to Page 135

the flood, you have hydrogen sulfide moving up from 1 2 the updip? 3 A. It's coming out of the basin, yes. O. It's what? 4 5 A. It's coming up out of the basin for H2S. 6 Q. So in both the Guadalupian and Leonardian Formation intervals, you're showing that there's 7 8 sulfates in the system from hydrogen sulfide, correct? 9 A. Yeah, H2S. 10 O. H2S. 11 A. So if you want to go out and see an example 12 of that, just walk through Carlsbad Caverns. That's 13 what made it, the H2S mixing with fresh water made sulfuric acid and dissolved the carbonate and made the 14 15 big caverns. 16 Q. And where there's H2S, there's also sulfate 17 in the system, correct? 18 A. Yes, H2S. Yes. Q. Doesn't this also show that there would be 19 or expected to see sulfates in the Grayburg? 20 21 A. Well, that's calcium -- anhydrite is calcium 22 sulfate. 23 Q. Right. A. And it's in the Grayburg. It's cement. 24 25 Okay? So I thought we talked about that. Page 136

Q. Yeah, I guess I'm trying to get the point, 1 2 though, that you're distinguishing, based on 3 Mr. Carpenter, that there was no sulfate in the 4 Grayburg? 5 A. This is sulfate cement. And Alden was talking about the water chemistry. That's totally 6 7 different. 8 O. Well, I quess my point is that, if there's 9 sulfate in the Grayburg, it would also dissolve in the 10 water, wouldn't it? 11 A. It would. Now, you'd have to have an awful 12 lot of anhydrite to dissolve to get enough in solution 13 so Alden's machines could detect it. And, apparently, he couldn't detect it. 14 15 O. Okay. So even though he had all that 16 anhydrite cement just to the east updip, there wasn't --17 A. Well, that's bedded anhydrite updip. Okay? 18 19 And in the reservoir was maybe like 5 percent 20 anhydrite cement. It's a very small volume. 21 As a matter of fact, it was actually 22 reduced when Mother Nature's Waterflood came through 23 because it preferentially dissolved the anhydrite 24 first and pushed it out of the reservoirs that was pushing out the oil. So that actually created less 25 Page 137

1 anhydrite cement inside of the EMSU and the Grayburg 2 Reservoir. Q. Okay. Very good. I'll move to Exhibit B-23 3 in your direct testimony. This is, again, your 4 5 cross-section of the 88 different cycles within the 6 Grayburg. 7 I don't think this is actually what I 8 meant to be -- I meant to be on B-23. My apologies. 9 Okay. So this exhibit, B-23, as I understand it, is a composite of two different cores, 10 11 correct? 12 A. That's correct. 13 Q. And on the left, the upper part of the core interval is from the EMSU 649 well? 14 15 A. Yes. 16 Q. And the lower part is from the EMSU 679 well 17 that we discussed before, correct? 18 A. Yes. 19 0. Okay. 20 A. And they're one location apart. 21 Q. I'm sorry? 22 A. They're one location apart. So just a few 23 hundred feet is where the one core -- the 649 was 24 taken to the north, and to the south, the 679 was 25 taken.

1	Q. Got it.
2	A. So we could get a bigger, longer section to
3	look at.
4	Q. So what you've done here is you've blown up
5	a portion of the really, it's the lower portion of
6	that core, the EMSU 679 on the right, correct?
7	A. Just in the San Andres and just a little bit
8	of the Grayburg.
9	Q. And you've indicated here your pick for the
10	top of the San Andres, correct?
11	A. Yes. And that's based from the core. It's
12	a beautiful subaerial exposure surface.
13	Q. And based on your pick of the top of the
14	San Andres, you've identified in the the portion
15	that you've identified here as having porous
16	oil-stained dolostone and collapse breccia, you've
17	identified areas that have basically oil staining,
18	correct?
19	A. The black bars are the oil staining. And
20	the red intervals are the collapse breccia in the core
21	description. So you'll see one, two, three, four,
22	five, six, seven collapse breccias from the top of the
23	San Andres down to the base of the core.
24	Q. Okay. And the black intervals, the black
25	bars, are from the core-log description, correct?
	Page 139

1	A. That's visible oil saturation to the naked
2	eye. And then there's a little extra oil saturation
3	at the very base that you couldn't quite see with the
4	naked eye, but the ultraviolet photographs showed it.
5	Q. So from this section here down, then there's
6	a bit of missing core, correct?
7	A. Yes.
8	Q. So the portion that you're showing with oil
9	shows goes down to about I'm not going to zoom in
10	to see this, but this is the section you've identified
11	as having the oil shows, correct?
12	A. Yes.
13	Q. And on this exhibit, there are no further
14	oil shows below that depth, correct?
15	A. No, there is.
16	Q. There are?
17	A. We saw some with the UV photographs right at
18	the very base of the core.
19	Q. But you didn't show that on this?
20	A. I didn't see them, yes, because they were so
21	subtle. And the UV photographs made them stand out.
22	Q. But you went and took those photographs
23	before you prepared this testimony, right?
24	A. I think we presented it between the first
25	and second. I think it's whenever the two plates
	Page 140

1	were added to my testimony.
2	Q. This testimony has those plates at the end,
3	right? Because we went through them.
4	A. And we had and we had done it.
5	Q. Okay.
6	A. So if you go to the plate with the 679, you
7	can see the saturation right at the very base. It's
8	very light, but you can see it right there. On the
9	very last box on the lower right, you see the gold
10	color?
11	Q. That right there?
12	A. There's the giveaway right there. Being a
13	good exploration geologist, I had to say, "Ah, there's
14	got to be more, deeper in the section."
15	Q. But you didn't update this exhibit to
16	reflect your understanding that there's more oil at
17	that depth?
18	A. Oh, no. No.
19	Q. Okay.
20	A. I just left it the way it was. That had
21	been described, gee whiz, way back in the early 1990s.
22	Q. Well, if that's the case, why wouldn't you
23	show it on your exhibit? If it was described back in
24	the '90s, why wouldn't you put it on your exhibit?
25	A. You mean the oil stain at the very base?

1	Q. Yeah.
2	A. Because we never noticed it until this last
3	yeah, when we got the core out to photographic it.
4	And there it was staring us in the face.
5	Because, normally, you just look at the
6	plain light photographs when you're describing the
7	cores. You don't look at the UV photographs, and we
8	didn't have those. So we photographed those just a
9	few months back.
10	I called up Empire and I said, "You
11	know, it might be a really good idea to photograph the
12	679 and the RR Bell so you can see, everyone can see
13	where the oil saturation really is, not only in the
14	Grayburg but in the Upper San Andres."
15	That's the beauty of those two
16	illustrations. There's oil in the Upper San Andres
17	and that's why we took the photographs. So anybody,
18	me, you, the Commission, anybody can see it. It
19	stands out like a sore thumb.
20	Q. And then it's recorded on the core-log
21	report, correct?
22	A. Yes.
23	Q. And do you recall what the oil saturations
24	are at from the core-log report?
25	A. Not off the top of my head.
	Page 142

1 Q. We can go back to that in a moment. I'm 2 going to skip over that for now. 3 I want to discuss with you some parts of your rebuttal testimony. You prepared some rebuttal 4 5 testimony, and this particular testimony here, let me 6 go to it here at Page 3. Having a PDF problem. One moment. Let me take a five-minute break so I get my 7 8 PDF to work properly. 9 HEARING OFFICER HARWOOD: Five minutes. 10 MR. RANKIN: Thank you. 11 (Recess held from 1:52 to 2:00 p.m.) 12 MR. RANKIN: Thank you very much, 13 Mr. Hearing Officer. BY MR. RANKIN: 14 15 Q. I apologize for the break, Dr. Lindsay. Ι 16 was unable to get my PDF to cooperate with me. 17 I've got on my screen here your Exhibit B, which is your rebuttal testimony. It's 18 19 Page 3 of your rebuttal testimony. Do you recall this statement that I've 20 21 highlighted here from your rebuttal testimony? 22 A. Yes. 23 Q. And in it, you're addressing one of 24 Goodnight Midstream's witnesses, Mr. Preston McGuire, 25 his testimony?

1	A. Yes.
2	Q. And you refer back to your Ph.D.
3	dissertation which you had prepared in 2014, correct?
4	A. Yes.
5	Q. And you cite to your Ph.D. dissertation, and
6	you say, quote, "There have been places found in the
7	EMSU, EMSU-B, and AGU where faults/fractures have
8	allowed Upper San Andres Formation fluids to move up
9	section into Grayburg Formation strata, which form
10	vertically oriented plumes of Upper San Andres
11	Formation water within the Grayburg Formation."
12	And you go on to say that, "Injected
13	matter that is not managed by proper water injection
14	monitoring can cause nonuniform sweep in the reservoir
15	and bypass reserves," correct?
16	A. Mm-hmm. That's correct.
17	Q. Now, you're citing to your dissertation, and
18	I have it pulled up here. I'm going to just scroll
19	down to it. I believe it's on the second page here.
20	And what I've highlighted here in yellow I believe is
21	the portion that you put in your rebuttal testimony,
22	correct?
23	A. Yes.
24	Q. But you left off the last portion of that
25	paragraph from your rebuttal testimony, correct?
	Page 144

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1	A. Yes.
2	Q. And you say, "These localities tend to be
3	only associated with one well, indicating that faults/
4	fractures are localized in small areas." Agree?
5	A. Yes.
6	Q. And when I asked you about this in your
7	deposition, I asked you to identify any wells, if you
8	could, in the EMSU where this had been documented. Do
9	you recall that?
10	A. Yes.
11	Q. And what you gave me was the EMSU-B-887. Do
12	you recall that?
13	A. Yes.
14	Q. Okay. But that's the unit to the north,
15	correct?
16	A. Yes. It's one well into EMSU-B.
17	Q. Nevertheless, it's several miles away from
18	where Goodnight's disposal operations are, correct?
19	A. Yes.
20	Q. Okay. Now
21	A. But it's laterally equivalent. And the only
22	difference between EMSU-B and EMSU is a line. That's
23	all. It's a continuous reservoir across that.
24	There's just a line there separating EMSU from EMSU-B.
25	It's all the same reservoir.

1	So it doesn't matter where we find these
2	plumes. And we happen to have a core there and it
3	happened to be oriented and we got a beautiful
4	fracture study, and there was this plume of water
5	right around that one well, and it was highly
6	fractured.
7	Q. And you included your description of that
8	fracture study in your rebuttal testimony, did you
9	not?
10	A. Yes.
11	Q. And in that fracture study, you would
12	present a gross plot showing the orientation of the
13	fractures?
14	A. Yes.
15	Q. But you don't provide any depths, do you?
16	A. No.
17	Q. Okay. Thank you. And just for the record,
18	I'm referring to what's been marked as Goodnight
19	Midstream Exhibit B-25, that was part of Mr. McGuire's
20	direct testimony.
21	Now, earlier, you and I went through and
22	discussed Mr. Love's 1998 SPE paper. And I wanted to
23	just kind of not revisit that paper, but I wanted
24	to address another paper.
25	This is a 997 SPE paper by Matthew
	Page 146

1	Miller and some other fellows who were with
2	Schlumberger. Have you ever seen this paper before,
3	Dr. Lindsay?
4	A. No.
5	Q. Okay. It's a paper that addresses the EMSU
6	and water issues and permeability issues in the EMSU.
7	And I'm going to scroll down to an entry here that
8	addresses, in particular, the EMSU. And the section
9	here is titled, "Field objections during Bullhead
10	Gelant injection."
11	And it goes on to say, "The Eunice
12	Monument South Unit produces primarily from the
13	Grayburg Formation in southeast New Mexico." And the
14	portion of I have highlighted here says, "The Grayburg
15	Formation is broken into 6 zones between 30 and 100
16	feet thick."
17	My understanding is that each of those
18	zones is about 30 to 100 feet thick; is that about
19	right?
20	A. No. That's too thick.
21	Q. Too thick, you think?
22	A. Yes. That's much too thick.
23	Q. Thirty feet or a hundred?
24	A. A hundred feet is way too thick.
25	Q. Okay.

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1 A. Yes, that's a misnomer. 2 O. "Each layer contains horizontal laminations or stringers of different permeability." 3 Do you agree with that statement? 4 5 A. No, I do not. Because they're not 6 laminations. A lamination is a centimeter thick. 7 Okay? We're talking about bedding that's up to --8 massive, up to 4 feet or greater than 4 feet thick in 9 some cases. So he apparently doesn't understand the reservoir very well. 10 11 Q. But nonetheless, he also refers to them as stringers. Is that a fair characterization? 12 13 A. No. These are beds. 14 Q. Beds. Okay. 15 A. They're not stringers. 16 Q. All right. 17 A. Yeah. Stringer infers that they disappear 18 laterally. 19 O. Okay. 20 A. These beds are continuous. 21 Q. Through the EMSU? 22 A. Yeah, yeah. Yeah. 23 Q. Now, he goes on to call them stringers. He 24 says, "The stringers have horizontal permeabilities as high as several Darcies. They're vertical 25 Page 148

1 permeability is very low." 2 Do you agree with that? 3 A. The highest rock I've ever seen in a dolomitized ooid grainstone is 2.2 darcies. He better 4 5 be careful saying "several darcies." That's 6 incorrect. 2.2 is the highest, and I only saw 1. 1. 7 The next highest that I recall seeing 8 was 750 millidarcies. So saying "several darcies," 9 that's not quite correct. 10 Q. Okay. He goes on to say that, "Many wells 11 had a poor waterflood production response." 12 Do you agree with that statement? 13 A. Absolutely. Yes. 14 Q. He goes on to say, "The response was 15 characterized by water cycling through the high 16 permeability," he calls them "stringers, which 17 handicapped the pressure maintenance program to cause high water-to-oil ratios." 18 19 Do you agree with that statement? 20 A. Yes. 21 Q. And then he goes to say that, "The 22 operator, " meaning Chevron, "is working to minimize the water cycling to achieve several goals, " including 23 24 "increasing the reservoir pressure." 25 Do you agree with that statement? Page 149

1	A. Yes.
2	Q. Okay. So do you agree with his statement
3	here that the vertical permeabilities are generally
4	low within the EMSU Grayburg?
5	A. Yes, when you're looking at matrix
6	permeability, that is correct.
7	Q. Okay.
8	A. But if you're looking at vertical fractures,
9	that is incorrect.
10	Q. In this paper which addresses these water
11	issues in the EMSU and Grayburg, there's no reference
12	again of any San Andres water pluming up into the
13	Grayburg. Now, you haven't seen this paper?
14	A. I haven't seen it, no.
15	Q. Okay. So you're not familiar with it?
16	A. No.
17	MR. RANKIN: Mr. Hearing Officer, I would
18	move this as Goodnight Cross Exhibit Number 2.
19	HEARING OFFICER HARWOOD: Any objection from
20	Empire?
21	MS. HARDY: Well, I think the witness
22	testified he's not familiar with it. I think
23	Mr. Rankin has used it in cross. I don't know that
24	it should be admitted into evidence as an exhibit.
25	HEARING OFFICER HARWOOD: Well, he's been
	Page 150

1	examined on it and he's been examined on fine points
÷	within the paper and held demonstrated knowledge and
2	within the paper, and he s demonstrated knowledge and
3	understanding of the technical points of the paper,
4	so I don't think that we can unring the bell.
5	Objections from Pilot or Rice?
б	MR. BECK: No objection.
7	MR. SUAZO: No objections from Pilot.
8	HEARING OFFICER HARWOOD: It'll be admitted
9	over Empire's objection.
10	(Admitted: Goodnight Midstream
11	Cross Exhibit 2.)
12	A. I might just say that I would be a little
13	worried about what he's saying if he doesn't
14	understand the reservoir.
15	Q. Dr. Lindsay, the lead author of that paper
16	was the second author of the paper with Mr. Love in
17	the next year, that we referred to previously. Do you
18	see Mr. Miller is the second author third author in
19	that?
20	A. Okay. And he works for Dowell, so he
21	probably doesn't know much about the reservoir.
22	That's a chemical company.
23	Q. Now, going back to your testimony from your
24	rebuttal, okay, let's see if I have this correct. One
25	moment, I apologize. Next page down from where you
	Page 151

1 were talking about your Ph.D. testimony.

Actually, before I move off of that, I wanted to just touch on a couple things. You know, I pointed out the one section of your Ph.D. testimony.

6 throughout your Ph.D. testimony, you had identified 7 throughout that there was a seal that separates the 8 Grayburg from the San Andres. Do you recall that from 9 your 2014 dissertation?

In Mr. McGuire's Exhibit B-25,

10

A. Yes.

5

11 Q. And you go on to say throughout that, "The 12 reason why the composite sequence boundary is not a 13 porous pathway from the Upper San Andres Formation up section into the Grayburg Formation is explained by 14 15 subaerial exposure and karstification associated with 16 the Upper San Andres Formation was cemented to form a 17 tight, non-porous interval of strata. Dolomitic sandstones at the base of the Grayburg Formation 18 contain enough dolomitized carbonate matrix that 19 20 they're also non-porous and nonpermeable. Between 21 these two, the nonporous karst and nonporous basal 22 sandstone a seal (aquiclude) was formed within the top 23 of the Upper San Andres Formation and the basal 24 Grayburg Formation."

25

Did I say that correctly?

1

2

25

A. Yes.

0. Okay.

A. And I might point out that that seal is not laterally extensive. When you karstify a reservoir, you make sinkholes that tend to be round to oval in shape. And one might be here, one might be over here, and one might be somewhere else, and they fill in and they form rather tight rock.

9 They start out as an open, porous 10 system, a cavern, and then they fill in with cement 11 and sediment. And we see those in core in the Upper 12 San Andres, but they're not laterally continuous. So 13 you can get the seal, but it's not laterally 14 continuous.

And then, when the Grayburg -- when the EMSU anticline formed and you take this flat-line strata and you flex it and make the asymmetric anticline, because it's dolomitized, dolomite is a brittle mineral, you fracture that and you break it.

20 So even if you do have something there 21 that is acting like a seal, now it's fractured. And 22 then you get Mother Nature's Waterflood sweeping 23 through and solution enhancing those vertical 24 fractures and making them wider.

And so to have a continuous barrier

1	there, yes, you kind of start out with one, but you
2	don't end up with one. And it doesn't look laterally
3	continuous on logs.
4	Q. Now, you didn't say that in your Ph.D.
5	dissertation, did you?
6	A. No, I didn't.
7	Q. And in your Ph.D. dissertation, you said
8	that, and this is the same portion here I'm quoting
9	from, "The ultimate test has come from pressure data
10	that shows one pressure system associated with the
11	Upper San Andres Formation, and a different pressure
12	system associated with the Grayburg Formation."
13	A. Yes.
14	Q. Isn't it true that if you're going to have
15	a you would need a continuous seal in order to
16	establish differ pressure zones or structure regimes
17	between the different formations?
18	A. Yeah.
19	Q. You would, wouldn't you?
20	A. Yes, you would. But if it's fractured, you
21	just lost it.
22	Q. If.
23	A. No, they're there. We've measured them.
24	We've shown them to you.
25	Q. Which exhibit? Where do we have that?
	Page 154

1 A. EMSU 679, we 36 feet of oriented core in the 2 Upper San Andres. I just showed it in my initial 3 deposition. All those fractures are in the Upper San Andres. There's 129 in just 36 feet. 4 5 O. Okay. So I'll get to that in a moment. Now, in your preparation for this 6 7 testimony, neither in your rebuttal nor your direct 8 testimony, did you review any of Goodnight's drilling 9 reports --10 A. No. 11 Q. -- for any saltwater disposal wells? 12 A. No. 13 Q. Okay. I apologize. I want to pull up your 14 fracture report, Dr. Lindsay. Thank you. 15 You testified in your direct testimony 16 about your fracture study on the 679 well, correct? 17 A. Yes. 18 Q. And that was prepared back in 1991, correct? A. That was the first one. 19 20 O. Yeah, and this is the one that you referred to as having identified fractures into the San Andres, 21 22 correct? 23 A. This was the one where I focused on the 24 Grayburg. 25 Q. Right. Page 155

1 A. So I then did another one on the San Andres. 2 Q. Which was the one that you did on the San Andres? 3 4 A. It's the ones that we showed this morning. 5 O. Okay. So the ones that you showed this 6 morning, do you give any depths in that analysis? 7 A. It starts at the top of the San Andres and 8 it goes 36 feet down. 9 Q. And how do you find -- and your definition of San Andres, how you define the San Andres, that's 10 11 the depth that you're talking about, correct? 12 A. Yeah. We found out it via the cores. 13 Q. But you didn't give us any subsea depths or 14 any measured depths in that analysis, did you? 15 A. No. I could give them to you, if you'd like 16 them. 17 Q. Well, I didn't see them in your testimony. And I haven't had a chance to evaluate them. But they 18 19 weren't in your rebuttal, were there. 20 A. To the best of my knowledge, no. 21 Q. Okay. 22 A. This was done in Hobbs, New Mexico, just on the lower part of the Grayburg. And then we did 23 24 another fracture study more recently on the continuation of that oriented core that went down into 25 Page 156

1 the top of the San Andres. So there's actually two 2 fracture studies done on this particular core and well. 3 Q. There's things I want to address from this 4 I'd like 5 morning in your overview summary testimony. to pull up from your direct testimony Exhibit B-1. I 6 want to understand a little more about this. 7 8 What are the gray zones? 9 HEARING OFFICER HARWOOD: This is 10 Exhibit B-4, right? 11 MR. RANKIN: Thank you. I apologize. This 12 is Exhibit B-5 in Dr. Lindsay's direct testimony. 13 BY MR. RANKIN: 14 Q. Looking at Exhibit B-5, Dr. Lindsay, what 15 are the gray zones on this exhibit? 16 A. With the question marks? 17 O. Yes. A. Those are areas where we didn't have any 18 19 data, and I did not want to guess what was happening. 20 I only work with real data. Okay? 21 So in the lower part here, the cores 22 didn't go down deep enough so we knew what kind of rocks were really there and how thick the beds were 23 24 and how they laterally connected to lateral wells. So I didn't want to put anything in. No guesswork. 25 No Page 157

1 quesswork. 2 Q. Across the Grayburg, then, how do you identify -- what have you identified is the worst --3 4 poorest quality rock? 5 A. The dolowackestones. Q. And where are they on this? 6 7 A. They're the gray over on the far right side. Where the name is, "dolowackestone." 8 9 Q. Where I'm highlighting right here? The word gray -- that will be up high, 10 A. Yes. 11 yes. Because they're the muddiest rock. They have 12 the lowest reservoir potential. 13 Q. It's a little hard to see, but the gray intervals embedded in here? 14 15 A. Yeah, there's gray intervals in there. And 16 then there's some blue intervals in there, light blue. 17 They're more mud-dominated dolopackstones. 18 And then the orange intervals are 19 grain-dominated dolopackstones. 20 And then the red are dolograinstones, 21 and they are the best potential reservoirs. 22 O. The red zones? A. The red zones, yes. So best reservoir is 23 24 red. The next best reservoir is orange. And then next reservoir, lower quality, will be the blue. And 25 Page 158

1	then the gray, to the right, will be the lowest
2	potential reservoir.
3	Q. We talked about this throughout your
4	testimony. I just want to make sure I want to
5	summarize here.
6	But as I understand, you counted 82 to
7	88 different cycles within the EMSU Grayburg, correct?
8	A. Yes.
9	Q. And each cycle is representative of a
10	change in sea level, correct?
11	A. Yes.
12	Q. And with the change in sea level, there may
13	be the evaporites forming with each sea-level change?
14	A. Yes. Updip in the Inner Ramp, where we
15	looked and saw the bedded evaporites. They're just
16	east of the field. That right here.
17	Q. The two zones that had the worst conformance
18	issues were Zone 1 and Zone 2, correct?
19	A. Yes.
20	Q. And within the Grayburg, within Zone 4, is
21	there a perm barrier that functions as a pressure
22	barrier?
23	A. When you go to the east side of the field,
24	all of these dolomitic sandstones that are coming into
25	the field if I kind of use my hands for this, if
	Page 159

1 this is updip and this is downdip, the sandstones that 2 are coming in on the east side, they tend to be tight 3 and nonporous. If you follow them downdip into the 4 reservoir, they become porous.

5 And the reason they're porous is when 6 Mother Nature's Waterflood swept through, they 7 dissolved out potassium feldspar grays and made 8 secondary porosity in these dolomitic sandstones.

9 There should have been interparticle 10 porosity in these sandstones. But when these 11 sandstones were deposited, they were mixed in with 12 carbonate, and the carbonates filled in all the 13 interparticle porosity.

So these things are tight and nonporous to begin with, but when Mother Nature's Waterflood swept through, the downward, more porous part of the reservoir on the left side of the illustration, when you swept through, you dissolve potassium feldspar grains to make secondary pores.

20 And if you get about 15 percent porosity 21 within the secondary porosity, you'll get one 22 millidarcy of permeability, and that's all.

23 So these sands don't produce very well. 24 And so updip, where they're first coming in, where the 25 water couldn't get to them that well, they're tight,

1 they're nonporous. As you come do into the reservoir, 2 they become porous by secondary dissolution of 3 feldspar grains, but they're not very permeable. 4 Q. Very good. I'm going to move on to another 5 topic here. We haven't talked about it yet, but the 6 RR Bell Number 4, and I believe it's in your Exhibit B-25. 7 8 Here, again, you've identified as the 9 San Andres top, correct? That's your San Andres top? 10 A. Yes. 11 Q. And you discuss the oil saturations that 12 you've identified in the RR Bell before, correct? 13 A. Yes. 14 Q. Now, at the time of your direct testimony, 15 you were not aware of what Goodnight Midstream's 16 San Andres tops are? 17 A. No. Q. And at the time you prepared this, you were 18 19 not aware of where Goodnight had identified its 20 disposal zone, correct? 21 A. That's correct. 22 Q. And the 679 --23 A. While this slide is up, could I just point 24 something out to the Commission? 25 We talk about these little cycles. All Page 161

1 you have to do is look for the little red surfaces on 2 the top of the blue, and those are exposure surfaces. And the arrows on the left, those little upward 3 arrows, those are little individual cycles of 4 5 deposition. Just so you're more clear about what this 6 core description is showing. Okay? And that'll be 7 the same way in the other core description, as well. 8 Just to point a few things out. 9 Q. In your opening summary, Dr. Lindsay, you discussed core saturations and a study on Seminole 10 11 San Andres that showed using sponge core and pressure 12 core, that conventional core has the lowest 13 saturations of core relative to these other coring 14 techniques, correct? 15 A. Yes. 16 Q. And you gave us a range of I think 17 14 percent, that you would expect conventional core to be about 14 percent lower than --18 19 A. 18 percent lower to start. 20 Q. And 18 is where you start with what, so I'm 21 clear? 22 A. The oil saturation conventional cores. That was the number that the Hess engineers talk about. 23 24 Q. So they start at 18 percent, right? 25 A. Yeah. Page 162

1	Q. That was the lowest saturation they recorded
2	in their conventional core?
3	A. In the residual oil zone at Seminole
4	San Andres Unit. And so 18 percent. And then when
5	they would come in and sponge cored, they would get
6	24 percent. And when the came in and pressure cored,
7	they would get 32 percent.
8	Q. What's the increase in saturation from
9	18 percent to 32 percent, do you know? How much of a
10	change in saturation would that be?
11	A. Well, that's 14 percent.
12	Q. The difference between
13	A. And 32.
14	Q. Okay. So is there, in your view, based on
15	that study, a 14 percent correction?
16	A. Yes, yes. So that tells you how much super
17	flushing was going on.
18	Q. And as to the SSAU, given the viscosities,
19	the API, the gravity of that oil, a 14 percent
20	correction is appropriate for the SSAU?
21	A. Yeah.
22	Q. But you haven't done an assessment to
23	determine whether that same correction is appropriate
24	for the EMSU?
25	A. No. You'd have to compare the oil types,
	Page 163

1 the gravity, the viscosity, features like that, to 2 find out how it might compare directly. 3 I have to take my hat off to the Hess 4 people for doing that. Because sponge cores are very 5 expensive and pressure cores are outrageously 6 expensive. So I take my hat off to them for being 7 willing to take that kind of data. 8 Q. I want to talk to you a little bit about how 9 you picked the San Andres. My understanding from what 10 you have said, and I want to be clear, if I can, is 11 that in order to pick the top of the San Andres, you 12 need to understand or have the core to do so; is that 13 correct? 14 A. That helps. That's the best. That's best 15 by far. 16 Q. Okay. And what is the indication to you in 17 the core that you're at the top of the San Andres?
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15 by far. 16 Q. Okay. And what is the indication to you in 17 the core that you're at the top of the San Andres?
Q. Okay. And what is the indication to you in the core that you're at the top of the San Andres?
17 the core that you're at the top of the San Andres?
18 A. You have a very large subaerial exposure
19 surface developed. Not a little dinky exposure
20 surface that would develop on a little cycle within
21 the Grayburg where you might see dissolution down a
22 few inches.
23 You start to see massive dissolution
24 down sections in the top of the San Andres, and that
25 makes it stand out like a sore thumb in core
Page 164

1 descriptions. 2 O. That's correlatable across the EMSU? 3 A. Yes, yes. Q. But you need the core to identify it? 4 5 A. The core helps you the most. Then after that, then you just tie it into the well log where it 6 7 fits, and then where you don't have core, you have to 8 correlate the well logs. 9 Q. And what are you looking for in the well logs to identify that specific --10 11 A. You look at the gamma ray, you look at the 12 porosity, you look at the resistivity, you look at all 13 them tied together. 14 And generally what you'll see in some 15 cases is on that surface, there will be a sandstone 16 called the "premier sandstone." It's not very thick, 17 but it might be there. And in some cases, it's not 18 there. And that helps a bunch, too. 19 Q. Is the top of the San Andres indicated by an 20 erosional surface? A. Yes. It's a big unconformity. There's a 21 lot of missing time there. 22 23 Q. And isn't it true that throughout the Lower 24 Grayburg, there are unconformities? 25 A. Yes. And they're smaller. Page 165

1 Q. They're smaller? 2 A. Much deep and shorter lived. So you can see 3 dinky little subaerially exposure surfaces on some -on most of these cycles, we see little subaerial 4 5 exposure surfaces. But when you go to the 6 unconformity, like on the San Andres, you see this 7 much, much bigger subaerial exposure surface. And if 8 you're really lucky, you start to see the sinkholes 9 and the collapse breccia and features like that, if you're really lucky. 10 11 And once you get used to looking at 12 these different levels of exposure surfaces, they're 13 fairly easy to tell smaller services from bigger surfaces. But you need a core to do that. You can't 14 15 do any of that on well logs. 16 Q. Understood. Now, at the opening of your 17 testimony today, you mentioned that you're not aware, have never experienced a situation where operators of 18 19 disposal wells were authorized or allowed to inject 20 for disposal purposes into a unitized interval, 21 correct? 22 A. That's absolutely correct. Because if 23 you're not the working -- if you don't have working 24 interest and if you're not the operator, you should

Page 166

not be allowed to inject inside of a unitized

25

1	interval. That should be against the law.
2	Q. So, Dr. Lindsay, are you aware that before
3	the EMSU was even created, there were disposal well
4	operations occurring within what later became the EMSU
5	and the San Andres?
б	A. No.
7	Q. Okay. So this well here
8	A. Is that by some other company other than
9	Gulf or Chevron or XTO?
10	Q. Yes.
11	A. Mm-hmm. I would wonder how they ever got
12	permission to come in. Because once you unitize an
13	interval, you're the unit operator. Nobody else is
14	allowed to come in and work. So how those companies
15	ever got permission, that's a great question. Because
16	it sounds like somebody's breaking the law.
17	MR. MOANDER: I'm going to object to some of
18	this testimony. This is legal opinion, and I think
19	this is out of the scope of expertise.
20	HEARING OFFICER HARWOOD: I think the
21	objection is well taken. It's one thing to say that
22	it should technically not be allowed. It's another
23	thing to say it's breaking the law.
24	THE WITNESS: That's true. Maybe I should
25	apologize for that.

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1 HEARING OFFICER HARWOOD: No, you don't have 2 to apologize. But the objection is well taken. Try and limit your testimony to technical stuff, and 3 leave the law to the lawyers. 4 5 A. Of course now, I worked on unitization projects, and you try to unitize to the base of your 6 oil saturation. And the base of the oil saturation 7 8 has to be somewhere down in the San Andres. Okay? Is 9 that a fair enough statement? Q. Dr. Lindsay, have you reviewed the 10 11 unitization information that was presented to the 12 Commission in 1984? 13 A. No. Q. Are you aware that the information presented 14 15 to the Commission in 1984 represented that the base of 16 the oil saturation was at minus 325 subsea? 17 A. That is incorrect. 18 Q. That's the information that was presented to the Commission. 19 A. They say that's the oil-water contact. 20 It's 21 the oil saturation beneath that. All you have to do 22 is look at a core. We just looked at the San Andres cores and there's saturation there. 23 We became aware of it when we looked out 24 on the west side of the EMSU, the EMSU 329. And that 25 Page 168

1 original number, minus 325, is completely incorrect. 2 It's actually minus 350, is where -- above there is 3 where you tended to get water-free oil production through time. And then from minus 350 to minus 540 is 4 5 where you started to get a mixture of oil and water. 6 And below minus 540 is where you got water production 7 only.

8 So we had this well, EMSU 329, out on 9 the west side of the field, and when we got down to 10 minus 540, we found the core kept going down deeper 11 and it had oil saturation through it. So we realized 12 right then and right there that we were dealing with 13 some kind of residual oil zone in the Grayburg.

And we didn't know where the base of the 14 15 oil column is. So you call that spot, the minus 540, 16 the producible oil-water contact. That's not the true 17 oil-water contact. It is much deeper. And we don't 18 know how deep it is.

19 Q. I understand that's your opinion, 20 Dr. Lindsay.

A. That's the facts. That's the cold, hard 21 22 facts, my friend.

23 Q. This Exhibit B-47 is Mr. McGuire's rebuttal 24 exhibit, Number 347. And I just want to point out to you that there is a well here. It shows the date of 25

Page 169

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1	first injection for this well, and I'll increase the
2	size for you, but it's 1966 and it's a Rice-operated
3	well. And it was pre-existing the formation of the
4	EMSU.
5	A. Okay.
6	Q. But you were unaware of that, correct?
7	A. I am not aware of that.
8	MR. RANKIN: Mr. Hearing Officer, may I just
9	take five minutes to determine whether I have any
10	more questions? I apologize for the break. I know
11	everyone wants to move on. But I just want to make
12	sure I can confer with my client and make sure I have
13	addressed everything I need to address.
14	HEARING OFFICER HARWOOD: How about I give
15	you till 2:40 p.m., which is four minutes. And you
16	have to bring us back on the record.
17	MR. RANKIN: Thank you.
18	(Recess held from 2:36 to 2:40.)
19	HEARING OFFICER HARWOOD: Mr. Rankin, are
20	you done?
21	MR. RANKIN: Thank you, Mr. Examiner. I am
22	done. I have no further questions for the witness
23	and pass him for examination by the commissioners.
24	HEARING OFFICER HARWOOD: Well, first let's
25	give OCD an opportunity, then Rice and Pilot, if you
	Page 170

1 guys have questions. 2 I'd like to break at 3 o'clock for a 3 midafternoon break. Not to constrain you, Mr. Moander. If you're not done by then, we'll just 4 5 pick up afterwards. So we'll break for 15 minutes at 6 3 o'clock or thereabouts. 7 MR. MOANDER: Understand, Mr. Hearing 8 Officer. Happy to comply. May I proceed? 9 CROSS-EXAMINATION BY MR. MOANDER: 10 11 Q. Good afternoon, Dr. Lindsay. Let me move 12 over a little so I can actually see you there. 13 MR. RUBIN: Mr. Moander, let's bring the microphone closer to you. The doctor has a hard time 14 15 hearing. 16 MR. MOANDER: Can do. 17 MR. RUBIN: Thank you. BY MR. MOANDER: 18 19 Q. So, Dr. Lindsay, you're under oath today; is 20 that right? 21 A. That's correct. 22 Q. And you're here to tell the truth? 23 A. Yes. 24 Q. In your earlier summary, you didn't give the 25 full body of your opinions; isn't that right? Page 171

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1	A. That's true.
2	Q. And one of those opinions that you omitted
3	was, and I'm going to quote you here and we'll discuss
4	that in a moment, "There's no migration of injection
5	fluids from the San Andres in the Hobbs Channel into
6	the Capitan Reef," right?
7	A. Hobbs Channel into the Capitan Reef. Yes,
8	that's correct.
9	Q. And you gave that testimony in your initial
10	witness disclosure, right?
11	A. Yes.
12	Q. You also gave it in your rebuttal testimony,
13	right?
14	A. Yes.
15	Q. And you also testified to that you
16	testified to as much in your deposition?
17	A. Yes.
18	Q. And going back to your deposition, do you
19	recall being asked what your basis for that opinion
20	was?
21	A. Well, first of all, the Capitan is
22	Q. Hold on, Doctor. I asked if you remember
23	being asked that question.
24	A. Repeat the question, then.
25	Q. The question was, what do you base that on,
	Page 172

1	Dr. Lindsay? And that was your opinion.
2	A. Okay. My opinion?
3	Q. Yes.
4	A. As to why there's no communication from the
5	Hobbs Channel to the Capitan Reef?
6	Q. Yes, in the deposition.
7	A. Well, I don't know the exact words I'd use,
8	but I would just simply say it's too far away.
9	There's no lateral communication between the Grayburg
10	at EMSU and the Capitan. It's two townships away, if
11	I remember right. But there is communication with the
12	Goat Seep Reef.
13	Q. And did you share all of that with me when I
14	asked you for the basis of your opinion in your
15	deposition?
16	A. Yes.
17	Q. Are you sure of that?
18	A. I think I did. I told you there was no
19	communication.
20	Q. You did. I'm going to share an exhibit
21	here. So, Doctor, I'm going to zoom in a little. See
22	the highlighted section there?
23	A. I don't see anything.
24	Q. Is the sharing not coming up? Well, that's
25	no fun. Let me try again. Nothing like a good
	Page 173

1 old-fashioned technological issue. There we go. 2 Do you see that there highlighted, 3 Dr. Lindsay? 4 A. Okay. Yes. 5 O. So you do see it? 6 A. Yes. 7 Q. And if you look below, on Line 9 through 10, I asked what you based your opinion on, and you 8 represented, "...go down to Figure B-3." 9 10 A. Okay. 11 Q. So let's take a look at that. I'm going to 12 represent to you --13 A. Okay. Here we go. Q. -- that this is the exhibit you based your 14 15 opinion on per your testimony, correct? 16 A. Yes. 17 Q. All right. So, Dr. Lindsay, do you recall being asked by me whether or not you factored in 18 19 during your deposition the Safe Drinking Water Act? 20 A. I did not. 21 Q. No. Do you recall me asking about that? 22 A. Not off the top of my head. 23 Q. Would you like proof that that was asked of 24 you? 25 A. Well, I'll believe you. Page 174

1	Q. Okay. But you did, in fact, say that you
2	hadn't factored it in, but, and I'm going to quote you
3	here, "No, but that's an issue. Because the Goat Seep
4	is a source of fresh water. Well, low salinity, less
5	than 10,000 ppm water."
6	A. Yes, that's the Goat Seep.
7	Q. And then I asked the second question.
8	"QUESTION: You said just a second ago
9	that the Safe Drinking Water Act is an issue vis-a-vis
10	the Goat Seep. Why is that the case?
11	"ANSWER: I've not reviewed that Safe
12	Water thing, but just realize when we were studying
13	this that the downdip is the source of fresh water and
14	could potentially be contaminated."
15	Does that sound right?
16	A. Yes. And I'm talking about the Goat Seep,
17	not the Capitan.
18	Q. So is it your testimony here today that you
19	did incorporate Safe Drinking Water analysis for the
20	San Andres?
21	A. No.
22	Q. Okay. And did you address the San Andres in
23	your rebuttal filing before this Commission?
24	A. No.
25	Q. So let's shift topics a little bit.
	Page 175

1 My understanding is your area of focus 2 primarily, not exclusively, is the issue of fractures in this case. Is that a fair statement? 3 4 A. Well, it's reservoir characterization, and 5 fractures happens to be part of that. Q. So fractures are part of your analysis, 6 7 correct? 8 A. Yes. 9 Q. And you testified earlier today, as well as providing through your rebuttal, that there are 10 11 fractures in play in this case at issue? 12 A. Yes. 13 MR. MOANDER: Okay. One moment. My apologies to the Commission. There's lots of paper. 14 15 BY MR. MOANDER: 16 Q. All right, Doctor. I'm showing what's been 17 marked as Empire's Exhibit J-4. 18 A. Yes. 19 Q. Do you recognize that document? 20 A. Yes. 21 Q. On the left-hand side, it appears to say, "San Andres Total Fractures (129)"; is that correct? 22 23 A. Yes. 24 Q. And that 129 reflects the number of 25 fractures you found in this analysis, right? Page 176

1	A. Yes. In 36 feet.
2	Q. In 36 feet. Okay. Let's scroll down to
3	Empire Exhibit J-5. Now, this Exhibit J-5, again, you
4	recognize this document?
5	A. Yes.
6	Q. And, again, on the left-hand side, it says
7	San Andres Large Fractures (18)"; is that right?
8	A. Yes.
9	Q. And that would be 18 fractures within how
10	many feet?
11	A. In a 36-foot interval. And they're
12	somewhere between 1 and 3 feet in length.
13	Q. Let's take a look at Empire Exhibit J-6.
14	Again, I'll direct your attention to the left side,
15	"San Andres Small Fractures (109)." And that was done
16	based on the same parameters that you described with
17	the last two exhibits, correct?
18	A. Yes.
19	Q. And then finally, we'll come to Empire
20	Exhibit J-7. Again, I'm assuming you recognize this
21	document?
22	A. Yes.
23	Q. And, again, on the left-hand side, it says,
24	"San Andres Collapse Breccia," if I'm pronouncing it
25	right, "Fractures (82)"?
	Page 177

1	A. Yes.
2	Q. So between Exhibits J-4 and J-7, you've
3	outlined what, over 200 fractures in the San Andres?
4	A. Mm-hmm. Yes. And some of them are in
5	collapse breccias and some of them are small. So
6	we're kind of repeating just a little bit, because
7	there's only 129 total.
8	Q. Oh, so those are duplicative? Is that your
9	testimony today?
10	A. Pardon?
11	Q. So those are duplicative exhibits? Is that
12	your testimony?
13	MS. HARDY: I object to the form. I think
14	that misstates his testimony.
15	MR. MOANDER: I'm just asking a
16	clarification question. I don't understand the basis
17	for the objection.
18	HEARING OFFICER HARWOOD: Go ahead and
19	rephrase the question. That question is somewhat
20	unfair.
21	BY MR. MOANDER:
22	Q. So, Dr. Lindsay, those 129 fractures, those
23	account for the in Exhibit J-4, those account for
24	the exhibits in J-5, 6 and 7?
25	A. Yes. Because there might be small
	Page 178

1 fractures, and some of those small fractures might be 2 in collapse breccias. 3 O. But the point being that there's 129? A. There's 129 total. 4 5 MR. MOANDER: Thank you. I'll pass the 6 witness. 7 HEARING OFFICER HARWOOD: We still have 8 10 minutes. Let's see, Mr. Beck, you look like 9 you're itching for cross-examination. Do you have any questions? 10 11 MR. BECK: No, I don't. Thank you. 12 HEARING OFFICER HARWOOD: Then we'll pass it 13 on to Pilot. Is it Mr. Suazo? He may be asleep. Is there anyone present in the room? 14 15 MR. PARROT: Pardon me, Mr. Hearing Officer. 16 This is James Parrot, with Beatty & Wozniak, representing Pilot. I'm having a little trouble 17 getting my microphone turned on. I'll be taking over 18 19 the remainder of day for Mr. Suazo. And Pilot does 20 not have any questions. Thank you. 21 HEARING OFFICER HARWOOD: Okay. Thank you. 22 Then I guess last but certainly not 23 least, how about the Commission? Would you prefer to 24 break and then do Commission questions, or you want 25 to just start now?

