In the Matter Of: STATE OF MISSISSIPPI vs STATE OF TENNESSEE 143, Original PROCEEDING May 21, 2019 ALPHA REPORTING Corporation 1st in Reporting, 1st in Service, 1st in Technology We Bridge the State and Cover the Nation! www.alphareporting.com 800-556-8974

IN THE SUPREME COURT OF THE 1 UNITED STATES 2 ----x 3 STATE OF MISSISSIPPI, 4 Plaintiff, 5 No. 143, Original v. б STATE OF TENNESSEE, CITY OF MEMPHIS, TENNESSEE, AND 7 MEMPHIS LIGHT, GAS & WATER DIVISION, 8 Defendants. 9 -----x 10 11 May 21st, 2019 9:00 a.m. 13 14 ON BILL OF COMPLAINT 15 Before: 16 HON. EUGENE SILER, 17 Special Master 18 19 APPEARANCES 20 BARRETT LAW GROUP, P.A. Attorneys for Plaintiff 21 BY: DAVID M. MCMULLAN, JR. 22 DANIEL COKER HORTON & BELL, P.A. Attorneys for Plaintiff 23 BY: C. MICHAEL ELLINGBURG LARRY D. MOFFETT 24 NEAL & HARWELL 25 Attorneys for Plaintiff BY: CHARLES BARRETT

230 1 2 A P P E A R A N C E S (continued) 3 KELLOGG, HANSEN, TODD, FIGEL & FREDERICK Attorneys for Defendant State of Tennessee 4 BY: DAVID C. FREDERICK JOSHUA D. BRANSON 5 T. DIETRICH HILL GRACE W. KNOFCZYNSKI б HERBERT H. SLATTERY III Attorney General for Defendant State of Tennessee 7 BY: BARRY TURNER 8 BAKER, DONELSON, BEARMAN, CALDWELL & BERKOWITZ 9 Attorneys for Defendants City of Memphis, Tennessee and Memphis Light, Gas & Water Division 10 LEO M. BEARMAN BY: DAVID L. BEARMAN KRISTINE L. ROBERTS 11 12 BRUCE A. MCMULLEN Attorney for Defendants City of Memphis 13 14 EXAMINATION 15 RICHARD K. SPRUILL PAGE Direct by Mr. Ellingburg 16 232 Cross by Mr. Branson 277 17 Cross by Mr. L. Bearman 353 Redirect by Mr. Ellingburg 369 18 Recross by Mr. Branson 388 19 DAVID A. WILEY 20 Direct by Mr. McMullan 397 21 EXHIBITS ADMITTED 22 Docket 73 416 23 J58, J15, J10, J3 433 24 25

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1	231 THE CLERK: The United States Supreme Court, Special
2	Master Eugene Siler presiding. All who have business before
3	this honorable court, draw near.
4	THE COURT: When we left off yesterday we had the
5	issue of whether the present witness, Dr. Spruill, should go
6	ahead and testify sort of as a rebuttal witness to the witness,
7	Mr. Waldron. And I think what we'll do, we won't require him
8	to do that because that's not in the ordinary way that you try
9	cases. And although we're not bound by the rules, we generally
LO	follow those.
L1	So he can testify that way if he wants to or if
L2	counsel wants him to, but he's not required to. And then if
L3	Dr. Waldron takes the stand, it will be up to Mississippi to
L4	decide whether they want to call the witness in rebuttal.
L5	I do not anticipate that we would allow it out of
LG	order since that's generally not procedure in the courts.
L7	So with that, you may proceed for Mississippi.
L8	MR. ELLINGBURG: Thank you, Your Honor. One thing.
L9	We have someone coming over on the way with the copies of this,
20	but they were circulated yesterday, and I just wanted to show
21	you these figures. Oh, here it is. Thank you.
22	MR. BRANSON: You're saying these are the ones that
23	you're going through one by one to authenticate?
24	MR. ELLINGBURG: That's just for the authenticity of
25	them.

232 1 MR. BRANSON: Thank you. 2 MS. ROBERTS: And you'll be using these again with this witness? 3 4 MR. ELLINGBURG: Yes. 5 THE REPORTER: I can't hear you, Counsel. (Off-the-record discussion.) 6 7 MR. ELLINGBURG: Can you hear me now? 8 Dr. Spruill, will you take the stand? 9 DIRECT EXAMINATION 10 BY MR. ELLINGBURG: 11 Dr. Spruill, do you have a copy of the figures from your 0 12 report we identified vesterday? 13 Α Yes. 14 Q Thank you. 15 MR. ELLINGBURG: Your Honor, may we proceed? 16 THE COURT: Yes. Go ahead. 17 MR. ELLINGBURG: Thank you. 18 BY MR. ELLINGBURG: 19 Dr. Spruill, yesterday afternoon we marked a set of 0 20 plaintiff's exhibits, and I'm going to walk through them 21 briefly now for purposes of a few clarifications. And so what 22 I'd like you to do is to look at P191, which is the first 23 figure in front of you. 24 And I don't think we need to go into any detail with 25 it except I'd like to ask you if you know where that came from.

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Proceeding - May 21, 2019 233 1 Where did that figure come from? 2 Α It's a figure from Alley, et al., in 1999, somewhat modified. 3 4 Q Okay. And the Alley report is J2. 5 And this basically shows the top area, the undefined off to the right? 6 7 А That's correct. We don't need to discuss it any further, I don't think. 8 0 9 Okay. 10 Now, the next figure is also one that we discussed at 11 some length yesterday at P192. 12 And this is taken from Heath; is that correct? 13 А No. 14 Q No? 15 I think it's found on the -- on a website. А 16 Q Okay. The State of Minnesota. 17 А 18 Q Thank you. 19 But you discussed this figure yesterday, so we won't. 20 It's P192. And this is the one that titled "Confined versus 21 Unconfined Aquifers and Artesian Wells"? 2.2 А Yes. 23 Figure -- the next figure, it's P193, is the aerial view. Q 24 It says, "Physiographic Provinces of the Mississippi 25 Embayment."

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1	And was that taken from USGS documents?
2	A It was.
3	Q And basically what does it show? What does physiographic
4	mean?
5	A It shows the different subdivisions of the Mississippi
6	Embayment, such as the West Gulf Coastal Plain, the Mississippi
7	Alluvial Plain, et cetera.
8	Q Thank you.
9	And what is the Mississippi Alluvial Plain? Is that
10	the area of the Mississippi Delta primarily?
11	A Primarily.
12	Q Thank you.
13	Now, the next slide or the next figure is P194. And
14	that is the chart we looked at for some time yesterday, right?
15	A Yes.
16	Q And it
17	A No. No. I don't believe we looked at this chart yesterday
18	other than during this time when you we looked at a
19	modification, a different version of this chart.
20	Q Okay. Now, this one is limited to West Tennessee and
21	Northern Mississippi?
22	A Correct.
23	Q And these are all figures that came out of your June out
24	of your report issued in 2017; is that correct?
25	A That's correct.

1	235 Q Okay. And so and this one, it clearly shows a division
2	you were pointing out on the larger chart, I believe, between
3	West Tennessee and North Mississippi under those two columns;
4	is that correct?
5	A That's correct.
6	Q And you go into some detail.
7	And that came from is that Alt 2016?
8	A Yes.
9	Q And that is Joint Joint Exhibit 39.
10	Exhibit 195, which came from your report, what is this
11	showing different than what we talked about yesterday?
12	A We talked about a lot of
13	MR. D. BEARMAN: Excuse me, Your Honor. I'm sorry to
14	interrupt.
15	Mr. Ellingburg, you identified that previous exhibit
16	as Joint Exhibit 39, and I believe it is Plaintiff's
17	Exhibit 194.
18	MR. ELLINGBURG: That comes the point is Joint
19	Exhibit 39 is the source of that document, as I believe shown
20	on the document.
21	MR. D. BEARMAN: I'm sorry. I just want to make sure
22	because ours is listed
23	MR. ELLINGBURG: Okay. I'll make this clear.
24	THE COURT: Okay. Clear it up. Thank you.
25	MR. ELLINGBURG: P194 states on its face that it is

1	236 from Haugh 2016, Table 1. That and I stand to be corrected,
2	but I believe, looking at it I know it's a joint exhibit,
3	and I believe it's J39, is the document from which this chart
4	was obtained.
5	BY MR. ELLINGBURG:
6	Q Moving on back to Exhibit 1
7	MR. ELLINGBURG: And the same was true of P194. In
8	each of these cases, the reference that I'm making is to the
9	source is joint exhibits where they are that provided the
10	original document from
11	THE COURT: I'm sorry?
12	MR. ELLINGBURG: When I refer to a joint exhibit, what
13	I'm pointing out is that the particular figure was taken from
14	that joint exhibit, not that it is entire joint exhibit.
15	THE COURT: Okay. You may proceed.
16	MR. ELLINGBURG: Is that clear? Okay.
17	BY MR. ELLINGBURG:
18	Q If you would, look at Figure 1 of 9 or P195.
19	Do you see it, Dr. Spruill?
20	A Yes, sir.
21	Q All right. P195 is not in a joint exhibit, but it states
22	on its face that it's from Grubb 1998.
23	What is Grubb 1998?
24	A It's a publication that I utilized.
25	Q Is it a book or a