1 CHAIR ROZATOS: I would say let's take a 2 I think it's a good natural breaking point. break. And then we can start up again with the Commission 3 4 questions. 5 HEARING OFFICER HARWOOD: Okay. How about 3:05 p.m.? That's 14 minutes, not quite 15, but 6 7 better than 10. 8 Off the record. 9 (Recess held from 2:52 to 3:06 p.m.) 10 HEARING OFFICER HARWOOD: I guess it's time 11 for Commission questions. Mr. Rozatos, is there any 12 particular order you guys prefer to go in? CHAIR ROZATOS: We don't. I'll just say 13 that I don't have any questions. 14 15 HEARING OFFICER HARWOOD: Okay. 16 That leaves you, Mr. Lamkin and Dr. Ampomah. Between the two of you, who wants to 17 18 volunteer to go first? 19 COMMISSIONER AMPOMAH: I'll go first. Thank 20 you. 21 EXAMINATION BY THE COMMISSION 2.2 BY COMMISSIONER AMPOMAH: 23 Q. Dr. Lindsay, good afternoon to you. Thank 24 you so much for your expert testimony. 25 I'm going to ask a couple questions, and Page 180
1 if you feel like this one has to be a reservoir 2 engineer question and you might not be able to respond to it, please do so. 3 4 So you categorized your testimony to 5 different section, to I'll start with the A and the 6 heading, "The proposed SWD wells would inject into the San Andres Formation which contains a residual oil 7 8 zone." So I'm going to focus on that subheading.

9 So from your direct testimony, on Number 6, you talked about, while describing core and 10 11 characterizing Greenburg in San Andres reservoirs in 12 the EMSU, looking at that area, you just said it was discovered that the San Andres contains a ROZ. 13

When was this discovered?

14

15 A. Let's see. The first time I noticed this, 16 it had to be back in the 1990s. The EMSU 679 was 17 cored in 1990. And when it came in, I was asked to 18 describe it. And so as we went down, getting sampling and looking at the cores, and finding the San Andres 19 20 contact, we realized there was all of this oil stain into the San Andres. And that was the first time I 21 22 got to physically see oil saturation in the 23 San Andres. So that was the first time. And then I was asked to do the RR Bell 24

25 Number 4, and here was another core that not only went

1 through the Grayburg but went down into the 2 San Andres, and there was more oil saturation in the 3 San Andres. So at that point, we realized, yes, there's some kind of reservoir in the San Andres. 4 5 And then when you look at the oil saturations they're really low. So what we called 6 them back then was a "residual oil interval," that's 7 how I termed it. Some people like to call them 8 "transition zones." 9 And so I just called it a residual oil 10 11 interval, but then later, terminology came along from 12 Steve Melzer and another friend of mine, Bob Trentham, 13 where they started to call them "residual oil zones." 14 Q. So which year was it called residual oil 15 zones? 16 A. That, I don't know, when that first came 17 out. Steve could tell you. I'm not sure. Because I 18 think when that happened was when I was working in the 19 Middle East, and I don't know exactly when that change 20 occurred. But Steve could tell you about that. Q. Okay. So in the EMSU, you're saying that it 21 was way back in the '90s, 1990, that was when the 22 first -- when the studies was done to identify these 23 saturations in the San Andres? 24 25 A. Yeah. We'd never seen the San Andres before

Page 182

1 in EMSU. Well, there was one core that just got a 2 couple of feet into the San Andres, the EMSU 459. But 3 it was just a couple of feet, that was all, so we didn't get to see much. 4 5 But in the 679, by coring the EMSU 649, 6 and then coring a little bit deeper in the EMSU 679, which is just one location to the south of the 649, 7 8 they got this big, long core through all of the 9 Grayburg, so we got to see all of that. But then it happened to go down into the 10 11 San Andres, as well. And that happened to be an 12 oriented core at the top, and it stayed oriented for the first 36 feet into the San Andres. 13 14 And then the lower part of the core 15 interval, they didn't orient it. And for whatever 16 reasons, I don't know. 17 So we had that data. And then we 18 started describing the core. You always start at the bottom and work your way up. So right at the get-go, 19 20 we saw oil saturation in the San Andres, and so we said, "Oh, there must be something here." 21 22 And at the same time, there were geologists that were working EMSU that said, "Well, 23 24 here's our potential oil-water contact, somewhere around minus 714 or minus 750, somewhere around 25 Page 183

1 there." And that oil-water contact would -- I don't 2 know how they exactly come up with that, but they did. So I saw this saturation in both the 679 3 and in the RR Bell Number 4. And right then, we 4 5 realized there was some kind of saturation in there that was low, but there was oil saturations. And the 6 7 great catch was how deep did it go. And we didn't 8 have any deeper cores than those two, so I didn't 9 personally know how deep it went after that. But there was some kind of residual oil zone there. 10 11 Q. So from the '90s up until now, has there 12 been any pilot project on recovering from ROZs in the 13 EMSU, that you're aware of? A. No. Just a lot of talk that there's some 14 15 kind of ROZ in there. 16 Q. Okay. So on that same Number 6, you go 17 further to talk about potentially deeper and it's a ROZ. So I want to ask you, is this still in the 18 19 prospecting stage, or is it proven, or is it probable 20 reserves that we're talking about here? 21 A. Well, what happened, was at the base of both 22 cores, we saw oil saturations. And, like I said 23 before, being a good exploration geologist, you say, 24 "Oh, if it's at the base of the core, there must be more. How many more is there?" But there was no more 25

1	core. And so that's where my work ended.
2	And then other folks look at well logs
3	and try to calculate oil and water saturations to see
4	how much deeper that might extend down into the
5	San Andres.
б	So that's where I kind of had to stop,
7	because then I had to go on and describe the next
8	core, the next core, the next core, the next core and
9	the next core in the EMSU and EMSU-B and AGU. And
10	chews up a lot of time.
11	So we knew there was some kind of
12	residual oil zone there, but we just didn't know how
13	thick it was.
14	Q. Has been there been any production, either
15	water, oil, that you know of, in the San Andres?
16	A. Oh, there's plenty of water production, but
17	there's very little to no oil saturation being
18	produced out of the vertical wells. Because we're
19	probably below what we call this producible oil-water
20	contact, where we're just looking at residuals. And
21	then vertical wells, you can't produce residual very
22	well by primary recovery. You just can't.
23	Q. So in your testimony, you talked about ROZs
24	could be from, let's say, 20 percent to about
25	40 percent saturation; is that correct?
	Page 185

Veritext Legal Solutions Calendar-nm@veritext.com 505-243-5691 www.veritext.com A. Yeah, some range like. And 20 seems to be
 kind of a good number to start at, then you just hope
 it gets higher.

Q. I know you have a lot of experience in the
Permian Basin. So what is the typical residual oil
saturation to water injection in a typical reservoir?
Let's say, Greenburg, for example, let's say even the
San Andres that you might have a fair idea about.

9 A. That's a tough question, because you're 10 getting into log analysis, and if you don't have a 11 core, you don't know the -- how much oil saturation is 12 really there. And that's -- I don't think I can 13 answer your question, to tell you the truth.

Q. Okay. I will rephrase it in another way. In a typical reservoir, let's say -- I will just use a for instance. A typical residual oil saturation to water injection, probably about 25 percent, 26 percent Procent, depending on the area that you're working in.

So I'm asking, in the Permian Basin, in some of the rocks that we are talking about here, what would be the typical residual oil saturation to water injection? For instance, at what saturation level would you start CO2 injection in the Greenburg Formation?

1 A. Oh, boy. I don't think I'm qualified to 2 answer that question. I worked with one fellow that 3 tried to answer that question in Goldsmith Field, what's the residual oil saturation there, and this was 4 5 years ago. This was back in the 1990s. A guy named 6 Doug "Jassic," he was trying to figure that out. And 7 it ended up being his master's thesis at Texas A&M. 8 And I can't remember what kind of number he came up 9 with. But he was looking at the -- I believe it was 10 the San Andres, yeah, when we were working on that 11 particular reservoir. 12 But I don't think I'm qualified to kind 13 of answer that question. Because we're getting into the kind of the world of reservoir engineering more 14 15 than geology there. 16 Q. Now, this one is all on the core analysis, 17 because if you analyzed the core, you say that 18 probably that is special core analysis, and you do a 19 lot of routine core analysis? 20 A. Yes. 21 Q. Okay. Then I got you. I'll save my 22 question. 23 A. Okay. 24 0. Okay. Thank you. 25 Now, still, I believe, on the Number 6, Page 187

1 on the Capitan Reef Aquifer question, so I want to 2 know, is the Goat Seep, is it in any way communicating 3 with the Capitan Reef any way, anyhow? A. No. If you go out to the Guadalupe 4 5 Mountains, you'll see the Capitan -- well, I'll kind 6 of do this. Here's the top of the Grayburg, and then 7 the front of it is eroded away, like so. And then the 8 Capitan glues itself onto it like that. Okay? 9 And then the overlying strata progrades much further out. And then here's the Capitan 10 11 starting to prograde out into the basin. And that 12 distance is several miles. And the progradation of 13 just the Capitan in the one mountains is eight to ten miles of progradation, but it does not touch any 14 15 of Goat Seep strata at all. It's further outboard, 16 downdip. And then it progrades about eight or 17 ten miles. 18 If you go up to the northern end of the 19 Delaware Basin, there the Capitan progrades about 18 miles, quite a ways. 20 21 If you swing around to the west side of 22 the Central Basin Platform, there it only progrades maybe three or four miles, not very far at all, just a 23 24 short distance. And that's just downdip from the EMSU and southern AGU. 25

But the distance from the edge of it, from this field to where the Capitan is, where it's been mapped, the downdip limit of it is about two townships apart. So they're probably not connected at all.

6 But what is connected is the Goat Seep, 7 because you can see it in outcrop in the Guadalupe 8 Mountains. And people from the University of 9 Wisconsin have actually described it and studied it 10 back in the 1970s. And then it -- and it comes 11 around -- this eroded edge comes all the way around 12 the Delaware Basin.

And in front of EMSU, it is eroded away there, and there's the Goat Seep, like that. And that distance to this spot, to where the field is, is just a couple of miles. And there, the Goat Seep is in pressure communication with the Grayburg.

18 And that's how the edge water coming from the Goat Seep, that is being reached from the 19 20 Guadalupe Mountains and Glass Mountains, is being recharged into the subsurface. And then that water is 21 22 being sucked by production updip into EMSU, because 23 there is this pressure drop. And this is higher 24 pressure down here. So it's just simply being sucked updip into the reservoir, and that's how you get the 25

1	edge water.
2	Q. And that is very interesting. The Goat
3	Seep, can it be classified as USDW?
4	A. As what?
5	Q. Underground source of drinking water.
6	A. It's less than 10,000 ppm, so it's fairly
7	fresh water. I don't know if I'd want to drink
8	something with 10,000 ppm, but maybe somebody's cattle
9	would.
10	Q. Okay. But there's no injection that you
11	have a direct communication with the Goat Seep that
12	you are aware of?
13	A. Oh, no, the Goat Seep is in communication
14	with the EMSU. That's how all the edge water is
15	coming in, into the reservoir sideways.
16	So if here's the reservoir, here's the
17	edge water coming in, like this. It's coming from the
18	Goat Seep through the downdip part of the Grayburg and
19	coming into the west side of the field.
20	So it's in communication, but, to the
21	best of my knowledge, we're not in communication with
22	the Capitan at all.
23	Q. Okay. And Capitan is the one that NMOCD is
24	more concerned about?
25	A. Yes, yes, yes.
	Page 190

1 Q. On your Exhibit B-1, what type of ROZ are we 2 dealing with in this area, if you can respond to that? 3 A. Well, there's a couple different kind of ROZs. There's one that's called a brownfield and 4 5 there's one that's called a greenfield. And the way you define a brownfield is you have a producing 6 7 reservoir above a ROZ. So just in real simple terms, you can say, well, here's the reservoir in the 8 9 Grayburg and here's the ROZ beneath, in the 10 San Andres. So you could say that's a brownfield. 11 Q. Okay. 12 A. Okay? 13 Q. On your Exhibit B-2, where you show -- and I 14 don't know if you can bring it up, but that is the 15 porosity fairway's faults and fractures. And based on 16 the cross-examination from Mr. Rankin, I got to know 17 the location of the EMSU in relation to --18 A. Oh, we didn't show it, did we? 19 Q. Yeah, you did. 20 A. Okay. 21 O. It was shown here? 22 A. Where he pointed to, it was the right location. 23 24 Q. Yeah, okay. So how does the performance of the ROZ in the Tall Cotton, Goldsmith, and I don't 25 Page 191

1 know if -- oh, it's Seminole, can you speak to that? 2 A. I don't have enough hands-on experience with Seminole or with Goldsmith to answer that. When I 3 work on Goldsmith, what I can tell you is, we did --4 5 we had all these cores in the San Andres, and one of 6 them went down into the ROZ. 7 And we knew it was there, we had cored 8 it and we had the oil saturations. And we could see 9 this profile of higher oil saturation coming down to lower oil saturation. And that interval was probably 10 11 100, maybe a little more than 100, maybe just about 100 feet of section. 12 13 And you see it start at a higher oil saturation and drop down literally almost to zero at 14 15 the bottom. Because at the bottom of the core, it 16 turned out it wasn't dolomitized anymore, it was 17 limestone. And the limestone was nonporous, so there 18 was really no oil saturation in there. 19 So we had this really nice ROZ sitting there, and then above it was the San Andres main pay 20 reservoir. And so it was another brownfield, but it 21 22 was totally within the San Andres. Then to the west side, we were going to 23 24 try to put in a CO2 pilot in the main reservoir, and 25 when they put it in, it didn't work well. And at Page 192

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1 first they thought it worked great because there was no early CO2 breakthrough. But after a year or so, 2 everyone said, "Where did the CO2 go? Why don't we see 3 a bank forming? What happened?" 4 5 Well, it turned out there was a wettability issue in that reservoir. And as you tend 6 7 to be more oil wet, there's two ways a waterflood would work. It'll either go through the water pores 8 9 or through the small pores. And if it's more oil wet, you'll flood through the larger pores. And that's 10 11 kind of where we were at. 12 Well, the peripheral waterflood had 13 flooded a lot of that movable hydrocarbon out. And 14 when the CO2 came in, it popped into these big -little micro moldic pores. They weren't exactly 15 16 small, but they were kind of maybe fingernail size and 17 smaller, about this size and smaller. 18 And when the CO2 popped in, it couldn't 19 get back out of that big moldic pore. And so what we 20 were doing, we didn't realize, was we were 21 sequestering the CO2 in the reservoir and there was no 22 oil there in the pores for it to dissolve into. So it was a failed CO2 flood. 23 But what people found out years later, 2.4 25 was, after it was sold from Chevron to XTO, that that Page 193

1 area up around there where the CO2 was injected in, the 2 wells around there started to produce better. So there was this long-term soaking effect of the CO2 that 3 mobilized some of the oil in that area. But it didn't 4 5 really bank oil, because we were basically sequestering the oil for -- we sequestering the CO2 in 6 7 these large moldic pores. And we did this really detailed study 8 9 of: How big are the pores? How big are the pore throats? What's the ratio? 10 11 And the answer was, if these were 3,000, 12 this was 1. And so once it popped in, it couldn't get 13 out. 14 So once that didn't work, they never attacked the ROZ in the Chevron acreage. But across 15 16 the street and to the north, in Goldsmith, there was 17 an active CO2 project in the ROZ, from what I 18 understand. But I know nothing about it. 19 But my colleague, a friend of mine, Bob 20 Trentham, he actually got to work on that and he could 21 tell you about how that worked. Q. Just to clarify, did I hear you saying that 22 23 there is not enough data to make -- let's say, to assess the economics of the ROZ within the EMSU? Did 2.4 25 I hear you say that?

1	A. Oh, for the San Andres, for the ROZ?
2	Q. Yes, yes.
3	A. There's just that little bit of data in the
4	upper part, where we got core analysis. We got the
5	logs and then we got logs deeper in the section, but
6	we don't know the oil saturations. That's the
7	problem.
8	So we need to get a core down through
9	the deeper part of the section so we know what the oil
10	saturations look like and how big you know, how
11	in-depth the ROZ might be. And that's a real problem.
12	Q. But that is interesting. So if we do not
13	know let me put it this way. Then would it be
14	appropriate for, let's say, your client to drill to
15	get this information?
16	You know, the decision that you're
17	asking the Commission to make is a really difficult
18	one, really complex, when you have saltwater injection
19	going on, a lot of facilities being drilled, they're
20	built out, and you're asking us to revoke these
21	existing injection permits.
22	A. Yeah.
23	Q. And even the new ones, we should deny them.
24	I mean, do you believe that enough work
25	has been in the EMSU to confirm that there is a
	Page 195

1	recoverable oil saturation enough, you know, to
2	warrant these revokes that is being asked here?
3	A. We don't have enough direct evidence in the
4	core. We've just got indirect evidence via well logs
5	about how much oil saturation might be there.
6	But I believe some other folks are going
7	to address that particular issue to help you out to
8	make a reasonable judgment for your case.
9	Q. I appreciate that. So in your geological
10	characterization work, you testified that you analyzed
11	two wells; is that correct?
12	A. Yeah. In the San Andres?
13	Q. Yeah, in the San Andres.
14	A. Two cores.
15	Q. Yeah, two cores.
16	A. Just those two, that's all we had. Just a
17	little bit of data. But the really surprising thing
18	was, you get to the bottom, there's oil saturation.
19	You say, "Oh, how much deeper does it go?" And that's
20	the great question: How big is this ROZ? How much
21	oil is there in place to try to be recovered by
22	whatever process?
23	Q. So what is the distance between the 679
24	or is it the two wells?
25	A. There's a map.

Page 196

1 Q. Yeah, there is a map. We can bring it up. 2 A. I think my first illustration, if we could 3 bring that up, I could show you the distance. Because 4 we've got them on there. 5 THE WITNESS: Is that possible to bring that up some way, somehow? 6 7 MS. HARDY: Is it in your direct testimony? THE WITNESS: Yes. It's going to be, I 8 9 think, the first slide after the introduction. It's the very first one. 10 11 CHAIR ROZATOS: It was B-4, Ms. Hardy. 12 A. You can see right in the middle of the 13 field, you can see the 649 and the 679, yeah, it's 14 right next to each other, right there. 15 So the 679 went down into the 16 San Andres. And then the RR Bell is way over here to 17 the east. It is up near the stratigraphic trap. So we're kind of really losing a lot of 18 19 reservoir quality right there. But those are the two 20 that got into the San Andres a fair distance. 21 Now, the 458, there at the end, there on the east side, it got down into it just a couple of 22 feet. That's about all. 23 24 So the two biggies are the 679 and the RR Bell Number 4. And that distance is about two and 25 Page 197

1 a half miles apart. 2 Q. Okay. Now, I will get to the 679 --A. More like three miles. Excuse me. 3 O. Three miles? 4 5 A. Yeah, three miles. Yeah. 6 Q. Okay. I will get to that in a second. 7 Now, I'm still on the 6. You showed a 8 table comparing Goodnight's saltwater injection water 9 analysis compared to Empire's produced water analysis. 10 So where is Empire's produced water 11 coming from? 12 A. I don't think I showed that. Did I? 13 Q. There's a table on Page 5 of your direct 14 testimony. 15 A. Let's look at it and see what it was, yes. 16 Q. Right there. 17 A. Oh, okay. Yeah, this was added in later on 18 that. So I can't say too much about that. Sorry about that. Yeah. 19 20 Q. So is it not part of your testimony? 21 A. This was added in later, okay, by one of the 22 Empire folks. 23 Q. Okay. 24 A. That's not my data. But it's just showing 25 the range and stuff. Because these are the ions you Page 198

1 really have to worry about if you're injecting all of 2 this high-salinity water into the San Andres. Because it could fix with the sulfate that's in there and 3 create an enormous amount of scale and start to cement 4 5 up the reservoir. That's the big worry. That's the big worry. You're going to start to destroy their ROZ 6 7 basically. 8 O. Yeah, but where is the source of Empire's 9 produced water? A. Oh, this data? 10 11 O. Yeah. 12 A. I have no earthly idea. I'm sorry. They 13 can respond to that. 14 Q. Okay. 15 A. That's a good guestion, though. 16 Q. And since you said you -- because I'm 17 asking, my follow-up was, is this within the EMSU? 18 A. That, I don't know. I'm sorry. I don't 19 know. 20 O. Okay. A. I would assume it is, but I don't know. 21 22 Q. Okay. Now, if we can go back to the map where we showed the 679 well. 23 24 A. Okay. 25 Q. So I'm going to show you, if you can Page 199

1	respond. But do you know where at least one of the
2	wells from Goodnight is located?
3	A. I have a base map of where they are. I
4	didn't bring it with me. They're basically to the
5	south, is where most of them are, the southern part of
6	EMSU. So I've got a base map, but I left it home.
7	Sorry about that.
8	Q. So it's way south of the 679?
9	A. Yeah, where this line is of all these cored
10	wells, a lot of them are just to the south of there.
11	But I don't have a map to show where they're located.
12	I had a hard copy and I left it home.
13	Q. So, you know, B of your direct testimony,
14	you've categorized that. Under the B, you talk about,
15	"Geologic and engineering interpretation will identify
16	vertical fractures and plumes which would not prevent
17	vertical migration of fluids."
18	Am I reading it wrongly?
19	A. Let's see.
20	Q. "Which would not prevent vertical migration
21	of fluids"?
22	MS. HARDY: What page are you on?
23	COMMISSIONER AMPOMAH: Yeah, so I'm just on
24	Page 4.
25	CHAIR ROZATOS: It's right here in B,
	Page 200

1 Ms. Hardy.

2 BY COMMISSIONER AMPOMAH:

Q. Right there. "Geologic and engineering interpretation will identify vertical fractures and plumes which would not prevent vertical migration of fluids."

7 So meaning there would be vertical8 migration of fluids?

9 A. Oh, yeah, the fluids. Because we've known 10 about these plumes for years when I was working in the 11 Hobbs office back in 1998 through 1990, before we 12 moved to Midland and continued working there. They 13 were well known about, and so the big issue was the 14 fractures.

And so we started taking all of these oriented cores so we could do fracture studies. And this was in the 1990s. And then the idea was to try to understand the fracture distribution within these reservoirs and see if they were going to be our friends or if they were going to be our enemies.

And then this one core, the 679, when it was oriented and went down into the San Andres, so we could see fractures from the San Andres all the way up to the Grayburg. And initially, our work was so focused on just the Grayburg, that we only described

Page 201

those fractures in the Grayburg for our initial
 report.

But then later, with all of this hearing coming up, these become really important. So I went back to my original fracture studies. I happened to have a copy because Chevron released all my data to me from my Ph.D., so I was lucky, because this work was done back in the early '90s.

9 So I went back just last a year and did 10 the fracture study on the San Andres part of that 11 oriented core. And luckily I had a hard copy of the 12 data so I could put together the different diagrams 13 showing the fracture orientations.

14 That became really important, not only 15 in EMSU, but up in EMSU-B, we had a oriented core up 16 there. And then down in AGU, instead of taking one 17 oriented core, we took two, because that was such valuable data to understand these fractures. And in 18 19 AGU, we actually mapped the area where we started to 20 see bottom water out of the San Andres coming up into 21 the Grayburg.

Before that, we just kind of took it for granted that we had these little plumes here and there, these little one-well plumes, kind of like my finger, coming up like this to where there was a

Page 202

1 little more intense fracturing, and we just took them 2 for granted. Then after a while, I said, "Well, you 3 know, it would be a good idea to maybe map these out." So by the time we got to unitizing AGU 4 5 in 1992, actually made a map showing where these 6 plumes were kind of located in AGU so the folks could 7 know that there might be bottom-water problems coming 8 up into the Grayburg that would affect the waterflood. 9 Q. So based on what you described, I just want to be -- let's be clear. The EMSU 679, do have the 10 11 plume that you are describing? 12 A. Right there, we didn't know of a plume. But 13 to the north, which is one well out of EMSU into 14 EMSU-B, we knew there was a plume there in the 887. 15 And out of dumb luck, that happened to be the well 16 that was cored with an oriented core and we got a 17 fracture study. So here, we knew we had a plume 18 around this well, and we happened to core it and we 19 took an oriented core and we got a fracture study. 20 And I remember when I opened that core up to start describing it, there were all these 21 22 fractures. And I thought, oh, boy, this is a real But we went ahead and did the fracture study, 23 mess. 24 and then I described the core. 25 So that's the best one that I can point

1 out, off the top of my head. And this is way back in 2 the early 1990s when we were doing some of this work. O. So what I'm getting at is, let's say you 3 described one core from 679, but you are using that to 4 5 generalize, maybe I'm saying that wrongly, that there 6 could be or there will be a vertical migration of water that is injected into the San Andres all the way 7 8 to, let's say, the Greenburg. 9 Is that your testimony? A. Yes, yes. There's a problem. The higher 10 11 the pressure you generate in the San Andres, the more 12 fluid will move up. 13 Q. So is there going to be a reservoir engineer to testify to confirm this, aside just one core? 14 15 A. That, I don't know. That, I don't know. 16 Sorry about that. 17 Q. So it is your testimony that based on one particular well-core information, one well, 679 well, 18 19 there is this 36 feet, as you describe, that is a 20 fracture, right? 21 A. Yeah. 22 Q. So that is why I wanted to know the location of the Goodnight's saltwater injection well in 23 24 relation to this particular 679 well and see that there could be an reservoir engineering explanation to 25 Page 204

see that, you know, whatever is happening here can be
 more than generalized to cover whatever is going on in
 the other areas.

A. I would assume, because you're on this --4 5 you've taken this rock and you've flexed it like that. 6 679 is somewhere right about here. It's just not 7 fractured right here. The whole area is fractured. 8 Because dolomite is brittle and it's 9 easy to fracture and the tighter it is, the easier it will fracture. The more porous it is, it'll absorb 10 11 some of the energy of flexing, but it will fracture. 12 So I would assume you have quite a few fractures 13 throughout EMSU. 14 Q. Do you know between which period was there 15 injection in the San Andres? Do you know when it 16 started? 17 A. Injection? Q. Yeah, water injection. 18 A. I do not know. I do not know. I can't 19 20 answer that. Somebody else would have to answer that 21 for you. Q. Yeah, so definitely from my point of view, 22 what I want to see is that you do have actual 23 24 engineering data. So you do have actual reservoir engineering data, which is going to be the injection, 25

1 the injection rate, the pressures in the San Andres? 2 A. That, I don't know. That, I don't know. 3 No, sorry. That's an engineer's --Q. Yeah, so let me try to make my point. You 4 5 do have this actual engineering data, water injection rate, pressure recorded, right, within the San Andres? 6 7 And that's been numerous injection rates over the 8 period. So I want to see that. 9 And then also, I want to see, within the 10 Greenburg, I want to see the pressure profile. I want 11 to see the production profile. I want to see the 12 water-cut profile. 13 You know, when we see this, I mean, most 14 of us, we are all engineers, we should be able to tell 15 what is the impact of, let's say, if there's a 16 fracture, is it really impacting whatever is going on 17 out there. 18 A. Okay. 19 Q. It's so difficult, let's say, using only one 20 well to generalize within the entire area to say that 21 there could be a vertical migration of the water that has been injected in the San Andres all the way to the 22 Greenburg, knowing that the first injection -- I know 23 Mr. Rankin talked about it. When was it? Can someone 24 remind me? Way back, 1950s. 25

1 So definitely engineering data -- you 2 should have pulled probably all this to say Empire should use engineering data to back whatever for, 3 4 let's say, the one well is saying. 5 A. Yeah, and that's an engineering question. I can't answer that. What I can tell you is, whenever 6 we have these oriented cores and we do these fracture 7 8 studies, there's a lot of fractures there. Some are 9 large, some are small, but there's a lot of them. 10 That's the key. 11 Q. Okay. Let's go to Exhibit B-7. If you can 12 show the core snaps on the screen. B-7. Right there. 13 So are there fractures that are visible 14 here? 15 A. There's just a few, but I wouldn't rely on 16 those too much. You can see one there in the middle box at the bottom. You can see one to the side right 17 18 This is in fairly porous rock right here. there. Ιt 19 would tend not to break as well as if you were 20 slightly tighter. But that's why I've shown it in that 21 22 other sample, where you can actually see those 23 fractures and solution-widened and see how they're oil 24 stained, where it tends to be a little tighter. Ιf 25 you can show that one, that would help you out, too.

1 Yeah, this right here. Yeah. This is 2 kind of -- oh, we got to back off a little -- we're a little too -- okay. There we go. Because you can --3 that's a whole foot on the left side. It must have 4 5 been cut off or something. Okay. Well, anyway, there's about a 6 7 half foot of section and there's how many fractures 8 can be there. Now, that's nonporous rock. Well, less 9 porous rock, let's put it this way. And so in that 10 case, this is where you tend to fracture the most. So 11 if you have any low porosity intervals, they're going 12 preferentially fracture more than porous intervals. Like that last slide we had before this 13 14 one, you didn't see many fractures. Now, here, where 15 it's less porous, you see more fractures. And these 16 fractures, at first glance, they would look like 17 they're not touching each other and they're not connected. Yet, the oil stain is telling you the oil 18 has communicated through all of these. So three 19

20 dimensionally, all of these fractures are connected.
21 This is what these fracture halos look

21 like. It's a series of fractures, and when they pop, 23 they're all kind of interconnected on the larger 24 scale. And it's really hard to see these in just a 25 little 4-inch core. But here's just a good example of

one of these halos.

1

2 And then this late stage water, this 3 Mother Nature's Waterflood has come through and actually solution-widened these fractures. So instead 4 5 of just being little paper thin fractures, they're 6 solution-widened, so they have quite a gap to them. 7 And then once the reservoir had a chance 8 to try to re-saturate, when that head of energy went 9 away and you could kind of backfill the reservoir, here's the oil coming in these fractures. 10 So that's 11 telling you these fractures are three dimensionally 12 interconnected. Q. Thank you. So back to the other one, the 13 14 B-7, so you're showing saturations of oil, 30 percent, 15 25 percent, 38 percent? 16 A. Yes. 17 Q. You know, just out of curiosity, let's take one of them. Let's take the first one on your extreme 18 19 right -- upper left. 20 A. Okay. 21 Q. So you have 34 percent water and then 30 22 oil. 23 A. Yeah. 24 Q. What is the remaining one? What is the remaining? 25

1 A. This is all they got with the core analysis. 2 I don't know where the other part went. 3 Q. No, I'm just saying --A. And part of the problem is, this has been 4 5 super flushed when the coring took place, so you have to add extra oil back in. But that still won't get 6 7 you to 100 percent. So I don't know where the rest of 8 the numbers went. 9 This is where somebody who has done core 10 analysis for years and years and years needs to come 11 in and explain this phenomenon. 12 But these are the numbers that were 13 generated. The numbering that I look at, though, is 14 just the SO. I kind of tend not to look at the SW 15 much. 16 Q. Okay. 17 A. Because that's where the money is, is in the 18 oil. This is just a conventional core, so in this residual oil zone, this is the lowest saturations. 19 20 But based on some of the work that was done in Seminole, that tells us, oh, they could be much 21 22 higher, because this has been super flushed. 23 Q. They could be higher, but I think that they could be lower. 24 25 A. Oh, no. No, no. Page 210

1	Q. No?
2	A. Because this core has come from 4,000 feet
3	down. That top depth is 4239, and so, as you bring it
4	up to the surface and as pressure decreases, more oil
5	will come out. And so as you go down
6	Q. I got you.
7	A. And that's why they have to take these
8	pressure cores to try to get more accurate readings.
9	But oooh, they're really expensive.
10	I've only done one in my whole career, and it was up
11	in North Dakota in the Wilson Basin, and it was so
12	hard to just collect about 57 feet of core. It was
13	really difficult and it was very expensive.
14	So I take my hat to the people at Hess,
15	over at Seminole, for even doing a pressure core.
16	Because they're time consuming and they're expensive,
17	really expensive.
18	Q. I'm sure we all agree that in our industry,
19	we don't necessarily just use only one resource to
20	make a determination, right?
21	A. Yeah.
22	Q. So am I going to see a log that backs this
23	up? Because the log data, unless you have a let's
24	say you do have a consent with whatever is coming
25	through the logs, definitely the logs is going to give
	Page 211

1	us something
2	A. Oh, yeah.
3	Q and then we should be able to correlate
4	that back to the core.
5	A. Yes.
6	Q. So irrespective of the method that is being
7	utilized, we still have the core to confirm whatever,
8	let's say, each of the methods that we did.
9	A. Yes. And that's a little bit beyond me, but
10	there's a couple petrophysical guys that will explain
11	that.
12	Q. I appreciate that. And I'm really
13	interested in the typical residual oil saturation for,
14	let's say, a typical reservoir in the EMSU, typical
15	residual oil saturation. So if the engineers are in
16	the room, hopefully they can get me some answers on
17	that.
18	A. Okay. Fair enough.
19	Q. Okay. You said there will be a log with the
20	core information. But is there any FMI data?
21	A. Not in these two wells that had cored into
22	the San Andres, there isn't. To the best of my
23	knowledge, there is no FMI data on that. That would
24	be helpful. That would be very helpful.
25	As a matter of fact, that's an
	Page 212

1 alternative to coming in and a doing an oriented core 2 deeper into the San Andres. But then you have to 3 orient the core, and so that would chew up some money. 4 The other way is just where you drill 5 down just to run an FMI and to see the fractures on the image log. That's the other way a fracture study 6 could be done deeper. 7 8 But the catch is, you just see the 9 fractures, you don't get the oil saturation. Okay? So there's this trade-off, what's more important? And 10 11 to me, I think it's a little bit of both, to see the 12 fractures and to get the oil saturation. That's the 13 bottom line, to know how big the residual oil interval 14 is, you know, what's the resource there, how much is 15 in the San Andres. 16 Q. So would you say, based on your knowledge in 17 this EMSU, would it be a recommendation to NMOCD that any well that would be drilled through this unit 18

24

production zones?

19

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23

25

A. Yeah. And I'm the consultant and all I can

Page 213

where, based on your testimony, there could be some

fractures that could impair a producing zone, that

there should be FMI run or there should be a detailed

fracture study performed to establish whether there's

going to be an impairment to understand, let's say,

1 say do is say, "This would be a good idea. What do 2 you guys think?" But they're the ones who have the 3 money and have to shake their head this way, instead of no, no, you know. So I can just advise. But 4 5 that's a good thought. 6 Q. So you mapped 313 vertical fractures? 7 A. Well, in the San Andres, the total fractures 8 were 129. There's more up in the Grayburg study, and 9 that might be the bigger number that you're thinking 10 about. So if you add those two up, that's quite a few 11 fractures. 12 So it took us a couple of weeks to do 13 the fracture study, because we did it in-house. We 14 did not send it out to Core Lab or anybody else to do 15 it, because we wanted to get very familiar with the 16 fractures in the reservoir. 17 Q. So am I going to see a log where we've 18 mapped these fractures right depth? Are we going to 19 be able to see, like, is there any estimate that shows 20 that? 21 Or is it going to be as part of the 22 physical analysis, where we are coordinating the core, as you've shown in some of the petrophysics, and then 23 24 also showing the actual locations of the fractures for us to, more or less, see where are the fractures? 25 Page 214

1 Are there any -- talk to us about that 2 whole thing? Can we see something like that? A. Well, the only thing that I've done with 3 mine is, there's that one illustration of the 679 4 5 where we zoom in on the Upper San Andres. If we could 6 take a look at that, then I can show you right where 7 they're located. But we really can't see them, but, I 8 can show you right where they're located. 9 THE WITNESS: Could we go to that illustration that shows 679, the core and the 10 11 fractures? I don't know what number that is. We 12 just have to move up and down a little bit. 13 MS. HARDY: Oh, J-18? 14 CHAIR ROZATOS: I don't see a J-18. 15 MS. HARDY: That would be rebuttal 16 testimony. 17 CHAIR ROZATOS: We're thinking B-18, 18 Ms. Hardy. 19 HEARING OFFICER HARWOOD: B-18, maybe. 20 COMMISSIONER AMPOMAH: No. B-18 is the 21 fracture. 22 THE WITNESS: There should be one that shows EMSU 679, the whole core, and then to zoom in on just 23 the San Andres. 24 25 COMMISSIONER AMPOMAH: So one would be B-25. Page 215

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1 I don't know if that works. 2 THE WITNESS: There we go, yeah. There's 3 one other. I think we need to go down one, because we've got arrows pointing to the fracture study. Oh, 4 5 no, that's not it. I don't know. COMMISSIONER AMPOMAH: I see arrows on the 6 7 B-25. THE WITNESS: If we just -- where did that 8 9 go? There's one where we're actually pointing to the 10 top and the bottom of the fracture study, and it 11 looks just like this. But we actually had to decide 12 arrows. But it's on 679. Then you can see that 13 little interval where there's 129 fractures that we 14 measured. 15 HEARING OFFICER HARWOOD: Is it B-23? 16 COMMISSIONER AMPOMAH: So you said it's only 17 679. MS. HARDY: J-3? I believe it's in the 18 19 rebuttal testimony. So let me see if I can get that. 20 B-23? A. There, yes. There, yeah. In that little 21 22 interval, that's the part of the oriented core in 679. That's the base of the oriented core. All the rest of 23 24 the oriented core is up in the Grayburg. 25 So beneath that lower arrow, of those Page 216
1 two arrows pointing out where the fracture study was, 2 the rest of that core was not oriented. But this is the base of the oriented core. So we thought hey, 3 well, let's go in, let's get those fractures. We 4 5 already had them measured. Let's just make the diagram to show how many fractures are there, how big 6 7 or how small they are. So that's the interval right 8 there.

9 Q. So on this particular paper, Exhibit J-3, so 10 one is the red, and then you have the black kind of 11 strings in that, what is that?

12 A. These black areas, those are collapse 13 These are these little sinkholes that breccias. 14 developed with subaerial exposure of the San Andres. 15 So those -- and the catch is, we don't know how deep 16 the subaerial exposure extended. Because if we look 17 at the red line that is the top of the San Andres, that's the unconformity. And when sea level dropped, 18 it probably dropped, let's see, 10, 20, 30 -- 60, at 19 20 least about 70 feet to create a series of collapse 21 breccias.

Because one of the problems is, with a sinkhole, they're kind of shaped like this, but sometimes they'll go like this down section. And so here we are coring, with only 4 inches to look at, and

Page 217

1	you're in the sinkhole, it's in the side of you and
2	you miss it, then it comes back and you're back in it.
3	So each one of these red intervals could
4	be all tied together. So that would mean that you
5	have at least a 70-foot sinkhole. But vertically, as
6	we cored through it, we were in and out of it, because
7	it was kind of doing this down section.
8	Q. Okay. So based on your knowledge in the
9	EMSU or working in the Permian Basin, is there in
10	there reported or published material talking about the
11	movement, the potential movement of injected water
12	into the Greenburg from the San Andres?
13	A. Other than right here, at EMSU, somewhere
14	else, I'm not aware of. I can't answer that, I'm
15	sorry.
16	Q. Thank you. I think I'm going to pause here
17	so other commissioners can also ask some questions.
18	HEARING OFFICER HARWOOD: Mr. Lamkin.
19	EXAMINATION
20	BY COMMISSIONER LAMKIN:
21	Q. Good afternoon, Dr. Lindsay. Thank you for
22	your testimony. I've got a couple questions for you,
23	probably a little bit more pedestrian than
24	Dr. Ampomah, to try to arouse your interest.
25	So the fracture halos on that slide, it
	Page 218

1 indicates that those are generally created as the 2 result of movement of a fault. Are there any known 3 faults in the EMSU or the EMSU-B that you're aware of?