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1	237 A It's a publication, if I remember correctly.
2	0 Okay. Thank you.
2	Do you know who the source what the source of it
4	wag?
5	A I do not recall.
6	0 Thank you.
7	Tell me what it shows.
8	A It shows that the surface distribution of the regional
9	aquifers and confining units in the Mississippi Embayment and
10	the larger Gulf Coastal Plain, and so as far as distribution,
11	it means what you would see at the surface if you walked around
12	the surface and looked at the composition and nature of
13	materials.
14	Q Okay. And the Gulf Coastal Plain is the Mississippi
15	Embayment is within the Gulf Coastal Plain; is that correct?
16	A That's my opinion.
17	Q Okay. Well, is that what the geology shows?
18	A Yeah. That's what the geologists say.
19	Q Okay. Now, Figure 198 is the figure we talked about at
20	some length yesterday. We're not going to talk about it again.
21	But I just want to point out for the record that it is has
22	been taken from Joint Exhibit 36, which is a Parks 2008 USGS
23	report. And I believe the arrows are probably added off of
24	that particular version.
25	P199 was it says that it's the figure in your

Proceeding - May 21, 2019 238 report said it was modified and taken from Arthur and Taylor, 1 2 1998, which is a USGS report; is that correct? 3 Α Correct. So how was it modified? With the arrows? 4 0 5 I drew two flow lines on this figure. Α 6 0 Okay. So what was the purpose of drawing the two flow 7 lines? Flow lines are drawn at right angles to lines that equal 8 А total hydraulic head, and flow lines would be an indication, 9 10 based on this head distribution, of flow direction. 11 Okay. And that -- is this -- I think it says, 0 12 "Predevelopment Groundwater Equipotential Map." What does that mean? 13 14 Α It means that prior to any significant pumping, this --15 these authors, Arthur and Taylor -- so it's confusing; the 16 author is Arthur and Taylor -- depict their equipotential 17 surface using a series of contour lines, each of which is a line of equal total hydraulic head. 18 19 Okay. You discussed that some yesterday. Did you modify 0 20 this in any way other than adding the arrows showing where the 21 groundwater would flow with these -- within their map? 2.2 А No. 23 So the only thing you did was add the arrows? Q 24 А That is correct. Okay. And what does this show with regard to groundwater 25 Q

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1	flow before development in Mississippi?
2	A It shows that in where I drew the arrow down in the
3	State of Mississippi, that there is a westward I suppose
4	slightly north of a westward flow direction, and in Tennessee
5	there is a more northwestern flow direction as it based on
6	these lines of total hydraulic head.
7	Q Okay. Thank you.
8	P200 is another map from that same source, is it not?
9	A That is correct.
10	Q Okay. And have you changed anything about this map other
11	than drawing those arrows on it?
12	A I did not.
13	Q And what does this shows it says it's
14	"Postdevelopment Groundwater Equipotential Map and Flow
15	Patterns in Middle Claiborne Aquifer" from Plate 7 or from
16	Arthur and Taylor, 1998.
17	THE REPORTER: From?
18	MR. ELLINGBURG: And I will try to speak up. I'm bad
19	about doing that. My wife tells me all the time.
20	BY MR. ELLINGBURG:
21	Q So did you change anything about this map other than adding
22	the arrows?
23	A No.
24	Q What did this map show? Why was it in your report?
25	A This map is was produced by the authors, Arthur and

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1	Taylor, to depict the configuration of the equipotential
2	surface in this area based on data, I assume, from prior to
3	1998, which is the published data, publish date. And it shows
4	the impact of groundwater withdrawals on the equipotential
5	surface.
6	Q In Tennessee?
7	A In Tennessee and Mississippi. Well, it shows the it
8	shows the impact of groundwater withdrawals generally.
9	Q Okay. Which has changed the flow pattern predevelopment?
10	A That is correct.
11	Q From an essentially western, maybe a little north, to
12	north, right, in Mississippi?
13	A The flow path previously indicated in the predevelopment
14	map is shifted more towards the cone of depression as shown by
15	some closed contours, roughly in the position of the City of
16	Memphis, and it shows a deviation of groundwater flow direction
17	more towards the northwest in northern Mississippi and more
18	westward, with a slight slight southwestward bend at the end
19	of the flow line, up in Tennessee.
20	Q That was a little confusing to me.
21	A Okay.
22	Q The P1 let's see. P199 is their predevelopment natural
23	flow; is that correct?
24	A Yes.
25	Q That's 199. 200 is postdevelopment, after there is

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1	pumping?
2	A Correct.
3	Q Does P200 show the impact of pumping in Tennessee on the
4	natural flow direction?
5	A Yes.
6	Q Okay. And those arrows are indicated to that you added
7	are put on there to show that change in the natural flow
8	direction; is that correct?
9	A They're they're on there to show the direction of flow
10	based on those lines of equitotal hydraulic head.
11	Q After pumping starts?
12	A Absolutely. After the onset of pumping, but not beyond
13	1998, which was the obvious publication date.
14	Q Thank you.
15	Okay. P201 is the next one I have. And this is just
16	a general unconfined groundwater example, is it not?
17	A Yes, it is.
18	Q And it says you took it from Graniman? Is Graniman
19	[phonetic] a book or a publication?
20	A I don't recall whether Graniman is a small book or a
21	publication or sorry, or a reference paper.
22	Q But it's published hydrogeological information?
23	A Yes. Absolutely.
24	Q Now, we covered P202 in some detail yesterday. We don't
25	need to talk about it again at any length.

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1	But what I'd like to ask you, it says it's a it's
2	modified from Winter, et al., 1998. Now, Winter, 1998, is
3	Joint Exhibit 79, which is a USGS publication.
4	Was taken from Winter?
5	A Yes.
б	Q And when it says "modified," was that modified by you or
7	was it
8	A I'm not sure about that, but I did modify it. So there
9	could have been modifications on the figure that I looked at,
10	and I further modified it by adding a couple of small arrows.
11	Q All right. And where do they appear?
12	A Those small arrows appear between the the water table
13	and the land surface in the unsaturated zone.
14	Q And how did you draw those small arrows? Was it based on
15	those equipotential lines?
16	A No. It was based on the concept that I think is poorly
17	understood, and that is that when you look up at the top of
18	this diagram and see groundwater recharge areas area, it
19	leads people to believe that recharge only occurs in the
20	groundwater recharge areas and not in the discharge area, that
21	is, across the land surface and down to the water table.
22	So I emphasized that, when it rains, it doesn't just
23	rain in the recharge area and water doesn't just make it down
24	into the aquifer in the recharge area.
25	Q Okay. So but all you added to this figure was the

1	arrows?	243
2	A That's what I recall.	
3	Q Thank you.	
4	A Yep.	
5	Q If you would, look at P204.	
6	And this is taken from Criner and	Parks, 1976; is that
7	correct?	
8	A Correct.	
9	Q And that is Joint Exhibit 24.	
10	Did you modify this in any way?	
11	A I don't believe that I did, no.	
12	Q Okay. This is the chart, to your knowl	edge, that came out
13	of Criner and Parks?	
14	A To the best of my knowledge, yes.	
15	Q Thank you.	
16	I'd like to look at P205, Figure 3	3.
17	A Yes.	
18	Q It says, Criner and Parks, 1976 Equipot	cential Map
19	A Correct.	
20	Q for Confined Portions of the Middle	Claiborne Aquifer,
21	right?	
22	A Correct.	
23	Q And you added, "Also known as SMS or Me	emphis Aquifer," and
24	then, paren, "in 1886."	
25	That's going to be predevelopment;	is that correct?

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1	A Yes.
2	Q Now, you used SMS in this report to refer to Sparta and
3	Memphis Sand, right?
4	A Yes.
5	Q Okay. Are the Sparta and the Memphis Sands strike that.
6	Yesterday you said those were different from aquifers.
7	Why would you refer to them as SMS here?
8	MR. BRANSON: Objection, Your Honor. He's testifying
9	for the witness.
10	MR. ELLINGBURG: I didn't. I'm just asking him.
11	THE COURT: Go ahead. You may ask.
12	BY MR. ELLINGBURG:
13	Q Did you testify yesterday that the Sparta Sand and the
14	Memphis Sand were separate aquifers?
15	A The Sparta Sand and the Memphis Sand are separate
16	formations, and my opinion is that the Sparta Aquifer and the
17	Memphis Aquifer are different aquifers.
18	Q Thank you.
19	And are they part of the same hydrogeological unit?
20	A Yes.
21	Q Is that why you referred to them this way?
22	A Yes.
23	Q Thank you.
24	Next figure is 206. And it says on its face that it
25	is from pre-2000 1972.

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1	And it shows an equipotential map for confined
2	portions of the Middle Claiborne Aquifer, again, same
3	nomenclature, in 1886. This is part of J Joint Exhibit 67.
4	Now, why did you use this figure?
5	A I was looking for different reports that indicated the
б	configuration of the equipotential surface in this region, but
7	I was also interested in finding reports that showed how
8	different aquifers exist in different parts of the system. And
9	I believe this diagram shows both equipotential lines and as an
10	indication of how aquifers exist in different parts of the
11	region.
12	Q Okay. Now, this is a 1972. Does this show the transitions
13	we were discussing yesterday?
14	A It shows the approximate zone of transition.
15	Q And does it show outcrop areas for the two aquifers in
16	Tennessee and Mississippi?
17	A Yes.
18	Q And how are those shown?
19	A It's shown by this darkest pattern, which would occur on
20	the east side of the Mississippi Embayment in Tennessee and
21	Mississippi but, again, on the west side of the Mississippi
22	Embayment.
23	Q Okay. So this shows the east side and the west side?
24	A Yes.
25	Q So on the east side, the dark pattern is the area that's