A. We found one in AGU, and we found a long 4 5 fracture -- I can't remember if it's in the EMSU-B or Because you're only able to see this much, 6 EMSU. 7 4 inches. So it could be to just right there, or it 8 could be over here. So it's really hard to find these 9 faults. And they don't appear to be very big. Very small. 10

11 And you really kind of don't need a 12 When you're taking strata like this and you're fault. 13 bending it like that, it's going to break without a fault. I just put one in the middle for kind of 14 15 convenience sake. Because if you do have a little bit 16 of fault movement, then the bigger fractures will be 17 right adjacent to it and then a little further out, 18 smaller, smaller, and then you'd lose it, making these 19 halos. So we don't know how big these are. We have 20 no earthly idea.

When I was in the Middle East, we were actually doing a bunch of laterals through the field, and we went in and out, in and out, in and out of fracture halo. So that's where we kind of learned about these.

1 And so before, when I was describing the 2 core, I just saw all these fractures and we just tried to map them as best we could. But we didn't 3 understand there was this potential genetic way of 4 5 generating a halo here, maybe a halo over here. And 6 then we honestly don't the distribution of them, how 7 wide or how narrow they are, and if they're all 8 attached to a small fault or not. We just know 9 there's something there where they're three dimensionally interconnected. 10 11 Because the real surprise is looking at 12 these dinky little fractures that are only this long 13 and solution-widened, and they're all oil stained. And that means that oil had a way to get into all of 14 15 So they have to be three dimensionally them. 16 interconnected. So it's kind of like there's a halo 17 of these fractures, not just a fracture. When I was younger, I used to just think 18 19 it's a fracture, with no movement, maybe next to a 20 fault that had a little bit of movement. I didn't realize that if you faulted it or if you just folded 21 22 it, you could create a halo of fractures instead. 23 But one structural geologist years ago 24 actually published a paper. I can't remember the name of it. But he actually showed a surface outcrop where 25

1 he had a photo looking down, you could see the fault 2 and you could see the halo of fractures. And I wish I had a copy of that. This was back in the 1970s into 3 the '80s that this one guy did this official outcrop 4 5 that you could actually look down and see this halo of 6 fractures around a fault. 7 But I don't know how big the fault was, I don't know what the movement was on it. But you 8 9 could see the halo effect. And I just remember it 10 because I thought that was really neat. 11 Well, here we are looking in the 12 subsurface and we're seeing these dinky little 13 fractures and all of a sudden, they're solution-widened, meaning fluid got in to 14 15 solution-enhance it, and that oil was able to migrate 16 back into them and stain them. And how did it get in 17 there? Well, that infers that they're all 18 interconnected. That's the important thing. So there's some kind of fracture halo 19 20 there. But how big or how small these are, I have no 21 earthly idea. 22 Q. Okay. Thank you. Do you have insight into the core-orientation method that you guys used? 23 Was 2.4 it paleomagnetic or mechanical? 25 A. Paleomagnetic.

1	Q. Paleomagnetic?
2	A. Yes.
3	Q. You mentioned that the core analysis that
4	you did when you were with Chevron was later revisited
5	by Core Lab; is that correct? Is that another agency
6	or another organization outside of Chevron?
7	A. For doing, like, the oil saturations and
8	water saturations and porosities and permeabilities?
9	Q. I'm assuming that's what you were talking
10	about.
11	A. Yeah, that's all done by Core Lab.
12	Q. Did you guys do one initially in-house at
13	Chevron?
14	A. No, because well, we had one core
15	facility in Houston, but it's just a very small
16	set-up, and they only kind of worked on international
17	projects.
18	Q. Okay.
19	A. So we basically when the core would come
20	in, we'd call Core Lab. They'd come out, pick it up,
21	take it in. And they're right in Midland, and so it
22	was just a short drive to well, a couple hours to
23	get there, to Midland, and then they would start
24	analyzing the core. So I spent a lot time with Core
25	Lab.

1	Q. The UV imaging, was that technology that
2	wasn't around during the first analysis, or was that
3	performed there?
4	A. It was there, but I didn't have any copies
5	of it.
6	Q. Okay.
7	A. And so it's being a retiree from Chevron,
8	it's kind of hard to go back when you don't know
9	anybody there, because it's like a new staff of
10	people, and ask, "Can I get a copy of the
11	photographs?"
12	And there's better technology now with
13	these digital images than the older film cameras. And
14	so the idea was, let's just if we can get the core
15	from the Bureau of Economic Geology, that's where it
16	was stored, can we get permission to take it back to
17	Core Lab and have them photograph it.
18	So we did that last year, once we got
19	permission, and got a nice set of photos. And then
20	they said, "We can do UV, too."
21	And I said, "Well, these are such old
22	cores, I don't think UV is going to work." And they
23	showed me some, and I said, "Oh, this works great.
24	Let's do both plain light and UV."
25	Even though it's an old core, from
	Page 223

like the EMSU 679 is from 1990, you can see still with
 UV the oil saturation.

That was a real surprise. I thought all the light ends would be gone and we wouldn't get an image worth beans. And they got beautiful images.

And they have these digital cameras. They can see more in lower light settings than the old film cameras can. So it was actually to our advantage to take these pictures with a digital camera versus the old film cameras.

Q. Another one of the things that you mentioned was how waterflooding can change the wettability of a reservoir. Can you expand on your understanding of that or the process by which that would occur?

A. That's a tough question. How would I say this nicely? If I were trying to explain that, not being a reservoir engineer, I think I'd be prostituting myself, just to be very blunt. I wouldn't want to try that.

20 Wettability is incredibly important, 21 though. Because what we found is, there was a guy up 22 in Canada at the University of Calgary that did a 23 study of how oil wet and water wet reservoirs flood. 24 And he made little glass models and he coated one with 25 oil, and the glass was basically acting like it was

1 already water wet. And then he put in real crude from 2 a reservoir and heated it up and had a little entry 3 point and a little exit point, and he put the water 4 through to simulate a waterflood. And they flood 5 completely differently.

In the water wet case, they flood through the smaller pores. In the oil wet case, they flood through the larger pores. And that was really significant.

10 And so years later, when we were having 11 this CO2 flood in Goldsmith that didn't work, and we 12 were just sequestering CO2, I said to them guys, I 13 said, "Hey, guys, I think we might have a wettability 14 problem here. I think this tends to be oil wet. All 15 the flooding has went through the larger pores, it's 16 displaced the oil, and all we're doing is putting in 17 CO2 into vacated moldic pores," and that's kind of what 18 we were doing. So we proved up what not to do in a CO2 19 flood in that particular case, because it didn't work.

20 Q. Well, maybe I'll pose that question to our 21 reservoir engineer later.

22 One final question. In the section of 23 the 679 that you guys cored, on the bottom of it, 24 where you guys saw evidence of staining that prompted 25 you to think that the saturation went further, did you

1 guys make any estimations on what that saturation was 2 at the lower end of the core? 3 A. Just what Core Lab was able to tell us. That was all. 4 5 The thing that caught my eye was the UV 6 fluorescence. That's what caught my eye. 7 Q. Okay. A. And so right there. In one core, it stood 8 9 out really well and we saw it right at the base of the 10 core. 11 In the other core, I think it's the 679, it didn't stand out well. But it did in the UV 12 13 photographs. 14 And so when I saw it in -- I think it 15 was the RR Bell -- I said, "Oh, it's got to be 16 deeper." But then the great question was: How deep? 17 And we don't know, other than if you 18 talk to some guys that really know how to analyze 19 logs. They can tell you from a log perspective how 20 deep they are. But me, being kind of a core guy and 21 22 working on rocks, I like to see the numbers of the oil saturation myself. In this case, we have no data once 23 24 go past the base of those two cores. 25 And they're just in the Upper Page 226

1	San Andres, so there's all the rest of the San Andres
2	that needs to be evaluated, and you have to do that
3	with the logs. And that's beyond me.
4	Q. Okay. Thank you. Those are all my
5	questions.
6	MR. RUBIN: Mr. Hearing Officer, if I may, I
7	have one or two questions.
8	EXAMINATION
9	BY MR. RUBIN:
10	Q. Maybe it's just idle curiosity, but
11	Dr. Lindsay, I'm asking you, just based on your
12	testimony about the communication between and the Goat
13	Seep and the San Andres, how large is the Goat Seep
14	Aquifer?
15	A. Oh, it's not very wide. It's not very wide.
16	Q. Can you share maybe acre feet or
17	A. Well, at outcrop, where you can see it, I
18	would guess the width of it would be a quarter mile,
19	half mile, something like that, from updip to downdip,
20	the massive part of it that stands out like a sore
21	thumb, yeah. It's probably even bigger than that.
22	But that's where I've seen it.
23	On the seismic, you can see a width to
24	it, as well. You can see the edge of where the
25	here's the Grayburg, here's the eroded interval. It
	Page 227
24 25	it, as well. You can see the edge of where the here's the Grayburg, here's the eroded interval. It
	Page 227

1 eroded through the Grayburg, down into the San Andres, 2 actually. And then the Goat Seep is here, like this. And that width, I'm not sure how wide it 3 But it could be a quarter mile, half mile, maybe 4 is. 5 a little bit wider. Something like that. Not too wide, not too wide that we see on the image, on the 3D 6 7 seismic. 8 But it extends all the way around the 9 basin from the Guadalupe Mountains, down to the EMSU 10 and probably connects with the Glass Mountains some 11 way that I -- that's kind of beyond me because we have 12 no data. 13 Q. Do you know if there were having any geologic studies about the size of the aquifer? 14 15 A. No. But there was a Ph.D. on the outcrop 16 Goat Seep by the University of Wisconsin back about 17 somewhere around 1970 or so. I can't --18 O. That's okay. A. I can't remember the guy's name. And it was 19 20 that thick. It was real well done stuff. 21 MR. RUBIN: Let the record reflect that's 22 about an inch and a half. 23 A. A couple inches, yeah. A couple inches. 24 0. Okay. 25 A. Probably 300, 350 pages, quite a bit of data Page 228

1 in an incredibly difficult spot to get to, because 2 it's cliffs that are literally that steep. So you have to be a mountain goat to do that kind of work, 3 and this guy did it. It was at the University of 4 5 Michigan -- no, University of Wisconsin. Excuse me. 6 And his professor was known to be a 7 mountain goat, and so these students had to go work 8 with the professor on these sheer cliffs on the 9 western escarpment of the Guadalupe Mountains. And so there were three studies done there, two master's 10 11 degrees and then this Ph.D. on the Goat Seep. 12 Q. Is it fair to say, then, that we don't know 13 the size of the Goat Seep Aquifer, sitting here today? 14 A. Yeah, yeah. That's a fair question. 15 Because you'd have to get a few wells through it and 16 see how thick it is, how porous it is, and then try to 17 look on the 3D to say here's the updip limit, here's 18 the downdip limit, here's my width, here's thickness, here's my porosity. And then you'd know. 19 20 Q. Okay. Thank, you, Doctor. 21 MR. RUBIN: Thank you. Nothing else. 22 HEARING OFFICER HARWOOD: Chair Rozatos, you get a second chance, if any of the commissioners' 23 24 questions and answers spurred your curiosity. 25 I appreciate it, but I CHAIR ROZATOS:

1 don't. Thank you, Doctor, for your testimony, but I 2 have any other questions. HEARING OFFICER HARWOOD: So, Doctor, is it 3 because of this guy who was a mountain goat that it's 4 5 called the Goat Seep Aquifer? THE WITNESS: No. This guy's name was 6 7 "Lapray" --8 HEARING OFFICER HARWOOD: Okay --9 THE WITNESS: -- and he would take field trips out to the western escarpment, with these 10 11 students, with the University of Wisconsin, and at 12 the end of the day, he'd say, "It's time to go stroke 13 the Goat." And that meant they were going to have to climb up through these cliffs to touch the Goat Seep. 14 15 And I felt sorry for those students, because it was 16 really steep. But he could do it. He was a very 17 healthy guy. 18 HEARING OFFICER HARWOOD: He was, right, 19 till he fell? All right. Thank you, Doctor. So let's see, what time is it? 4:24. 20 21 I'm hoping we can get poor Dr. Lindsay off the stand 22 today. No pressure. MS. HARDY: I have very few redirect 23 questions. I think they will be quick. Because I 24 25 would actually like to get to Mr. Bailey, if we can Page 230

1	do that. So I will be brief.
2	REDIRECT EXAMINATION
3	BY MS. HARDY:
4	Q. Dr. Lindsay, when Mr. Rankin was questioning
5	you this morning, he asked questions about a composite
6	sequence boundary. Do you recall those questions?
7	A. Yes, yes.
8	Q. And I just want to be sure it's clear here,
9	is it your opinion that there is a ROZ above and below
10	a composite sequence boundary at the EMSU?
11	A. Yes. There's one ROZ associated with the
12	Grayburg. And then there's another associated with
13	the San Andres. So there's actually two. Yes,
14	there's actually two. Yeah.
15	Q. And, Dr. Lindsay, did you do a drawing of
16	the composite sequence boundary?
17	A. Yes, I did. Because I think there was a
18	little bit of confusion about where the composite
19	sequence boundaries are located, and so I just drew a
20	cartoon for you folks.
21	It's basically, here's the top of the
22	San Andres, where my thumb is right there. Okay? And
23	here's the this is the first interval here; it's
24	called the Upper San Andres. We used to just call it
25	the San Andres, but then people studying that
	Page 231

1 outcropping above the mountains realized there's an 2 Upper San Andres that has a composite sequence 3 boundary on it that the Grayburg rests on. And then there's a Lower San Andres with 4 5 another composite sequence boundary, right here. And 6 then the Lower Grayburg is really thick. It can been 7 100 feet think with no problem. 8 And then there's another composite 9 sequence boundary at the base on top of what's called the Glorieta. So those are the big exposure surfaces. 10 11 And then, in the Upper San Andres, you 12 can divide it into an upper half and a lower half. And there in the middle is an another smaller 13 14 unconformity. And then on top of that is what's 15 called the Lovington Sandstone. 16 And then on top of the composite 17 sequence boundary at the top of the Upper San Andres there's another sandstone. It's called the premier 18 sandstone. 19 20 Now, down here, we don't see a sandstone 21 on this composite sequence boundary because this is 22 the bounding surface where the complete Brushy Canyon 23 Formation went across this surface and poured into and 24 was deposited into the Delaware Basin. 25 It's this huge volume of sand that went Page 232

1 over this round surface right here. So that meant this surface was exposed for a long time, but we don't 2 3 know how long. We have no earthly idea. We just know that there's a lot of missing time right here where my 4 5 finger is, right there. 6 And then the next big missing time is up 7 here at the very top. And this is where you start to 8 create sinkholes in the San Andres. What I was 9 showing you in that core description, those red intervals, those were some of the sinkholes. 10 11 But just to clarify, this stratigraphy, 12 it's like there's an Upper San Andres, there's this 13 much, much thicker lower San Andres. Composite 14 sequence boundary here, another composite sequence 15 boundary down here. And then one at the base. 16 MS. HARDY: I'd like to offer this as Empire 17 Exhibit J-13, which would be Dr. Lindsay's next rebuttal exhibit. 18 19 HEARING OFFICER HARWOOD: Any objection from 20 Goodnight? MR. RANKIN: I don't know what it is. Are 21 22 you talking about that piece of paper? 23 MS. HARDY: Yes. 24 MR. RANKIN: I quess my question is, I don't know if it's different than what any of other 25

Page 233

Veritext Legal Solutions Calendar-nm@veritext.com 505-243-5691 www.veritext.com 1 witnesses have testified to.

2 HEARING OFFICER HARWOOD: Is this a brand-new exhibit that he did over lunch? 3 THE WITNESS: I drew it at lunch, yes. 4 5 MS. HARDY: It's his drawing to clarify the 6 questions that were asked earlier. 7 THE WITNESS: Because there was a little 8 confusion about where are the composite sequence 9 boundary, and I don't know if I answered it very well. And so I just thought I would just draw a 10 11 little section to clarify where composite sequence 12 boundaries are, the bigger unconformities, and where 13 they're not. Just to be real simple. 14 CHAIR ROZATOS: Mr. Hearing Officer --15 HEARING OFFICER HARWOOD: Let's take a 16 five-minute break. 17 CHAIR ROZATOS: Let's give it a ten. HEARING OFFICER HARWOOD: Let's make it a 18 19 ten-minute break. It's only fair. This exhibit was a lunchtime exhibit. Let's give people a chance to 20 21 look it over. So for now, it's not admitted. We'll wait and see. We'll be off the record. 22 23 (Recess held from 4:30 to 4:37 p.m.) 24 HEARING OFFICER HARWOOD: Has Goodnight had a chance to look over this exhibit, Mr. Rankin? 25 Page 234

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1 MR. RANKIN: Thank you, Mr. Hearing Officer. 2 Yes, we've reviewed the exhibit and have no objections to its admission. I've asked counsel to 3 send me a picture of it and they have done so. 4 5 HEARING OFFICER HARWOOD: Pilot and Rice, 6 any objection to this exhibit? 7 MR. BECK: No objection. 8 MR. MOANDER: None from the OCD. 9 MR. SUAZO: No objection from Pilot. HEARING OFFICER HARWOOD: Okay. It will be 10 11 admitted. 12 (Admitted: Empire New Mexico Rebuttal Exhibit J-13.) 13 HEARING OFFICER HARWOOD: I don't remember 14 15 where we were. I'll leave that up to you. 16 MS. HARDY: Thank you. 17 BY MS. HARDY: Q. Dr. Lindsay, is it correct that A composite 18 19 sequence boundary may or may not be a barrier to fluid 20 flow? 21 A. Yes, that's true. 22 Q. Mr. Rankin asked you a number of questions about Goodnight's cross-examination Exhibit 1 which 23 24 was the article by Love. Do you recall that? 25 A. Yes.

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1	Q. And is it true that the conformance problems
2	discussed in that article were addressing the
3	Grayburg?
4	A. Yes, that's correct.
5	Q. And they were not the article was not
6	addressing vertical plumes, was it?
7	A. That's correct, too.
8	Q. In your opinion, does the article have any
9	bearing on the issues that the Commission is
10	evaluating here?
11	A. No, no.
12	Q. Do you defer to Empire's reservoir
13	engineering experts on recovery of the residual oil
14	zone in the EMSU?
15	A. Yes. Yes.
16	Q. With regard to the core data that you've
17	discussed extensively, the conventional core, it shows
18	a ROZ in the EMSU even at those conventional
19	saturations; is that correct?
20	A. That's correct.
21	Q. Mr. Rankin asked you a number of questions
22	about the depths of the fractures in your fracture
23	study. Do you recall those questions?
24	A. Yes.
25	Q. Okay. And let me try to just turn my screen
	Page 236

1	here. And I've pulled up here Exhibit J-12 to your
2	rebuttal. Are those the depths that you were
3	analyzing in your fracture study?
4	A. Yes. We have wrote them all and put all the
5	orientations in the per depth. And then to the right,
6	are the large or small fractures, information like
7	that, yeah.
8	Q. And with respect to the wells that have
9	fractures, and we've talked extensively about two of
10	them, but are there actually three?
11	A. Fractures in the EMSU?
12	Q. Yes.
13	A. There's just the well, how did we do
14	what I would describe fractures, I've seen them in all
15	the cores that I've studied. And they're different
16	sizes. You know, they can be a foot or two, they can
17	be less than a foot, they can be inches. And even in
18	core where it's not oriented, you see these fractures
19	all the time.
20	And the surprising thing was, there's a
21	lot of these little fractures. And they make up a
22	huge number of the total fractures. So there's a lot
23	of fractures in the core. You can't get away from
24	them because of the flexing and making of the
25	anticline. There's just a lot of fracturing.
	Page 237

1	Q. Dr. Lindsay, Mr. Moander, OCD's counsel,
2	asked you a number of questions about the Capitan Reef
3	the Safe Drinking Water Act. Do you recall those
4	questions?
5	A. Yeah.
6	Q. But you're not a lawyer, are you?
7	A. No.
8	Q. In fact, Mr. Moander objected to you earlier
9	testifying about a legal opinion, correct?
10	A. Yes.
11	Q. And with respect to the fracture studies
12	that Mr. Moander asked you about, those are the
13	studies in your testimony that we've been discussing
14	here today, is it correct that those deal with the
15	vertical fractures that allow fluid migration between
16	the San Andres and the Grayburg?
17	A. Yes.
18	Q. And so your fracture studies are not
19	well, let me ask it this way. Do you fracture studies
20	show that there would be any migration to the Capitan
21	Reef?
22	A. There's no way that can happen. It's too
23	far away. It's absolutely too far away.
24	Q. And just to sum up here, and I think this is
25	clear, but I want to make sure. Do you disagree with
	Page 238

1	Goodnight's position that there is no ROZ in the
2	San Andres?
3	A. Oh, yes, yes, there's a ROZ.
4	Q. And is that based on your study and
5	characterization of the reservoir, including the core
6	analysis?
7	A. Yes.
8	Q. And do you disagree with Goodnight that
9	there is a barrier to fluid flow between Goodnight's
10	injection zone and the residual oil zone?
11	A. Yes. Because there's too many fractures.
12	And it seems to be there's discontinuous tight
13	intervals. They don't seem to be continuous.
14	MS. HARDY: Those are all of my redirect
15	questions.
16	HEARING OFFICER HARWOOD: Okay. Well, then,
17	may this witness be excused?
18	MS. HARDY: Yes.
19	MR. RANKIN: Mr. Hearing Officer, based on
20	Ms. Hardy's questions of Dr. Lindsay, I have to ask
21	him a question about the SPE paper that he referred
22	to.
23	HEARING OFFICER HARWOOD: I hate to open the
24	door to recross-examination, so unless it has to do
25	with something that was brought up on redirect only.
	Page 239

1 MR. RANKIN: It was redirect only. 2 HEARING OFFICER HARWOOD: Lawyers always say one last question. How many do you have, Mr. Rankin? 3 I guess we can run out the clock. It's 4:43. So if 4 5 you have a few more questions. 6 I don't think, Ms. Hardy, we're going to get to another witness today. That was, in 7 8 hindsight, very wishful thinking, apparently. 9 All right, Mr. Rankin. 10 RECROSS-EXAMINATION 11 BY MR. RANKIN: 12 Q. Dr. Lindsay, I'm showing here on the screen 13 a portion of your transcript from your deposition. Okay? And I'm going to show a portion of this 14 15 discourse between yourself and me. Okay? 16 And here, where it says "Q," that's me 17 talking, where there's an "A," that's you. 18 So here I start and I say... 19 The question I have, though, "OUESTION: is about -- back to these wells. You referred to 20 21 Tracy Love and the work he did showing the 22 high-water-cut wells, and your opinion is -- is your 23 opinion that the high-water cut is associated only 24 with the water from the San Andres? 25 "ANSWER: Most likely, yes." Page 240

1 A. Yes. 2 Q. "QUESTION: And that would be from the Upper 3 San Andres, right? 4 "ANSWER: It would be -- yeah. However water comes out of the San Andres itself and the Upper 5 San Andres is right there are the top, so it's 6 probably coming out of it. And it would be coming out 7 8 of the Lower too." 9 My response, "Okay. "ANSWER: We just know that it's 10 11 San Andres water that's ascending up." And then you 12 said, "From plumes of water." 13 My question to you was... 14 "QUESTION: Your opinion is the 15 San Andres water coming up. That's your --16 "ANSWER: No. That is a fact, because 17 we analyzed the water and it was sulfate rich. "QUESTION: And that's based on 18 19 Mr. Carpenter's presentation to you, " right? 20 "ANSWER: And basic water chemistry 21 studies done by Hobbs Division in Hobbs, New Mexico, 22 before that: 23 "QUESTION: So do you have the data on 24 the Hobbs Division water chemistry? "ANSWER: No. No. It common knowledge, 25 Page 241

1 though. 2 "QUESTION: Okay. So you're telling me 3 it was common knowledge that there were these 4 plumes --5 "ANSWER: Yes. 6 "QUESTION: -- coming up? 7 "ANSWER: Yes. 8 "QUESTION: But Mr. Love would know 9 that, right? He would be informed of that, right? 10 "ANSWER: Yes. And he wrote an SPE 11 paper on it so you can look it up. 12 "OUESTION: Okay. Very good. 13 So now, today, Dr. Lindsay, I presented to you that SPE paper, and if there were such 14 15 San Andres plumes, which I understood you to say that 16 there were, they were not addressed in the SPE paper. 17 So you're telling me that it's not 18 relevant to the Commission's review? 19 A. No, it's -- what Tracy and his co-author were chasing were horizontal high-perm streaks that 20 21 made it conformance work done on it. That was the focus of their work. Not vertical plumes. 22 23 Q. If they were worried about waterflood 24 operations and improving the waterflood, why wouldn't 25 they have addressed in their paper an issue that was Page 242

1 affecting the waterflood, if it truly were the case? 2 If it truly were the case that water was 3 pluming up and it was common knowledge, why wouldn't it have been addressed in this paper? 4 5 A. Because they were talking about conformance. 6 They weren't talking about plumes of water. 7 MR. RANKIN: Very well. No further 8 questions. 9 MR. MOANDER: And, Mr. Hearing Officer, based on a response to a line of questions from 10 11 Commissioner Ampomah, OCD has a couple of questions 12 they would like to ask on recross that took things a 13 little deeper than they had been on 14 cross-examination. 15 HEARING OFFICER HARWOOD: Well, all right. 16 This is why I try not to open this door, but now I 17 have. And I quess everybody is going to drive right 18 through it. So go ahead. 19 MR. MOANDER: Thank you. 20 **RECROSS-EXAMINATION** 21 BY MR. MOANDER: 22 Q. So, Dr. Lindsay, I'm going to go back to 23 your deposition in this case during my examination of 24 you. I'm assuming you still recall that? A. Mm-hmm. 25

1	Q. And I asked you a question on where you
2	would place any doubt that was had concerning
3	communication between the EMSU and the Capitan. And I
4	asked if those were your opinions within a reasonable
5	degree of scientific probability. Do you recall that?
6	A. Yes.
7	Q. I'm sorry, what was that, Doctor?
8	A. Yes.
9	Q. And do you recall what your response was to
10	that?
11	A. No.
12	Q. Well, you initially asked what I meant by
13	that. And when I posed the query, you said you
14	doubted there was communication, which would bring
15	into question, meaning there's a possibility.
16	You testified: There's no communication
17	between the Capitan and the EMSU?
18	Do you recall that?
19	A. Yes.
20	Q. And then you stated further: If you wanted
21	a little more rock solid, there's no communication.
22	A. Yes, that's correct. That's because
23	they're
24	Q. Well, that's all right, Doctor.
25	A too far apart.
	Page 244

1	Q. Thank you.
2	A. That's why. It's too far apart.
3	MR. MOANDER: I'm going to ask that the
4	continuous answer be stricken. Dr. Lindsay has got a
5	habit of continuing to answer questions after the
6	answer has been provided.
7	HEARING OFFICER HARWOOD: I'm going to
8	strike it. I think it's probably the third time
9	we've heard it. But he's been consistent in his
10	testimony throughout. You asked the question. Yes,
11	does he over-volunteer, that's why you've been here
12	all day. But, you know, it is what it is. This is
13	going to be a long hearing and all this stuff is
14	interesting.
15	So I, for one, thank you for your time.
16	You have 12 minutes to put on another
17	witness, or we can close for the day, Ms. Hardy.
18	MS. HARDY: Yeah, let's just start fresh
19	tomorrow at this point.
20	HEARING OFFICER HARWOOD: I think that's a
21	great idea.
22	MR. MOANDER: As a housekeeping question, I
23	assume we're going to lock the hearing room, so
24	perhaps binders could be
25	CHAIR ROZATOS: So before we start with your
	Page 245

1 housekeeping, Mr. Moander, I think Commissioner 2 Ampomah had a question regarding the case itself. HEARING OFFICER HARWOOD: Yeah, would like 3 to know the order of witnesses, and I think 4 5 Mr. Rankin needs that courtesy as well. MS. HARDY: Sure. And I gave it to 6 7 Mr. Rankin earlier and I can give it to you, as well. 8 Our next witness is Ryan Bailey. 9 HEARING OFFICER HARWOOD: And then after 10 that, is it Mr. Birkhead? 11 MS. HARDY: Yes. 12 HEARING OFFICER HARWOOD: And then maybe 13 overly optimistic, but if we get to more than two witnesses tomorrow, who is going to be the third? 14 15 MS. HARDY: Dr. Jim Buchwalter. 16 HEARING OFFICER HARWOOD: Anything else, 17 Mr. Rozatos? CHAIR ROZATOS: I don't have anything else 18 19 for the case, unless anybody else on the Commission 20 does. 21 MR. RANKIN: May I just pipe up on the order 22 of witnesses? My understanding is that Empire only 23 has one witness who has a limitation on availability, 24 and that was Dr. Trentham; is that correct? 25 MS. HARDY: I believe at this point that's Page 246

1	correct. Dr. Trentham needs to testify on Thursday.
2	MR. RANKIN: And then after Dr after
3	Mr. West, we had discussed what the other sequence
4	would be. Is that going to change, do you think,
5	between now and the time that's been presented?
6	MS. HARDY: I don't think so. We might have
7	to make minor adjustments.
8	MR. RANKIN: Okay. And that will be Melzer,
9	Dillewyn, McShane, Wheeler and then Trentham and then
10	Marek. Is that right?
11	MS. HARDY: Yes.
12	MR. RANKIN: Okay.
13	CHAIR ROZATOS: I will just state, everybody
14	start looking at your calendars, because we're not
15	going to get through all of these people by Friday.
16	And the scheduling is getting tight.
17	We, as the Commission, are looking at
18	calendars, and I think everybody in the audience also
19	needs to start looking at calendars, because we're
20	going to have to start proposing dates by Friday. So
21	just keep that in the back of your minds, please.
22	MS. HARDY: Thank you.
23	CHAIR ROZATOS: Mr. Hearing Officer, if
24	we're done with the actual case part, we do have the
25	housekeeping question that came up.
	Page 247

1	HEARING OFFICER HARWOOD: We don't need to			
2	have that on the record, so we can release the			
3	long-suffering court reporter with our thanks for			
4	today.			
5	And we'll reconvene the hearing again			
6	tomorrow morning, promptly at 9 o'clock.			
7	(Proceedings adjourned 4:51 p.m.)			
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	Page 248			

1 AFFIRMATION OF COMPLETION OF TRANSCRIPT 2 3 I, Kelli Gallegos, DO HEREBY AFFIRM that on 4 February 24, 2025, a hearing of the New Mexico Oil Conservation Commission was taken before me via video 5 conference. 6 7 I FURTHER AFFIRM that I did report in 8 stenographic shorthand the proceedings as set forth herein, and the foregoing is a true and correct 9 transcript of the proceedings to the best of my 10 11 ability. I FURTHER AFFIRM that I am neither employed 12 13 by nor related to any of the parties in this matter 14 and that I have no interest in the final disposition 15 of this matter. 16 Kelli Gallegos 17 VERITEXT LEGAL SOLUTIONS 18 500 Fourth Street, NW- Suite 105 Albuquerque, New Mexico 87102 19 20 21 22 23 24 25 Page 249

&	<b>105</b> 249:18	<b>17</b> 5:25 47:15	<b>1991</b> 155:18
<b>&amp;</b> 2.18 3.9 14	<b>109</b> 29:15	<b>171</b> 4:7	<b>1992</b> 35:15
7.12 179.16	177:15	<b>18</b> 25:1 36:2,9	203:5
1	<b>10:29</b> 56:4	95:22 162:19	<b>1998</b> 99:4
	<b>10:30</b> 55:24	162:20,24	109:25 111:12
<b>1</b> 2:18 4:12,13	<b>10:40</b> 56:3,4	163:4,9 177:7	111:22 146:22
4:13,13 13:5,6	<b>11</b> 4:6	177:9 188:20	201:11
13:6,15,16,16	<b>110</b> 2:18	215:13,14,17	<b>1:15</b> 115:13
24:5,5 29:4	<b>11:58</b> 115:16	215:19,20	<b>1:16</b> 115:17
45:9 62:9 63:1	<b>12</b> 4:13 13:6,16	<b>180</b> 4:10	<b>1:52</b> 143:11
63:23 100:18	23:15 237:1	<b>19</b> 22:6	<b>1st</b> 1:5
101:8 103:18	245:16	<b>1920</b> 47:13	2
109:19 110:1	<b>120,000</b> 31:12	<b>1930</b> 47:13	<b>2</b> A·14 27·3
111:2,7,14	<b>1220</b> 1:6 3:4	<b>1934</b> 47:13	2 4.14 27.5
112:18 114:21	<b>12400</b> 2:14	<b>1950s</b> 206:25	62.9 63.1
127:16 135:4	<b>129</b> 28:18	<b>1966</b> 170:2	78.24 86.21
149:6,6 157:6	155:4 176:22	<b>1970</b> 228:17	109.20 110.1
159:18 177:12	176:24 178:7	<b>1970s</b> 189:10	111.3 8 14
191:1 194:12	178:22 179:3,4	221:3	114.21 150.18
235:23	214:8 216:13	<b>1976</b> 43:3	151.11 159.18
<b>1.9</b> 42:11	<b>13</b> 4:13,14	<b>1984</b> 43:21	191.13
10 28:23,24	60:23 233:17	168:12,15	2.2 112.19
63:15,16 174:7	235:13	<b>1985</b> 43:6,18	149.4 6
179:8 180:7	<b>14</b> 25:7,11	<b>1988</b> 12:1	20 25.18 73.22
217:19	162:17,18	43:18,19,23	74.15 21
10,000 31:16,21	163:11,15,19	44:12 48:10	185.24 186.1
117:7,14,17	180:6	124:7	217.19
118:13 119:9	<b>14.9</b> 22:6	<b>1990</b> 23:7,11	217.17 200 42.21
131:10 175:5	<b>14th</b> 45:19	48:17 49:23,24	178.3
190:6,8	<b>15</b> 22:6 115:11	181:17 182:22	<b>2000</b> 111.23
100 47:8,9	115:12 160:20	201:11 224:1	2002 12.3
147:15,18	171:5 180:6	<b>1990s</b> 12:2,3	45.18 19 46.1
192:11,11,12	<b>151</b> 4:14	141:21 181:16	48.10
210:7 232:7	<b>16</b> 77:24	187:5 201:17	2004 12.5
<b>101</b> 4:13		204:2	111:23

[2014 - 500]

<b>2014</b> 12:6 41:8	163:6 249:4	<b>30</b> 147:15,18	148:8,8 157:10
144:3 152:9	<b>240</b> 4:8	209:14,21	159:20 161:6
<b>2015</b> 45:25	<b>24018</b> 5:25	217:19	176:17 178:2
46:2	<b>24020</b> 5:25	<b>300</b> 2:14 122:9	178:23 181:25
<b>2023</b> 58:7,12,24	<b>24025</b> 6:1	228:25	184:4 197:11
59:4,10,15	<b>24123</b> 5:24	<b>313</b> 214:6	197:25 200:24
61:7 65:21	<b>243</b> 4:8	<b>32</b> 25:6 95:24	208:25 217:25
66:5,15,24	<b>249</b> 4:15	163:7,9,13	219:7
67:16 68:1	<b>24th</b> 5:6	<b>325</b> 168:16	<b>4,000</b> 211:2
<b>2024</b> 51:18	<b>25</b> 146:19	169:1	<b>4-6</b> 107:23
52:1,9 53:5	152:5 161:7	<b>329</b> 168:25	<b>40</b> 4:6 73:23
60:20,23 66:24	186:17 209:15	169:8	77:23 185:25
67:19 76:17	215:25 216:7	<b>34</b> 4:12 13:5,15	<b>4239</b> 211:3
90:20,25 91:17	<b>2523</b> 2:10	209:21	<b>4357</b> 64:6
93:2,7 116:11	<b>25245</b> 3:10	<b>347</b> 169:24	<b>458</b> 197:21
123:25 125:17	<b>26</b> 19:1 186:17	<b>35</b> 23:10	<b>459</b> 183:2
129:9	<b>27</b> 186:18	<b>350</b> 122:11	<b>47</b> 169:23
<b>2025</b> 1:11	<b>28</b> 33:12	169:2,4 228:25	<b>48</b> 39:16
124:18 249:4	<b>28.4</b> 22:8	<b>36</b> 20:2 26:12	<b>4:24</b> 230:20
<b>2026</b> 47:7	<b>281</b> 2:13	28:17,18 29:16	<b>4:30</b> 234:23
<b>2068</b> 2:4	<b>285</b> 36:12	155:1,4 156:8	<b>4:37</b> 234:23
<b>21</b> 30:22 35:12	<b>28943</b> 249:16	177:1,2,11	<b>4:43</b> 240:4
120:4	<b>2:00</b> 143:11	183:13 204:19	<b>4:51</b> 248:7
<b>218</b> 4:10	<b>2:36</b> 170:18	<b>38</b> 24:4 209:15	<b>4th</b> 46:2
<b>22</b> 47:14	<b>2:40</b> 170:15,18	<b>38.4</b> 22:7	5
<b>227</b> 4:11	<b>2:52</b> 180:9	<b>3:05</b> 180:6	<b>5</b> 1.3 18.1 29.3
<b>23</b> 138:3,8,9	<b>2d</b> 27:22	<b>3:06</b> 180:9	<i>5</i> 4.5 10.1 27.5 <i>1</i> 5.10 108.13
216:15,20	3	<b>3d</b> 33:14 134:4	112.22 24
<b>2307</b> 2:7	3 25.24 29.5	228:6 229:17	112.22,24 113.25,134.24
<b>231</b> 4:7	<i>4</i> 5·10 1 <i>4</i> 3·6 19	4	137.19 157.12
<b>235</b> 4:14	171.2 6 174.9	<b>4</b> 14.4 18 16.3	157.12
<b>23614</b> 5:25	177.12,0174.7	17.7 18.3 10.3	178.74 198.13
<b>23775</b> 5:25	217.9	19.11 20.13	<b>500</b> 3.14 17.2
<b>24</b> 1:11 25:4	<b>3 000</b> 194.11	28.15 22 20.15	249.18
93:13 95:23	5,000 177.11	<u>45.10 107.24</u>	2 <b>77.10</b>
		TJ.10 107.24	

[540 - achieve]

<b>540</b> 169:4,6,10	197:13,15,24	<b>800</b> 106:23	abandon 36:13
169:15	198:2 199:23	<b>80s</b> 221:4	aberdeen 41:5
<b>57</b> 211:12	200:8 201:21	<b>82</b> 102:18	<b>abg</b> 129:16
6	203:10 204:4	159:6 177:25	ability 83:3
169:15 <b>57</b> 211:12 <b>6</b> <b>6</b> 28:23 29:9,11 36:14 45:10 60:12 103:18 107:24 108:18 108:20 109:5 147:15 177:13 178:24 181:10 184:16 187:25 198:7 <b>60</b> 217:19 <b>600</b> 122:12 <b>61</b> 63:16 <b>62</b> 63:16 <b>649</b> 26:3 138:14,23 183:5,7 197:13 <b>679</b> 14:4,18 19:9 20:12	198:2 199:23 200:8 201:21 203:10 204:4 204:18,24 205:6 215:4,10 215:23 216:12 216:17,22 224:1 225:23 226:11 <b>7</b> <b>7</b> 19:7 106:2 111:13 177:20 178:2,24 207:11,12 209:14 <b>70</b> 217:20 218:5 <b>714</b> 183:25 <b>719</b> 60:14 61:15 <b>750</b> 60:15	<pre>80s 221:4 82 102:18 159:6 177:25 87102 249:18 87125-5245 3:10 87504 2:10 87504-2068 2:4 87504-2208 2:19 87504-2307 2:8 87505 3:4,15 88 102:23,24 103:6,8 133:19 133:21 138:5 159:7 887 34:25 49:15 50:2,7 50:10 145:11 203:14 9</pre>	aberdeen 41:5 abg 129:16 ability 83:3 249:11 able 17:1,19 24:11 121:20 122:4,20 123:5 130:14 181:2 206:14 212:3 214:19 219:6 221:15 226:3 above 18:5 73:6 88:21 90:18 107:24 134:17 169:2 191:7 192:20 231:9 232:1 absolutely 149:13 166:22 238:23 absorb 205:10 abstract 76:16
19.9 20.12         21:6 23:16         26:6,9,11         28:17 37:17         48:13,22,25         49:9,20 50:20         62:22 63:18,24         64:1 71:9         138:16,24         139:6 141:6         142:12 155:1         155:16 161:22         181:16 183:5,6         184:3 196:23	750       60.13         61:15,24       62:4         63:14       65:18         112:21       149:8         183:25       760       62:20         63:16       762       63:18       64:7         64:12,21       78216       2:14       8         8       28:23       63:23       105:12       106:7	9 23:15 174:7 248:6 90s 141:24 182:22 184:11 202:8 997 146:25 9:16 5:1 a a&m 187:7 a.m. 5:1 56:4 115:16	abstract 76:16 76:21 81:16 82:20 89:8,12 89:16,21,24 access 67:12 accommodate 10:5 account 178:23 178:23 accurate 211:8 achieve 74:2 149:23
acre227:16230:25231:13235:3103:11acreage194:15231:14237:10admitted4:12agu14:13act174:19adam2:196:713:7,12,1441:2349:1175:9238:3add210:6101:6,7150:24117:2513acting5:8,9214:10151:8,10144:7185:2153:21224:25added32:6234:21235:11188:25202actual24:8131:4141:1adopt94:3219:4205:23,24198:17,21advantageah141:13206:5214:2465:22address113:21affect203:817:4,2418:4113:23114:5affecting243:1243:1821:622:2130:1146:24249:3,7,12albuquerqu26:12,2530:2157:4170:13affirm12:25air30:4,9,13175:22196:7249:1alden117:32:1834:3addressedafternoon137:5	5:22 6,18 1:12 9 2:16 3:4,6		
---	--		
acreage194:15231:14 237:10admitted4:12agu14:1 3.act174:19adam2:19 6:713:7,12,1441:23 49:1175:9 238:3add210:6101:6,7 150:24117:25 13.acting5:8,9214:10151:8,10144:7 185:153:21 224:25added32:6234:21 235:11188:25 20.actual24:8131:4 141:1adopt94:3219:4205:23,24198:17,21advantageah141:13206:5 214:24additional224:8ahead92:1247:2465:22address113:21affect203:817:4,24 18:4113:23 114:5affecting243:1243:1821:6 22:2114:14 116:12affirm12:25air24:16,17 25:25130:1 146:24249:3,7,12albuquerqu26:12,25 30:2157:4 170:13affirmation3:10 249:130:4,9,13175:22 196:7249:1alden117:32:18 34:3addressedafternoon137:5	5:22 6,18 1:12 9 2:16 3:4,6		
act174:19adam2:19 6:713:7,12,1441:23 49:1175:9 238:3add210:6101:6,7 150:24117:25 13acting5:8,9214:10151:8,10144:7 185:153:21 224:25added32:6234:21 235:11188:25 202active194:1761:22 93:25235:12202:19 202actual24:8131:4 141:1adopt94:3219:4205:23,24198:17,21advantageah141:13206:5 214:24additional224:8ahead92:1247:2465:22advise214:4115:3,8,9actually10:8address113:21affect203:817:4,24 18:4113:23 114:5affecting243:1243:1821:6 22:2114:14 116:12affirm12:25air24:16,17 25:25130:1 146:24249:3,7,12albuquerqu26:12,25 30:2157:4 170:13affirmation3:10 249:130:4,9,13175:22 196:7249:1alden117:32:18 34:3addressedafternoon137:5	6,18 1:12 9 2:16 3:4,6		
175:9 238:3 acting 5:8,9add 210:6101:6,7 150:24117:25 13153:21 224:25 active 194:17added 32:6234:21 235:11144:7 185:153:21 224:25 actual 24:8added 32:6234:21 235:11188:25 202actual 24:8131:4 141:1adopt 94:3219:4205:23,24198:17,21advantageah 141:13206:5 214:24additional224:8ahead 92:1247:2465:22address 113:21affect 203:8178:18 20217:4,24 18:4113:23 114:5affecting 243:1243:1821:6 22:2114:14 116:12affirm 12:25air 27:724:16,17 25:25130:1 146:24249:3,7,12albuquerqu26:12,25 30:2157:4 170:13affirmation3:10 249:130:4,9,13175:22 196:7249:1alden 117:32:18 34:3addressedafternoon137:5	1:12 9 2:16 3:4,6		
acting5:8,9214:10151:8,10144:7 185:153:21 224:25added32:6234:21 235:11188:25 202active194:1761:22 93:25235:12202:19 202actual24:8131:4 141:1adopt94:3219:4205:23,24198:17,21advantageah141:13206:5 214:24additional224:8ahead92:1247:2465:22address113:21affect203:817:4,24 18:4113:23 114:5affecting243:1243:1821:6 22:2114:14 116:12affirm12:25air24:16,17 25:25130:1 146:24249:3,7,12albuquerqu26:12,25 30:2157:4 170:13affirmation3:10 249:130:4,9,13175:22 196:7249:1alden117:32:18 34:3addressedafternoon137:5	:9 2:16 3:4,6 3:23		
153:21 224:25 active 194:17added 32:6 61:22 93:25234:21 235:11 235:12188:25 202 202:19 202actual 24:8 205:23,24131:4 141:1 198:17,21adopt 94:3 advantage219:4 ah 141:13 224:8206:5 214:24 247:24additional 65:22224:8 ahead 92:1actually 10:8 17:4,24 18:4address 113:21 113:23 114:5affect 203:8 affect 203:8178:18 202 243:117:4,24 18:4 21:6 22:2114:14 116:12 114:14 116:12affect ing 243:1 249:3,7,12air 27:7 albuquerqu 3:10 249:126:12,25 30:2 30:4,9,13175:22 196:7 175:22 196:7249:1 249:1alden 117: 32:18 34:3	2:16 3:4,6 3:23		
active194:1761:22 93:25235:12202:19 203actual24:8131:4 141:1adopt94:3219:4205:23,24198:17,21advantageah141:13206:5 214:24additional224:8ahead92:1247:2465:22advise214:4115:3,8,9actually10:8address113:21affect203:817:4,24 18:4113:23 114:5affecting243:1243:1821:6 22:2114:14 116:12affirm12:25air24:16,17 25:25130:1 146:24249:3,7,12albuquerqu26:12,25 30:2157:4 170:13affirmation3:10 249:130:4,9,13175:22 196:7249:1alden117:32:18 34:3addressedafternoon137:5	3:4,6 3:23		
actual24:8131:4 141:1adopt94:3219:4205:23,24198:17,21advantageah141:13206:5 214:24additional224:8ahead92:1247:2465:22advise214:4115:3,8,9actually10:8address113:21affect203:817:4,24 18:4113:23 114:5affecting243:1243:1821:6 22:2114:14 116:12affirm12:25air24:16,17 25:25130:1 146:24249:3,7,12albuquerqu26:12,25 30:2157:4 170:13affirmation3:10 249:130:4,9,13175:22 196:7249:1alden117:32:18 34:3addressedafternoon137:5	3:23		
205:23,24198:17,21advantageah141:13206:5 214:24additional224:8ahead92:1247:2465:22advise214:4115:3,8,9actually10:8address113:23affect203:817:4,2418:4113:23114:5affecting243:121:622:2114:14116:12affirm12:2524:16,1725:25130:1146:24249:3,7,12albuquerqu26:12,2530:2157:4170:13affirmation3:1030:4,9,13175:22196:7249:1alden117:32:1834:3addressedafternoon137:5	3:23		
206:5 214:24additional224:8ahead92:1247:2465:22advise214:4115:3,8,9actually10:8address113:21affect203:817:4,2418:4113:23114:5affecting243:121:622:2114:14116:12affirm12:2524:16,1725:25130:1146:24249:3,7,12albuquerqu26:12,2530:2157:4170:13affirmation3:1030:4,9,13175:22196:7249:1alden117:32:1834:3addressedafternoon137:5	3:23		
247:2465:22advise214:4115:3,8,9actually10:8address113:21affect203:817:4,2418:4113:23114:5affecting243:121:622:2114:14116:12affirm12:2524:16,1725:25130:1146:24249:3,7,12albuquerqu26:12,2530:2157:4170:13affirmation3:1030:4,9,13175:22196:7249:1alden117:32:1834:3addressedafternoon137:5	3:23		
actually10:8address113:21affect203:8178:1820317:4,2418:4113:23114:5affecting243:1243:1821:622:2114:14116:12affirm12:25air27:724:16,1725:25130:1146:24249:3,7,12albuquerqu26:12,2530:2157:4170:13affirmation3:10249:130:4,9,13175:22196:7249:1alden117:32:1834:3addressedafternoon137:5	3:23		
17:4,24 18:4113:23 114:5affecting 243:1243:1821:6 22:2114:14 116:12affirm 12:25air 27:724:16,17 25:25130:1 146:24249:3,7,12albuquerqu26:12,25 30:2157:4 170:13affirmation3:10 249:130:4,9,13175:22 196:7249:1alden 117:32:18 34:3addressedafternoon137:5			
21:6 22:2114:14 116:12affirm 12:25air 27:724:16,17 25:25130:1 146:24249:3,7,12albuquerqu26:12,25 30:2157:4 170:13affirmation3:10 249:130:4,9,13175:22 196:7249:1alden 117:32:18 34:3addressedafternoon137:5			
24:16,17 25:25130:1 146:24249:3,7,12albuquerqu26:12,25 30:2157:4 170:13affirmation3:10 249:130:4,9,13175:22 196:7249:1alden 117:32:18 34:3addressedafternoon137:5			
26:12,25 30:2157:4 170:13affirmation3:10 249:130:4,9,13175:22 196:7249:1alden 117:32:18 34:3addressedafternoon137:5	e		
30:4,9,13175:22 196:7249:1alden 117:32:18 34:3addressedafternoon137:5	8		
32:18 34:3 addressed afternoon 137:5	18		
35:2 48:15       129:25 170:13       116:6 171:11       alden's 118	3:19		
50:7 54:25 242:16,25 180:23 218:21 137:13			
75:12,13 76:6 243:4 <b>agency</b> 222:5 <b>allow</b> 29:22	2		
81:2 85:2         addresses         ago         38:1 77:24         238:15			
103:5 121:20 147:5,8 150:10 94:20 175:8 <b>allowed</b> 39	:19		
121:22 125:20addressing187:5 220:2377:2 144:8	)		
127:16129:15112:9143:23agrankin2:20166:19,25			
137:21,25 236:2,6 <b>agree</b> 64:11 167:14,22			
138:7 152:2adjacent65:4,12 68:14alma47:21	-		
157:1 169:2219:1769:10 73:24alternative			
171:12 189:9adjourned91:8 97:14,22213:1			
194:20 202:19248:7114:5 145:4ambiguous			
203:5 207:22       adjusted       18:12       148:4 149:2,12       116:2			
209:4 216:9,11adjustments149:19,25amend66:	2		
219:22 220:24       247:7       150:2 211:18       amendment			
220:25 221:5 67:18,21			

# [american - anhydrite]

american 76:17	241:17	92:11 93:3,9	181:23 182:2,3
amount 17:3	analyzing	93:18 94:12	182:4,24,25
54:17 77:24	34:11 222:24	95:9 96:7	183:2,11,13,20
199:4	237:3	98:16 99:21	185:5,15 186:8
ampomah 1:22	<b>andres</b> 18:7,10	103:5 111:18	187:10 191:10
4:10 5:13,14	18:13,18 19:5	113:25 116:13	192:5,20,22
9:8 22:18	19:25 20:2,5	116:21 121:1	195:1 196:12
180:17,19,22	20:10,16 21:2	123:1,3,8,14	196:13 197:16
200:23 201:2	21:11 23:1,3	124:4,10	197:20 199:2
215:20,25	23:19,20 24:23	125:14,20	201:22,23
216:6,16	25:12 26:7,8	126:3,11 127:2	202:10,20
218:24 243:11	26:12,13,15,17	127:15,20	204:7,11
246:2	26:25 27:5,8	128:11 129:1	205:15 206:1,6
analyses 48:11	28:17 29:23	130:1,9,20	206:22 212:22
53:6 92:18	31:20 32:16,20	131:4,11	213:2,15 214:7
analysis 14:19	34:7,20 35:9	135:19 139:7	215:5,24
23:4,16 24:2	35:19,23 37:5	139:10,14,23	217:14,17
25:8,9,9,17	37:9,10,20,24	142:14,16	218:12 227:1,1
53:25 54:1,6,9	38:2,8,15 39:6	144:8,10	227:13 228:1
54:11 55:10	47:1 48:12,18	150:12 152:8	231:13,22,24
64:18,20 91:11	49:11 50:20,22	152:13,16,23	231:25 232:2,4
95:25 96:16	50:23 51:1	153:12 154:11	232:11,17
118:23 121:12	54:3,24 55:19	155:2,4,21	233:8,12,13
128:24 156:6	59:20 60:4,5,8	156:1,3,7,10,10	238:16 239:2
156:14 175:19	60:12 61:9,13	157:1 161:9,9	240:24 241:3,5
176:6,25	63:17 68:8,13	161:16 162:11	241:6,11,15
186:10 187:16	68:17 69:1,16	163:4 164:9,11	242:15
187:18,19	69:23,25 70:4	164:17,24	<b>andrew</b> 100:1
195:4 198:9,9	70:13 71:25	165:19 166:6	101:16 106:18
210:1,10	72:14,20,23	167:5 168:8,22	anhydrite
214:22 222:3	78:5,16,24	172:5 175:20	131:23 132:19
223:2 239:6	81:1,2,13	175:22 176:22	132:21,25
<b>analyze</b> 226:18	82:18,19 86:14	177:7,15,24	133:2,7,8,12
analyzed	87:9,12 90:18	178:3 181:7,11	134:19,23
187:17 196:10	91:23 92:9,10	181:13,19,21	136:21 137:12
1	1		

137:16,18,20	214:14 223:9	appropriate	<b>areas</b> 35:21
137:23 138:1	246:19	163:20,23	89:1 139:17
anhydrites	anymore	195:14	145:4 157:18
131:15,15,18	192:16	approve 9:9	205:3 217:12
131:24 132:8	<b>anyway</b> 208:6	approved 9:15	<b>argue</b> 97:3
132:18 133:13	apache 42:3	approximate	<b>arouse</b> 218:24
133:16 134:21	apart 16:19	80:16 86:23	arrow 216:25
134:22	17:18 138:20	approximately	arrowhead
<b>animals</b> 69:3,7	138:22 189:4	45:18 79:25	35:13 116:23
<b>annual</b> 76:18	198:1 244:25	87:1,2	<b>arrows</b> 34:5,5,6
<b>answer</b> 63:19	245:2	aquiclude	87:7 162:3,4
70:20 86:4	<b>api</b> 163:19	152:22	216:4,6,12
175:11 186:13	apologies 138:8	<b>aquifer</b> 31:17	217:1
187:2,3,13	176:14	33:20 39:1	artesia 87:6
192:3 194:11	apologize	116:22 188:1	article 106:13
205:20,20	143:15 151:25	227:14 228:14	235:24 236:2,5
207:6 218:14	155:13 157:11	229:13 230:5	236:8
240:25 241:4	167:25 168:2	<b>aramco</b> 45:22	ascending
241:10,16,20	170:10	45:24 46:8	241:11
241:25 242:5,7	apparently	architecture	<b>aside</b> 204:14
242:10 245:4,5	137:13 148:9	51:5 127:4	<b>asked</b> 46:20
245:6	240:8	<b>area</b> 14:10	55:9 66:23
answered	<b>appear</b> 63:19	16:18,19 17:17	72:1,9 73:11
132:24 234:9	219:9	33:17 41:21	73:19 88:7,7
<b>answers</b> 212:16	appeared 8:10	42:18 55:19	145:6,7 172:19
229:24	appearing 6:7	87:4 105:11,20	172:22,23
anticline 28:10	7:12	106:5 107:13	173:14 174:8
31:3 110:9,19	<b>appears</b> 176:21	111:16 112:19	174:18,23
110:20,25	appendix 4:13	112:20 135:24	175:7 181:17
122:6 153:16	13:6,16	176:1 181:12	181:24 196:2
153:18 237:25	applies 25:12	186:18 191:2	231:5 234:6
antonio 2:14	appreciate	194:1,4 202:19	235:3,22
anybody 7:15	196:9 212:12	205:7 206:20	236:21 238:2
115:4 118:1	229:25	<b>areally</b> 107:22	238:12 244:1,4
142:17,18			244:12 245:10

[asking - back]

asking 72:25	asymmetric	<b>ave</b> 2:14 3:14	138:3,8,9
73:5 91:13	28:10 31:3	average 74:14	143:18 144:7
97:8 113:11,19	110:25 153:17	awarded 41:10	145:11,16,22
174:21 178:15	atmospheric	aware 17:22	145:24 146:19
186:20 195:17	77:3,10	72:2,6,10 73:2	152:5 157:6,10
195:20 199:17	attached	73:5,13,14	157:12,14
227:11	116:23 220:8	74:13 84:12	161:7 169:23
asleep 179:13	attacked	88:9,18 94:19	174:9 185:9
assess 194:24	194:15	95:6 97:13	191:1,13
assessment	attempt 50:25	124:2 161:15	197:11 200:13
78:3 163:22	attendance	161:19 166:17	200:14,25
assessments	118:1,8	167:2 168:14	202:15 203:14
97:10	attention 94:21	168:24 170:7	207:11,12
assigned 43:14	177:14	184:13 190:12	209:14 215:17
43:15 44:14	attorney 95:1	218:14 219:3	215:19,20,25
associated 21:9	audience	<b>awful</b> 137:11	216:7,15,20
21:22 23:23	247:18	<b>axis</b> 108:3,15	219:3,5
145:3 152:15	<b>august</b> 51:18	108:17,23	<b>back</b> 5:21 9:16
154:10,12	52:1,9 53:5	109:7,9	38:24 43:2,3
231:11,12	60:23 90:20,25	<b>aye</b> 9:11,12	46:19 47:9,9
240:23	91:16 93:2	b	47:22 48:8
association	123:25 125:17	<b>b</b> 4.12, 12, 12	56:3,5 57:16
76:18	129:9	13.5 5 5 15 15	58:7,11 59:10
<b>assume</b> 199:21	<b>author</b> 94:13	13.15 25 19.1	60:25 61:20
205:4,12	101:15 129:17	27.3 30.22	62:2,7,21
245:23	151:15,16,18	32:5 33:12	63:12,13,20,22
assumed 79:10	151:18 242:19	35:21 41:23	65:16,17,20
assuming 101:5	authorized	49:15 50:2.2.8	67:6,24 68:1
177:20 222:9	166:19	50:10.18 60:20	72:1 73:12
243:24	authors 94:14	63:23.23 86:21	75:13 82:2,11
assumption	95:3	93:13 110:3	89:8 90:20
83:13,14	availability	116:10 117:25	93:12 100:12
126:14	246:23	120:4.25	105:23 106:20
assumptions	available 21:13	127:10 129:8	107:15 115:13
130:8	39:25 66:4,22	131:12 135:4	115:18 116:10

121:16 122:11	barnett 47:3	<b>based</b> 12:12	<b>basin</b> 16:5,8,11
127:9,12,12	48:2	32:9 41:10	16:23 17:15
141:21,23	<b>barrels</b> 106:23	56:22 57:1	27:7,11 41:16
142:9 143:1	108:16,21	65:25 66:1	41:25 47:11,17
144:2 151:23	<b>barrier</b> 71:16	67:19 79:25	78:10,10,12
155:18 170:16	71:18 90:17,22	83:13,13 88:8	79:4,9,22 80:2
172:18 181:16	91:1,15,22	97:13 111:14	81:6 82:21
182:7,22 187:5	92:3,13 153:25	117:5,17 118:5	83:1 87:19,19
189:10 193:19	159:21,22	122:19,20	88:11,13,22,23
199:22 201:11	235:19 239:9	128:23 131:25	88:24 95:11
202:5,8,9	<b>bars</b> 15:2 18:14	137:2 139:11	96:9,14 135:5
204:1 206:25	26:20 139:19	139:13 163:14	135:8 136:3,5
207:3 208:2	139:25	174:8,14	186:5,20
209:13 210:6	<b>basal</b> 152:21,23	177:16 191:15	188:11,19,22
212:4 218:2,2	<b>base</b> 18:5,21	203:9 204:17	189:12 211:11
221:3,16 223:8	19:5,14,21,23	210:20 213:16	218:9 228:9
223:16 228:16	20:8,14 26:4	213:19 218:8	232:24
240:20 243:22	26:23 27:1	227:11 239:4	basinal 135:9
247:21	34:7 38:10	239:19 241:18	<b>basis</b> 99:3
<b>backfill</b> 17:20	62:5,6,14,20	243:10	118:12 172:19
209:9	63:17 64:21	baseline 74:20	173:14 178:16
backfilled 82:6	66:12 67:9	74:20	baylen 1:21
background	69:9,22 70:3	basement 31:4	5:17
97:9	70:11 74:21	<b>basic</b> 241:20	<b>beans</b> 224:5
backpack 95:4	83:7 112:18	basically 16:24	<b>bear</b> 40:21
backs 211:22	127:25 128:10	20:6 24:13,22	bearing 236:9
<b>bailey</b> 56:15	139:23 140:3	25:15 32:23	beatty 3:14
57:11 230:25	140:18 141:7	33:16 34:3	7:12 179:16
246:8	141:25 152:18	39:14 73:20	beautiful 69:19
baker 3:9	168:6,7,15	78:11 96:1	139:12 146:3
<b>bank</b> 193:4	169:14 172:25	101:19 112:3	224:5
194:5	184:21,24	139:17 194:5	<b>beauty</b> 34:17
<b>barium</b> 31:13	200:3,6 216:23	199:7 200:4	97:6 142:15
39:10	217:3 226:9,24	222:19 224:25	<b>beck</b> 3:11 7:3,3
	232:9 233:15	231:21	7:5,6 9:1,2

# [beck - boundary]

151:6 179:8,11	161:6,12	233:6	<b>bled</b> 97:17
235:7	181:24 184:4	<b>bigger</b> 103:22	<b>bleed</b> 97:4,21
<b>bed</b> 113:5	197:16,25	103:24 139:2	bleeding 96:17
133:14	226:15	166:7,13 214:9	blocks 31:5
<b>bedded</b> 15:19	<b>bending</b> 219:13	219:16 227:21	<b>blown</b> 139:4
131:24 132:8	beneath 26:18	234:12	<b>blue</b> 15:9,15
132:21 133:7	31:4 33:7	<b>biggies</b> 197:24	22:4 135:13
133:12 134:5	168:21 191:9	<b>binders</b> 245:24	158:16,16,25
134:14,19	216:25	birkhead 56:15	162:2
137:18 159:15	<b>benefit</b> 100:15	57:11 246:10	<b>blunt</b> 224:18
<b>bedding</b> 128:15	<b>best</b> 22:16 58:2	<b>bit</b> 14:5 16:21	<b>bob</b> 94:22
128:15,17	73:15 156:20	27:18 45:15	182:12 194:19
148:7	158:21,23,24	48:16 52:21	<b>body</b> 171:25
<b>beds</b> 15:20	164:14,14	75:12,19,22,24	<b>bottom</b> 26:24
113:6 148:13	190:21 203:25	80:10,20 83:4	31:20,25 32:5
148:14,20	212:22 220:3	85:22 86:8	32:19 33:4,14
157:23	249:10	90:15 92:5	34:2,6,16,22
<b>begins</b> 108:7,25	<b>better</b> 45:15	98:2,3 104:14	35:18,21,22
<b>behalf</b> 6:8,11	56:10 57:7,25	107:6 112:22	36:20 45:11
6:18,22 7:1,3,7	59:13 128:3	116:8 130:5	75:15 120:24
7:13 8:25	149:4 180:7	131:23 139:7	127:19 135:21
<b>believe</b> 7:20	194:2 223:12	140:6 164:8	183:19 192:15
18:20 64:24	<b>beyond</b> 8:10	175:25 178:6	192:15 196:18
65:9,11 71:23	212:9 227:3	183:6 195:3	202:20 203:7
76:6 144:19,20	228:11	196:17 212:9	207:17 213:13
161:6 174:25	<b>big</b> 14:14 96:20	213:11 215:12	216:10 225:23
187:9,25	100:9 110:25	218:23 219:15	boundaries
195:24 196:6	136:15 165:21	220:20 228:5	125:11 231:19
216:18 246:25	183:8 193:14	228:25 231:18	234:12
<b>believes</b> 130:15	193:19 194:9,9	black 15:2	boundary
<b>bell</b> 14:4,18	195:10 196:20	18:14 26:20	31:18 69:19,21
18:3 19:3,10	199:5,6 201:13	139:19,24,24	69:25 70:1,4,7
20:13 21:16	213:13 217:6	217:10,12	70:11,18 71:12
48:15 62:22	219:9,19 221:7	blackout 8:18	72:3,4,12,18
142:12 151:4	221:20 232:10		73:3,7 127:15

#### [boundary - carbonates]

127.10 129.1	177.24	hullotin 120.16	77.11 70.9
127:19 128:1	1//:24	bulletin 129:10	77:11 79:8
152:12 231:6	<b>Drecclas</b> /1:/	<b>builnead</b> 147:9	87:18 142:10
231:10,16	139:22 178:5	bunch 165:18	165:16 182:6
232:3,5,9,17,21	179:2 217:13	219:22	182:10,14
233:14,15	217:21	<b>bureau</b> 66:19	191:4,5 230:5
234:9 235:19	<b>brief</b> 11:21	223:15	231:24 232:9
bounding	231:1	business 39:17	232:15,18
232:22	<b>bring</b> 5:21 6:12	<b>button</b> 10:19	calling 10:1
<b>box</b> 2:4,7,10	170:16 171:13	bwenergylaw	calls 105:11
3:10 19:9,9,10	191:14 197:1,3	3:16	149:16
19:10,17 20:12	197:5 200:4	<b>bypass</b> 144:15	camera 224:9
21:7,23,25,25	211:3 244:14	<b>byu</b> 41:2 47:21	<b>cameras</b> 223:13
63:15 141:9	<b>brittle</b> 28:8,11	48:6	224:6,8,10
207:17	153:19 205:8	С	canada 224:22
<b>boy</b> 63:8 187:1	<b>broggi</b> 2:20	c 2.1 3.1 32.5	<b>canyon</b> 232:22
203:22	<b>broken</b> 31:5	121.7	<b>cap</b> 107:21
<b>brand</b> 234:3	147:15	calcium 30.0	capacity 11:11
break 55:25	brought 16:10	121.1 126.21	<b>capitan</b> 172:6,7
56:9 94:23	21:13 94:21	131.1 130.21	172:21 173:5
115:3,5,9	95:16 96:4	130.21 colculate 185.2	173:10 175:17
143:7,15	239:25	calculate 103.5	188:1,3,5,8,10
153:19 170:10	brown 20:19	$\frac{\text{calelluars}}{247.14, 19, 10}$	188:13,19
171:2,3,5	20:25	247.14,10,19	189:2 190:22
179:24 180:2	brownfield		190:23 238:2
207:19 219:13	191:4,6,10		238:20 244:3
234:16,19	192:21		244:17
breaking	brushy 232:22	<b>call</b> 5:12 15:4	caption 120:9
167:16.23	buchwalter	1/:5 2/:16	120:11
180:2	57:12 246:15	29:5 34:23	captured 16:10
breakthrough	building 1:5	81:10 120:14	carbonate 28:4
193·2	2·13	148:23 169:15	28.7 71.1
breakthroughs	<b>built</b> 106.23	182:8,13	128:14 136.14
101.23	195.20	185:19 222:20	152.19 160.12
breccia 139.16	bullet 37.13	231:24	carbonates
139.20 166.9	61.13 131.8	<b>called</b> 15:8,11	70.23 160.12
157.20 100.7	01.15 151.0	17:6 42:4 45:9	70.23 100.12

# [care - chasing]

care 21.1/	50.7 61.2	79.22 80.2	133.24 150.10
$\begin{array}{c} \text{care} 21.14 \\ \text{corean}  45.24 \end{array}$	149.0 165.15	07.10 00.11 12	150.12 12
<b>Career</b> 45:24	148.9 103.13	87.19 88.11,15	139:12,15
211:10	165:17	88:21,22,23	163:10 182:19
careful 149:5	catch 77:22	95:11 96:8,14	224:12 247:4
carlsbad	184:7 213:8	188:22	changed 58:17
136:12	217:15	centre 2:13	59:14 85:25
carpenter	categories	<b>certain</b> 105:11	changes 59:11
117:18 118:6	120:17	certainly 56:24	133:22
119:11 120:18	categorized	179:22	channel 172:5
123:4,19	181:4 200:14	certificate 4:15	172:7 173:5
130:14 137:3	<b>cattle</b> 190:8	<b>chair</b> 1:20 5:3,9	characteristics
carpenter's	<b>caught</b> 226:5,6	5:20 6:9,12,16	107:23
118:24 121:11	<b>cause</b> 144:14	6:20,24 7:2,5,9	characterizati
122:19 128:23	149:17	7:14 9:8,10	45:7 51:15
129:11 241:19	<b>caused</b> 107:23	10:15 22:16,21	89:24 106:16
cartoon 28:12	causing 113:22	56:2 101:1	107:17 124:23
231:20	<b>cavern</b> 153:10	115:11 180:1	126:12 148:12
<b>case</b> 5:23,24	<b>caverns</b> 136:12	180:13 197:11	176:4 196:10
12:23 17:22	136:15	200:25 215:14	239:5
22:5 31:22	<b>cement</b> 39:14	215:17 229:22	characterizati
40:16 51:10	131:23 133:2,8	229:25 234:14	90:8
52:13,16,23	133:10 134:20	234:17 245:25	characterize
53:3 55:9	134:24 136:24	246:18 247:13	45:6
89:25 123:13	137:5,16,20	247:23	characterized
128:17 141:22	138:1 153:10	challenge 102:5	149:15
175:10 176:3	199:4	103:13	characterizing
176:11 196:8	cemented	challenges	55:14 60:3,8,9
208:10 225:6,7	134:22,23	102:2	181:11
225:19 226:23	152:16	<b>chance</b> 40:14	<b>charge</b> 47:21
243:1,2,23	<b>cements</b> 132:20	156:18 209:7	charged 27:8
246:2.19	<b>center</b> 122:18	229:23 234:20	27:12 30:12
247:24	centimeter	234:25	<b>chart</b> 69:19
<b>cases</b> 6:8 14:8	148:6	<b>change</b> 61:22	<b>chasing</b> 114:10
52:18 53:7 10	central 41.15	61:22 62:1	242:20
53.12.20.58.6	41.25 78.12	83.5 86.1	

# [chemical - coming]

chemical	chihuahuan	<b>clearly</b> 122:20	<b>collect</b> 211:12
151:22	39:3	<b>cleave</b> 44:20	collection
chemistries	<b>chino</b> 1:5	client 55:8	105:21
31:11,24 34:15	<b>chris</b> 3:5 7:7	170:12 195:14	<b>college</b> 40:24
121:15 129:3	chris.moander	<b>cliffs</b> 229:2,8	<b>color</b> 20:18,19
chemistry	3:5	230:14	20:20,21,21
30:24 31:9	<b>circle</b> 100:7	<b>climb</b> 230:14	33:19 135:13
32:4,12,25	<b>circles</b> 100:9	<b>clock</b> 240:4	141:10
33:3 34:12,17	105:21 109:1,2	<b>close</b> 14:2 18:9	<b>column</b> 23:19
34:19 39:7	circumstance	19:2 21:5	64:5 169:15
118:22 122:21	72:2,10,10	26:14 132:5	<b>come</b> 10:16,18
127:9 128:24	73:6	245:17	16:23 35:25
129:7,10,13	<b>cite</b> 144:5	<b>closed</b> 8:16	38:16,17,19
130:2 137:6	<b>cited</b> 119:17	<b>closer</b> 51:24	44:16 63:21
241:20,24	129:23	92:4 171:14	75:16 92:6
chevron 12:4	<b>cites</b> 106:1,7	closure 17:4	104:17 121:15
25:20 31:10	<b>citing</b> 144:17	<b>closures</b> 17:1,2	134:18 154:9
32:9,10 43:7,9	<b>city</b> 86:24	77:6 78:14	161:1 163:5
43:10,11,13	clarification	<b>co2</b> 186:24	167:12,14
45:5,17 46:22	178:16	192:24 193:2,3	177:19 184:2
48:8,10 50:25	<b>clarify</b> 194:22	193:14,18,21	209:3 210:10
51:2 60:7	233:11 234:5	193:23 194:1,3	211:2,5 222:19
98:15 101:16	234:11	194:6,17	222:20
101:16,21	classes 47:20	225:11,12,17	<b>comes</b> 15:18
117:19 118:6	48:5	225:18	189:10,11
121:20 124:6,7	classified 190:3	<b>coated</b> 224:24	218:2 241:5
149:22 167:9	cleaned 20:22	<b>cold</b> 169:21	<b>coming</b> 31:17
193:25 194:15	21:8 22:2	collapse 71:7	33:14 34:10
202:6 222:4,6	<b>clear</b> 32:8 70:5	139:16,20,22	35:18,19,23
222:13 223:7	100:14 119:23	166:9 177:24	36:1,10,21
chevron's	122:21 123:5	178:5 179:2	57:7 83:23
50:19	125:1 129:8	217:12,20	120:20 122:4
<b>chew</b> 213:3	162:5,21	colleague	122:21 123:1,7
<b>chews</b> 185:10	164:10 203:10	194:19	123:10,14
	231:8 238:25		128:6 129:1

135:8 136:3,5	commissioner	companies	<b>comply</b> 171:8
159:24 160:2	4:10,10 5:13	46:25 167:14	composite
160:24 173:24	5:17,19 6:6 9:8	company 3:8	69:18,21,24
189:18 190:15	180:19,22	7:4 28:19	70:4,7,10,18
190:17,17,19	200:23 201:2	39:18 46:22	71:11 72:3,18
192:9 198:11	215:20,25	47:1,2 151:22	73:3,7 127:19
202:4,20,25	216:6,16	167:8	128:1 138:10
203:7 209:10	218:20 243:11	compare 25:8	152:12 231:5
211:24 213:1	246:1	163:25 164:2	231:10,16,18
241:7,7,15	commissioners	compared	232:2,5,8,16,21
242:6	5:12 6:7,21	37:15 75:15	233:13,14
commenced	7:11 12:11	95:18 97:2	234:8,11
123:15	13:3 22:13	198:9	235:18
commences	40:1,2 100:15	comparing	comprises
109:12	170:23 218:17	198:8	103:4
commercial	229:23	complete 18:3	concentration
74:19 88:10,20	committee 48:5	18:6 26:1 65:7	117:6
commission 1:3	<b>common</b> 34:22	83:14 232:22	concept 75:23
1:19,24 4:9	98:14 122:25	completed	conceptually
5:10 6:2,10,14	241:25 242:3	125:13,20	74:24
6:18 8:15	243:3	126:21	concerned
11:15 37:3	communicated	completely	190:24
52:12,24 53:1	208:19	17:20 20:22	concerning
56:9,25 59:13	communicating	83:10 89:22	244:2
126:5,10	73:4 188:2	169:1 225:5	conclusion 37:4
142:18 161:24	communication	completion	conclusions
168:12,15,19	29:23 108:14	249:1	36:23 37:3
175:23 176:14	173:4,9,11,19	<b>complex</b> 80:22	conditions 84:3
179:23,24	189:17 190:11	103:10 126:5	<b>conduct</b> 55:10
180:3,11,21	190:13,20,21	195:18	conducted
195:17 236:9	227:12 244:3	complexity	53:25 118:16
246:19 247:17	244:14,16,21	103:14	124:18
249:5	communicati	complicated	<b>confer</b> 170:12
commission's	117:18	106:19 107:6	conference
242:18			249:6

<b>confirm</b> 30:17	connects	containing	<b>control</b> 112:15
36:23 58:22	228:10	131:10	convenience
59:1 195:25	conquer 44:21	contains 59:20	219:15
204:14 212:7	consent 211:24	60:5,13 61:10	conventional
confirmed	conservation	61:14 68:9	24:19 25:2,8
68:21 71:23	1:3 3:2 5:9,10	148:2 181:7,13	25:17 95:19,22
72:16 91:5	7:8 8:6 58:11	contaminate	95:25 96:17
conformance	249:5	39:1 116:22	97:5,11,17,22
101:12,22	consider 14:9	117:4	98:7 162:12,17
102:14 103:22	considered	contaminated	162:22 163:2
104:22 105:11	25:19	175:14	210:18 236:17
105:19,25	consistent	contamination	236:18
106:5,6,8	245:9	116:13	converse 40:14
107:20 109:20	consolidated	<b>context</b> 14:16	<b>cool</b> 16:21
109:21 111:3	5:23	continent 43:16	cooperate
112:11 113:7	constrain 171:3	continuation	143:16
114:21 159:17	<b>consult</b> 46:24	5:4 23:21	coordinating
236:1 242:21	consultant 46:4	156:25	214:22
243:5	46:7 213:25	continue	<b>copies</b> 223:4
confused 52:22	consulting	109:13	<b>copy</b> 95:5,17
confusion	11:12 46:9,11	continued	200:12 202:6
231:18 234:8	46:12	57:21 81:15	202:11 221:3
<b>connate</b> 31:12	consuming	201:12	223:10
31:24 32:6	211:16	continuing	<b>core</b> 18:2,4,10
34:16 121:8	<b>cont'd</b> 3:1	5:22 245:5	18:11 19:4,9
connect 45:8	116:4	continuous	19:16,24 20:1
connected 16:1	<b>contact</b> 66:20	71:20 145:23	20:4,7,12,22
106:25 115:22	168:20 169:16	148:20 153:12	21:5,12 22:1
117:9,11	169:17 181:20	153:14,25	23:2,4,7,10,16
126:25 157:24	183:24 184:1	154:3,15	23:17,23 24:8
189:4,6 208:18	185:20	239:13 245:4	24:19 25:2,3,8
208:20	contacted 53:3	continuously	25:9,9,17
connectivity	<b>contain</b> 152:19	12:1 26:3	26:11,19,24
112:14	contained	123:14	27:1 28:19
	107:20		30:21 35:2,3,5

37:6,10 42:11	184:24 185:1,8	181:17 192:7	correct 13:1
42:15 46:25	185:8,8,8,9	200:9 203:16	37:22 41:12,16
47:3,3,4,6,15	186:11 187:16	212:21 218:6	41:19 43:7,8
49:14,15 50:10	187:17,18,19	225:23	43:21 45:2,22
55:7 62:3,5,6	192:15 195:4,8	<b>cores</b> 20:14	46:4,7 50:4,9
62:14 63:4,15	196:4 201:21	21:20 23:1,5	50:12,16,17
63:18,22 64:1	202:11,15,17	24:13,15 25:25	53:22 54:3,6,9
64:18,20,21,25	203:16,18,19	36:7 37:9 38:7	54:12 55:11,15
65:1,3,9,17	203:20,24	38:10 44:15,17	58:7,8,12 59:7
66:1,10,11,12	204:4,14,18	45:1 46:20	59:25 60:1,5,6
66:13,21 67:4	207:12 208:25	47:2,15 48:19	60:23 62:4
67:12,20,24,25	210:1,9,18	48:20 49:17	63:18,23 64:4
68:4,5 95:19	211:2,12,15	60:3 62:22	64:7,22 65:23
95:19,19,22,22	212:4,7,20	67:7,10 98:8	65:24 66:5,16
95:23,25 96:17	213:1,3 214:14	125:24 138:10	67:16,20 68:2
96:23,24 97:11	214:22 215:10	142:7 156:12	68:5,6,22
97:17,22 132:1	215:23 216:22	157:21 162:22	69:22,25 71:14
132:2 138:13	216:23,24	164:4,5 168:23	71:17 72:20,21
138:23 139:6	217:2,3 220:2	181:19 184:8	72:23 73:14
139:11,20,23	221:23 222:3,5	184:22 192:5	75:3,4 76:19
139:25 140:6	222:11,14,19	196:14,15	76:20,23,24
140:18 142:3	222:20,24,24	201:16 207:7	78:6,12,18
142:20,24	223:14,17,25	211:8 223:22	79:17 80:2,17
146:2 153:11	226:2,3,8,10,11	226:24 237:15	80:18 81:7,23
155:1 156:25	226:21 233:9	<b>corey</b> 2:15 6:25	82:16,17 83:2
157:2 162:6,7	236:16,17	<b>coring</b> 18:4	83:15,24 86:21
162:10,11,12	237:18,23	24:10,11,20,20	87:9,20,24
162:12,13,17	239:5	50:19 96:2,18	88:3,24 89:3
163:2 164:12	<b>cored</b> 14:3 15:2	96:20 162:13	89:10,13 90:6
164:17,25	18:22 19:5,13	183:5,6 210:5	90:10,13,14,22
165:4,5,7	19:14 20:1,8	217:25	91:2,3,12,23
166:14 168:22	25:5 26:3,6,15	<b>corner</b> 96:10	92:10,14 93:19
169:10 181:10	26:24 37:11	96:13,14	94:1,4,8,9
181:25 183:1,8	42:13 49:20,21	106:22 112:17	95:11 98:17,18
183:12,14,18	50:8 163:5,6		100:10 102:1
		1	1

103:20 105:15	176:7,22	212:10 214:12	110:5 111:7
108:4,23	177:17 185:25	218:22 222:22	116:4 120:4,8
109:13,22	196:11 222:5	228:23,23	120:14,15
110:6,19 111:9	235:18 236:4,7	243:11	134:4 138:5
111:15 117:8	236:19,20	<b>course</b> 97:19	150:18,23
117:15 118:15	238:9,14	168:5	151:11 171:9
118:18,23	244:22 246:24	<b>court</b> 115:14	179:9 191:16
120:6,22 121:5	247:1 249:9	116:1 248:3	235:23 243:14
121:13 122:9	correction	courtesy 246:5	<b>crude</b> 225:1
122:22 124:4	163:15,20,23	<b>cover</b> 205:2	cumulative
124:16,21	correctly 59:22	<b>creamy</b> 20:21	108:3,17,22
125:14,21	60:17 61:18	20:21	109:9
129:12 130:11	103:9 117:1	create 17:5	curiosity 74:1
130:12,17,22	131:6 152:25	38:18 39:11	209:17 227:10
131:12,13,16	correlatable	199:4 217:20	229:24
131:17,19	165:2	220:22 233:8	currently 52:24
133:22,23	correlate 15:24	created 16:14	cursor 87:2
134:1 135:2,3	45:11 125:24	17:14 27:15,18	<b>cut</b> 18:11 99:18
136:8,17	165:8 212:3	28:10 31:8	100:10 114:20
138:11,12,17	correlation	38:20 75:23	206:12 208:5
139:6,10,18,25	15:4	137:25 167:3	240:22,23
140:6,11,14	correlations	219:1	<b>cuts</b> 113:17
142:21 144:3	37:11	creates 28:8	cuttings 24:12
144:15,16,22	<b>cotton</b> 191:25	creating 31:6	42:14 96:21
144:25 145:15	counsel 1:24	33:25	cwehmeyer
145:18 149:9	235:3 238:1	crestal 122:5	2:15
150:6 151:24	<b>count</b> 103:8	123:2	<b>cycle</b> 15:4,4
155:16,18,22	<b>counted</b> 159:6	cretaceous 28:2	102:18 159:9
156:11 159:7	<b>couple</b> 23:14	<b>cross</b> 4:6,7,8,13	164:20
159:10,18	31:19 32:23	4:14 14:25	<b>cycles</b> 102:20
161:9,12,20,21	33:21 47:25	15:3 16:4	102:24 103:6
162:14 164:13	58:16 59:16	33:15 37:9	127:17 138:5
166:21,22	152:3 180:25	39:25 40:9	159:7 161:25
170:6 171:21	183:2,3 189:16	57:21 79:2,14	162:4 166:4
172:8 174:15	191:3 197:22	100:18 101:8	

cycling 45:13	212:23 226:23	141:14 169:10	<b>deny</b> 195:23
69:20 80:19	228:12,25	169:17 183:6	depending
101:23 102:17	236:16 241:23	184:8,17 185:4	122:10 186:18
109:22 110:3	database 92:5	195:5,9 196:19	depends 56:18
113:2 149:15	date 59:1 99:7	213:2,7 226:16	85:20
149:23	169:25	243:13	<b>depict</b> 121:11
d	dated 59:3	<b>defer</b> 236:12	deposed 124:1
<b>d</b> 1.1	<b>dates</b> 247:20	<b>defies</b> 39:22	deposited
dakota 211.11	<b>day</b> 56:11,17	<b>define</b> 75:8,10	160:11 232:24
dan 7.18	106:23 108:16	92:10 156:10	deposition
dana 2.5 6.18	108:22 179:19	191:6	61:20 68:12,19
danial 1.25	230:12 245:12	defined 75:2	69:14 70:6
darcies $112.20$	245:17	106:5	71:11 72:1,9
1/8.25 1/0.4 5	days 57:8 109:9	definitely	73:1 76:4
140.25 149.4,5	deadline 8:10	205:22 207:1	82:14 83:19
147.0	<b>deal</b> 238:14	211:25	86:9 91:5 94:6
data 12.4 21.18	<b>dealing</b> 169:12	definition	98:12,21
25.12 26.23	191:2	73:19 156:9	102:21,24
32.0 12 16.22	december 46:2	definitive 68:10	103:4 110:21
54.6 8 55.21	<b>decide</b> 92:20	<b>degree</b> 28:24	113:10,15
70.11 00.8 12	216:11	40:23 41:2	121:19 124:17
02.5 117.24	<b>decision</b> 195:16	43:3 48:1,3	125:18 145:7
118.22 110.6	decrease	244:5	155:3 162:5
110.22 117.0	109:22	<b>degrees</b> 229:11	172:16,18
173.71 179.7	decreases	delaware 78:10	173:6,15
129.10 130.4	211:4	79:4 81:6	174:19 240:13
154.9 157.19	<b>deep</b> 62:6,19	188:19 189:12	243:23
157.20 164.7	157:22 166:2	232:24	<b>deposits</b> 133:13
183.17 194.73	169:18 184:7,9	delivered 131:9	<b>dept</b> 3:3
195.3 196.17	217:15 226:16	demonstrated	<b>depth</b> 18:12
198.74 199.10	226:20	151:2	63:7 64:6,19
202.6 12 18	<b>deeper</b> 18:24	<b>dense</b> 132:19	140:14 141:17
202.0,12,10 205.24.25	20:16 38:11	<b>density</b> 116:24	156:11 195:11
205.27,25	61:17,23,23	<b>denver</b> 43:15	211:3 214:18
211.23 212.20	62:15 65:23	43:17,24 44:2	237:5