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1	outcropped or unconfined; is that correct?
2	A Correct.
3	Q And the rest of it would be confined?
4	A That's correct.
5	Q Okay. And that would be the dark line within the diagram?
6	There's a dark line
7	A Dark pattern.
8	Q Dark pattern?
9	A Yes.
10	Q Thank you.
11	Now, Exhibit P207, it says it explains that it is
12	taken from two different USGS reports; is that correct?
13	A Yes.
14	Q Okay. And could you tell me what you're showing in these
15	two USGS reports?
16	A The one at the top was produced by Criner and Parks in
17	1976, and the one at the bottom was produced by Reed in 1972.
18	Q And you've blown up the Reed portion at the
19	Mississippi-Tennessee border; is that correct?
20	A Yes.
21	Q So what do these two what were you illustrating with
22	these two in your report?
23	A Once again, I was very interested in how groundwater flows
24	in the Memphis Aquifer and the Sparta Aquifer, and the way you
25	determine that is to find maps that show contours of total

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1	hydraulic head, and then you can begin to understand the	41
2	directions of groundwater flow and hydraulic gradients.	
3	Q Is the bottom figure predevelopment?	
4	A Yes.	
5	Q Okay. Is that a blowup that's a blowup of the I	
6	think the figure we just looked at, right, at the border?	
7	A That's correct.	
8	Q Okay. And the top figure, is that one of those while	
9	there's pumping going on?	
10	A No.	
11	Q There is no	
12	A I can't say there was none, but I think this is an	
13	equipotential surface map for the year 1886.	
14	Q Okay. So they're both predevelopment, and the Mississippi	
15	state line is at the very bottom of the top figure; is that	
16	correct?	
17	A Yes, it is. It's hard to see, but it's at the 35th mor	е
18	or less at the 35th parallel.	
19	Q Or latitude?	
20	A Latitude.	
21	THE COURT: I don't understand what you're telling me	•
22	THE WITNESS: 35th degree latitude, more or less. I	
23	apologize.	
24	BY MR. ELLINGBURG:	
25	Q And the last of these figures is P208.	

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1	And this is a this is, again, a general educational
2	slide we discussed yesterday?
3	A Yes.
4	Q Okay. And it was taken by a guy by the name of Tarbuck and
5	Lutgens. And so who are they?
6	A They are the authors of the only textbook I've ever
7	considered using for the last 15 years for teaching fundamental
8	concepts of geology to the graduates.
9	Q Okay. Thank you.
10	MR. ELLINGBURG: Excuse me, Your Honor.
11	BY MR. ELLINGBURG:
12	Q Dr. Spruill?
13	A Yes, sir.
14	Q I'm handing you a document titled "Appendix A," list of
15	references.
16	Can you identify this as the appendix to your original
17	report?
18	A Yes, I can.
19	Q Okay. So would you tell me, what is this list?
20	A This is a list of publications of different types,
21	including books, such as each book or series of books, like
22	Groundwater Reaches of the US and other publications that I
23	have relied on since my involvement in this in this process.
24	Q Yesterday you testified that part of your basis for the
25	pre- and postdevelopment flow were the Brahana reports; is that

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T	correct?
2	A Correct.
3	Q And are those listed on your list of references?
4	A Yes.
5	Q So yesterday when we were talking about USGS reports that
6	you'd utilized and relied on, does this list reflect those?
7	A Yes, it does.
8	Q And I think are there any other USGS reports that are
9	not on this list? I mean, it says at the top it's not or
10	you say at the top comprehensive.
11	A I would just say generally that I'm a voracious reader, and
12	I'm sure that I've read lots of reports that may not show up on
13	this list.
14	MR. ELLINGBURG: Okay. Can we mark this for
15	identification, the appendix?
16	THE COURT: Any objection on that?
17	MR. BRANSON: Is this the same version in his expert
18	report?
19	MR. ELLINGBURG: It's exactly the one taken from his
20	expert report
20	MR D READMAN: No objection
21	MR. D. BEARMAN: NO ODJECTION.
22	THE COURT: Okay. That would be fine.
23	MR. ELLINGBURG: I'd like to mark this for
24	identification as Exhibit P197.
25	THE COURT: All right.

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1	MR. ELLINGBURG: No, that's not right. I'd like to
2	mark this for identification as Exhibit P209.
3	THE COURT: That's fine.
4	(Exhibit No. P209 was marked for identification.)
5	MR. ELLINGBURG: And yesterday we circulated the
6	drawing made on the white board. I'd like to mark it as P210.
7	THE COURT: All right.
8	MR. BRANSON: No objection.
9	MR. D. BEARMAN: No objection, Your Honor.
10	(Exhibit No. P210 was marked for identification.)
11	BY MR. ELLINGBURG:
12	Q Before we look at this, I wanted to get them circulated so
13	everyone would have them. I'd like to ask a few questions,
14	Dr. Spruill.
15	A Yes.
16	Q Before you look at those, I'd like to ask a few questions.
17	Yesterday you talked some about the impact you
18	talked a lot about the impact of pumping and the conditions and
19	some about well field design. I'd like to turn briefly to the
20	issue of well field management.
21	In terms of cones of depression that are created by
22	pumping the wells, now, is it is it possible to avoid
23	impacts the area influenced by cones of depression of
24	pumping a well?
25	A Can you repeat that question?