# [depths - direct]

<b>depths</b> 60:14	139:25 146:7	dhardy 2:5	181:5 191:3
61:15 64:2,3	162:6,7 233:9	diagnosis	202:12 233:25
146:15 156:6	descriptions	101:11	237:15
156:13,14	165:1	diagnostic	differentially
236:22 237:2	desert 39:3	108:13	31:5
<b>der</b> 84:22	71:5	diagram 16:7	differently
describe 44:15	<b>design</b> 101:11	217:6	225:5
71:9 81:16	designee 5:15	diagrams	<b>difficult</b> 195:17
82:1 89:12	5:18	202:12	206:19 211:13
102:2 105:25	<b>destroy</b> 135:24	diamond	229:1
125:24 181:18	199:6	105:11,13,20	<b>digital</b> 223:13
185:7 204:19	destroyed	106:5,8 107:20	224:6,9
237:14	16:19 81:19	109:20,21	dillewyn 247:9
described 15:3	detail 38:7	diamonds	dimensionally
26:19 36:8	45:11 101:20	109:1	27:21 208:20
42:10,14,15	132:7	diction 58:3	209:11 220:10
48:14 57:1	detailed 89:23	<b>differ</b> 154:16	220:15
59:18 89:15	194:8 213:21	difference	<b>dinky</b> 113:2
141:21,23	<b>detect</b> 137:13	24:21 130:15	164:19 166:3
177:16 189:9	137:14	145:22 163:12	220:12 221:12
201:25 203:9	determination	differences	<b>direct</b> 4:6 11:3
203:24 204:4	211:20	59:11	11:18 12:13,22
describes	determine	different 31:11	13:4 36:25
105:24	34:12 163:23	31:24 34:15	39:23 40:15
describing	170:9	46:14,24 56:23	51:17 52:1
44:17 47:3	<b>develop</b> 55:3,6	57:2 68:25	53:4 76:8,13
55:7 142:6	164:20	69:3,7,7 71:22	90:19,24
181:10 183:18	developed	87:6 93:8 96:7	108:14 130:6
203:11,21	164:19 217:14	102:18,24	130:24 138:4
220:1	developing	103:6 106:8	146:20 155:7
description	102:3	127:17 129:3	155:15 157:6
18:2,4,10,11	development	133:21 137:7	157:12 161:14
19:4 20:4	88:10	138:5,10 148:3	177:14 181:9
45:13 48:18	developments	154:11,17	190:11 196:3
107:16 139:21	88:9,19 89:3	159:7 166:12	197:7 198:13

#### [direct - dolomitized]

200:13	88:12 91:4	<b>dissolve</b> 71:1,2	document 76:4
direction	105:7 130:18	137:9,12	76:6,7,11
135:18	135:1 138:17	160:18 193:22	176:19 177:4
directions	146:22 162:10	dissolved 31:13	177:21
113:4	236:2,17 247:3	97:15 117:6	documentation
directly 33:7	discussing 39:6	136:14 137:23	93:15
164:2	50:3 69:6	160:7	documented
director 5:8	71:10,22,25	distance 95:8	145:8
disagree	89:9 238:13	188:12,24	documenting
114:22 238:25	discussion	189:1,15	7:24
239:8	111:18 113:24	196:23 197:3	documents
disagreed	displaced	197:20,25	94:15
53:15	225:16	distinction	<b>doing</b> 20:3,3
disagrees	disposal 37:16	133:11	46:11,17 47:18
106:15	90:17 93:4	distinguishing	48:18 60:8
disappear	107:9 124:3,9	137:2	92:2 107:5
148:17	124:19,25	distracted 98:1	164:4 193:20
<b>discern</b> 130:15	126:18 145:18	distribution	204:2 211:15
disclosure	155:11 161:20	201:18 220:6	213:1 218:7
172:10	166:19,20	diversion 96:5	219:22 222:7
discontinuous	167:3	<b>divide</b> 44:21	225:16,18
239:12	disposed	89:9 232:12	dolograinstone
discourse	126:19 127:1	<b>division</b> 3:2 5:9	112:19
240:15	disposition	7:8 8:6 51:20	dolograinsto
discovered	249:14	52:5,12,13,19	112:6 158:20
60:4 181:13,14	disputes 52:17	53:7,22 58:10	<b>dolomite</b> 28:11
discoveries	53:1	58:11,24 59:7	134:25 153:18
47:10,13	<b>disrupt</b> 123:16	241:21,24	205:8
discuss 89:24	dissertation	<b>doctor</b> 22:22	dolomitic 15:19
91:14 100:13	41:11 90:5	171:14 172:22	134:15 152:17
143:3 161:11	144:3,5,17	173:21 176:16	159:24 160:8
172:3	152:9 154:5,7	229:20 230:1,3	dolomitized
discussed 69:8	dissolution	230:19 244:7	15:5,9,10 28:7
77:1 78:2	131:1 161:2	244:24	36:14 149:4
82:14 83:18	164:21,23		152:19 153:18

# [dolomitized - east]

192:16	<b>dozen</b> 84:19	230:21 231:4	<b>duly</b> 11:2
dolopackstones	<b>dozens</b> 78:3,3	231:15 233:17	<b>dumb</b> 203:15
15:12 158:17	<b>dr</b> 5:13 10:8	235:18 238:1	duplicative
158:19	11:5 12:12,22	239:20 240:12	178:8,11
dolostone	13:4,18,22	242:13 243:22	<b>dynamic</b> 81:18
15:21 139:16	14:8 15:22	245:4 246:15	е
dolowackest	16:2 17:25	246:24 247:1,2	ρ. 2·1.1.3·1.1./·1
158:8	18:17,25 19:6	<b>draw</b> 234:10	7.73 8.7 37.5
dolowackest	20:17 21:3,23	drawing	116.19 120.22
158:5	22:18,25 23:13	231:15 234:5	earlier 50.1
<b>domed</b> 28:5,6	24:1 25:13,23	<b>drew</b> 231:19	53·20 58·6
dominated	27:2,24 29:22	234:4	$102.11 \ 113.11$
15:9,10 158:17	30:22 32:8	drill 195:14	127.14 130.18
158:19	34:11 35:11	213:4	130.19 20
<b>don</b> 3:14	36:22 37:21	<b>drilled</b> 48:22	146.21 171.24
<b>door</b> 239:24	39:24 40:11	48:25 49:1,20	176.9 234.6
243:16	56:12,15 57:23	50:8 195:19	238.8 246.7
<b>double</b> 31:3,4,6	58:5 67:11	213:18	early 12.2 16.9
110:9,18,25	76:5 85:23	<b>drilling</b> 155:8	16.17 28.3
122:6	88:1 98:6 99:9	<b>drink</b> 190:7	141.21 193.2
<b>doubt</b> 244:2	106:15 107:7	drinking	202.8 204.2
<b>doubted</b> 244:14	107:18 111:17	174:19 175:9	earthly 199.12
<b>doug</b> 187:6	113:10 114:7	175:19 190:5	$219 \cdot 20 \ 221 \cdot 21$
<b>dowell</b> 151:20	114:12 116:6	238:3	233.3
<b>downdip</b> 15:25	116:17 126:4	<b>drive</b> 1:6 3:4	easier 205.9
31:18 33:21	143:15 147:3	222:22 243:17	east 14:16 16:4
42:11 77:4	151:15 155:14	<b>drop</b> 31:15	29:8.20 33:15
78:9 81:21	157:12,14	32:22 70:19,21	41:24.25 44:22
120:21 135:8	162:9 167:2	70:24 109:12	78:10 79:14.16
160:1,3 175:13	168:10 169:20	189:23 192:14	79:19 110:8
188:16,24	171:11,19	dropped	122:16.17
189:3 190:18	173:1 174:3,17	217:18,19	134:14 137:16
227:19 229:18	178:22 180:17	drops 109:3	159:16.23
downward	180:23 218:21	<b>due</b> 116:24	160:2 182:19
160:16	218:24 227:11		197:17 22

#### [east - encroachment]

219:21	<b>empire</b> 2:2 4:12	34:9,22,25	145:8,11,16,22
eastern 78:11	4:14 5:24 6:11	35:13 37:15,17	145:22,24,24
88:22	6:15,18,22 7:1	39:19 41:18,23	147:5,6,8
<b>easy</b> 33:6	8:25 9:20,21	41:23,24 42:8	148:21 150:4
166:13 205:9	13:14 51:8	42:17 43:20,25	150:11 153:16
economic 54:6	52:16,19,25	44:8,10,14,20	155:1 159:7
54:11,19,22	53:16 54:5,8	48:9,13,20,21	163:24 165:2
66:19 223:15	55:10 58:6	49:7,15 50:2,2	167:3,4 168:25
economically	91:10 92:24	50:7,8,9,10,12	168:25 169:8
54:2	93:9,25 100:22	50:16,18,18,19	170:4 173:10
economics	124:8,14	51:11 54:3	181:12,16
194:24	142:10 150:20	55:11 60:13	182:21 183:1,2
<b>edge</b> 31:14,25	177:3,13,19	61:14 63:18,24	183:5,6,23
32:5,21 33:13	198:22 207:2	64:1 68:13,22	184:13 185:9,9
34:10,15 35:25	233:16 235:12	69:9 71:9 74:3	188:24 189:13
36:4,10,20	246:22	79:25 80:5,17	189:22 190:14
42:1 88:22	<b>empire's</b> 37:22	80:21 82:16	191:17 194:24
120:20 121:4	38:5 51:19	87:3,13 90:1	195:25 199:17
121:17,21	52:3,7 56:10	93:5 95:9	200:6 202:15
123:11 127:24	91:16 151:9	96:12 98:23	202:15 203:10
189:1,11,18	176:17 198:9	101:22 110:6	203:13,14
190:1,14,17	198:10 199:8	112:10 117:25	205:13 212:14
227:24	236:12	117:25 120:15	213:17 215:23
education	employed	120:18 124:2	218:9,13 219:3
11:18	11:10,13	124:10,20,20	219:3,5,6
<b>effect</b> 96:16	249:12	125:4,11	224:1 228:9
194:3 221:9	<b>emsu</b> 11:24,25	130:21 131:12	231:10 236:14
effective 93:16	13:25 14:1,3,9	131:12,19,22	236:18 237:11
<b>eight</b> 188:13,16	14:18,25 15:1	131:24 132:9	244:3,17
<b>either</b> 88:20	17:16 19:9	132:11,18,19	encroaching
128:3 185:14	21:6 23:16	132:20 133:5,8	122:2
193:8	25:12,20 26:3	133:15,20	encroachment
<b>el</b> 16:6	26:6,11 27:25	134:18,19,22	121:17,21
embedded	28:17 33:5,16	138:1,14,16	123:6,17
158:14	33:18,21,22	139:6 144:7,7	127:24

# [ended - example]

<b>ended</b> 185:1	199:4	<b>etch</b> 71:2	everybody 9:19
187:7	enriched	<b>eunice</b> 11:22	115:10 117:24
<b>ends</b> 224:4	130:10	12:5 14:10	243:17 247:13
<b>enemies</b> 201:20	enrichment	28:1,4,9 30:24	247:18
<b>energy</b> 3:3 5:15	130:6	30:25 31:2	everybody's
82:10 96:20	entering 27:10	34:1 116:23	63:21 95:6
205:11 209:8	<b>entire</b> 106:1	117:9 129:14	evidence 89:21
engineer 5:14	135:5 206:20	130:3 147:11	100:17 150:24
5:18 181:2	<b>entry</b> 60:11	evaluate 90:21	196:3,4 225:24
204:13 224:17	61:6,12 81:7	90:25 91:21	evidentiary 6:1
225:21	147:7 225:2	92:13 93:8	<b>ex</b> 4:13,14,14
engineer's	enunciate 58:2	97:21 113:22	<b>exact</b> 173:7
124:11 126:3	eocene 16:9,17	124:13 156:18	<b>exactly</b> 87:14
127:3 206:3	equivalent 42:4	evaluated 93:3	182:19 184:2
engineering	64:7 145:21	125:19 227:2	193:15
124:25 187:14	ernest 2:11	evaluating 88:2	examination
200:15 201:3	6:11,15	106:9 236:10	4:6,6,7,7,8,8,9
204:25 205:24	<b>eroded</b> 188:7	evaluation	11:3 39:24,25
205:25 206:5	189:11,13	14:11 41:14	40:9 57:21
207:1,3,5	227:25 228:1	96:16	96:5 116:4
236:13	erosional	evaluations	170:23 171:9
engineers 36:3	165:20	97:10	179:9 180:21
162:23 206:14	escarpment	evaporation	191:16 218:19
212:15	229:9 230:10	133:17	227:8 231:2
<b>enhance</b> 221:15	especially	evaporite 131:1	235:23 239:24
enhanced	102:4	132:20	240:10 243:14
30:11	essentially 45:5	evaporites	243:20,23
enhancing	81:17,21 84:4	131:14,16	examined
153:23	87:7 110:5,9	132:13,22	151:1,1
enlarged	establish	133:5 134:1,5	examiner 9:23
105:21	154:16 213:22	134:5,14	10:4 12:12
enmrd.nm.gov	estimate	159:13,15	170:21
3:5,6	214:19	eventually	example 30:4
enormous	estimations	38:24	34:25 136:11
54:16 77:24	226:1		186:7 208:25

# [examples - facility]

• • • • • • •		• -	
examples 20:11	176:17 177:3,3	experienced	162:2 164:18
excellent 5:20	177:13,20	166:18	164:19 166:3,5
6:9 7:9,14,16	178:23 191:1	<b>expert</b> 12:14	166:7,12
excluding	191:13 207:11	51:14,15 54:18	217:14,16
88:17	217:9 233:17	180:24	232:10
exclusively	233:18 234:3	expertise 55:13	<b>exs</b> 4:12
176:2	234:19,20,25	167:19	<b>extend</b> 185:4
<b>excuse</b> 198:3	235:2,6,13,23	experts 78:2	extended 18:7
229:5	237:1	91:16 92:18	26:11,11
<b>excused</b> 239:17	exhibits 4:12	236:13	217:16
<b>exhibit</b> 13:5,6	9:7 12:23 13:5	explain 14:22	extending
19:1 22:11	13:15 45:16	21:3 23:13	98:16
25:23 27:3	51:19 52:4,7	38:6 52:21	extends 16:5
28:15 29:3,9	53:21 62:25	60:2 70:17	228:8
29:11 30:5,22	177:17 178:2	72:8 77:15	extensive
33:12 60:20	178:11,24	83:1 102:7	107:22 153:4
86:21 93:13	<b>exist</b> 71:23	210:11 212:10	extensively
100:18,21	82:21 83:1	224:16	236:17 237:9
101:8 110:3	existed 85:25	explained	<b>extra</b> 96:22
114:13,13	existing 38:18	61:21 152:14	140:2 210:6
116:10 120:4	107:8 170:3	explains 76:25	extracted 55:15
121:18 127:10	195:21	77:7 82:21	<b>extreme</b> 209:18
127:13,16	exists 82:25	explanation	<b>eye</b> 18:16 30:8
129:8 134:11	<b>exit</b> 225:3	204:25	140:2,4 226:5
135:4 138:3,9	<b>expand</b> 224:13	exploration	226:6
140:13 141:15	expect 162:17	18:22 43:16	<b>eyes</b> 67:8
141:23,24	expected	62:13 141:13	f
143:18 146:19	136:20	184:23	<b>f</b> 2.15 02.14
150:18,24	expensive	explore 69:4	1 2.13 93.14
151:11 152:5	164:5,6 211:9	80:20	90.J
154:25 157:6	211:13,16,17	exploring	factor 142.4
157:10,12,14	experience	80:23	facilities
157:15 161:7	11:18,22 88:8	exposed 233:2	
169:23,24	97:9 186:4	exposure	193:19 footliter 202:15
173:20 174:14	192:2	139:12 152:15	<b>iacinity</b> 222:15

# [fact - find]

<b>fact</b> 61:1 80:21	158:7 164:15	147:16,18,23	17:19 41:21
88:19 89:2	173:8 188:23	147:24 148:8,8	45:9 46:12
99:25 123:7	238:23,23	155:1,4 156:8	47:14,16,16
137:21 175:1	244:25 245:2	177:1,2,10,12	90:1 116:23
212:25 238:8	farming 44:4	183:2,3,13	figs 107:23
241:16	fascinating	192:12 197:23	<b>figure</b> 62:24
factored	45:14 76:1,14	204:19 211:2	100:5,13
174:18 175:2	81:24	211:12 217:20	105:12,24
factors 55:18	fashioned	227:16 232:7	106:2,7 107:16
97:16,23	174:1	feldewert 2:21	108:13,18,20
<b>facts</b> 169:21,22	<b>fast</b> 101:23	<b>feldspar</b> 160:7	109:5,17
<b>failed</b> 193:23	<b>fault</b> 27:17,17	160:18 161:3	111:13 174:9
<b>fair</b> 57:5	27:19 219:2,12	<b>fell</b> 230:19	187:6
126:14 148:12	219:14,16	<b>fellow</b> 48:3	<b>figures</b> 63:3
168:9 176:3	220:8,20 221:1	118:25 129:13	<b>filed</b> 8:6,19
186:8 197:20	221:6,7	187:2	52:1,8 53:5
212:18 229:12	<b>faulted</b> 220:21	<b>fellows</b> 147:1	58:10,24
229:14 234:19	<b>faults</b> 27:14	<b>felt</b> 44:4 230:15	<b>filing</b> 8:14,15
fairly 112:1	144:7 145:3	<b>field</b> 17:23	175:23
118:2 126:5	191:15 219:3,9	24:17,19,22	<b>fill</b> 71:7 153:7
166:13 190:6	<b>favor</b> 9:11	35:16 36:1,6	153:10
207:18	<b>fe</b> 1:7 2:4,7,10	36:13 38:25	<b>filled</b> 160:12
fairway 87:6	2:19 3:4,15	41:24 44:23	<b>film</b> 85:21
88:12	<b>features</b> 104:13	46:19 47:10,12	223:13 224:8
fairway's	164:1 166:9	79:8 86:25	224:10
191:15	february 1:11	90:2,4 99:13	<b>final</b> 225:22
fairways 27:6	5:6 73:13	106:1,21	249:14
87:6 88:3	116:10 249:4	109:16 147:9	<b>finally</b> 177:19
<b>fall</b> 103:2,3,7	<b>feel</b> 181:1	159:16,23,25	<b>find</b> 24:8 37:10
<b>familiar</b> 150:15	<b>feet</b> 17:2 20:2	169:9 187:3	75:25 92:6,15
150:22 214:15	26:12 28:17,18	189:2,15	95:23,24 110:4
<b>fane</b> 2:6	29:5 36:12,14	190:19 197:13	134:12 146:1
<b>far</b> 33:19 34:4	60:14,15 62:20	219:22 230:9	156:9 164:2
56:18 78:13	112:22,24	<b>fields</b> 13:25	219:8
87:14 96:1	122:9 138:23	14:15,24 17:18	

# [finding - forth]

<b>finding</b> 181:19	<b>fix</b> 199:3	flushed 24:13	237:16,17
<b>finds</b> 46:21	<b>flat</b> 27:22	210:5,22	footages 64:25
<b>fine</b> 84:9,10,11	153:16	<b>flushing</b> 163:17	<b>force</b> 113:4
151:1	<b>flex</b> 153:17	<b>fmi</b> 212:20,23	<b>forces</b> 84:22
<b>finger</b> 123:10	<b>flexed</b> 28:10	213:5,21	foregoing
202:25 233:5	205:5	<b>focus</b> 42:22,25	249:9
fingernail	<b>flexing</b> 205:11	49:11 106:4	<b>forgive</b> 80:15
193:16	237:24	126:24 127:3	<b>form</b> 134:1
finished 45:24	<b>flood</b> 102:4	176:1 181:8	144:9 152:16
<b>firm</b> 2:9	136:1 193:10	242:22	153:8 178:13
<b>first</b> 7:22 9:20	193:23 224:23	focused 14:9	formation 18:5
10:2,3,7 11:2	225:4,6,8,11,19	41:11 49:13	41:12 42:4,5
11:25 37:4	<b>flooded</b> 193:13	89:25 105:10	59:20 61:10
40:3 44:7,18	<b>flooding</b> 135:22	155:23 201:25	68:9 69:10
49:6,11 60:11	225:15	focusing 51:4	78:16 81:5
61:13 66:9	<b>floor</b> 1:5 21:14	<b>folded</b> 220:21	82:7 136:7
75:11 76:21	57:19	<b>folks</b> 7:19	144:8,9,11,11
92:2 101:21	<b>flow</b> 71:17	101:17 185:2	147:13,15
119:18 137:24	135:18 235:20	196:6 198:22	152:13,14,16
140:24 155:19	239:9	203:6 231:20	152:18,23,24
160:24 170:1	<b>fluid</b> 30:12	<b>follow</b> 27:13,13	154:11,12
170:24 172:21	38:23 77:25	128:16 160:3	170:3 181:7
180:18,19	112:24 113:4	199:17	186:25 232:23
181:15,21,23	204:12 221:14	<b>followed</b> 87:11	formations
182:16,23	235:19 238:15	87:23,25	77:4,5 78:9,21
183:13 193:1	239:9	101:16 102:16	82:3 154:17
197:2,9,10	<b>fluids</b> 29:23	following	<b>formed</b> 16:20
206:23 208:16	33:8 144:8	128:11	28:2,10 133:16
209:18 223:2	172:5 200:17	follows 11:2	152:22 153:16
231:23	200:21 201:6,8	102:11 127:24	<b>forming</b> 159:13
<b>fit</b> 14:15	201:9	128:5	193:4
<b>fits</b> 165:7	fluorescence	<b>foot</b> 23:20,20	<b>forrest</b> 4:5 11:1
<b>five</b> 139:22	226:6	29:16 63:15	11:9
143:7,9 170:9	<b>flush</b> 77:3	113:2,5 177:11	forth 249:8
234:16		208:4,7 218:5	

# [forward - generally]

forward 56:24	213:6,22	207:8,13,23	171:25
57:2	214:13 215:21	208:7,14,15,16	<b>fun</b> 46:23 48:7
<b>found</b> 25:5	216:4,10 217:1	208:20,22	173:25
28:24 29:14	218:25 219:5	209:4,5,10,11	functions
30:2 31:11,11	219:24 220:17	213:5,9,12,20	159:21
31:14,21,22	220:19 221:19	214:6,7,11,16	<b>further</b> 50:20
35:22 42:14	236:22 237:3	214:18,24,25	57:15,17 89:4
47:15 79:9	238:11,18,19	215:11 216:13	89:5 140:13
93:19,22 95:21	fractured	217:4,6 219:16	170:22 184:17
106:24 144:6	28:11 35:7	220:2,12,17,22	188:10,15
156:12 169:10	146:6 153:21	221:2,6,13	219:17 225:25
176:25 193:24	154:20 205:7,7	236:22 237:6,9	243:7 244:20
219:4,4 224:21	fractures 27:14	237:11,14,18	249:7,12
<b>four</b> 14:24 36:1	27:18,20,23	237:21,22,23	furthermore
36:9 115:1	28:18,22,23	238:15 239:11	109:19
139:21 170:15	29:1,4,5,13,14	fracturing	fusulinid 15:20
188:23	29:17,18,22	203:1 237:25	g
<b>fourth</b> 249:18	30:2.7.13 31:8	<b>francis</b> 1:6 3:4	
	0012,1,1000110		$\mathbf{gallegos}$ 249.3
fracture 20:3	35:10 37:18	free 39:9 47:21	<b>gallegos</b> 249:3
<b>fracture</b> 20:3 26:10,13,17	35:10 37:18 38:16 49:4,12	<b>free</b> 39:9 47:21 47:24 169:3	gallegos 249:3 249:17 gamma 165:11
<b>fracture</b> 20:3 26:10,13,17 27:16 28:13,16	35:10 37:18 38:16 49:4,12 49:18 104:13	free 39:9 47:21 47:24 169:3 fresh 136:13	<b>gallegos</b> 249:3 249:17 <b>gamma</b> 165:11 <b>gap</b> 209:6
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7	<b>gallegos</b> 249:3 249:17 <b>gamma</b> 165:11 <b>gap</b> 209:6 <b>gas</b> 17:24 97:15
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18	<b>gallegos</b> 249:3 249:17 <b>gamma</b> 165:11 <b>gap</b> 209:6 <b>gas</b> 17:24 97:15 107:21
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18 49:8 50:3	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21 144:7 145:4	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18 friday 7:17,23	gallegos 249:3 249:17 gamma 165:11 gap 209:6 gas 17:24 97:15 107:21 gaspar 3:14
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18 49:8 50:3 146:4,8,11	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21 144:7 145:4 146:13 150:8	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18 friday 7:17,23 8:3 247:15,20	gallegos 249:3 249:17 gamma 165:11 gap 209:6 gas 17:24 97:15 107:21 gaspar 3:14 gee 111:20
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18 49:8 50:3 146:4,8,11 153:19 155:14	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21 144:7 145:4 146:13 150:8 153:24 155:3	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18 friday 7:17,23 8:3 247:15,20 friend 47:5	gallegos 249:3 249:17 gamma 165:11 gap 209:6 gas 17:24 97:15 107:21 gaspar 3:14 gee 111:20 141:21
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18 49:8 50:3 146:4,8,11 153:19 155:14 155:16 156:24	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21 144:7 145:4 146:13 150:8 153:24 155:3 155:21 176:2,5	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18 friday 7:17,23 8:3 247:15,20 friend 47:5 94:22 169:22	gallegos 249:3 249:17 gamma 165:11 gap 209:6 gas 17:24 97:15 107:21 gaspar 3:14 gee 111:20 141:21 gelant 147:10
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18 49:8 50:3 146:4,8,11 153:19 155:14 155:16 156:24 157:2 201:16	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21 144:7 145:4 146:13 150:8 153:24 155:3 155:21 176:2,5 176:6,11,22,25	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18 friday 7:17,23 8:3 247:15,20 friend 47:5 94:22 169:22 182:12 194:19	gallegos 249:3 249:17 gamma 165:11 gap 209:6 gas 17:24 97:15 107:21 gaspar 3:14 gee 111:20 141:21 gelant 147:10 general 87:22
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18 49:8 50:3 146:4,8,11 153:19 155:14 155:16 156:24 157:2 201:16 201:18 202:5	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21 144:7 145:4 146:13 150:8 153:24 155:3 155:21 176:2,5 176:6,11,22,25 177:7,9,15,25	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18 friday 7:17,23 8:3 247:15,20 friend 47:5 94:22 169:22 182:12 194:19 friends 201:20	gallegos 249:3 249:17 gamma 165:11 gap 209:6 gas 17:24 97:15 107:21 gaspar 3:14 gee 111:20 141:21 gelant 147:10 general 87:22 generalize
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18 49:8 50:3 146:4,8,11 153:19 155:14 155:16 156:24 157:2 201:16 201:18 202:5 202:10,13	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21 144:7 145:4 146:13 150:8 153:24 155:3 155:21 176:2,5 176:6,11,22,25 177:7,9,15,25 178:3,22 179:1	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18 friday 7:17,23 8:3 247:15,20 friend 47:5 94:22 169:22 182:12 194:19 friends 201:20 front 6:2 10:20	gallegos 249:3 249:17 gamma 165:11 gap 209:6 gas 17:24 97:15 107:21 gaspar 3:14 gee 111:20 141:21 gelant 147:10 general 87:22 generalize 204:5 206:20
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18 49:8 50:3 146:4,8,11 153:19 155:14 155:16 156:24 157:2 201:16 201:18 202:5 202:10,13 203:17,19,23	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21 144:7 145:4 146:13 150:8 153:24 155:3 155:21 176:2,5 176:6,11,22,25 177:7,9,15,25 178:3,22 179:1 179:1 191:15	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18 friday 7:17,23 8:3 247:15,20 friend 47:5 94:22 169:22 182:12 194:19 friends 201:20 front 6:2 10:20 21:23 58:20	gallegos 249:3 249:17 gamma 165:11 gap 209:6 gas 17:24 97:15 107:21 gaspar 3:14 gee 111:20 141:21 gelant 147:10 general 87:22 generalize 204:5 206:20 generalized
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18 49:8 50:3 146:4,8,11 153:19 155:14 155:16 156:24 157:2 201:16 201:18 202:5 202:10,13 203:17,19,23 204:20 205:9	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21 144:7 145:4 146:13 150:8 153:24 155:3 155:21 176:2,5 176:6,11,22,25 177:7,9,15,25 178:3,22 179:1 179:1 191:15 200:16 201:4	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18 friday 7:17,23 8:3 247:15,20 friend 47:5 94:22 169:22 182:12 194:19 friends 201:20 front 6:2 10:20 21:23 58:20 123:16 128:24	gallegos 249:3 249:17 gamma 165:11 gap 209:6 gas 17:24 97:15 107:21 gaspar 3:14 gee 111:20 141:21 gelant 147:10 general 87:22 generalize 204:5 206:20 generalized 205:2
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18 49:8 50:3 146:4,8,11 153:19 155:14 155:16 156:24 157:2 201:16 201:18 202:5 202:10,13 203:17,19,23 204:20 205:9 205:10,11	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21 144:7 145:4 146:13 150:8 153:24 155:3 155:21 176:2,5 176:6,11,22,25 177:7,9,15,25 178:3,22 179:1 179:1 191:15 200:16 201:4 201:14,23	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18 friday 7:17,23 8:3 247:15,20 friend 47:5 94:22 169:22 182:12 194:19 friends 201:20 front 6:2 10:20 21:23 58:20 123:16 128:24 188:7 189:13	gallegos 249:3 249:17 gamma 165:11 gap 209:6 gas 17:24 97:15 107:21 gaspar 3:14 gee 111:20 141:21 gelant 147:10 general 87:22 generalize 204:5 206:20 generalized 205:2 generaliv 71:12
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18 49:8 50:3 146:4,8,11 153:19 155:14 155:16 156:24 157:2 201:16 201:18 202:5 202:10,13 203:17,19,23 204:20 205:9 205:10,11 206:16 207:7	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21 144:7 145:4 146:13 150:8 153:24 155:3 155:21 176:2,5 176:6,11,22,25 177:7,9,15,25 178:3,22 179:1 179:1 191:15 200:16 201:4 201:14,23 202:1,18	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18 friday 7:17,23 8:3 247:15,20 friend 47:5 94:22 169:22 182:12 194:19 friends 201:20 front 6:2 10:20 21:23 58:20 123:16 128:24 188:7 189:13 full 11:7 34:22	gallegos 249:3 249:17 gamma 165:11 gap 209:6 gas 17:24 97:15 107:21 gaspar 3:14 gee 111:20 141:21 gelant 147:10 general 87:22 generalize 204:5 206:20 generalized 205:2 generalized 205:2 generally 71:12 71:16 74:25
fracture 20:3 26:10,13,17 27:16 28:13,16 29:25 30:18,19 35:3,7 37:18 49:8 50:3 146:4,8,11 153:19 155:14 155:16 156:24 157:2 201:16 201:18 202:5 202:10,13 203:17,19,23 204:20 205:9 205:10,11 206:16 207:7 208:10,12,21	35:10 37:18 38:16 49:4,12 49:18 104:13 107:21 123:1 128:21,21 144:7 145:4 146:13 150:8 153:24 155:3 155:21 176:2,5 176:6,11,22,25 177:7,9,15,25 178:3,22 179:1 179:1 191:15 200:16 201:4 201:14,23 202:1,18 203:22 205:12	free 39:9 47:21 47:24 169:3 fresh 136:13 175:4,13 190:7 245:18 friday 7:17,23 8:3 247:15,20 friend 47:5 94:22 169:22 182:12 194:19 friends 201:20 front 6:2 10:20 21:23 58:20 123:16 128:24 188:7 189:13 full 11:7 34:22 43:25 46:17	gallegos 249:3 249:17 gamma 165:11 gap 209:6 gas 17:24 97:15 107:21 gaspar 3:14 gee 111:20 141:21 general 87:22 generalize 204:5 206:20 generalized 205:2 generalized 205:2 generaliy 71:12 71:16 74:25 75:7 84:1 85:5

85:24 86:1,9	getting 35:8	56:5 58:25	229:7 230:12
128:16 150:3	51:21 53:17	59:11 60:2,12	243:18,22
165:14 219:1	57:23 101:19	60:25 61:16	<b>goal</b> 109:20
generate	112:11 115:22	62:7,21 63:10	goals 149:23
204:11	116:2 135:7	63:12,13,15	<b>goat</b> 31:17
generated	179:18 181:18	66:14 67:1	33:20 34:4,9
210:13	186:10 187:13	74:25 75:2	39:1 116:9,13
generating	204:3 247:16	92:1,7 100:4	116:22 117:5,6
220:5	<b>give</b> 46:10	104:20 106:20	117:11,13,16
genetic 220:4	47:22 51:11	107:3 108:7	118:5,13,18,22
gentlemen	57:6 90:7	109:2 110:2	119:6 120:3,21
22:19	94:25 95:1	112:3 113:4,5	122:21 123:6
geochemist	115:11 156:6	115:3,8,9,18	123:17 130:10
118:20	156:13,15	116:10,11	173:12 175:3,6
geochemistry	170:14,25	120:3 122:11	175:10,16
118:22	171:24 211:25	122:15 127:9	188:2,15 189:6
geologic 80:15	234:17,20	127:12,12	189:14,16,19
200:15 201:3	246:7	134:2,9 135:4	190:2,11,13,18
228:14	giveaway	135:9,12	227:12,13
geological 47:8	141:12	136:11 141:6	228:2,16 229:3
196:9	<b>given</b> 78:3	143:1,6 144:12	229:7,11,13
geologist 11:12	163:18	152:11 157:22	230:4,5,13,14
18:23 46:9,11	giving 106:15	159:23 166:5	goes 9:20 38:9
62:13 141:13	glance 208:16	174:1,9,13	73:3 96:25
184:23 220:23	glass 189:20	178:18 180:12	105:24 109:3
geologists	224:24,25	180:18,19	140:9 147:11
76:18 183:23	228:10	183:10,19	148:23 149:10
<b>geology</b> 12:10	<b>glorieta</b> 232:10	184:7,16 185:7	149:14,21
12:15 14:10,16	glues 188:8	188:4,18 193:3	156:8
40:23 41:2,5	<b>go</b> 8:16 10:22	193:8 196:19	going 6:1 13:18
66:20 187:15	19:22,22 29:1	199:22 207:11	15:1 24:15
223:15	37:21 38:10,12	208:3 211:5	29:2 38:15,16
gerasimos 1:20	43:14,23 44:1	215:9 216:2,3	38:17,18,23
5:8	44:23,24 47:9	216:9 217:4,24	39:1,10,11,12
	47:18,23,24	223:8 226:24	39:13,14 43:2

44:5 45:12	208:11 211:22	goodnight 2:17	grant 9:6
47:8 48:8	211:25 213:23	4:13,14 5:23	granted 8:19
56:11,23,24	214:17,18,21	6:8 8:23 52:17	202:23 203:2
57:2,2 58:2,14	218:16 219:13	52:19,25 53:6	gravity 97:14
59:10 60:19	223:22 230:13	53:12,19,21	163:19 164:1
61:4,5 62:15	240:6,14	76:5 90:16,21	gray 15:11,16
64:7 65:16	243:17,22	91:1,22 92:12	157:8,15 158:7
75:6 76:2,3	245:3,7,13,23	94:17 100:18	158:10,13,15
85:21 86:20	246:14 247:4	101:7 143:24	159:1
89:8 93:12,13	247:15,20	146:18 150:18	grayburg 18:5
96:4 97:4	<b>gold</b> 20:19,19	151:10 161:15	18:6 19:23
100:3,4,15,17	141:9	161:19 200:2	20:4,10 26:1,4
105:23 107:15	goldsmith	233:20 234:24	26:5,6 29:24
110:2,3 112:25	187:3 191:25	239:8	32:16,21,22
112:25 114:14	192:3,4 194:16	goodnight's	33:6,7 34:6,7,9
115:14 116:6,8	225:11	37:15 52:11	34:20,24 35:9
116:9,11 117:4	<b>good</b> 5:3 6:6,17	59:25 91:15	35:13,19,23
119:3 120:3	6:21 7:11,19	107:8 116:20	37:20 38:17,20
121:14,16	9:18 11:5,6	117:3 145:18	41:12,15 42:4
127:9 128:12	14:6 18:22	155:8 198:8	42:10,12,22,25
128:16 140:9	40:11 44:22	204:23 235:23	43:1 45:2,6
143:2 144:18	49:3 62:13	239:1,9	48:20 49:12,13
147:7 151:23	79:11 86:10	<b>gotten</b> 30:15	51:5 60:3,9
154:14 161:4	112:11 114:24	graduate 47:23	68:21 69:8,10
163:17 167:17	115:2 116:6	grain 15:9 28:5	69:20,22 70:3
169:10 172:3	123:11 138:3	158:19	70:8,9,11
172:18 173:20	141:13 142:11	grains 160:19	71:23 72:16,19
173:21 174:11	161:4 171:11	161:3	78:5,15 81:1,3
175:2 180:25	173:25 180:2	grainstone 28:5	81:12 82:15
181:8 192:23	180:23 184:23	149:4	87:9 90:9,13
195:19 196:6	186:2 199:15	grainstones	93:17 98:17
197:8 199:6,25	203:3 208:25	15:6 36:2,9,14	99:21 102:19
201:19,20	214:1,5 218:21	36:15	103:4,5 104:4
204:13 205:2	242:12	grande 16:20	105:4 110:6,23
205:25 206:16		81:17	111:8,19

113:23,25	<b>great</b> 18:24	73:11 77:14	227:19 228:4
114:6,15	22:23 23:11	86:19 118:3	228:22 232:12
117:11 123:3,6	56:1 57:14	120:14 126:4	232:12
125:25 127:6,7	95:20 132:7	127:12 137:1,8	hall 1:5
127:15,18,20	167:15 184:7	157:19 179:22	<b>halo</b> 27:16
127:25 128:4,7	193:1 196:20	180:10 227:18	28:13 30:19
128:10,13	223:23 226:16	233:24 240:4	219:24 220:5,5
129:1,25	245:21	243:17	220:16,22
130:21 131:18	greater 17:3	guesswork	221:2,5,9,19
132:23 133:1,6	25:18 73:22	157:25 158:1	halos 208:21
133:15 134:22	116:24 148:8	<b>guide</b> 42:7	209:1 218:25
135:2 136:20	greatest 105:20	<b>gulf</b> 43:3,6,7,11	219:19
136:24 137:4,9	<b>green</b> 23:19,22	43:13 167:9	<b>hand</b> 111:6
138:1,6 139:8	greenburg	<b>guy</b> 98:25	176:21 177:6
142:14 144:9	181:11 186:7	187:5 221:4	177:23
144:11 147:13	186:24 204:8	224:21 226:21	handicapped
147:14 150:4	206:10,23	229:4 230:4,17	149:17
150:11,13	218:12	<b>guy's</b> 228:19	hands 159:25
152:8,14,18,24	greenfield	230:6	192:2
153:15 154:12	191:5	<b>guys</b> 113:8	handy 36:19
155:24 156:23	<b>gross</b> 146:12	171:1 180:12	hanson 3:9
158:2 159:7,20	<b>ground</b> 38:21	212:10 214:2	<b>happen</b> 39:3,4
164:21 165:24	group 118:2	221:23 222:12	99:4 146:2
169:13 173:9	<b>growing</b> 110:20	225:12,13,23	238:22
182:1 183:9	guadalupe 2:18	225:24 226:1	happened 16:7
188:6 189:17	42:5 188:4	226:18	35:2 48:5
190:18 191:9	189:7,20 228:9	h	146:3 182:18
201:24,25	229:9	<b>h2s</b> 136:5.9.10	183:10,11
202:1,21 203:8	guadalupian	136:13.16.18	184:21 193:4
214:8 216:24	78:20 79:4	habit 115:24	202:5 203:15
227:25 228:1	80:3,4,25 81:4	245:5	203:18
231:12 232:3,6	136:6	<b>habra</b> 117:22	happening
236:3 238:16	guess 53:17	<b>hairline</b> 104:13	157:19 205:1
grays 160:7	56:20,22 63:4	half 44:20	happens 70:21
	65:25 66:13	198:1 208:7	97:12 176:5
	1	1	1

[happy - helped]

<b>happy</b> 5:4 57:9	harwood 1:17	<b>he'll</b> 12:19	150:19,25
171:8	7:22 8:4 9:17	head 62:10,12	151:8 157:9
hard 27:22	9:18,24 10:6,9	62:18 73:8	167:20 168:1
30:20 51:21	10:12,23 12:16	81:20 82:1,10	170:8,14,19,24
86:20 158:13	12:19 13:8,11	96:20 129:18	171:7,15
169:21 171:14	22:9,19,23	142:25 174:22	178:18 179:7
200:12 202:11	40:2,7 55:23	204:1 209:8	179:12,15,21
208:24 211:12	56:5,8,16 57:4	214:3	180:5,10,15
219:8 223:8	57:10,13,17,18	<b>header</b> 68:7	202:3 215:19
<b>hardy</b> 2:5 4:6,7	100:22 101:4	93:14 98:3,4	216:15 218:18
6:17,18,20	114:3,9 115:6	heading 59:18	227:6 229:22
8:25 9:23 10:4	115:12,18,23	61:8 181:6	230:3,8,18
10:7,11,23,24	143:9 150:19	healthy 230:17	233:19 234:2
11:4 12:11,21	150:25 151:8	<b>hear</b> 57:24	234:14,15,18
13:3,13,17	157:9 167:20	194:22,25	234:24 235:1,5
22:13,24 39:23	168:1 170:14	heard 1:16 6:2	235:10,14
56:13,14,18	170:19,24	119:22 245:9	239:16,19,23
57:9,12 100:24	178:18 179:7	<b>hearing</b> 1:1,17	240:2 243:9,15
106:11 114:2,7	179:12,21	5:5,23 6:1 8:4	245:7,13,20,23
150:21 178:13	180:5,10,15	9:18,24 10:6,9	246:3,9,12,16
197:7,11	215:19 216:15	10:12,23 12:11	247:23 248:1,5
200:22 201:1	218:18 229:22	12:16,19 13:8	249:4
215:13,15,18	230:3,8,18	13:11 22:9,19	<b>heated</b> 16:14
216:18 230:23	233:19 234:2	22:23 33:18	225:2
231:3 233:16	234:15,18,24	40:2 51:22	<b>heavier</b> 38:23
233:23 234:5	235:5,10,14	53:1 55:23	height 17:2
235:16,17	239:16,23	56:5,8,16,21	<b>held</b> 56:4
239:14,18	240:2 243:15	57:4,10,13,18	115:16 143:11
240:6 245:17	245:7,20 246:3	57:20 58:11	170:18 180:9
245:18 246:6	246:9,12,16	100:22 101:4,4	234:23
246:11,15,25	248:1	114:3,9,25	help 45:5 48:7
247:6,11,22	<b>hat</b> 164:3,6	115:6,12,18,21	56:12 196:7
hardy's 239:20	211:14	115:23 119:4	207:25
<b>hart</b> 2:18	hate 239:23	119:18 143:9	<b>helped</b> 47:25
		143:13 150:17	48:2,3 55:7

# [helped - idea]

90:9	highlight 100:4	115:24 119:8	<b>hot</b> 16:15
<b>helpful</b> 56:20	highlighted	121:24 144:16	<b>hour</b> 57:6
56:25 95:7	59:16 100:4	167:11 178:4	115:10,11,12
212:24,24	130:25 143:21	243:25	hours 222:22
helps 37:11,12	144:20 147:14	<b>hobbs</b> 34:21	house 28:20
83:4 164:14	173:22 174:2	43:25 44:2,8	31:10 48:11
165:5,18	highlighting	48:8 86:24,25	214:13 222:12
hess 24:23	158:9	95:9 156:22	housekeeping
94:14 162:23	highlights	172:5,7 173:5	245:22 246:1
164:3 211:14	13:20	201:11 241:21	247:25
<b>hey</b> 217:3	highly 35:6	241:21,24	houston 43:12
225:13	49:13 103:18	<b>hold</b> 8:17	76:19 222:15
<b>high</b> 16:15,15	146:5	172:22	huge 232:25
16:25 37:14,15	highway 2:13	holding 84:23	237:22
38:14,22 39:8	hindsight 240:8	holland 2:18	<b>hump</b> 110:18
39:19 104:2,19	hinkle 2:3	hollandhart.c	110:25
108:7 111:12	hinklelawfir	2:20,21,22	<b>humped</b> 31:3,4
112:6 113:17	2:5	<b>home</b> 44:5	31:6 110:9
116:21 123:2	<b>hired</b> 45:4	200:6,12	122:6
148:25 149:15	hiss 119:1,3,5	honestly 220:6	hundred
149:18 158:10	119:12,15,20	hope 186:2	138:23 147:23
199:2 240:22	119:24	hopefully	147:24
240:23 242:20	<b>history</b> 126:13	212:16	<b>hung</b> 46:3,6
<b>higher</b> 25:11	126:16	hoping 230:21	hydraulic
75:2,14 83:5	<b>hmm</b> 49:2,22	horizontal	81:18,20 82:1
89:13 99:1,18	63:25 68:11	104:3,7,18	hydrocarbon
100:10 104:12	72:5 76:10	112:14 114:10	193:13
114:17,20	80:24 81:14	128:15,17,22	hydrocarbons
186:3 189:23	85:17 86:22	148:2,24	54:2
192:9,13	93:20 95:12	242:20	hydrogen
204:10 210:22	101:14 106:10	horizontally	136:1,8
210:23	107:19 108:2,5	104:8 112:5	i
highest 15:6,13	108:9,24	128:20	ibc 2.13
24:3 149:3,6,7	109:14,23	horizontals	idea 20.3 44.16
	111:5,10	75:17	<u>44.73</u> 45.11
			TT.2J TJ.11

47:9 56:10	illustrated	27:25 35:17	<b>increase</b> 109:21
57:7 98:11	107:23	97:22 202:4,14	163:8 170:1
107:10,11	illustration	213:10 221:18	increased
113:3,7 142:11	16:16 23:18	224:20	116:24
186:8 199:12	32:2,7,9 33:16	improvement	increasing
201:17 203:3	34:2 78:25	106:6	149:24
214:1 219:20	99:3 134:3	improves	incredibly
221:21 223:14	160:17 197:2	101:12	224:20 229:1
233:3 245:21	215:4,10	improving	increment
identified	illustrations	242:24	28:24
47:14 55:20	19:13 110:14	<b>inch</b> 30:21 36:2	independent
90:16,21 91:1	142:16	36:9 208:25	46:4,7 118:17
91:22 101:21	<b>image</b> 34:3	228:22	124:18 129:13
103:18,21	86:10 110:4	<b>inches</b> 29:15	independently
109:25 111:4	135:5,20,25	164:22 217:25	129:9
111:12,13	213:6 224:5	219:7 228:23	<b>index</b> 13:24
113:13 120:18	228:6	228:23 237:17	14:23
120:25 139:14	<b>images</b> 62:25	<b>include</b> 65:21	indian 79:8
139:15,17	223:13 224:5	88:15	indicated 139:9
140:10 152:6	imaging 223:1	included 8:2	165:19
155:21 158:3	immobile 84:4	36:24 41:18,22	indicates 60:22
161:8,12,19	<b>impact</b> 28:5,6	42:2 78:21	219:1
identify 34:15	32:24 33:2	90:5 94:15	indicating
44:16 46:21	49:5 206:15	129:20 146:7	145:3
69:9 90:9	impacting	includes 80:25	indication
113:24 122:20	206:16	including 17:16	128:25 164:16
145:7 158:3	<b>impacts</b> 113:22	81:11,12	<b>indirect</b> 196:4
165:4,10	124:19	149:23 239:5	individual
182:23 200:15	<b>impair</b> 213:20	incomplete	162:4
201:4	impairment	65:9,12,13,14	industry
identifying	213:23	incorporate	211:18
87:5 113:16	implementati	175:19	<b>infers</b> 134:23
<b>idle</b> 227:10	101:11	incorrect 149:6	148:17 221:17
<b>ii</b> 1:12	important	150:9 168:17	infinite 30:1
	15:23 17:8	169:1	

influence 97:16	116:21 117:4	<b>interior</b> 125:11	126:2 136:7
<b>inform</b> 124:14	144:13 147:10	intermediate	139:20,24
information	170:1 172:4	15:14	158:14,15,16
27:24 32:1,15	186:6,17,23,24	international	158:18 208:11
53:6,18 66:4	190:10 195:18	222:16	208:12 218:3
168:11,14,18	195:21 198:8	interparticle	233:10 239:13
195:15 204:18	204:23 205:15	160:9,13	intricate 110:5
212:20 237:6	205:17,18,25	interpretation	introduced
informed 242:9	206:1,5,7,23	75:21 200:15	100:21
initial 61:5	239:10	201:4	introduction
76:8 155:2	<b>inner</b> 15:19	interrupt	197:9
172:9 202:1	159:14	123:17	investigation
initially 17:6	inserted 98:9	interrupted	118:17 124:18
58:11 201:24	inside 28:7	81:18	<b>ions</b> 39:9
222:12 244:12	125:25 132:6,8	interval 17:5	198:25
initiated	138:1 166:25	18:22 19:5,13	irrespective
101:21	<b>insight</b> 221:22	19:14 20:9	212:6
initiation 102:4	inspection 66:1	23:22 25:1,3	<b>isolate</b> 113:3
<b>inject</b> 39:19	<b>instance</b> 186:16	26:1,15,16,24	<b>isolated</b> 109:19
59:19 61:9	186:23	29:16 39:20	110:1
68:8 166:19,25	intense 203:1	71:14 75:1	<b>issue</b> 8:5 38:13
181:6	interconnected	112.3 122.13	46:21 120:2
		115.5 122.15	
injected 38:14	27:21,23 30:9	138:14 152:17	126:5,5 174:1
<b>injected</b> 38:14 106:22 112:24	27:21,23 30:9 30:14 208:23	138:14 152:17 166:20 167:1	126:5,5 174:1 175:3,9 176:2
<b>injected</b> 38:14 106:22 112:24 116:25 144:12	27:21,23 30:9 30:14 208:23 209:12 220:10	138:14 152:17 166:20 167:1 167:13 177:11	126:5,5 174:1 175:3,9 176:2 176:11 193:6
<b>injected</b> 38:14 106:22 112:24 116:25 144:12 194:1 204:7	27:21,23 30:9 30:14 208:23 209:12 220:10 220:16 221:18	138:14 152:17 166:20 167:1 167:13 177:11 182:7,11	126:5,5 174:1 175:3,9 176:2 176:11 193:6 196:7 201:13
<b>injected</b> 38:14 106:22 112:24 116:25 144:12 194:1 204:7 206:22 218:11	27:21,23 30:9 30:14 208:23 209:12 220:10 220:16 221:18 interest 39:18	138:14 152:17 166:20 167:1 167:13 177:11 182:7,11 183:15 192:10	126:5,5 174:1 175:3,9 176:2 176:11 193:6 196:7 201:13 242:25
<pre>injected 38:14   106:22 112:24   116:25 144:12   194:1 204:7   206:22 218:11 injecting 33:2</pre>	27:21,23 30:9 30:14 208:23 209:12 220:10 220:16 221:18 interest 39:18 166:24 218:24	138:14 152:17 166:20 167:1 167:13 177:11 182:7,11 183:15 192:10 213:13 216:13	126:5,5 174:1 175:3,9 176:2 176:11 193:6 196:7 201:13 242:25 <b>issues</b> 7:17,24
<pre>injected 38:14 106:22 112:24 116:25 144:12 194:1 204:7 206:22 218:11 injecting 33:2 39:8 124:3,9</pre>	27:21,23 30:9 30:14 208:23 209:12 220:10 220:16 221:18 interest 39:18 166:24 218:24 249:14	138:14 152:17 166:20 167:1 167:13 177:11 182:7,11 183:15 192:10 213:13 216:13 216:22 217:7	126:5,5 174:1 175:3,9 176:2 176:11 193:6 196:7 201:13 242:25 <b>issues</b> 7:17,24 101:20 113:16
<pre>injected 38:14   106:22 112:24   116:25 144:12   194:1 204:7   206:22 218:11 injecting 33:2   39:8 124:3,9   199:1</pre>	27:21,23 30:9 30:14 208:23 209:12 220:10 220:16 221:18 interest 39:18 166:24 218:24 249:14 interested	138:14 152:17 166:20 167:1 167:13 177:11 182:7,11 183:15 192:10 213:13 216:13 216:22 217:7 227:25 231:23	126:5,5 174:1 175:3,9 176:2 176:11 193:6 196:7 201:13 242:25 <b>issues</b> 7:17,24 101:20 113:16 147:6,6 150:11
<pre>injected 38:14   106:22 112:24   116:25 144:12   194:1 204:7   206:22 218:11 injecting 33:2   39:8 124:3,9   199:1 injection 32:24</pre>	27:21,23 30:9 30:14 208:23 209:12 220:10 220:16 221:18 interest 39:18 166:24 218:24 249:14 interested 212:13	138:14 152:17 166:20 167:1 167:13 177:11 182:7,11 183:15 192:10 213:13 216:13 216:22 217:7 227:25 231:23 intervals 15:3	126:5,5 174:1 175:3,9 176:2 176:11 193:6 196:7 201:13 242:25 <b>issues</b> 7:17,24 101:20 113:16 147:6,6 150:11 159:18 236:9
<pre>injected 38:14   106:22 112:24   116:25 144:12   194:1 204:7   206:22 218:11 injecting 33:2   39:8 124:3,9   199:1 injection 32:24   33:5,9 38:23</pre>	27:21,23 30:9 30:14 208:23 209:12 220:10 220:16 221:18 interest 39:18 166:24 218:24 249:14 interested 212:13 interesting	138:14 152:17 166:20 167:1 167:13 177:11 182:7,11 183:15 192:10 213:13 216:13 216:22 217:7 227:25 231:23 <b>intervals</b> 15:3 18:19 19:3	126:5,5 174:1 175:3,9 176:2 176:11 193:6 196:7 201:13 242:25 issues 7:17,24 101:20 113:16 147:6,6 150:11 159:18 236:9 it'll 101:5
<pre>injected 38:14   106:22 112:24   116:25 144:12   194:1 204:7   206:22 218:11 injecting 33:2   39:8 124:3,9   199:1 injection 32:24   33:5,9 38:23   107:21 108:7</pre>	27:21,23 30:9 30:14 208:23 209:12 220:10 220:16 221:18 interest 39:18 166:24 218:24 249:14 interested 212:13 interesting 80:5 190:2	113.3 122.13 138:14 152:17 166:20 167:1 167:13 177:11 182:7,11 183:15 192:10 213:13 216:13 216:22 217:7 227:25 231:23 <b>intervals</b> 15:3 18:19 19:3 20:25 21:8,10	126:5,5 174:1 175:3,9 176:2 176:11 193:6 196:7 201:13 242:25 <b>issues</b> 7:17,24 101:20 113:16 147:6,6 150:11 159:18 236:9 <b>it'll</b> 101:5 122:12 151:8
<pre>injected 38:14   106:22 112:24   116:25 144:12   194:1 204:7   206:22 218:11 injecting 33:2   39:8 124:3,9   199:1 injection 32:24   33:5,9 38:23   107:21 108:7   108:15 109:6,7</pre>	27:21,23 30:9 30:14 208:23 209:12 220:10 220:16 221:18 interest 39:18 166:24 218:24 249:14 interested 212:13 interesting 80:5 190:2 195:12 245:14	113.3 122.13 138:14 152:17 166:20 167:1 167:13 177:11 182:7,11 183:15 192:10 213:13 216:13 216:22 217:7 227:25 231:23 <b>intervals</b> 15:3 18:19 19:3 20:25 21:8,10 22:2 65:2	126:5,5 174:1 175:3,9 176:2 176:11 193:6 196:7 201:13 242:25 <b>issues</b> 7:17,24 101:20 113:16 147:6,6 150:11 159:18 236:9 <b>it'll</b> 101:5 122:12 151:8 193:8 205:10

[itching - knowledge]

itching 179:9	julia 2:20	187:8,12,14	169:14,18
j	k	188:5 191:3	170:10 173:7
<b>i</b> 4.13 13 13 14	k 3.6	193:11,16	182:16,19
13.6661516	karst 152.21	197:18 202:22	183:16 184:2,9
13.16 25.24	karstification	202:24 203:6	185:12,15
28.15 29.3 9	152.15	208:2,23 209:9	186:4,11 188:2
20:13 29:5,9	karstify 71.3	210:14 217:10	190:7 191:14
176.17 177.3 3	153·4	217:23 218:7	191:16 192:1
177:13.20	<b>keen</b> 63:20	219:11,14,24	194:18 195:6,9
178:2.2.23.24	134:12 247:21	220:16 221:19	195:10,13,16
215.13.14	kelli 249·3 17	222:16 223:8	196:1 199:18
216:18 217:9	<b>kent</b> 169:10	225:17 226:21	199:19,21
233:17 235:13	<b>kev</b> 14:3 27:21	228:11 229:3	200:1,13 203:3
237:1	130:8 207:10	<b>knew</b> 15:25	203:7,12
iack 10:2 93:25	kind 15:14	36:3 66:14	204:15,15,22
james 179:16	25:15 28:13	125:9 157:22	205:1,14,15,19
january 40:15	29:7.20 35:17	185:11 192:7	205:19 206:2,2
61:20 68:20	36:5 37:6.13	203:14,17	206:13,23
72:1 73:12	39:21 40:18	<b>know</b> 7:16 14:6	209:17 210:2,7
124:1.17	44:4.6.21	14:8 22:17,18	213:13,14
125:18	46:10,12,17,22	23:3 37:6,6	214:4 215:11
jassic 187:6	47:22 48:6	38:9,10 53:2	216:1,5 217:15
jbroggi 2:21	51:12 73:18	56:21,21,25	219:19 220:8
jesse 3:6	76:15 88:10	57:3,5 58:19	221:7,8 223:8
jessek.tremaine	91:25 92:15	62:19 78:2,13	226:17,18
3:6	96:12 104:15	86:3,12 87:14	228:13 229:12
<b>jim</b> 57:12	107:4,5 109:13	87:21 92:12	229:19 233:3,3
246:15	132:22 135:13	95:2,16 96:19	233:21,25
job 47:23 51:4	135:16 146:23	97:12 98:6,8	234:9 237:16
51:4,7 118:19	154:1 157:22	102:17 105:16	241:10 242:8
124:11,23	159:25 164:7	107:8 113:19	245:12 246:4
125:22,24	169:13 178:6	116:16 122:9	knowing
126:3 127:3.3	182:4 184:5,10	126:2,4 142:11	206:23
judgment	184:15 185:6	150:23 151:21	knowledge
196:8	185:11 186:2	152:3 163:9	34:22 73:15

# [knowledge - lindsay]

98:15 122:25	177:7 194:7	<b>leave</b> 168:4	levels 166:12
151:2 156:20	207:9 227:13	235:15	<b>lie</b> 132:3,4
190:21 212:23	237:6	leaves 180:16	<b>life</b> 105:18
213:16 218:8	larger 70:19,24	<b>left</b> 13:24 14:23	<b>lift</b> 24:12 96:21
241:25 242:3	193:10 208:23	15:20 18:3,8	light 15:9 19:16
243:3	225:8,15	19:8,12,20,21	19:17 21:1,19
<b>known</b> 17:7	late 16:9,17,20	20:7 21:6,10	21:19 26:23,25
99:25 201:9,13	30:12 44:12	21:12,19,25	67:2,3,9 141:8
219:2 229:6	209:2	26:1,2 27:4,15	142:6 158:16
l	lateral 33:25	33:19 34:4	223:24 224:4,7
<b>I</b> 2.11 6.11 15	132:15 157:24	46:8 63:13,13	likely 84:5,6,7
<b>l</b> 2.11 0.11,13 <b>l</b> 117.22	173:9	64:25 79:18	116:20 117:4
$\begin{array}{c} 1a & 117.22 \\ 1ab & 28.19/3.12 \end{array}$	laterally 16:1	80:8 85:1,22	240:25
$67.4\ 21.1.14$	71:20 113:4	116:7 138:13	limestone
222.5 11 20 25	145:21 148:18	141:20 144:24	192:17,17
222.3,11,20,23	153:4,12,13	160:17 162:3	<b>limit</b> 168:3
laheled 93.1/	154:2 157:24	176:21 177:6	189:3 229:17
lamination	laterals 219:22	177:14,23	229:18
1/18.6	<b>law</b> 2:9 167:1	200:6,12 208:4	limitation
laminations	167:16,23	209:19	246:23
1/18.2 6	168:4	<b>legal</b> 167:18	limited 45:2
140.2,0 Iomkin 1.21	lawyer 238:6	238:9 249:17	90:13 111:14
<i>A</i> ·10 5·17 18	<b>lawyers</b> 168:4	length 29:5,15	lindsay 4:5
180.16 218.18	240:2	177:12	10:8,16 11:1,5
218.20	layer 133:14,14	leonardian	11:9 12:22
lands 5.10	133:19 134:24	78:21 79:5	13:18,22 14:8
$\begin{array}{c} \text{Iallus}  5.17 \\ \text{Ianguage}  61.22 \end{array}$	148:2	81:3 136:6	15:22 16:2
65.22	layers 15:25	lesser 29:2,19	17:25 18:17,25
190.22	104:18 127:17	letters 32:5	19:6 20:17
lapiay 250.7	134:14	<b>level</b> 70:20,22	21:3,23 22:25
110.24	<b>lead</b> 101:15	70:24 102:25	23:13 24:1
110.24 Jargo 20.5	151:15	103:6 133:21	25:13,23 27:2
47.18 47.6	leading 67:15	133:24,25	27:24 29:22
70.21 100.7	learned 219:24	159:10,12,13	30:22 32:8
118.7 161.18		186:23 217:18	34:11 35:11
110.2 104.10			

36:22 37:21	217:17 243:10	162:1,3,4	215:7,8 231:19
39:24 40:11	liniments 87:18	164:8,19,20	location 80:5
56:12,15 57:23	liquid 108:22	166:3,4 171:12	80:15,17 86:23
58:5 67:11	<b>list</b> 90:7	173:21 175:25	91:14 95:13
76:5 85:23	listed 64:17	178:6 179:17	138:20,22
98:6 99:9	listened 119:1	183:6 185:17	183:7 191:17
106:15 107:7	<b>liter</b> 117:7	192:11 193:15	191:23 204:22
107:18 111:17	literally 50:17	195:3 196:17	locations 96:7
113:10 114:7	192:14 229:2	202:23,24	123:2 214:24
114:12 116:6	literature	203:1 207:24	lock 245:23
116:17 126:4	76:22	208:2,3,25	<b>locked</b> 62:3
143:15 147:3	little 8:18 10:19	209:5 212:9	<b>log</b> 18:11
151:15 155:14	14:5,15,23	213:11 215:12	139:25 142:20
157:14 162:9	15:20 16:21	216:13,21	142:24 165:6
167:2 168:10	18:14 27:18	217:13 218:23	186:10 211:22
169:20 171:11	28:12 29:14	219:15,17	211:23 212:19
171:19 173:1	30:4 32:4	220:12,20	213:6 214:17
174:3,17	34:24 36:1	221:12 224:24	226:19
178:22 180:23	45:14 48:16	225:2,3 228:5	<b>logs</b> 37:12
218:21 227:11	51:24 52:21,22	231:18 234:7	154:3 165:8,10
230:21 231:4	58:3 63:13	234:11 237:21	166:15 185:2
231:15 235:18	75:12,19,20,22	243:13 244:21	195:5,5 196:4
238:1 239:20	75:24 80:10,20	<b>lived</b> 166:2	211:25,25
240:12 242:13	83:4 85:22	<b>llc</b> 3:8,13 6:19	226:19 227:3
243:22 245:4	86:8,19 90:15	7:4	<b>long</b> 43:17
lindsay's 12:12	92:5 98:2,3	<b>llp</b> 2:3,6	75:17 90:7
13:4 157:12	99:12 102:20	localities 145:2	183:8 194:3
233:17	104:13,14	localized 145:4	219:4 220:12
<b>line</b> 3:8 7:4	107:6 112:2,22	located 14:7	233:2,3 245:13
19:25 50:14	113:2,5 120:22	23:19 33:20,22	248:3
53:14,14,14	123:9 128:9	80:1 89:3	<b>longer</b> 70:24
84:9,10,11	130:5 131:23	92:14 126:18	139:2
145:22,24	139:7 140:2	126:20 129:4	look 14:21
153:16 174:7	151:12 157:7	134:19 135:11	19:15,19 20:11
200:9 213:13	158:13 161:25	200:2,11 203:6	21:14 25:17

28:13 44:22	looking 9:25	233:4 237:21	165:23 183:14
46:20 47:10	30:21 31:6	237:22,25	192:10 210:24
49:3 62:7,21	37:12 47:12,12	lots 20:20 42:6	216:25 224:7
63:9 66:21	60:2 68:7	112:1 176:14	226:2 232:4,6
67:5 74:25	79:14,15,16	love 98:25 99:8	232:12 233:13
77:17 78:24	97:1 104:5	101:15 102:6	241:8
91:11 92:4,17	107:7,25 110:7	105:24 113:21	lowest 24:4,9
99:10 100:3	112:18 130:2	114:19 151:16	24:14 25:11
132:4,5,6	150:5,8 157:14	235:24 240:21	85:7,7 158:12
134:17 139:3	165:9 166:11	242:8	159:1 162:12
142:5,7 154:2	181:12,19	love's 107:15	163:1 210:19
162:1 165:11	185:20 187:9	111:4 146:22	luck 203:15
165:11,12,12	220:11 221:1	lovington	luckily 202:11
168:22 174:7	221:11 247:14	232:15	lucky 166:8,10
174:11 177:13	247:17,19	<b>low</b> 16:22,22	202:7
179:8 182:5	looks 18:13	39:2 72:3,11	<b>lunch</b> 57:5
185:2 195:10	216:11	97:2 116:22	115:7,9,15,16
198:15 208:16	<b>lose</b> 135:23	128:1,1 131:4	116:8 234:3,4
208:21 210:13	219:18	131:9 149:1	lunchtime
210:14 215:6	losing 197:18	150:4 175:4	234:20
217:16,25	loss 81:25	182:6 184:6	m
221:5 229:17	97:10,21	208:11	<b>m</b> 3.11
234:21,25	<b>lost</b> 97:17	<b>lower</b> 15:15,19	machines
242:11	154:21	19:12,21 20:7	137:13
<b>looked</b> 24:19	lot 16:25 30:2	23:24 24:7	madam 115:14
24:24 25:2	32:13 54:16	26:6 42:5	made 22:3 32:2
26:23 32:3	80:22 83:19	71:13,13 72:19	32:13 35:14.20
35:5 36:7	88:1 104:15	74:20,20 75:3	39:22 47:11.18
41:14 47:17	119:4 132:5	83:6,22 89:10	61:21 62:1
49:8,18 67:24	137:12 165:22	89:18 99:2	99:25 118:6
74:8 84:12	184:14 185:10	119:7 121:1,5	136:13.13.14
86:5 91:6	186:4 187:19	138:16 139:5	140:21 160:7
113:20,20	193:13 195:19	141:9 156:23	203:5 224:24
159:15 168:22	197:18 200:10	157:21 158:25	242:21
168:24	207:8,9 222:24	162:18,19	

#### [mail - method]

<b>mail</b> 7:23 8:2	114:16 135:12	<b>matter</b> 137:21	measured
<b>main</b> 192:20,24	135:15 196:25	144:13 146:1	20:24 28:18
maintenance	197:1 199:22	212:25 249:13	42:6 64:3,6,19
149:17	200:3,6,11	249:15	68:5 154:23
<b>major</b> 89:2	203:3,5 220:3	matters 7:20	156:14 216:14
make 58:15	mapped 36:2	matthew 3:11	217:5
71:7 125:3	36:11 98:21	146:25	mechanical
132:5 153:5,17	189:3 202:19	<b>mbeck</b> 3:11	221:24
159:4 160:19	214:6,18	mccarty 99:8	mechanism
170:11,12	mapping 35:25	101:16	17:14 77:1
194:23 195:17	<b>maps</b> 93:10	mcelroy 41:24	<b>meet</b> 40:16
196:8 206:4	113:12,13	42:17 90:2,4	meeting 5:21
211:20 217:5	<b>marek</b> 247:10	<b>mcguire</b> 143:24	76:18 118:12
226:1 234:18	<b>margin</b> 80:1,6	mcguire's	<b>melzer</b> 78:1
237:21 238:25	80:14,21 96:12	146:19 152:5	88:1 182:12
247:7	135:10	169:23	247:8
makes 80:21	marked 27:3	mcshane 247:9	member 1:21
104:16 132:9	60:20 100:7,18	<b>mean</b> 52:14,15	1:22
132:15 164:25	100:19 146:18	54:23 62:19	members 1:19
making 106:18	176:17	73:4 82:24,25	6:10,14,17
107:6 110:24	<b>marks</b> 10:20	102:20 104:9	9:12 56:9
133:11 153:24	157:16	110:17 141:25	91:20
219:18 237:24	massive 148:8	195:24 206:13	mentioned 10:2
managed	164:23 227:20	218:4	50:2 166:17
144:13	master 41:1	meaning 35:22	222:3 224:11
<b>map</b> 13:24	master's 43:3	70:12 109:2	<b>merged</b> 43:7,13
14:23 27:4,16	48:1,3,6 187:7	149:22 201:7	<b>merger</b> 43:9,11
32:13 35:14,20	229:10	221:14 244:15	<b>mess</b> 203:23
35:24 36:19	<b>mater</b> 47:21	means 8:7	<b>meteoric</b> 16:12
78:24 86:11,13	material	117:10 220:14	16:15,22 30:12
87:5 88:4,5	218:10	<b>meant</b> 108:19	77:3,11 131:9
98:25 99:11,12	<b>matrix</b> 104:6	138:8,8 230:13	135:1
99:14,16,20,25	150:5 152:19	233:1 244:12	<b>method</b> 212:6
100:1,3 105:8	<b>matt</b> 7:3	measure	221:23
106:20 107:7		121:20 122:4	

#### [methods - moander]

methods 212:8	midstream	millidarcy	171:5 179:8
<b>mexico</b> 1:2,7	2:17 4:13,14	160:22	180:6 245:16
2:2,4,7,10,19	5:23 6:8 8:24	milligrams	<b>miocene</b> 16:9
3:2,4,10,15	101:7 146:19	117:7	16:17,20
4:12 5:15,24	151:10	<b>million</b> 77:23	misnomer
6:11,15,19,23	midstream's	77:24 117:8,14	148:1
7:8 13:14	143:24 161:15	117:17 118:14	missing 65:2,3
43:25 44:6	<b>migrate</b> 82:10	131:10	140:6 165:22
147:13 156:22	221:15	<b>mind</b> 63:21	233:4,6
235:12 241:21	migrated 75:13	115:8	misstates
249:4,18	82:2	<b>minds</b> 115:7	178:14
mfeldewert	migrating	247:21	<b>mix</b> 39:10
2:22	32:16	<b>mine</b> 47:6	<b>mixed</b> 160:11
<b>mic</b> 6:12 51:24	migration	94:22 124:11	<b>mixing</b> 136:13
michael 2:21	172:4 200:17	182:12 194:19	<b>mixture</b> 169:5
michigan 229:5	200:20 201:5,8	215:4	<b>mm</b> 49:2,22
<b>micro</b> 193:15	204:6 206:21	<b>mineral</b> 153:19	63:25 68:11
microphone	238:15,20	minerals 3:3	76:10 80:24
10:19,21	<b>miguel</b> 3:15	minimize	81:14 85:17
171:14 179:18	7:12	149:22	86:22 93:20
<b>mid</b> 43:16	<b>mile</b> 227:18,19	<b>minor</b> 247:7	95:12 101:14
midafternoon	228:4,4	<b>minus</b> 60:14,15	106:10 107:19
171:3	<b>miles</b> 31:19	61:15,15,23	108:2,5,9,24
<b>middle</b> 15:1	32:23 33:21	62:4 63:12,14	109:14,23
16:19 18:14	42:11,20,21	63:16,18 64:7	111:5,10
27:17 44:19,23	145:17 188:12	64:12,21 65:18	115:24 119:8
79:22 88:23	188:14,17,20	122:11,12	121:24 144:16
124:20 182:19	188:23 189:16	168:16 169:1,2	167:11 178:4
197:12 207:16	198:1,3,4,5	169:4,4,6,10,15	243:25
219:14,21	<b>miller</b> 147:1	183:25,25	moander 3:5
232:13	151:18	<b>minute</b> 38:1	4:7,8 7:6,7
midland 47:1	millidarcies	55:24 143:7	8:12 100:25
48:17,19 87:19	22:7 112:21	234:16,19	167:17 171:4,7
117:24 201:12	149:8	<b>minutes</b> 115:1	171:10,13,16
222:21,23		143:9 170:9,15	171:18 176:13
176:15 178:15	28:1,4,9 30:25	<b>move</b> 9:8,21	n
-----------------------	------------------------	-----------------------	-----------------------
178:21 179:5	31:1,2 34:1	22:10 80:7	<b>n</b> 2.1 3.1 4.1
235:8 238:1,8	116:23 117:10	84:2 138:3	<b>naked</b> 18.16
238:12 243:9	129:15 130:3	144:8 150:18	30.8 140.1 4
243:19,21	147:12	152:2 161:4	<b>name</b> 5.7 17
245:3,22 246:1	morning 5:3	170:11 171:11	11.7 119.1
<b>mobile</b> 17:23	6:6,17,21 7:11	204:12 215:12	158.8 220.24
73:24 74:3,9	7:19 9:19 11:5	<b>moved</b> 27:17	228.19 230.6
74:22 75:6,8	11:6 40:11,13	31:7 43:10	named 98.25
75:10,12,18,19	40:20 156:4,6	45:21 48:17	187.5
81:10 82:16	157:5 231:5	78:8 201:12	narrow 220.7
83:4,18,21,23	248:6	movement	natural 3:3
84:2,14,17,17	<b>mother</b> 76:23	218:11,11	107:21 180:2
89:23	77:2 79:10	219:2,16	nature 97:24
<b>mobility</b> 46:21	81:9 83:15	220:19,20	<b>nature's</b> 76:23
mobilized	85:24 86:11	221:8	77:2 79:11
194:4	87:7,22 130:21	<b>moves</b> 84:24	81:9 83:15
<b>models</b> 224:24	135:5 137:22	<b>moving</b> 31:6	85:24 86:11
<b>moldic</b> 193:15	153:22 160:6	32:20,21 34:12	87:8.23 130:21
193:19 194:7	160:15 209:3	34:19 127:8	135:6 137:22
225:17	<b>motion</b> 8:5,8,11	136:1	153:22 160:6
moment 56:8	8:13,17,18,20	<b>msuazo</b> 3:16	160:15 209:3
115:21 143:1,7	8:21 9:5,6,9,13	<b>mud</b> 15:10 28:6	<b>near</b> 197:17
151:25 155:5	9:15	158:17	<b>nearby</b> 42:14
172:4 176:13	mountain 42:2	muddiest	nearest 107:1
<b>monday</b> 5:4,6	42:16 229:3,7	158:11	<b>neat</b> 221:10
<b>money</b> 113:2	230:4	mullins 3:9	necessarily
210:17 213:3	mountains 42:3	multiple 42:6	134:2 211:19
214:3	42:6 188:5,13	77:13 78:4	<b>need</b> 154:15
monitoring	189:8,20,20	84:18 85:15	164:12 165:4
144:14	228:9,10 229:9	112:5	166:14 170:13
<b>month</b> 94:20	232:1	<b>munn</b> 42:4,5	195:8 216:3
<b>months</b> 142:9	movable		219:11 248:1
monument	193:13		needs 210:10
11:23 12:5			227:2 246:5

[needs - ocd]

247:1,19	nonporous	notice 7:24	0
neglected 121:4	134:15 152:21	noticed 67:7	o'clock 171.2.6
<b>neither</b> 155:7	152:21 160:3	142:2 181:15	248.6
249:12	160:14 161:1	november 12:1	ath 12.25
<b>never</b> 39:20	192:17 208:8	43:18 44:12	171.19
64:18,18,20	nonuniform	58:12,24	object 8.21
106:23 132:3,3	144:14	<b>number</b> 14:4	100.23 114.2
142:2 166:18	<b>noon</b> 115:1	16:3 18:1,3	167.17 178.13
182:25 194:14	normally 142:5	19:3,7,11	objected 238.8
nevertheless	<b>north</b> 2:13,18	20:13 29:2	objection 8.13
110:17 145:17	14:1 44:24	35:12 100:18	9.2 12.16 18
<b>new</b> 1:2,7 2:2,4	50:13 79:15,17	105:13 150:18	13.8 10 100.24
2:7,10,19 3:2,4	89:4,5 106:25	161:6 162:23	100.25 101.3
3:10,15 4:12	138:24 145:14	169:1,24	106.11 114.8
5:15,24 6:11	194:16 203:13	176:24 181:10	150.19 151.6 9
6:15,19,23 7:8	211:11	181:25 184:4	167.21 168.2
13:14 43:25	northeast 29:1	184:16 186:2	178.17 233.19
44:6 61:1	29:18 96:10	187:8,25	235.679
116:7 147:13	northeasterly	197:25 214:9	objections 9.4
156:22 195:23	29:8	215:11 235:22	101.1 147.9
223:9 234:3	northeastern	236:21 237:22	151.5 7 235.3
235:12 241:21	96:8	238:2	objects 101.5
249:4,18	northern 44:5	numbering	observed 106.1
<b>nice</b> 44:6 47:23	95:10 188:18	210:13	obtain $12.7$
135:5 192:19	northwest 29:2	numbers 5:24	123.5
223:19	29:19 42:9	14:3,4 23:15	obtained 41.1
<b>nicely</b> 224:16	50:9 88:16,17	24:7,9 28:22	0 $1$ $1$ $1$ $1$ $1$ $1$ $1$ $1$ $1$ $1$
<b>nm</b> 3:3	88:21 96:13,14	54:16 95:24	occur 224.14
<b>nmocd</b> 190:23	106:21 112:17	210:8,12	occurred
213:17	northwestern	226:22	182.20
<b>non</b> 37:11	89:5	numerous	occurring
80:15 152:17	<b>notes</b> 9:25 10:1	102:2 206:7	109:16 167:4
152:20	53:16 118:10	<b>nw</b> 249:18	occurs 70:22
nonpermeable	118:11 129:10		ocd 8:9.19 9:9
152:20			100:25 170.25
			100.20 170.20

[ocd - oil]

235.8 243.11	234.24 235.1 5	17.19 21 23 24	89.13 23 95.18
ocd's 9.6 238.1	235.10 14	18.15 18 20 21	96.1 17 24 25
ocean 133.21	239.16,19,23	18.24 19.3	97.11 14 16 17
october 59.3	240.2 243.9 15	20.13 15 18 22	97.24 108.1 7
odd 31.6	245:7 20 246:3	20:13,13,10,22	109.237812
offer 233.16	245.7,20 240.5	21.2, 9, 10, 21 22.1, 7, 23.1, 3, 5	137.25 130.16
office 19:16	240.9,12,10	22.1,7 23.1,3,3	137.23 139.10
117.20.22.22	24/.25 248.1	25.8,20,25,24	139.17,19
11/:20,23,23	$\begin{array}{c} \mathbf{OIIICIAI}  221:4 \\ \mathbf{ff}  4 122 0 \\ \end{array}$	24:1,14,18,25	140:1,2,8,11,14
201:11	offset 122:8	25:1,4,5,6,14	141:16,25
officer 1:17 8:4	offsetting 26:5	25:16,19,19	142:13,16,23
9:18,24 10:6,9	<b>oh</b> 17:14 19:8	26:21,25 30:15	149:18 161:11
10:12,23 12:16	23:6 29:12	30:15 37:5,23	162:22 163:3
12:19 13:8,11	33:4 34:21	38:2 39:13	163:19,25
22:9,19,23	38:4,6 46:8	54:1,15 55:14	168:7,7,16,20
40:2 55:23	51:11 53:8	55:18 58:10	168:21 169:3,5
56:5,8,16,21	63:8 66:8	59:20 60:5,13	169:11,13,15
57:4,10,13,18	67:21 73:4	60:16 61:10,14	169:16,17
57:20 100:22	79:2,16 102:20	61:17 62:4,13	181:7,20,22
101:4 114:3,9	115:23 132:12	65:18 66:11	182:2,5,7,10,13
114:25 115:6	135:7 141:18	67:2,3,10,23	182:14 183:20
115:12,18,22	178:8 183:21	68:4,9 73:21	183:24 184:1,6
115:23 143:9	184:24 185:16	73:21,24 74:2	184:10,22
143:13 150:17	187:1 190:13	74:3,8,9,14,21	185:3,12,15,17
150:19,25	191:18 192:1	74:22 75:2,3,6	185:19 186:5
151:8 157:9	195:1 196:19	75:6,12,14,18	186:11,16,22
167:20 168:1	198:17 199:10	75:19 77:4,17	187:4 192:8,9
170:8,14,19,24	201:9 203:22	77:18 78:9	192:10,13,18
171:8 178:18	208:2 210:21	81:10,21 82:5	193:7,9,22
179:7,12,15,21	210:25 212:2	82:10,16 83:4	194:4,5,6
180:5,10,15	215:13 216:4	83:6,6,14,18,21	195:6,9 196:1
215:19 216:15	223:23 226:15	83:23,24 84:2	196:5,18,21
218:18 227:6	227:15 239:3	84:13,13,16,17	207:23 208:18
229:22 230:3,8	<b>oil</b> 1:3 3:2 5:9	84:21,23 85:1	208:18 209:10
230:18 233:19	5:10 7:8 8:6	85:5,6,21,22	209:14,22
234:2,14,15,18	17:1,4,5,7,15	86:1 87:18	210:6,18,19