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1	251 Q Yes. Is it possible to control we talked about
2	calculating the reach of a cone of depression yesterday.
3	A Yes.
4	Q Is it possible to limit the reach of cones of depression
5	when you're developing groundwater in the Memphis Sand or some
6	other aquifer?
7	A It's possible to limit the cone of depression in both of
8	the dimensions that I've talked about yesterday, and that is,
9	it's possible to limit the size of the cone of depression as
10	area of extent, which we always referred to in terms of
11	arsetero [phonetic], the theoretical limit of the cone of
12	depression, as its radius.
13	But it's also possible to limit the depth of the cone
14	of depression, which is the drawdown associated with the
15	withdrawal centers in the wells and adjacent to the wells.
16	Q Okay. So first let's talk about the what I'll call the
17	geographic extent.
18	How do you limit the geographic extent of pumping the
19	same amount of groundwater in a particular aquifer on the
20	Memphis Sand?
21	A The geographic extent of the cone of depression is a
22	function of the hydraulic properties, transmissivity, storage
23	coefficient, and time.
24	Q Okay.
25	A So it's important to remember that. The pumping rate does

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1	not affect the limit of the cone of depression.
2	If you want to limit the geographic extent of the cone
3	of depression as you have described it, you can limit the
4	amount of time of pumping primarily. So that the cone of
5	depression, after a year of continuous pumping, is appreciably
б	larger than the cone of depression after a few days or weeks of
7	pumping at the same rate.
8	Q I think that was shown on one of your slides yesterday
9	A That's true.
10	Q that had the logarithmic scale.
11	A I used the example of pumping around 6,000 gallons a minute
12	versus 14,000 gallons a minute, if I remember correctly, at
13	Lichterman, as calculated early on for the Lichterman the
14	Lichterman study done by the USGS.
15	Q Have you ever designed a well field that was intended to
16	limit the reach of the cone of depression through cycle
17	through limiting the time of pumping?
18	A Often, yes.
19	Q So how is that done?
20	A So I try to calculate the I don't try. I calculate the
21	theoretical limit of the cone of depression by understanding
22	the hydraulic properties of the aquifer within the well field.
23	So I very systematically determine the hydraulic properties of
24	the aquifer.
25	Armed with transmissivity and storage coefficient of

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1	253 the aquifer, can calculate the cone of depression theoretical
2	limit for any time of continuous pumping.
3	And the way I like to limit the cone of depression is
4	by having multiple wells that pump on alternating schedules
5	with significant rest periods between the pumping cycles so
6	that the cone of depression expands outward during a pumping
7	cycle but recovers during the rest period.
8	Q I think the theoretical limit is based on continuous
9	pumping. Is that correct?
10	A The theoretical limit is based on continuous pumping of any
11	duration.
12	Q Okay.
13	A So you can the theoretical limit of the cone of
14	depression is a function of time.
15	Q So that was that was the 90,000 feet or so, 100,000 feet
16	we talked about yesterday?
17	A That was the example I gave for an aquifer of certain
18	hydraulic properties pumped for a year.
19	Q Okay. So if you pump it so explain again, these
20	wells, more than one well, are they right next to each other?
21	A Are you asking for a specific example of how I would do it?
22	Q Yes.
23	A Okay. Let's see. One of the examples I would give would
24	be a well field that I designed for the City of Washington,
25	North Carolina, that involved water supply for a town of about
20 21 22 23 24 25	<pre>wells, more than one well, are they right next to each other? A Are you asking for a specific example of how I would do : Q Yes. A Okay. Let's see. One of the examples I would give would be a well field that I designed for the City of Washington, North Carolina, that involved water supply for a term of above.</pre>

	254
1	10- to 12,000 people. I designed eight total wells, each well
2	spaced a mile apart.
3	I designed a pumping schedule where, in this sequence
4	of eight wells spread over many, many miles, I designed a
5	pumping schedule so that four of those wells would pump for 12
6	to 16 hours to meet a supply, including storage.
7	And the wells would be turned off. The cone of
8	depression would essentially recover. And after a period of
9	rest, I'd pump the alternate sequence. So I'm not even pumping
10	the same wells maybe once every 48 hours or 36 hours.
11	So pump pump half my wells for a while, shut them
12	off, let the system rest. Let the let the cone of
13	depression lessen to essentially what it was before pumping,
14	and then pump the other schedule of wells.
15	Q And was that well field designed for any specific
16	application in that case in terms of what the geology was and
17	the
18	MR. L. BEARMAN: May I interrupt just a second?
19	MR. ELLINGBURG: I'm leading. I'll stop. I'll
20	withdraw the question.
21	MR. L. BEARMAN: If I stood up every time he's
22	leading, Your Honor, I would be in better shape probably than I
23	am now.
24	I want to be sure that we are maintaining in the
25	record our continuing objection to this area and other areas