211:4 212:13	78:8 79:18,20	139:24 141:5	229:20 230:8
212:15 213:9	79:22 80:4,13	141:19 145:14	231:22 235:10
213:12,13	80:22 81:15	145:20 146:17	236:25 239:16
220:13,14	84:16 86:4,8	147:5,25 148:7	240:14,15
221:15 222:7	88:18 90:15,18	148:14,19	241:9 242:2,12
224:2,23,25	91:7,10,14,21	149:10 150:2,7	247:8,12
225:7,14,16	93:2 95:15	150:15 151:20	<b>old</b> 23:7 44:21
226:22 236:13	96:3,11,15	151:24 153:2	47:9,12,21
239:10 249:4	97:13 98:1,12	155:5,13 156:5	51:21 174:1
okay 5:3 8:18	98:19,24 99:23	156:21 157:20	223:21,25
9:13,18 11:25	100:12,18	162:6 163:14	224:7,10
13:22,24 14:21	102:10 103:13	164:16 167:7	<b>older</b> 223:13
14:23 19:2	104:7,14,16	168:8 170:5	omitted 172:2
22:20,22,23	105:2,6,6,22	173:2 174:4,10	<b>once</b> 10:18
23:11,12 25:25	106:3 107:15	174:13 175:1	29:25 32:1
27:4 29:12	109:5,15	175:22 176:13	43:13 45:15
36:18 37:2	110:12,16,22	177:2 179:21	107:2 166:11
38:13 40:21	111:1,17 112:3	180:5,15	167:12 194:12
43:19 44:13	114:11,24	182:21 184:16	194:14 209:7
45:21 49:24	115:13 116:3	186:14 187:21	223:18 226:23
51:25 53:24	117:3 119:3,11	187:23,24	<b>ones</b> 103:21
54:14 55:2	120:2,2,4,8,12	188:8 190:10	156:4,5 195:23
57:13 58:2,4,9	121:10,14	190:23 191:11	214:2
58:17,18 59:9	123:13,19,23	191:12,20,24	<b>ooid</b> 15:5 149:4
59:12 60:19,20	123:24 124:6	198:2,6,17,21	<b>oooh</b> 211:9
61:3 62:8,10	124:12,23	198:23 199:14	<b>open</b> 153:9
62:16 63:14	125:1,4,16,23	199:20,22,24	239:23 243:16
64:6,9,11,19,24	126:25 127:4	206:18 207:11	<b>opened</b> 203:20
65:15 66:7	128:5,7,23	208:3,6 209:20	opening 73:19
68:24 69:2,7	129:5,20	210:16 212:18	77:1 162:9
69:12 70:2,5	130:18 132:22	212:19 213:9	166:16
70:15 71:16,19	133:3,4,15	218:8 221:22	operated 124:8
72:13,14 73:9	135:20 136:25	222:18 223:6	170:2
74:11,19 76:1	137:15,18	226:7 227:4	operating 3:8
77:18,21,22	138:3,9,19	228:18,24	7:4
		1	1

# [operations - paper]

38:19 125:8   10:5 56:13,24   originally 36:5     145:18 167:4   57:1 67:12   orogeny 28:3     242:24   122:9 154:15   110:24     operator   164:11 180:12   outboard     149:22 166:24   246:4,21   188:15     167:13   organization   outcrop 189:7     operators   93:5   222:6     166:18   orient 79:13   227:17 228:15     opinion 22:25   111:2 183:15   outcropping     24:7 34:18   213:3   232:1     55:17 68:13 16   orientation   outlined 178:3
145:18 167:4   57:1 67:12   orogeny 28:3   p.m. 115:17     242:24   122:9 154:15   110:24   p.m. 115:17     operator   164:11 180:12   outboard   143:11 170:15     149:22 166:24   246:4,21   188:15   180:6,9 234:23     167:13   organization   outcrop 189:7   248:7     operators 93:5   222:6   220:25 221:4   3:10     166:18   orient 79:13   227:17 228:15   3:10     opinion 22:25   111:2 183:15   outcropping   3:9     24:7 34:18   213:3   232:1   outlined 178:3
242:24   122:9 154:15   110:24     operator   164:11 180:12   outboard     149:22 166:24   246:4,21   188:15     167:13   organization   outcrop 189:7     operators 93:5   222:6   220:25 221:4     166:18   orient 79:13   227:17 228:15     opinion 22:25   111:2 183:15   outcropping     24:7 34:18   213:3   232:1     55:17 68:13 16   orientation   outlined 178:3
operator164:11 180:12outboard180:11 170:10149:22 166:24246:4,21188:15180:6,9 234:23167:13organizationoutcrop 189:7248:7operators 93:5222:6220:25 221:43:10166:18orient 79:13227:17 228:153:10opinion 22:25111:2 183:15outcropping3:924:7 34:18213:3232:1pace 109:1355:17 68:13 16orientationoutlined 178:3
149:22 166:24   246:4,21   188:15   248:7     167:13   organization   222:6   0utcrop 189:7   248:7     operators 93:5   222:6   220:25 221:4   3:10   3:10     opinion 22:25   111:2 183:15   0utcropping   3:9   3:9     24:7 34:18   213:3   232:1   0utlined 178:3   178:3
167:13   organization   outcrop   189:7     operators   93:5   222:6   220:25   221:4     166:18   orient   79:13   227:17   228:15     opinion   22:25   111:2   183:15   outcropping   pace   109:13     24:7   34:18   213:3   232:1   outlined   178:3
operators     93:5     222:6     220:25     221:4     3:10       166:18     orient     79:13     227:17     228:15     3:10       opinion     22:25     111:2     183:15     232:1     3:9       24:7     34:18     213:3     232:1     pack 109:13       55:17     68:13     16     orient ation     outlined     178:3
166:18   orient   79:13   227:17   228:15   pa   3:9     opinion   22:25   111:2   183:15   outcropping   pace   109:13     24:7   34:18   213:3   232:1   pace   109:13     55:17   68:13   16   orientation   outlined   178:3
opinion     22:25     111:2     183:15     outcropping     pace     109:13       24:7     34:18     213:3     232:1     packstone     15:9
24:7 34:18 213:3 232:1 packstone 15:9   55:17 68:13 16 orientation outlined 178:3 packstone 15:9
55.17 68.13 16 orientation outlined 178.3
packstones
68:20 69:8,18 49:10 146:12 <b>outlook.com</b> 15:10
91:11 117:3,13 221:23 2:11 padilla 2:9.11
117:16 118:23 orientations outrageously 6:10,11,13,14
167:18 169:19 37:19 202:13 164:5 6:15
172:19 173:1,2 237:5 <b>outside</b> 222:6 <b>padillalawnm</b>
173:14 174:8 <b>oriented</b> 20:2 <b>oval</b> 153:5 2:11
174:15 231:9 26:10,11,16,19 <b>overall</b> 41:19 <b>page</b> 4:2 58:25
236:8 238:9 29:21 35:2 109:20 59:15 60:21
240:22,23 49:9,17 50:10 <b>overcomes</b> 143:6,19
241:14 112:6 144:10 84:22 144:19 151:25
opinions     51:9     146:3 155:1     overly     246:13     198:13 200:22
53:6 116:9 156:25 183:12 <b>overlying</b> 93:17 200:24
171:25 172:2 183:12 201:16 188:9 pages 228:25
244:4 201:22 202:11 overruled paleomagnetic
opportunity 202:15,17 114:3,9 221:24,25
79:7 170:25 203:16,19 overview 51:11 222:1
opposed 9:13 207:7 213:1 76:22 105:6 paper 24:18,24
optimistic 216:22,23,24 135:15 157:5 30:1,11 94:10
246:13 217:2,3 237:18 <b>overwhelm</b> 94:19 95:17.18
orange 14:24 orienting 49:14 128:21 98:7 99:1,5,9
15:8,14 33:24 <b>original</b> 42:13 100:13,16,17
134:13,14 47:10 58:23 101:10.20.25
158:18,24 59:6 77:17 102:6 104:23

105:7,10 111:4	51:3,7 53:24	<b>parties</b> 6:3 7:23	pedestrian
111:11,15,17	55:2,5 66:15	7:25 8:8,13,21	218:23
112:9,13,17	75:5 76:21	40:3 57:7	<b>pedro</b> 2:14
113:16,20,21	81:2 86:5	249:13	peifer 3:9
114:13,19	91:10 94:3	<b>parts</b> 117:7,14	peiferlaw.com
129:17,20,25	95:10 96:8	117:17 118:14	3:11
146:22,23,24	102:5 103:13	119:24 131:10	pennsylvania
146:25 147:2,5	107:12 118:23	143:3	79:10
150:10,13	119:14 120:5	<b>paso</b> 16:6	pennsylvanian
151:2,3,15,16	124:14 126:12	pass 170:23	79:5
176:14 209:5	126:16 130:19	179:5,12	<b>people</b> 47:16
217:9 220:24	138:13,16	passages 59:16	164:4 182:8
233:22 239:21	146:19 156:23	<b>passed</b> 16:13	189:8 193:24
242:11,14,16	157:21 160:16	87:8 129:19	211:14 223:10
242:25 243:4	176:5,6 183:14	passes 9:14	231:25 234:20
<b>papers</b> 93:19	190:18 195:4,9	<b>past</b> 51:12	247:15
93:22 94:7	198:20 200:5	82:11 226:24	<b>people's</b> 115:7
98:5,8 113:20	202:10 210:2,4	<b>path</b> 107:3	<b>percent</b> 22:6,6
paragraph	214:21 216:22	128:18	22:7,8 24:4,5,5
60:12 144:25	227:20 247:24	pathway 87:11	25:1,4,6,7,11
parameters	partially 17:20	87:22 128:5,12	25:18,18 73:22
177:16	82:3,7,15	152:13	73:23 74:15,21
<b>pardon</b> 17:9	particular 20:1	pathways 27:9	95:22,23,24
29:10 42:24	21:7,12 23:17	27:9 78:23	133:9 134:24
46:5 48:23	24:18 35:1,3	135:14	137:19 160:20
64:15 178:10	35:25 46:25	patterns	162:17,18,19
179:15	80:5 105:9,10	105:14,14	162:24 163:4,6
parenthesis	105:10 113:21	106:9	163:7,9,9,11,15
93:18,21	143:5 147:8	<b>pause</b> 218:16	163:19 185:24
<b>parrot</b> 179:15	157:2 180:12	<b>pay</b> 192:20	185:25 186:17
179:16	187:11 196:7	<b>pc</b> 2:12 3:14	186:17,18
part 18:10,20	204:18,24	7:1	209:14,15,15
23:24 26:2,2,6	217:9 225:19	<b>pdf</b> 143:6,8,16	209:21 210:7
26:7,9 38:8	particularly	pecos 1:5	percentage
41:18 49:9,10	14:19 105:14		23:4 133:9

# [perfect - platform]

<b>perfect</b> 23:12	149:1,16 150:6	144:2,5 152:1	pictures 62:3
35:7	160:22	152:4,6 154:4	65:17 66:10,11
perfectly 125:1	permeable	154:7 202:7	224:9
perforated	161:3	228:15 229:11	<b>piece</b> 22:3
126:2	permian 3:8	<b>phase</b> 93:21	95:20 233:22
performance	7:4 16:5,8,11	phenomenon	<b>pieces</b> 20:20,21
100:7 191:24	16:23 17:15	210:11	21:1
performed	27:7,11 47:11	<b>photo</b> 221:1	<b>pilot</b> 3:13 7:13
213:22 223:3	47:17 78:10	photograph	9:4 88:10,20
period 78:5	82:21 83:1	19:9,16 142:11	101:1,3 106:5
103:3 205:14	186:5,20 218:9	223:17	151:5,7 170:25
206:8	permission	photographed	179:13,17,19
peripheral	46:20 66:21,23	142:8	184:12 192:24
193:12	66:24 67:4,14	photographic	235:5,9
<b>perm</b> 72:3,3,11	167:12,15	142:3	<b>pipe</b> 246:21
72:11 91:22	223:16,19	photographs	<b>place</b> 35:7
92:13 159:21	<b>permits</b> 195:21	19:10,18 67:1	54:15 77:18
242:20	<b>person</b> 10:10	140:4,17,21,22	84:23 95:7
permeabilities	10:11,20	142:6,7,17	196:21 210:5
88:3 148:24	personal	223:11 226:13	244:2
150:3 222:8	117:18	<b>photos</b> 67:6,24	<b>places</b> 35:22
permeability	personally	223:19	144:6
15:7 20:23	184:9	physical 214:22	<b>plain</b> 19:16
21:8,18 22:7	perspective	physically 33:9	21:1,19 67:2
30:1 71:13	75:20 226:19	181:22	142:6 223:24
78:17 85:8	petroleum 5:18	<b>pick</b> 6:13 23:8	plane 128:15
90:16,21 91:1	12:15 39:17	116:7 139:9,13	<b>plate</b> 62:24
91:15 101:23	76:18	164:11 171:5	63:1,1 64:17
103:19 104:3,4	petrophysical	222:20	141:6
104:6,8,16,19	212:10	<b>picked</b> 92:13	plates 62:9
107:22 112:6	petrophysics	93:9 164:9	140:25 141:2
112:20,21	214:23	<b>picks</b> 93:4,8	platform 7:10
114:10 128:2,4	<b>ph.d.</b> 12:5,7	<b>picture</b> 14:14	7:15 41:16,25
128:19,22	41:4,10 48:4	235:4	78:12 79:23
147:6 148:3	90:5 119:1		80:2 87:19

# [platform - potential]

88:11,13,22,23	243:6	<b>poor</b> 31:16	229:19
88:24 95:11	<b>pluming</b> 99:21	85:3 100:6	porous 27:9
96:9,15 188:22	99:22 111:18	114:21 121:5	85:10,12,13,18
<b>play</b> 176:11	111:25,25	123:5 130:11	92:6 139:15
<b>plays</b> 82:21	113:12,14,18	149:11 230:21	152:13,17,20
83:1	113:24 114:6	poorest 85:7	153:9 160:4,5
<b>please</b> 10:16,18	114:14 122:25	158:4	160:16 161:2
10:21 11:7,21	123:8,16	<b>pop</b> 208:22	205:10 207:18
16:3 23:13	150:12 243:3	<b>popped</b> 193:14	208:9,12,15
37:2 56:6,9	<b>plutons</b> 16:13	193:18 194:12	229:16
114:8 181:3	<b>point</b> 16:21	<b>pore</b> 77:13,15	portion 62:2
247:21	35:15,16 37:13	77:18,20,22	95:10 130:25
<b>pleasure</b> 40:16	45:21 50:11,15	78:4 84:19	139:5,5,14
<b>plenty</b> 70:25	59:12 63:21	85:15 132:6	140:8 144:21
185:16	66:13 67:11	193:19 194:9	144:24 147:14
<b>plot</b> 107:25	73:23 74:22	<b>pores</b> 84:21	154:8 240:13
108:13 109:6	77:13 82:12	85:22 160:19	240:14
146:12	110:18 111:1	193:8,9,10,15	<b>pose</b> 225:20
plumbing	117:12 118:3	193:22 194:7,9	<b>posed</b> 244:13
126:24	119:4 125:3	225:7,8,15,17	position 8:1
<b>plume</b> 35:1,6	129:7 137:1,8	porosities 88:2	116:9 239:1
146:4 203:11	153:3 161:23	222:8	possibility
203:12,14,17	162:8 169:24	porosity 15:6	244:15
<b>plumes</b> 34:24	179:3 180:2	20:23 21:8,18	possible 24:9
38:19 98:16	182:3 203:25	22:4,5 27:6,13	123:4 197:5
100:2 104:17	205:22 206:4	60:13 61:14	potassium
112:2,2,8	225:3,3 245:19	71:13 78:16	39:10 160:7,18
113:9 114:18	246:25	81:6 85:7	potential 39:14
123:9,10 129:6	pointed 152:4	87:25 117:10	55:20 68:14,17
144:10 146:2	191:22	117:11 128:1,4	69:15 72:23
200:16 201:5	pointing 216:4	128:6,10,13	90:10 99:22
201:10 202:23	216:9 217:1	135:11 160:8	116:12 124:19
202:24 203:6	<b>points</b> 90:12	160:10,13,20	158:12,21
236:6 241:12	119:11 151:1,3	160:21 165:12	159:2 183:24
242:4,15,22		191:15 208:11	218:11 220:4
	1		

#### [potentially - process]

		1	
potentially	129:8 140:23	206:10 211:4,8	186:17 187:18
60:15 61:16,23	143:4 144:3	211:15 230:22	189:4 192:10
65:22 71:24	155:18 161:18	pressures	207:2 217:19
74:19 87:16	preparing 51:9	206:1	218:23 227:21
89:16 175:14	present 6:3	<b>preston</b> 143:24	228:10,25
184:17	146:12 179:14	presume 79:15	241:7 245:8
<b>pound</b> 106:23	presentation	<b>pretty</b> 79:11	problem 39:15
<b>pounds</b> 96:22	40:20 50:1	97:2	101:10 112:5,7
<b>poured</b> 232:23	118:6,10,12,24	<b>prevent</b> 200:16	112:23 143:6
<b>ppm</b> 31:12,16	129:11 130:20	200:20 201:5	195:7,11
31:21 175:5	241:19	preview 75:24	204:10 210:4
190:6,8	presented	previous 51:20	225:14 232:7
<b>pre</b> 170:3	40:15 52:13	52:4,11,17,25	problems 38:18
precipitate	53:7 78:19	previously	101:22 102:7
39:12	117:24 119:14	11:14 54:18,21	103:22,24
precisely 71:8	140:24 168:11	82:2,4 86:8	104:10,11,24
prefer 179:23	168:14,18	105:8 151:17	104:25 105:9
180:12	242:13 247:5	primarily	105:25 109:15
preferentially	press 10:19	147:12 176:2	109:19,25
137:23 208:12	pressure 16:15	primary	111:3,12
prehearing	16:22,25 17:3	185:22	112:10,12
56:22	24:20 25:5,9	<b>print</b> 95:4	113:22 114:11
preliminary	31:15 32:22	<b>prior</b> 43:10	203:7 217:22
7:20 9:20	38:15,20 83:22	52:13,16,23	236:1
<b>premier</b> 165:16	95:19,23 96:22	53:7,10,12,18	proceed 56:7
232:18	106:24 116:24	83:15 123:14	115:20 171:8
preparation	117:10 121:22	probability	proceedings
66:15 67:16	121:25 123:16	244:5	1:10 4:3 5:2
76:8,13 124:15	128:24 135:23	probable	248:7 249:8,10
155:6	149:17,24	184:19	process 71:6
prepare 32:9	154:9,10,11,16	probably 55:24	76:22 78:8
prepared 41:11	159:21 162:11	56:25 63:2	81:15 82:25
51:17,25 53:12	163:6 164:5	83:19 96:22	84:8 85:5 96:2
58:9 90:19,24	189:17,23,24	116:2 128:6	96:18 101:11
91:6 113:13	204:11 206:6	151:21 185:19	135:22 196:22
		1	

224:14	<b>profile</b> 192:9	prostituting	pursued 74:13
<b>produce</b> 36:16	206:10,11,12	224:18	<b>push</b> 17:1,4
50:25 75:17	progradation	protocol 10:13	33:9 85:19
126:22 160:23	188:12,14	<b>prove</b> 79:12	<b>pushed</b> 78:13
185:21 194:2	prograde	<b>proved</b> 225:18	78:14 82:9,11
produced 36:7	188:11	<b>proven</b> 184:19	83:11 87:18
39:8,19 76:5,6	progrades	provide 11:21	137:24
76:12 124:2	188:9,16,19,22	54:5,8 58:6	pushing 81:20
185:18 198:9	program	94:24 146:15	87:12,23 96:23
198:10 199:9	149:17	provided 11:17	137:25
produces	<b>project</b> 55:2,5	12:22 54:18,21	<b>put</b> 27:5 47:6
147:12	58:3 184:12	94:17 245:6	51:24 58:14
producible	194:17	provides 68:4	64:20 76:2
169:16 185:19	projects 74:13	providing	100:1 141:24
producing	168:6 222:17	125:8 176:10	144:21 157:25
33:10 93:17	prompted	<b>public</b> 1:1 5:19	192:24,25
107:1 125:14	225:24	published	195:13 202:12
191:6 213:20	promptly 248:6	24:24 95:3	208:9 219:14
production	pronounced	111:21 129:15	225:1,3 237:4
49:5 83:22	110:8,12	218:10 220:24	245:16
108:4,14,16,21	pronouncing	<b>pull</b> 96:24	<b>putting</b> 38:21
108:22 109:3,3	177:24	110:3 155:13	51:4 77:19
109:6,8,8,9,10	<b>proof</b> 174:23	157:6	92:22 225:16
109:12,13,22	<b>proper</b> 144:13	<b>pulled</b> 16:18	q
114:17 126:20	properly 143:8	17:18 34:23	qualifications
149:11 169:3,6	proposed 59:19	114:13 144:18	12.12
185:14,16	61:9 68:8	207:2 237:1	malified 12.14
189:22 206:11	181:6	<b>pump</b> 83:21	51.13 14 187.1
213:24	proposing	<b>purple</b> 35:20	187.12
productive	247:20	<b>purpose</b> 17:11	$\frac{107.12}{\text{mality}}$
89:16	prospecting	purposes	15.15 16 17
professional	184:19	166:20	85:3.7 118:5
5:14	prospectivity	<b>pursue</b> 50:20	118:17 158:4
professor 5:14	48:11	50:23	158:25 197:19
229:6,8			

# [quantified - really]

quantified	questions 8:15	<b>ramp</b> 80:13	<b>rather</b> 131:15
37:23 38:5	39:24,25 40:5	159:14	153:8
quarter 44:24	40:7 58:16	<b>range</b> 24:1,6	ratio 108:1,7
44:25 227:18	65:16 170:10	162:16 186:1	194:10
228:4	170:22 171:1	198:25	ratios 149:18
<b>queen</b> 18:5	179:10,20,24	<b>ranges</b> 42:3,16	<b>ray</b> 165:11
<b>query</b> 244:13	180:4,11,14,25	<b>rankin</b> 2:19 4:6	<b>reached</b> 189:19
question 18:24	218:17,22	4:8 6:5,6,7	<b>read</b> 53:14
49:19 65:25	227:5,7 229:24	8:23 12:17,18	59:22 60:11,17
72:4 73:12	230:2,24 231:5	13:9,10 40:4,6	61:18 111:20
86:4 97:8,24	231:6 234:6	40:10 55:23	111:24 117:1
114:2 126:22	235:22 236:21	56:1,7,20 57:6	<b>reading</b> 106:12
127:12,12	236:23 238:2,4	57:16,19,20,22	115:8 200:18
130:6 157:16	239:15,20	100:14 101:9	readings 25:11
167:15 172:23	240:5 243:8,10	106:12,14	121:22 211:8
172:24,25	243:11 245:5	114:4,25 115:8	<b>ready</b> 57:24
175:7,8 178:16	<b>quick</b> 7:20	115:20,21	115:20
178:19,19	104:20,21	116:5 143:10	<b>real</b> 5:12
181:2 186:9,13	230:24	143:12,14	157:20 191:7
187:2,3,13,22	quickly 5:12	150:17,23	195:11 203:22
188:1 196:20	<b>quite</b> 24:5 26:4	157:11,13	220:11 224:3
199:15 207:5	110:8 125:9	170:8,17,19,21	225:1 228:20
224:15 225:20	140:3 149:9	191:16 206:24	234:13
225:22 226:16	180:6 188:20	231:4 233:21	realize 35:17
229:14 233:24	205:12 209:6	233:24 234:25	175:12 193:20
239:21 240:3	214:10 228:25	235:1,22	220:21
240:19,19	<b>quote</b> 144:6	236:21 239:19	realized 18:23
241:2,13,14,18	172:3 175:2	240:1,3,9,11	31:23 36:9
241:23 242:2,6	quoting 154:8	243:7 246:5,7	49:15 67:9
242:8,12 244:1	r	246:21 247:2,8	107:3 169:11
244:15 245:10	<b>r</b> 2:1 3:1	247:12	181:20 182:3
245:22 246:2	<b>rain</b> 16:10	<b>rate</b> 206:1,6	184:5 232:1
247:25	rainwater 71:1	rates 108:16,21	<b>really</b> 30:20
questioning	raised 44:3	109:6 206:7	37:10 44:3
231:4			49:6,16 54:13

175:23 176:10	177:20	recovery 55:18
215:15 216:19	recognized	185:22 236:13
233:18 235:13	12:20	recross 4:8
237:2	recollection	239:24 240:10
rebutted 53:8	99:17 118:11	243:12,20
<b>recall</b> 24:3 51:3	119:5	<b>red</b> 15:5,13
62:11,24 66:9	recommend	139:20 158:20
72:25 76:9	8:17	158:22,23,24
91:13 98:20	recommendat	162:1 217:10
99:4 101:24	213:17	217:17 218:3
129:17,18	reconsider 8:6	233:9
142:23 143:20	8:11,14,19,22	redirect 4:7
145:9,12 149:7	9:6	230:23 231:2
152:8 172:19	reconvene	239:14,25
174:17,21	248:5	240:1
231:6 235:24	record 5:1 8:2	<b>reduce</b> 39:13
236:23 238:3	11:8 13:7 18:1	<b>reduced</b> 137:22
243:24 244:5,9	23:15 36:23	<b>reef</b> 34:4 172:6
244:18	56:6 100:20	172:7 173:5,12
<b>receded</b> 133:25	115:15,19,25	188:1,3 238:2
<b>recent</b> 94:18	119:23 146:17	238:21
recently 156:24	170:16 180:8	<b>refer</b> 11:23
recess 56:4	228:21 234:22	16:12 63:22
115:16 143:11	248:2	144:2
170:18 180:9	recorded	reference 14:6
234:23	142:20 163:1	119:24 150:11
recharge 16:12	206:6	referenced 76:7
16:15,19,22	recoverable	76:12 94:16
135:24	54:2 55:11	references
recharged	196:1	129:21
131:5 189:21	recovered	referred 13:25
recharging	55:19 196:21	50:7 106:4
131:9	recovering	151:17 155:20
recognize	184:12	239:21 240:20
176:19 177:4		
	175:23 176:10 215:15 216:19 233:18 235:13 237:2 rebutted 53:8 recall 24:3 51:3 62:11,24 66:9 72:25 76:9 91:13 98:20 99:4 101:24 129:17,18 142:23 143:20 145:9,12 149:7 152:8 172:19 174:17,21 231:6 235:24 236:23 238:3 243:24 244:5,9 244:18 receded 133:25 recent 94:18 recently 156:24 recess 56:4 115:16 143:11 170:18 180:9 234:23 recharge 16:12 16:15,19,22 135:24 recharged 131:5 189:21 recharging 131:9 recognize 176:19 177:4	175:23 176:10177:20215:15 216:19recognized233:18 235:1312:20237:2recollectionrebutted 53:899:17 118:11recall 24:3 51:3119:562:11,24 66:9recommend72:25 76:98:1791:13 98:20recommendat99:4 101:24213:17129:17,18reconsider 8:6142:23 143:208:11,14,19,22145:9,12 149:79:6152:8 172:19reconvene174:17,21248:5231:6 235:24record 5:1 8:2236:23 238:311:8 13:7 18:1243:24 244:5,923:15 36:23244:1856:6 100:20receded 133:25115:15,19,25recently 156:24170:16 180:8recess 56:4228:21 234:22115:16 143:11248:2170:18 180:9recorded234:23142:20 163:1recharge 16:12206:616:15,19,22recoverable131:5 189:21recoveredrecognize55:19 196:21131:9recovering184:12176:19 177:4

#### [referring - reservoirs]

referring 59:24	relevant 14:19	249:7	89:23 90:8,12
72:13,15 79:1	242:18	reported 25:14	100:6 103:11
98:7 109:16	<b>relied</b> 76:7,13	218:10	107:17 122:12
110:1,10	94:16	reporter	124:23 125:25
146:18	<b>rely</b> 207:15	115:14 116:1	126:12,13,17
<b>refers</b> 76:22	<b>relying</b> 119:18	248:3	126:23,24
148:11	<b>remain</b> 17:21	reports 155:9	127:3,4,5
<b>refill</b> 17:20	remainder 12:3	represent	134:18 137:19
<b>reflect</b> 141:16	19:24 26:18	174:12	138:2 144:14
228:21	179:19	representation	145:23,25
reflected	remaining 85:6	121:10 133:20	148:10 149:24
113:17	209:24,25	representative	151:14,21
reflective 71:13	remains 89:18	21:17 102:25	153:4 158:12
reflects 99:20	remember 72:4	113:14 159:9	158:23,24,25
176:24	99:6 103:8	represented	159:2 160:4,17
<b>regard</b> 236:16	114:15 115:25	168:15 174:9	161:1 176:4
regarding	172:22 173:11	representing	181:1 182:4
246:2	187:8 203:20	179:17	186:6,15
<b>regimes</b> 154:16	219:5 220:24	represents	187:11,14
regional 16:4	221:9 228:19	105:24	189:25 190:15
27:4 42:19	235:14	request 12:14	190:16 191:7,8
82:12 87:25	remind 43:9	13:3	192:21,24
134:3	206:25	required 74:2	193:6,21
regionally	reminder 43:20	requires 54:16	197:19 199:5
27:10	<b>repeat</b> 172:24	reserves 144:15	204:13,25
reiterate 81:5	repeating	184:20	205:24 209:7,9
<b>related</b> 249:13	178:6	reservoir 15:13	212:14 214:16
<b>relation</b> 191:17	rephrase 70:10	15:15,15,16	224:13,17
204:24	178:19 186:14	31:15,24 33:3	225:2,21
<b>relative</b> 162:13	<b>report</b> 25:14,21	33:7 34:13	236:12 239:5
release 248:2	63:5,22 64:1	36:10 38:17	reservoirs 60:4
released 202:6	64:25 65:1,4,9	39:12,13 44:20	89:22 137:24
relevance	67:20,25 68:4	45:6,7 48:2	158:21 181:11
17:10,12	142:21,24	51:15 60:13	201:19 224:23
	155:14 202:2	61:14 84:3	

residual 17:5,7	238:11	118:21 130:19	61:23 63:12,12
17:15,19,21	respond 181:2	168:10 175:11	63:14 64:12
18:18,20 24:18	191:2 199:13	235:2	65:18 66:2
24:25 25:6,14	200:1	reviewing	67:9,13,22,25
25:16,19 37:5	response	56:25 61:7	68:10 69:16
37:23 38:2	149:11,14	111:11	74:15,22 75:7
39:12 54:1	241:9 243:10	revised 65:21	77:5,8 78:17
59:20 60:5,15	244:9	<b>revisit</b> 146:23	78:22 79:19,23
61:10,17 68:9	responsibilities	revisited 222:4	80:6,8,9,10,14
73:21 75:5	44:13	<b>revoke</b> 195:20	81:1,13,18,22
83:23 84:2,17	<b>rest</b> 5:22 35:24	<b>revokes</b> 196:2	82:4,8,18,19,22
85:4,5 95:18	36:16 56:11	<b>rice</b> 3:8 7:3	83:8,10 84:1,4
131:11 163:3	134:25 210:7	101:2,5 151:5	84:14,19,24
169:13 181:7	216:23 217:2	170:2,25 235:5	85:3 86:13,18
182:7,10,13,14	227:1	<b>rich</b> 31:13,22	86:24 87:4
184:10 185:12	<b>rests</b> 232:3	39:7 121:1	89:2,6,16,19
185:21 186:5	<b>result</b> 50:19	241:17	90:2 91:8
186:16,22	74:9 81:25	<b>rift</b> 16:20 81:17	92:22 93:5,10
187:4 210:19	85:24 113:17	<b>rifted</b> 16:18	97:4,6,19 98:1
212:13,15	114:20 121:11	17:17	98:22,24
213:13 236:13	219:2	<b>right</b> 6:4 9:24	101:13,17
239:10	<b>results</b> 103:10	10:17,20 14:2	102:4,13,15
residuals	retained 58:5	14:25 15:1,11	103:5,24,25
185:20	retired 12:4	18:9 19:10,14	104:4 105:1,4
resistance	retiree 223:7	20:6,8,13 21:6	105:21 106:2,9
128:5,12,18	<b>review</b> 51:19	21:16,19 22:3	107:18,24
resistivity	52:11 53:18	26:14,23 27:12	108:1,8,11,19
165:12	66:15 67:19	33:15,23 38:9	109:3 111:6
<b>resolve</b> 102:8	88:9 102:6	40:24 41:6,23	117:12,14,19
resource	129:9 155:8	42:18,22,23	117:21 119:7
211:19 213:14	242:18	43:4 44:19,22	119:21,25
resources 3:3	reviewed 8:14	45:18 47:18	120:9,10,18
respect 24:19	52:3,7 53:5,11	50:11,13 51:15	121:2,8,12,16
27:25 102:14	53:20 65:17	55:21 57:14,18	121:23 122:2,6
104:6 237:8	76:12 94:16	58:16 61:2,10	122:19 125:4

126:8 127:21	233:5 237:5	<b>roz</b> 39:5,14	245:25 246:17
128:2 129:11	240:9 241:3,6	46:25 54:1,19	246:18 247:13
130:16 131:2,7	241:19 242:9,9	54:22,23,25	247:23
134:5,13	243:15,17	55:3,6,10,20	<b>rozs</b> 69:7 71:22
135:17,22	244:24 247:10	68:14,17,21	74:19,25 75:12
136:23 139:6	rio 16:20 81:17	69:1,8,15 72:3	75:23 83:19
140:17,23	<b>ripley</b> 1:17	72:11,16,23	86:10 89:9,13
141:3,7,8,9,11	<b>rise</b> 25:7 103:2	73:2,2,6,17,20	184:12 185:23
141:12 146:5	103:3,7	74:13,14,21	191:4
147:19 148:16	<b>robert</b> 4:5 10:8	75:1,2 78:3	<b>rr</b> 14:4,18 18:3
155:25 157:10	11:1,9	82:21 83:1,6	19:3,10 20:13
158:7,9 159:1	<b>rock</b> 28:8 55:14	88:9,10,19	21:16 48:15
159:16 162:24	71:3 77:20,23	89:3,10,18,19	62:22 142:12
169:12,12	85:2,3,7,8,10	90:10 126:11	161:6,12
171:20,25	85:11,20 149:3	131:11 181:13	181:24 184:4
172:6,10,13	153:8 158:4,11	184:15,18	197:16,25
173:11 174:17	205:5 207:18	191:1,7,9,25	226:15
175:15 176:16	208:8,9 244:21	192:6,19	<b>rubin</b> 1:25 4:11
176:25 177:7	rocks 84:22	194:15,17,24	7:19 8:5 9:1,3
177:25 183:19	85:12,13,18	195:1,11	9:5,11,13,16
184:4 191:22	132:3,3 157:23	196:20 199:6	57:15,17
197:12,14,14	186:21 226:22	231:9,11	171:13,17
197:19 198:16	<b>role</b> 45:4	236:18 239:1,3	227:6,9 228:21
200:25 201:3	<b>roll</b> 5:12	rozatos 1:20	229:21
203:12 204:20	<b>roman</b> 44:21	5:3,8,20 6:7,9	ruling 8:11
205:6,7 206:6	<b>room</b> 6:4	6:12,16,20,24	114:8
207:12,17,18	179:14 212:16	7:2,5,9,14 9:10	<b>run</b> 128:20
208:1 209:19	245:23	10:15 22:16,21	213:5,21 240:4
211:20 214:18	rough 107:10	56:2 101:1	<b>ryan</b> 56:15
215:6,8 217:7	107:11	115:11 180:1	57:10 246:8
218:13 219:7	<b>roughly</b> 107:8	180:11,13	S
219:17 222:21	<b>round</b> 153:5	197:11 200:25	s 1:6 2:1.5 3:1
226:8,9 230:18	233:1	215:14,17	<b>safe</b> 174:19
230:19 231:22	<b>routine</b> 187:19	229:22,25	175:9.11.19
232:5 233:1,4		234:14,17	238:3
	1		1

•			
saint 1:6	50:23 51:1	153:12 154:11	232:11,17
sake 219:15	54:3,24 55:19	155:2,4,21	233:8,12,13
salinity 38:14	59:20 60:4,5,8	156:1,3,7,10,10	238:16 239:2
38:22 39:2,8	60:12 61:9,13	157:1 161:9,9	240:24 241:3,5
39:19 116:21	63:17 68:8,13	161:16 162:11	241:6,11,15
116:22 131:4,9	68:17 69:1,16	163:4 164:9,11	242:15
175:4 199:2	69:23,25 70:4	164:17,24	sand 232:25
salt 37:16	70:13 71:25	165:19 166:6	sands 160:23
saltwater 93:4	72:14,20,23	167:5 168:8,22	sandstone
107:8 124:9,19	78:5,16,24	172:5 175:20	134:15 152:22
155:11 195:18	81:1,2,13	175:22 176:22	165:15,16
198:8 204:23	82:18,19 86:14	177:7,15,24	232:15,18,19
<b>sample</b> 21:17	87:9,12 90:18	178:3 181:7,11	232:20
123:11 207:22	91:23 92:9,10	181:13,19,21	sandstones
<b>samples</b> 129:14	92:11 93:3,9	181:23 182:2,3	15:19 28:7
130:14	93:18 94:12	182:4,24,25	134:16 152:18
sampling	95:9 96:7	183:2,11,13,20	159:24 160:1,8
181:18	98:16 99:21	185:5,15 186:8	160:10,11
<b>san</b> 2:14,14	103:5 111:18	187:10 191:10	santa 1:7 2:4,7
18:7,10,13,18	113:25 116:13	192:5,20,22	2:10,19 3:4,15
19:5,25 20:2,5	116:21 121:1	195:1 196:12	santoyo 2:12
20:10,16 21:2	123:1,3,8,14	196:13 197:16	6:25
21:11 23:1,3	124:4,10	197:20 199:2	saturate 83:3
23:19,20 24:23	125:14,20	201:22,23	209:8
25:12 26:7,8	126:3,11 127:2	202:10,20	saturated
26:12,13,15,17	127:15,20	204:7,11	17:24 60:13
26:25 27:5,8	128:11 129:1	205:15 206:1,6	61:14 82:3,7
28:17 29:23	130:1,9,20	206:22 212:22	82:15 83:10,20
31:20 32:16,20	131:4,11	213:2,15 214:7	saturating
34:7,20 35:9	135:19 139:7	215:5,24	17:23
35:19,23 37:5	139:10,14,23	217:14,17	saturation
37:9,10,20,24	142:14,16	218:12 227:1,1	18:15 21:21,21
38:2,8,15 39:6	144:8,10	227:13 228:1	22:8,8 23:8,20
47:1 48:12,18	150:12 152:8	231:13,22,24	23:24 25:1,4,6
49:11 50:20,22	152:13,16,23	231:25 232:2,4	26:21 62:14
,	, ,	,	

#### [saturation - sediments]

66:12 67:2,3	saudi 45:22,24	scheduling	<b>second</b> 8:5 9:10
67:10,23 74:21	save 187:21	247:16	37:8,13 59:15
82:25 83:6,7	<b>saw</b> 18:21	schlumberger	140:25 144:19
83:14 84:13	24:25 26:20,25	147:2	151:16,18
96:17 140:1,2	35:6,10 38:7	<b>school</b> 47:23	175:7,8 198:6
141:7 142:13	48:13 62:4	science 41:1	229:23
162:22 163:1,8	65:17 66:11	scientific 244:5	secondary
163:10 168:7,7	123:20 140:17	<b>scope</b> 54:12	160:8,19,21
168:16,21,23	149:6 159:15	167:19	161:2
169:11 181:22	183:20 184:3	scotland 41:5	secretary 5:15
182:2 183:20	184:22 220:2	<b>scott</b> 56:15	<b>section</b> 14:25
184:3,5 185:17	225:24 226:9	57:11	15:3 16:4 18:6
185:25 186:6	226:14	screen 13:19,23	19:22 22:3
186:11,16,22	<b>saying</b> 16:25	58:14,19,22	33:15 42:10,12
186:23 187:4	32:5 70:5	76:2 116:15,17	42:13,17 60:14
192:9,10,14,18	83:20 96:1	143:17 207:12	61:15 79:2,14
196:1,5,18	114:19 115:24	236:25 240:12	98:2 105:23
212:13,15	132:12,17	<b>scroll</b> 90:7	110:5 111:7
213:9,12 224:2	149:5,8 151:13	99:12 100:12	116:12 120:4,8
225:25 226:1	182:21 194:22	144:18 147:7	120:14,15
226:23	204:5 207:4	177:2	134:4 138:5
saturations	210:3	scrolling	139:2 140:5,10
20:16 23:23	says 28:22 61:8	134:12	141:14 144:9
24:2,14 25:13	61:13 65:22	<b>sea</b> 70:19,22,24	147:8 152:4,14
68:5 73:22	85:9 93:18	102:25 103:6	173:22 181:5
74:2,8,14 75:2	100:5 105:25	133:17,21,24	192:12 195:5,9
75:3,14 89:13	106:4 107:16	133:25 159:10	208:7 217:24
97:1 99:2,2	109:18 134:17	159:12,13	218:7 225:22
142:23 161:11	147:14 148:24	217:18	234:11
162:10,13	177:6,23	<b>seal</b> 93:16	<b>sections</b> 42:6,7
182:6,24 184:6	240:16	152:7,22 153:3	132:6 164:24
184:22 185:3	<b>scale</b> 39:11	153:13,21	sediment
192:8 195:6,10	199:4 208:24	154:15	153:11
209:14 210:19	schedules 10:5	<b>seat</b> 10:17	sediments
222:7,8 236:19			70:22

<b>see</b> 9:25 13:20	171:12 173:21	seems 29:6	192:1,3 210:21
18:12 19:20,23	173:23 174:2,5	104:5 126:22	211:15
20:13 21:2,10	179:8 181:15	186:1 239:12	<b>send</b> 214:14
22:1,2,17,18,20	181:22 183:4,9	seen 37:5 39:21	235:4
23:2 24:15	185:3 188:5	120:15 147:2	<b>sense</b> 32:13
25:3 26:1,20	189:7 192:8,13	149:3 150:13	46:10 74:2
28:21,22,25	193:3 197:12	150:14 182:25	<b>sent</b> 7:23 53:16
29:16 30:20	197:13 198:15	227:22 237:14	sentence
33:22,23 34:4	200:19 201:19	<b>seep</b> 31:17	109:18
44:22 47:16	201:23 202:20	33:20 34:4,9	separate
48:14 49:4,5,7	204:24 205:1	39:1 116:9,13	110:14
53:14 58:19,21	205:23 206:8,9	116:22 117:5,6	separates 50:14
59:3 60:21	206:10,11,11	117:11,13,16	72:19 90:17
61:1,5 62:13	206:13 207:16	118:5,13,18,22	152:7
63:9 67:2,8	207:17,22,23	119:6 120:3,21	separating
71:8 76:3	208:14,15,24	122:21 123:6	145:24
79:18 86:10,20	211:22 213:5,8	123:17 130:10	september
91:24 99:10	213:11 214:17	173:12 175:3,6	45:19
108:6,7,10,25	214:19,25	175:10,16	sequence 69:19
109:2,11,12	215:2,7,14	188:2,15 189:6	69:21,24 70:4
110:8,18 111:7	216:6,12,19	189:14,16,19	70:7,11,18
111:20 116:15	217:19 219:6	190:3,11,13,18	71:12 72:4,18
116:16,18	221:1,2,5,9	227:13,13	73:3,7 127:19
121:22,25	224:1,7 226:22	228:2,16	128:1 152:12
132:4,8,12	227:17,23,24	229:11,13	231:6,10,16,19
135:13 136:11	228:6 229:16	230:5,14	232:2,5,9,17,21
136:20 139:21	230:20 232:20	<b>sees</b> 22:21	233:14,14
140:3,10,20	234:22 237:18	<b>seismic</b> 33:14	234:8,11
141:7,8,9	seeing 24:3	134:4,7,10	235:19 247:3
142:12,12,18	32:14 67:23	227:23 228:7	sequences
151:18,24	127:23 128:25	<b>self</b> 11:13	133:21
153:11 156:17	149:7 221:12	seminole 24:22	sequestering
158:13 164:21	seeking 51:13	88:25 94:12	193:21 194:6,6
164:23 165:14	<b>seem</b> 239:13	95:9 96:7 97:7	225:12
166:2,4,6,8		162:10 163:3	
		1	

[series - similar]

<b>series</b> 27:18	89:6 133:25	140:4 155:2	shows 14:22,24
94:14 102:18	135:10	156:4,5 162:11	16:16 24:17
208:22 217:20	shift 175:25	198:7,12	86:23 93:16
<b>serve</b> 71:18	shifted 10:4	199:23 220:25	99:17 106:20
serves 71:16	<b>shingle</b> 46:3,6	223:23	110:5 120:16
<b>service</b> 3:8 7:4	<b>shock</b> 44:1	showing 19:3	134:3 135:16
services 166:13	<b>short</b> 115:5	20:9 21:7,17	140:9,11,14
session 8:16	188:24 222:22	21:21 23:18,23	154:10 169:25
<b>set</b> 12:13 34:5,6	<b>shorter</b> 166:2	25:10 26:16	214:19 215:10
44:18 222:16	shorthand	27:5 29:6	215:22 236:17
223:19 249:8	249:8	30:23,23,25	<b>side</b> 16:8 27:6
setting 71:5	<b>shot</b> 33:15	32:2,18,19,19	38:25 41:25
settings 224:7	<b>show</b> 10:2	32:21 33:11,13	78:11 88:11
seven 139:22	13:23 16:2	33:19 34:3,5,6	111:6 158:7
several 145:17	17:25 18:15,17	37:14 79:3	159:23 160:2
148:25 149:5,8	22:10 23:1	106:8 109:6	160:17 168:25
149:23 188:12	25:14,24 27:22	113:12 119:6	169:9 176:21
shaheen 2:8	29:11 30:4	136:7 140:8	177:6,14,23
6:21,22,24	32:15 34:19	146:12 162:6	188:21 190:19
<b>shake</b> 214:3	64:19,19 65:2	176:16 198:24	192:23 197:22
shanor 2:3	94:7 100:2	202:13 203:5	207:17 208:4
<b>shape</b> 31:6	114:17 127:16	209:14 214:24	218:1
153:6	129:3 134:4	233:9 240:12	sideways
<b>shaped</b> 217:23	135:21,25	240:21	190:15
<b>share</b> 13:18	136:19 140:19	<b>shown</b> 14:3,5	<b>signal</b> 122:21
116:15 173:13	141:23 191:13	18:25 19:6,19	123:5
173:20 227:16	191:18 197:3	21:4 23:14,25	signature 58:25
<b>shared</b> 46:21	199:25 200:11	24:2 27:2	59:3 60:21
<b>sharing</b> 173:24	207:12,25	28:13,14 30:17	249:16
<b>sharon</b> 2:8 6:22	215:6,8 217:6	30:22 35:11	<b>signed</b> 60:22
<b>sheer</b> 229:8	238:20 240:14	36:24 78:23	significant
<b>sheet</b> 30:1,11	<b>showed</b> 23:17	95:25 120:5,9	24:21 225:9
<b>shelf</b> 41:15	24:21 36:20	154:24 191:21	similar 25:2
42:9 80:6,21	37:18 67:8	207:21 214:23	59:9 61:6,12
88:16,17,21	99:1 105:8		

# [simple - spe]

<b>simple</b> 70:20	27:2 28:14,24	<b>soft</b> 51:23	244:7
106:18 107:4	30:5,6 33:11	<b>sold</b> 193:25	<b>sort</b> 76:25 80:1
191:7 234:13	33:22 35:11	<b>sole</b> 76:11	101:24
simply 39:4	37:22 38:12	<b>solid</b> 117:6	sorts 97:16
110:18 173:8	78:19 161:23	244:21	<b>sound</b> 175:15
189:24	197:9 208:13	<b>solids</b> 31:13	<b>sounds</b> 68:10
simulate 225:4	218:25	<b>solution</b> 30:3,7	167:16
sinkhole	<b>slides</b> 23:14	30:11,13	source 33:5
217:23 218:1,5	36:24	104:14 137:12	39:2 77:7
sinkholes 71:7	slightly 75:14	153:23 207:23	175:4,13 190:5
71:8 153:5	207:20	209:4,6 220:13	199:8
166:8 217:13	<b>slow</b> 71:6	221:14,15	<b>sources</b> 130:16
233:8,10	<b>small</b> 27:16	solutions 3:13	south 3:4 11:23
<b>sir</b> 8:4	29:13 30:7	249:17	14:1 35:13
sit 74:7 95:2	44:4 96:4	<b>solve</b> 104:24	42:1 44:24
sits 69:23	133:9 137:20	112:4,7,8,11	78:9 87:13
sitting 21:14	145:4 177:15	somebody	106:25 107:12
65:8 192:19	178:5,25 179:1	53:13 57:14	138:24 147:12
229:13	193:9,16 207:9	205:20 210:9	183:7 200:5,8
<b>situ</b> 84:3	217:7 219:10	somebody's	200:10
situation 82:13	220:8 221:20	167:16 190:8	southeast 29:2
166:18	222:15 237:6	someday 39:1	29:19 147:13
<b>six</b> 125:6,7	smaller 31:5	somewhat	southeastern
139:22	165:25 166:1	119:6 178:19	44:6
<b>size</b> 170:2	166:13 193:17	<b>soon</b> 32:11	southern
193:16,17	193:17 219:18	110:4	107:12 188:25
228:14 229:13	219:18 225:7	sore 142:19	200:5
sizes 237:16	232:13	164:25 227:20	southwest 29:1
<b>skip</b> 61:4 143:2	<b>smell</b> 23:5,6,8	<b>sorry</b> 63:17	29:19 87:1
<b>slide</b> 13:22 14:6	<b>snaps</b> 207:12	82:6 84:10	95:8 96:12
14:21,22 15:23	<b>snow</b> 16:10	106:11 138:21	southwesterly
16:2,24 17:8	soaking 194:3	198:18 199:12	29:8
17:10,25 18:1	society 47:8	199:18 200:7	<b>spe</b> 93:19,22
18:17,25 19:6	sodium 39:9	204:16 206:3	94:7,9 95:17
21:4 23:21		218:15 230:15	98:4,6 99:1,4

# [spe - stratigraphically]

113:16 146:22	sshaheen 2:8	164:23 166:8	stay 36:3,15
146:25 239:21	<b>st</b> 2:18 3:4	179:25 180:3	85:18
242:10,14,16	staff 91:20	181:5 183:18	<b>stayed</b> 45:17
speak 192:1	223:9	186:2,24	183:12
speaking 8:23	<b>stage</b> 30:12	192:13 199:4,6	stays 127:25
51:23	184:19 209:2	203:21 222:23	<b>ste</b> 2:14,18
speaks 106:14	stain 20:13	233:7 240:18	<b>steep</b> 229:2
special 187:18	21:2,10 22:1	245:18,25	230:16
specific 11:22	23:3 26:25	247:14,19,20	stenographic
165:10	141:25 181:20	<b>started</b> 5:5 7:21	249:8
specifically	208:18 221:16	11:25 18:4	steve 182:12,17
51:8 97:8	stained 19:3	35:17 43:2	182:20
spencer 2:6	21:9 30:16	44:10,19 46:1	sticking 93:12
spencerfane.c	139:16 207:24	46:15,24 47:5	<b>stomach</b> 115:4
2:8	220:13	47:17 169:5	<b>stone</b> 28:5,6
<b>spent</b> 80:22	staining 20:18	182:13 183:18	<b>stood</b> 226:8
88:1 222:24	23:1 62:4	194:2 201:15	<b>stop</b> 76:3 185:6
spill 82:12	65:18 139:17	202:19 205:16	<b>stops</b> 69:9
<b>spoke</b> 121:18	139:19 225:24	starting 188:11	<b>stored</b> 223:16
<b>sponge</b> 24:20	stand 10:14,17	starts 156:7	straight 9:21
25:3,8 95:19	10:19 22:10	state 1:2 8:1	strata 15:25
95:22 162:11	140:21 164:25	11:7 40:24	36:17 45:8
163:5 164:4	226:12 230:21	90:23 247:13	113:6 131:1
sponte 8:7	standards	stated 5:7	134:24 144:9
sporadically	96:19	98:20 127:18	152:17 153:17
12:2	stands 142:19	244:20	188:9,15
<b>spot</b> 105:16,17	227:20	statement 8:9	219:12
106:21 169:15	staring 142:4	56:22 62:17	stratigraphic
189:15 229:1	start 6:3 7:16	66:2,9 94:3	33:24,25 111:7
<b>spots</b> 92:6,6	19:21 33:23	98:4 117:13,16	132:10,11,12
<b>spurred</b> 229:24	39:13 44:17	118:4 119:19	132:15 133:20
<b>squeeze</b> 107:3	71:1,2,2,3,6	143:20 148:4	197:17
<b>ssau</b> 98:8	92:4 122:10	149:12,19,25	stratigraphica
163:18,20	153:9 154:1	150:2 168:9	110:11
	162:19,20,24	176:3	

# [stratigraphy - summary]

stratigraphy	students 47:25	61:5 168:3	subsequent
15:5,24 125:25	229:7 230:11	198:25 228:20	135:25
126:7 233:11	230:15	245:13	subsurface
streaks 101:24	studied 74:5	<b>stylized</b> 120:15	16:11 27:8,11
103:19 107:22	189:9 237:15	<b>sua</b> 8:7	131:5 189:21
242:20	<b>studies</b> 97:10	<b>suazo</b> 3:15 7:11	221:12
street 194:16	132:1,2 157:2	7:12,15 9:3,4	<b>subtle</b> 140:21
249:18	182:23 201:16	101:3 151:7	<b>sucked</b> 31:15
stricken 245:4	202:5 207:8	179:13,19	32:23 34:8
<b>strike</b> 14:17	228:14 229:10	235:9	189:22,24
245:8	238:11,13,18	subaerial	<b>sudden</b> 221:13
striking 9:6	238:19 241:21	139:12 152:15	suffering 248:3
<b>stringer</b> 148:17	<b>study</b> 20:3	164:18 166:4,7	<b>suite</b> 249:18
stringers 148:3	26:10,13,17	217:14,16	<b>sulfate</b> 31:16
148:12,15,23	28:16,19 30:18	subaerially	31:22 39:7,11
148:24 149:16	30:24 31:9	166:3	121:1,5 123:5
strings 217:11	34:17 35:3,8	subheading	130:6,9,10
strips 84:21	37:18 41:14,19	116:19 181:8	131:2,4,11
<b>stroke</b> 230:12	41:22 50:4	subject 12:9	136:16,22
strong 29:7	53:25 79:8	90:4 135:5	137:3,5,9
stronger 29:17	122:19 129:13	submissions	199:3 241:17
struck 8:8	146:4,8,11	51:20 52:5,12	sulfates 136:8
structural 17:1	155:16 156:24	<b>submit</b> 100:20	136:20
17:4 37:15	162:10 163:15	submitted	<b>sulfide</b> 136:1,8
77:6 81:11	194:8 202:10	51:18 53:19,21	<b>sulfuric</b> 136:14
84:24 220:23	203:17,19,23	59:1,7,10	<b>sum</b> 238:24
structure 28:2	213:6,22 214:8	60:22 125:17	summarize
28:9 30:25	214:13 216:4	submitting	37:3 159:5
31:2,7,7 32:3	216:10 217:1	91:16	summary 11:17
32:13 38:25	224:23 236:23	<b>subsea</b> 60:14	11:21 40:22
93:10 110:13	237:3 239:4	60:15 61:15,16	50:1 73:19
121:21 123:22	studying	62:6,20 63:7	75:24 78:20
127:24 154:16	175:12 231:25	63:18 64:2,7	81:17 98:13,20
<b>student</b> 48:6	<b>stuff</b> 22:10	64:18,20 65:18	101:20 106:15
	47:24 53:13	156:13 168:16	110:10 120:5

# [summary - teach]

120:16 130:7	166:12,14	<b>sworn</b> 11:2	76:15,17 90:15
157:5 162:9	232:10	symbolized	91:19 116:8
171:24	<b>surprise</b> 220:11	120:22	119:3 127:8
<b>super</b> 24:13	224:3	symptoms	130:5 161:25
163:16 210:5	surprises 39:17	100:6	162:23 164:8
210:22	surprising	<b>system</b> 44:1	184:14,17
superimposed	26:22 196:17	80:22 126:25	200:14 215:1
32:3,12 123:22	237:20	132:6 136:8,17	226:18
supplemental	surrounding	153:10 154:10	talked 71:11
8:9 9:7	14:10	154:12	73:17 74:11
<b>supply</b> 125:6,7	suspect 40:4	<b>systems</b> 128:14	76:3 83:17
<b>support</b> 54:6,9	<b>sve</b> 24:17,24	t	86:8 91:18
<b>sure</b> 9:25 10:6	<b>sw</b> 210:14	t 2.8	98:3,14 130:7
10:12 38:3	<b>swd</b> 3:13 59:19	tahla 108.813	133:19 136:25
52:23 53:17	59:24 61:9	tables 63.23	159:3 161:5
57:9 58:15	68:8 181:6	tables 05.25	181:10 185:23
74:7 99:7	sweep 78:21	96.1 101.19	206:24 237:9
111:24 115:7	81:21 144:14	115.3 5 130.13	talking 54:23
119:4 125:3	sweeping 77:4	1/3.7 153.16	69:3 95:7,13
134:11 159:4	77:19 96:23	16/1.3 6 7	96:6,11 104:23
170:12,12	153:22	170.9 17/.11	111:25 116:16
173:17 182:17	sweeps 135:10	177.13 180.1	127:5,6,14
211:18 228:3	swenergylaw	209.17 18	133:7,12 134:8
231:8 238:25	2:15	207.17,10	137:6 148:7
246:6	<b>swept</b> 77:23	211.7,14 213.0	152:1 156:11
<b>surface</b> 24:12	78:4 79:9	222.21 223.10	175:16 184:20
96:21,24	81:10 82:2,4,8	224.9 230.9	186:21 218:10
139:12 164:19	83:11 84:18	taken 23.7.11	222:9 233:22
164:20 165:15	85:3,15 86:11	AA.16 A9.15	240:17 243:5,6
165:20 166:7	89:22 96:2	127.1 138.24	tall 191:25
211:4 220:25	130:21 135:1	138.25 167.21	<b>tds</b> 117:14
232:22,23	160:6,16,18	168.2.205.5	119:7,9 121:1
233:1,2	swing 188:21	249.5	121:5
surfaces 162:1	<b>switch</b> 60:19	talk 13.19	<b>teach</b> 47:24
162:2 166:3,5		59:17 75:22	

# [teaching - thank]

teaching 47:20	208:10 210:14	51:19 52:1,4,8	152:6 155:7,8
<b>tech</b> 5:15 48:4	<b>tended</b> 49:11	52:8 53:4,11	155:15 156:17
technical 151:3	169:3	53:19,21,24	157:5,6,12
168:3	tends 128:9	54:19,21 57:1	159:4 161:14
technically	130:9,10	57:24 58:6,10	166:17 167:18
55:11 167:22	207:24 225:14	58:15,23 59:2	168:3 172:9,12
techniques	<b>term</b> 77:15	59:2,6,9,16	174:15 175:18
162:14	194:3	60:20,22 61:1	178:9,12,14
technological	termed 182:8	61:6 62:2	180:24 181:4,9
174:1	terminated	65:21 66:5,16	185:23 197:7
technology	81:22	67:16,19 68:1	198:14,20
223:1,12	termination	69:14 70:6	200:13 204:9
tectonic 76:25	81:25 135:21	72:15,22 73:1	204:17 213:19
tell 20:17 84:13	terminology	76:8,14 86:6	215:16 216:19
92:16 106:16	182:11	86:12,21 88:6	218:22 227:12
106:17 166:13	terms 92:12	90:20,25 91:5	230:1 238:13
171:22 182:17	191:7	91:6,17 92:17	245:10
182:20 186:13	tertiary 28:3	93:3,7,13,22	<b>texas</b> 2:14 16:6
192:4 194:21	<b>test</b> 154:9	94:1,4 98:10	47:8 48:4
206:14 207:6	testified 11:2	98:14 115:2	78:11 87:17
226:3,19	11:14 68:12,20	116:11,12	187:7
telling 109:24	69:21 150:22	118:4,13	<b>th</b> 63:7
126:10 128:15	155:15 172:15	119:15,25	<b>thank</b> 5:16 6:9
208:18 209:11	172:16 176:9	120:5,16	6:13,16,20,24
242:2,17	196:10 234:1	121:19 123:25	7:2,5,6,14 9:23
tells 28:23 39:7	244:16	124:15 125:16	10:24 13:13
62:14 115:4	<b>testify</b> 204:14	129:8,23 130:6	37:2 40:1,6
163:16 210:21	247:1	130:9,19,24,25	57:20 58:4
<b>ten</b> 55:24	testifying	138:4 140:23	65:15 71:21
188:14,17	106:12 238:9	141:1,2 143:4	116:3,14
234:17,19	testimony 9:7	143:5,5,18,19	143:10,12
tend 28:25 29:1	11:19 12:13,23	143:21,25	146:17 155:14
29:16 145:2	13:1,4,20	144:21,25	157:11 170:17
153:5 160:2	36:25 40:15,19	146:8,20	170:21 171:17
193:6 207:19	50:6 51:9,18	151:23 152:1,4	179:5,11,20,21

# [thank - time]

190.10 22	things 20.22	172.10 170.12	three 12.25
180:19,23	tnings 30:25	1/3:18 1/8:13	three 13:25
18/:24 209:13	40:19 46:10,14	180:2 182:18	27:20 31:11,23
218:16,21	46:15 59:12	186:12 187:1	34:14 120:17
221:22 227:4	87:17 152:3	18/:12 19/:2,9	129:3 139:21
229:20,21	157:4 160:14	198:12 210:23	188:23 198:3,4
230:1,19 235:1	162:8 224:11	213:11 214:2	198:5 208:19
235:16 243:19	243:12	216:3 218:16	209:11 220:9
245:1,15	think 22:22	220:18 223:22	220:15 229:10
247:22	24:3 30:8 38:1	224:17 225:13	237:10
thanks 248:3	45:13 48:14,15	225:14,25	threshold
thereabouts	48:17 50:6	226:11,14	74:20
171:6	52:10 53:23	230:24 231:17	<b>throats</b> 194:10
thesis 187:7	56:18 57:2,4	232:7 238:24	<b>thumb</b> 142:19
<b>thick</b> 36:12	57:23 63:23	240:6 245:8,20	164:25 227:21
112:22 133:14	64:9 73:18	246:1,4 247:4	231:22
147:16,18,20	74:12 78:1,19	247:6,18	thursday 5:5
147:21,22,24	79:3,6 80:11	thinking 98:9	247:1
148:6,8 157:23	80:19 82:13	99:14 214:9	<b>tick</b> 47:18
165:16 185:13	83:17 87:7,17	215:17 240:8	<b>tie</b> 165:6
228:20 229:16	91:3,18,24	thins 122:15	<b>tied</b> 42:16
232:6	94:2 95:6 97:3	<b>third</b> 36:6,13	165:13 218:4
<b>thicker</b> 133:12	98:19 99:7	37:17 88:23	<b>tight</b> 92:6
233:13	100:13,16	151:18 245:8	152:17 153:8
thickness 36:12	105:9 106:13	246:14	160:2,14,25
229:18	106:16,17	<b>thirty</b> 147:23	239:12 247:16
<b>thin</b> 22:3 132:5	107:25 110:7	thought 76:14	tighter 205:9
209:5	115:1,2 116:1	81:24 92:2,3	207:20,24
thing 20:7	120:4,11	105:17 132:24	<b>till</b> 45:19 46:2
26:22 37:8,17	126:12 127:16	133:18 136:25	53:2 134:12
39:17 96:19	127:18 135:4	193:1 203:22	170:15 230:19
101:24 115:24	138:7 140:24	214:5 217:3	<b>tilted</b> 16:8,10
167:21,23	140:25 147:21	221:10 224:3	27:7
175:12 196:17	150:21,22	234:10	time 32:10
215:2,3 221:18	151:4 162:16	thousand 96:22	34:22 35:15.16
226:5 237:20	167:18.20		38:24 40:17

43:2,25 45:2,5	74:17 86:6	34:5,5,7 37:10	totally 68:25
46:16,17 48:8	113:11 118:4	45:10 60:25	137:6 192:22
48:10,12 50:6	118:23 119:15	62:10,12,18	touch 40:18
50:21 51:1,17	130:18 166:17	69:23,25 70:3	152:3 188:14
51:25 53:4	171:19 175:18	70:8,9,12	230:14
56:1 66:5 68:1	176:9 178:9	72:13 73:8	touched 73:18
70:25,25 71:4	229:13 230:22	74:25 75:1,14	touching
71:25 73:17	238:14 240:7	83:6 92:9 93:3	208:17
74:12 80:22	242:13 248:4	93:9 96:25	tough 186:9
85:19 88:2	together 27:5	122:5 127:20	224:15
90:19,24 93:2	45:8 47:6 51:5	128:11 129:18	towards 42:1
93:7 108:4	100:2 165:13	139:10,13,22	128:10
109:10 110:23	202:12 218:4	142:25 152:22	town 44:4
113:1 115:3,10	told 20:15	156:7 157:1	townships
122:24 123:25	71:12 72:6	161:9,9 162:2	173:10 189:4
125:16 131:9	73:20 74:12	164:11,17,24	tracy 98:25
133:24 161:14	80:25 82:14	165:19 174:22	100:1 101:15
161:18 165:22	94:6 98:19,20	183:12 188:6	106:18 113:13
169:4 171:14	113:15 114:12	204:1 211:3	240:21 242:19
180:10 181:15	173:18	216:10 217:17	trade 213:10
181:21,23	tomorrow	231:21 232:9	trained 25:16
183:22 185:10	245:19 246:14	232:14,16,17	training 11:18
203:4 211:16	248:6	233:7 241:6	traits 90:13
222:24 230:12	took 27:9 62:3	topic 71:10,21	transcript 1:10
230:20 233:2,4	65:17 66:10,11	93:12 96:3	4:3,15 5:2
233:6 237:19	67:4 118:10	116:7 127:8	240:13 249:1
245:8,15 247:5	129:11 140:22	161:5	249:10
times 84:18	142:17 202:17	topics 175:25	transfer 7:18
<b>title</b> 100:5	202:22 203:1	tops 161:16	transferred
<b>titled</b> 101:10	203:19 210:5	total 31:12	43:24 44:8
147:9	214:12 243:12	36:12 117:6	transition
today 5:6,21	<b>top</b> 16:16 19:4	176:22 178:7	182:9
12:13,25 40:12	19:4,13,22	179:4 214:7	trap 33:25,25
51:13 59:11	20:7 23:18	237:22	82:11 132:10
65:8 69:4 74:7	26:3 33:16		132:11,12,16

# [trap - understand]

197:17	<b>try</b> 14:14 44:24	173:10 177:17	unconventional
trapped 85:2	58:2 75:16	180:17 184:8	47:2 48:1
traps 81:12	102:7 115:25	189:3 193:7	<b>under</b> 12:25
84:24	168:2,6 173:25	196:11,14,15	59:18 60:12
treated 126:17	185:3 192:24	196:16,24	61:12 99:21
treatment	196:21 201:17	197:19,24,25	112:14 116:19
101:11	206:4 209:8	202:17 212:21	171:19 200:14
tremaine 3:6	211:8 218:24	214:10 217:1	undergraduate
tremendously	224:19 229:16	226:24 227:7	40:23
37:13	236:25 243:16	229:10 231:13	underground
<b>trend</b> 29:6,7,17	<b>trying</b> 47:7,22	231:14 237:9	190:5
29:19,20 49:8	80:16 86:10	237:16 246:13	underlying
50:14	98:2 102:6	<b>type</b> 42:10,11	70:12 93:17
trending 29:18	104:23,24	42:13,17 191:1	understand
trends 28:21	109:17 112:4,7	<b>types</b> 90:8	14:15 25:16
trentham 88:1	112:8,14,16	120:17 163:25	35:8,18 40:22
94:22 182:12	113:8,22 137:1	<b>typical</b> 186:5,6	45:14 49:4
194:20 246:24	187:6 224:16	186:15,16,22	52:18,20,24
247:1,9	<b>turn</b> 9:16 10:21	212:13,14,14	58:23 59:13
tried 187:3	47:8 57:16	u	74:24 76:16
220:2	236:25	ultimate 154.9	97:23 105:15
trips 230:10	<b>turned</b> 179:18	ultimately 71.3	112:13 121:19
<b>trouble</b> 179:17	192:16 193:5	71.6	122:24 124:24
troubling	<b>two</b> 7:19 10:20	ultraviolet	125:4,7,10,13
105:15	14:4 25:25	19.17 140.4	126:1,13,17
<b>true</b> 13:1 60:9	30:23 42:2	unable 85.2	129:19 130:8
60:10 74:17	48:18 49:17	143.16	132:17 138:10
154:14 165:23	50:14 69:3,7	unaware $124.7$	148:9 151:14
167:24 169:16	71:22 87:7	125.19 170.6	157:7 159:6
172:1 235:21	89:22.25 94:20	unaleen 21.1	164:12 169:19
236:1 249:9		Indexa / P	
<b>truly</b> 243:1,2	96:6 119:11	unconformities	171:7 178:16
	96:6 119:11 130:15 138:10	<b>unconformities</b> 165:24 234:12	171:7 178:16 194:18 201:18
<b>truth</b> 92:16	96:6 119:11 130:15 138:10 139:21 140:25	unconformities 165:24 234:12 unconformity	171:7 178:16 194:18 201:18 202:18 213:23
<b>truth</b> 92:16 171:22 186:13	96:6 119:11 130:15 138:10 139:21 140:25 142:15 152:21	<b>unconformities</b> 165:24 234:12 <b>unconformity</b> 165:21 166:6	171:7 178:16 194:18 201:18 202:18 213:23 220:4

# [understanding - vertical]

		1	
understanding	unitize 36:6	81:2 89:10,13	142:7 223:1,20
9:19 42:25	167:12 168:6	120:25 127:20	223:22,24
43:20 48:21,24	unitized 13:25	138:13 142:14	224:2 226:5,12
49:20 85:23	14:15 33:18	142:16 144:8	v
86:2 99:17,20	35:16 39:20	144:10 152:13	vacated 225.17
100:8 102:8	43:21 45:9	152:16,23	vacuum 106.23
103:14 105:19	49:17 166:20	153:11 154:11	valuable 49.16
117:5 126:6,7	166:25	155:2,3 195:4	202.18
126:16 131:14	unitizing 203:4	209:19 215:5	values 64.20
141:16 147:17	university 41:5	226:25 231:24	114.20
151:3 164:9	189:8 224:22	232:2,11,12,17	van 84.22
176:1 224:13	228:16 229:4,5	233:12 241:2,5	variability
246:22	230:11	uppermost	104.2
understood	<b>unring</b> 151:4	111:8	variable $103.19$
49:18 50:15	<b>update</b> 66:2	<b>upward</b> 162:3	various $77.4$
53:17 56:23	67:18 141:15	<b>usdw</b> 190:3	<b>verified</b> 107.16
60:7 70:6 97:3	updated 65:20	<b>use</b> 37:8 42:7	veritext 249.17
105:3 110:15	<b>updip</b> 15:25	77:14 86:19	versus $99.2$
110:17 111:1	34:9 123:17	119:20 159:25	224.9
112:1,9 125:2	131:22 132:9	173:7 186:15	vertical 15.2
135:15 166:16	134:13 136:2	207:3 211:19	28.18 21 29.18
242:15	137:16,18	<b>used</b> 12:4 33:8	104:3.7.12
<b>unfair</b> 178:20	159:14 160:1	93:4 97:2	112:2.8 113:9
uniformly	160:24 189:22	150:23 166:11	113:12.14.18
83:11 112:1	189:25 227:19	220:18 221:23	113:24 114:6
<b>unit</b> 11:23	229:17	231:24	114:11.14
31:18 35:14	<b>uplift</b> 16:14	<b>using</b> 33:4	122:8 148:25
39:22 94:12	<b>upper</b> 16:7,24	162:11 204:4	150:3.8 153:23
95:9 96:7	18:12 19:14	206:19	185:18.21
145:14 147:12	20:8 26:2,2,7,9	usually 10:13	200:16.17.20
163:4 167:13	28:16 33:22	<b>utah</b> 44:5	201:4.5.7
213:18	38:7 61:13	utilized 212:7	204:6 206:21
unitization	68:13,17 69:15	<b>uv</b> 21:19 26:23	214:6 236:6
33:17 35:14	69:25 71:24	26:25 67:3,9	238:15 242:22
168:5.11	72:19.23 75:5	140:17,21	
	, , , , , , , , , , , , , , , , , , ,	,	

# [vertically - water]

vertically 34:24	<b>wait</b> 114:7	warrant 196:2	116:21,25
128:20 144:10	234:22	wasting 113:1	118:5,17 120:2
218:5	waiver 7:24	water 3:13 7:13	120:17,20,24
<b>video</b> 249:5	walk 40:19	16:10,13 21:21	121:4,8,17,21
<b>view</b> 14:2 21:1	121:15 136:12	22:8 27:7,9,12	122:2,4,20,21
27:22 66:24	want 36:6,13	30:12,24 31:9	123:1,6,7,9,12
86:11 163:14	39:3,4 40:18	31:11,12,14,20	123:13,16,17
205:22	45:14 58:15	31:24,25,25,25	124:3,25 125:6
<b>views</b> 67:2,3	59:12,17 69:4	32:4,11,15,19	125:7,8,14
<b>vis</b> 175:9,9	75:22,25 76:15	32:20,21,25	126:20,22,25
viscosities	80:20 90:15	33:3,4,5,13	127:1,9,24
163:18	95:17 108:10	34:8,10,11,12	128:5,16,24
viscosity 97:15	130:5 136:11	34:15,16,16,16	129:3,7,13
164:1	143:3 155:13	34:17,18,19,23	130:2,14 131:5
<b>visible</b> 18:15	157:4,7,19,25	34:24 35:1,8	131:9,10
26:21 62:4	159:4,4 164:8	35:18,21,22,23	133:17,21
65:18 140:1	164:10 169:24	35:25 36:4,7	135:1 136:13
207:13	170:11 179:24	36:10,20,20	137:6,10
<b>visual</b> 66:1	184:18 188:1	37:16 38:14,19	144:11,13
67:2	190:7 203:9	38:21,23 39:2	146:4 147:6
<b>volume</b> 1:12	205:23 206:8,9	39:6,8,20 71:4	149:15,18,23
16:15,22 77:15	206:10,10,11	77:3,8,11 81:7	150:10,12
77:18,20	224:19 231:8	81:21 82:1,5,6	160:25 168:20
137:20 232:25	238:25	82:9 83:21	169:3,5,6,16,17
<b>volumes</b> 77:14	wanted 15:24	84:19,21 86:1	174:19 175:4,5
77:23 78:4	22:10 36:23	87:12,23 98:16	175:9,12,13,19
84:19 85:16	46:15 49:3,4,7	99:1,2,18,21	183:24 184:1
111:13 126:19	67:1 118:1	100:10 101:23	185:3,15,16,19
volunteer	129:2 146:22	104:20 106:22	186:6,17,22
180:18 245:11	146:23 152:3	108:1,6,7	189:18,21
W	204:22 214:15	109:1,2,7,7,7,8	190:1,5,7,14,17
waals 84:22	244:20	109:11,12,21	193:8 198:8,9
wackestone	wants 170:11	109:22 111:13	198:10 199:2,9
28:6	180:17	113:2,17	202:20 203:7
		114:17,20	204:7 205:18

206:5,12,21	38:24 40:8	welcome 22:11	182:1 184:9
209:2,21	45:18 87:16	wells 14:3,18	192:6 197:15
218:11 222:8	96:21 122:5	33:9,10 37:11	201:22 202:4,9
224:23 225:1,3	141:20,21	37:16 50:3	203:23 209:8
225:6 238:3	147:24 162:7	51:1 59:19,24	210:2,8 219:23
240:22,23,24	182:22 183:19	59:25 61:9	225:15,25
241:5,11,12,15	186:14 188:2,3	68:8 90:22	232:23,25
241:17,20,24	189:11 191:5	91:2,23 93:10	west 14:17 16:4
243:2,6	195:13 197:6	99:17 100:6,8	16:8 27:6,10
waterflood	197:16 200:8	100:9 105:9	29:8,20 31:18
32:17 33:8	201:23 204:1,7	107:9 112:5	33:15 38:25
38:18 49:6	206:22,25	113:17 125:6,7	42:17 44:22
76:23 77:2	208:9 213:4,6	125:20 126:18	47:7 79:14,16
79:11 81:9	214:3 220:4,14	126:20 145:7	79:18 81:6
83:15 85:24	228:8,11	149:10 155:11	88:11,14,15
86:11 87:8,23	238:19,22	157:24 166:19	110:7 120:21
101:12,22	ways 188:20	181:6 185:18	135:8 168:25
102:3 103:14	193:7	185:21 194:2	169:9 188:21
105:14 106:9	<b>we've</b> 10:4	196:11,24	190:19 192:23
108:11,25	18:11 19:19	200:2,10	247:3
113:23 123:15	32:4 36:24	212:21 229:15	western 31:18
125:4,8 127:2	37:5 39:6	237:8 240:20	36:6,13 229:9
130:22 135:6	47:12,15 64:17	240:22	230:10
137:22 149:11	154:23,24	wendell 1:5	wet 85:21 86:1
153:22 160:6	196:4 197:4	went 18:6 25:5	86:1 193:7,9
160:15 193:7	201:9 214:17	32:12 41:4	224:23,23
193:12 203:8	216:4 235:2	42:9 43:10	225:1,6,7,14
209:3 225:4	237:9 238:13	46:19 49:10,16	wettability
242:23,24	245:9	52:18 53:1	85:20,25 193:6
243:1	<b>webster</b> 40:24	62:2 65:16	224:12,20
waterflooding	week 5:22	67:24 82:10	225:13
224:12	weeks 214:12	106:24 133:18	wheeler 10:2
wave 121:25	wehmeyer 2:12	140:22 141:3	93:25 98:9
way 6:4 16:5	2:15 6:25,25	146:21 156:25	247:9
22:21 25:15	7:1,2	181:18,25	

[whiz - yeah]

<b>whiz</b> 141:21	179:6 197:5,8	157:20 167:14	world 187:14
<b>wide</b> 220:7	215:9,22 216:2	183:19 185:1	worried 151:13
227:15,15	216:8 230:6,9	192:4,25 193:8	242:23
228:3,6,6	234:4,7 239:17	194:14,20	worry 199:1,5
<b>widened</b> 30:3,7	240:7 245:17	195:24 196:10	199:6
30:13 104:14	246:8,23	201:24 202:7	worse 105:17
207:23 209:4,6	witnesses 9:22	204:2 210:20	worst 105:16
220:13 221:14	10:13 37:22	223:22 225:11	106:21 158:3
<b>wider</b> 30:3	56:11,14 57:11	225:19 229:3,7	159:17
153:24 228:5	143:24 234:1	240:21 242:21	worth 224:5
width 29:25	246:4,14,22	242:22	wozniak 3:14
30:10,21	wolfcamp 47:3	worked 12:1,2	7:12 179:16
227:18,23	wolfcampian	46:1,12,19,25	<b>write</b> 12:5
228:3 229:18	79:5	47:2 105:17	82:20
wifi 115:22	wonder 167:11	117:23 168:5	<b>written</b> 53:13
<b>william</b> 1:22	wondered	187:2 193:1	58:9 90:20,24
5:13	115:4	194:21 222:16	98:13 113:16
<b>willing</b> 164:7	woodford 47:3	working 11:25	120:16
wilson 211:11	<b>wor</b> 108:1	25:20 34:21	wrongly 200:18
wisconsin	word 75:8,10	39:16,18 42:8	204:5
189:9 228:16	158:10	43:11,12 44:10	wrote 53:16
229:5 230:11	words 173:7	46:16 48:1,9	118:25 237:4
<b>wise</b> 117:10	<b>work</b> 6:4 24:16	48:19 49:6	242:10
<b>wish</b> 221:2	24:23 38:24	98:15 117:25	<b>wtr</b> 35:21
<b>wishes</b> 8:16	40:8 42:2,8	124:6 149:22	X
<b>wishful</b> 240:8	43:15,25 44:7	166:23,23	<b>x</b> 4.1 108.17 23
withdrawal	44:14,19 45:22	182:18 183:23	109.9 10
103:1	46:15,18 48:4	186:18 187:10	<b>xto</b> 124.8 167.9
witness 4:4	48:18 51:12	201:10,12	193.25
10:3,5,7,14,17	54:16,17 86:3	218:9 226:22	1)5.25
10:18 22:9,15	92:3 95:20	works 151:20	<u>y</u>
22:17 38:5	97:6 102:11	216:1 223:23	<b>y</b> 108:3,15,22
56:13 116:3	103:23 104:22	workshop 47:6	109:6,10
150:21 167:24	106.6 107.5 10	17.15	veah 23:9.11
	100.0 107.3,18	47.13	

45:7,19 48:13	207:5 208:1,1	37:23 38:2
49:25 50:17	209:23 211:21	39:13 45:9,10
51:12 57:4	212:2 213:25	45:10,10,10,10
62:10 63:8	216:2,21	59:21 60:5,16
64:23 67:14	222:11 227:21	61:10,17 68:9
68:3,3,6 70:16	228:23 229:14	73:21 75:6
73:15,15 77:6	229:14 231:14	83:24 84:2,17
78:1,13 80:7	237:7 238:5	90:17 93:17
80:10 85:4,14	241:4 245:18	95:18 103:15
86:25 91:9,9	246:3	112:18 122:5
96:10 99:10,13	<b>year</b> 47:7	131:11 159:18
99:15 102:16	106:24,24	159:18,20
102:17,22	124:2 125:18	161:20 163:3
109:4 116:14	151:17 182:14	169:13 181:8
117:12,20	193:2 202:9	184:10 185:12
119:3 122:14	223:18	210:19 213:20
124:13 125:2,2	<b>years</b> 23:10	236:14 239:10
129:2 132:3	39:16 42:7	239:10
135:7,15,18,23	47:8,9 77:24	<b>zones</b> 17:7,15
136:9 137:1	100:1 129:14	74:14 81:11
142:1,3 148:17	187:5 193:24	87:24 103:17
148:22,22,22	201:10 210:10	103:18,20
154:18 155:20	210:10,10	109:19 110:1
156:12 158:15	220:23 225:10	111:2,7,8,14
162:25 163:21	<b>yellow</b> 15:18	114:21 126:21
182:25 186:1	19:25 33:24	147:15,18
187:10 191:19	134:15 144:20	154:16 157:8
191:24 195:22	<b>yep</b> 79:24	157:15 158:22
196:12,13,15	<b>younger</b> 220:18	158:23 159:17
197:1,13 198:5	Z	182:9,13,15
198:5,17,19	<b>zero</b> 192:14	213:24
199:8,11 200:9	zone 17:21	<b>zoom</b> 63:9,20
200:23 201:9	18:18.20 24:18	140:9 173:21
204:21 205:18	24:25 25:6.14	215:5,23
205:22 206:4	25:16.19 37:5	