255 that have been attempted to introduce as being beyond the scope 1 2 of the issue that Your Honor has set out so that I don't have 3 to jump up every time. 4 THE COURT: Okay. You can have a continuous objection 5 on that. I'll overrule it. 6 You may proceed. 7 MR. L. BEARMAN: And as long as I'm up and he suggested it, I object to all the leading. 8 9 THE COURT: Okay. All right. 10 MR. ELLINGBURG: There hasn't been that much. Just 11 that question. 12 MR. L. BEARMAN: And the testifying, if I may add that 13 to my motion. 14 THE COURT: I understand. The Court will disregard any testimony by counsel anyway. 15 16 MR. ELLINGBURG: Thank you. 17 BY MR. ELLINGBURG: 18 0 That was an example of how the limitation -- was that just an example of how the cone of depression can be accomplished? 19 20 Α That was an example of how I designed a well field to limit 21 the cone of depression because of overwhelming concerns about 2.2 saltwater intrusion if the cone of depression was too large and 23 sustained. 24 Thank you. 0 25 Is there any way you use the existence of multiple

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	256
1	aquifer units to limit the reach of a cone of depression from
2	groundwater pumping?
3	A One of the ways to limit the cone of depression is to use
4	multiple units within an aquifer or multiple aquifers to limit
5	the size of the cone of depression.
6	Q And how is that done?
7	A Well, I'm sure it's done differently in different states.
8	We don't allow, in North Carolina, the construction of a single
9	well that taps multiple aquifers, so it would require different
10	wells tapping different aquifers. And the wells can be real
11	close together or tapping different zones within the same
12	aquifer.
13	But, again, depending on the transmissivity, storage
14	coefficient, and pumping time, each of those wells would be a
15	certain radius of the cone of influence.
16	Q Thank you.
17	Yesterday towards the end you referred to a USGS
18	report by the name Moore. Do you remember that?
19	A Yes.
20	Q Have I placed that report in front of you? Was it at the
21	top of the stack? That's not it.
22	A Did you say on the top of the stack?
23	Q No.
24	A Oh.
25	Q Okay. If you would look at J50 Joint Exhibit 58.

	257
1	A I found it now.
2	Q Is this the Moore report you were referring to yesterday?
3	A Yes.
4	Q And how did you use this in the analysis that you gave
5	yesterday in terms of your opinion about pumping in Tennessee?
б	A Moore offers a lot of information about the geology and
7	hydrology of the Claiborne group in Western Tennessee and
8	giving, I think, a pretty detailed analysis of the hydrology
9	conditions in the Memphis Sand in Western Tennessee.
10	Q When you say "pretty detailed information," what kind of
11	information are we talking about?
12	A He gives information on the size of the outcrop area, the
13	geological formations that exist in the region, the occurrence
14	and movement of groundwater. He gave information about
15	hydraulic properties of the Memphis Sand and what he called the
16	unnamed sand in that region.
17	Q What is the unnamed sand?
18	A The unnamed sand is a sand of different age; I interpreted
19	it to be above the Memphis Sand in this region. And at the
20	time he did the work, I suppose, is what I interpret, that
21	there was no formal name assigned to it, so he called it the
22	unnamed sand unit.
23	Q Well, without regard to whether he it was named, did he
24	provide you hydraulic properties for the unnamed sand and the
25	Memphis Sand in that report?

Γ

1	258
T	A les.
2	Q And is there extensive discussion in this report of Shelby
3	County, Tennessee?
4	A Yes.
5	Q Thank you.
б	And did you actually utilize in allowing this report
7	in forming your opinions?
8	A Yes.
9	Q Thank you.
10	I'd like you to look at Joint Exhibit 22.
11	A I'm sorry. While I've learned a lot about the legal
12	process sitting here, but I have trouble following by number.
13	What is
14	Q It has an exhibit sticker on the lower right-hand corner on
15	the far part of this report.
16	A Is it in this report?
17	Q Let me see. It's not Moore. No. I've changed to another
18	report. Let me see your stack.
19	A Okay.
20	Q There should be one more report here. There you go.
21	Now, do you see that number?
22	A I do.
23	Q Okay. Each of these reports has a number.
24	A Okay.
25	Q Thank you.

Γ

1	259 Have you seen Joint Exhibit 22 before and used this as
2	part of formulating your opinions?
3	A Yes.
4	Q And how did you use this report?
5	A In the same way. I used this report to gain information
6	about the groundwater system in the area around Memphis,
7	Tennessee.
8	Q And by "information," what kind of information do you mean?
9	A I'm mainly I'm very interested in the hydraulic
10	properties of aquifers and flow directions within aquifers, and
11	so I've used it because I was interested in finding values of
12	transmissivity and storativity for the Memphis Sand Aquifer.
13	Q And did you allow that in formulating your opinions that
14	you described that you gave yesterday?
15	A Yes.
16	Q And I have one more report, which is Joint Exhibit 59.
17	A Okay.
18	Q Have you you testified yesterday, I believe, about this
19	Lichterman report; is that correct?
20	A Yes.
21	Q Okay. And was that testimony based on information you
22	obtained from J59?
23	A Yes.
24	Q Now, I believe you gave an opinion yesterday, but you'll
25	have to let me know, about the availability of groundwater in

	260
1	West Tennessee, north of Memphis, that was subject to being
2	developed; is that correct?
3	A Yes.
4	Q And what information, if any, did you use from any of those
5	reports to as a foundation for that opinion?
б	A Well, I used the both of the two reports that we've just
7	been talking about.
8	Q Which ones? We listed three.
9	A J59, which is the predicted hydraulic effects of pumping
10	from the Lichterman well field. And then Moore's report, which
11	is J58 predominantly, but I've always used J22.
12	Q The Moore is J22?
13	A No.
14	Q No? That's Moore is J50 let's see, is 58, right? So
15	Moore is J58?
16	A It is.
17	Q So you're saying you used Moore?
18	A I used Moore.
19	Q For what?
20	A For developing an understanding of the geology and the
21	hydrology of the Memphis and unnamed aquifer in Western
22	Tennessee.
23	Q Okay. Now, I'm going to return to the I'm going to show
24	you some figures and maps that were part of the Moore report,
25	and I'm going to ask you one at a time what they showed you or

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1	261 told you about the geology and hydrology of West Tennessee.
2	A Okay.
3	0 The first one the first one is page 51 of J58, which is
4	the Moore report. And I'd like to ask you to explain what this
5	shows because it's difficult to understand otherwise.
6	MR. ELLINGBURG: Your Honor, it's in that stack I gave
7	you. But I apologize. I believe it's in the bottom of that
8	stack.
9	THE COURT: Okay.
LO	BY MR. ELLINGBURG:
L1	Q Do you have it in front of you?
L2	A I believe I do, yep.
L3	Q Okay. If you would, explain what is shown by page 51 of
L4	J58, Exhibit J58.
L5	A I didn't hear the last part.
LG	Q If you would, explain what is shown by page on page 51
L7	of Exhibit J58.
L8	A Okay. The best way to understand what's going on here is
L9	to look at the map in the lower right-hand corner of this
20	diagram, and that map is of Western Tennessee.
21	And on that map are a series of black lines running
22	generally north-south and east to west. Those are lines of
23	section. They would have letters at the end, which are so
24	small that I'm having trouble seeing them, but maybe things
25	like A and A prime on the right and so forth.

	262
1	Those are lines of section, and they indicate where a
2	geologist or hydrologist would develop a picture of what goes
3	on in the subsurface, called a geological cross-section, of
4	that line of section.
5	And so the one, two three figures above it are
6	geological profiles of what you would see in the subsurface in
7	this area of Tennessee along those profiles.
8	Q So is this done with well information?
9	A This is done with well information and geophysical logging.
10	Q So these are these are based on actual wells that were
11	drilled to determine the geology in this area?
12	A That's correct.
13	Q Or that show the geology?
14	A That is correct.
15	Q Okay. Now, if you would, look at page 52, the next page of
16	J58.
17	What is shown on this?
18	A Could I verify that you asked me about J58, page 52 of 58?
19	Q Yes, which is Plate 2 from the Moore report.
20	A Right.
21	Q First tell us what was shown in the upper left-hand corner
22	where you have the map of West Tennessee.
23	A These are really poor copies, so I'm having trouble reading
24	them, but if you'll just give me a second, I can focus on it.
25	Q Okay.

203
A So I got it now. And the lighting is not really great
right here.
Oh, the upper left-hand diagram is a map of Western
Tennessee showing several things. It's showing, in the dark
stipple pattern on the right, the outcrop area of the 500-Foot
Sand, which was an early designation for the Memphis Sand. And
it shows an interesting concept that we haven't talked about
called isopach. Isopach.
An isopach map is a map of equal thickness of a
geological formation. And so by drilling through the
geological formation, geologists can determine the thickness of
a formation, in this case, the 500-Foot Sand.
By knowing the thickness in a large number of areas, a
geologist can produce a map that contours the values of
thickness in an area, and so those light sort of those lines
between the outcrop area and the Mississippi that are
curvilinear
Q Mississippi River?
A the Mississippi River, are lines of equal thickness.
Q Thank you. That's helpful.
A Okay.
Q Now, looking to the right, we have something that I believe
is referred to as a fence diagram; is that correct?
A Uh-huh. Yes.
Q And so what just generally, first of all, what is this

263
	264
1	showing?
2	A It shows, for all these different orientations and
3	probably all of those orientations are also shown on the index
4	map in the upper left it shows in the subsurface the varying
5	lithologies, the different types of materials that you have in
6	the subsurface.
7	Q Okay. And so what are the dark portions?
8	A The dark portions that are sort of discontinuous across the
9	area are mapped by this geologist as clay, layers of clay.
10	Q So they have layers of clay and layers of sand and silt
11	shown in the map, based on the explanation to the left of the
12	fence diagram; is that correct?
13	A On this fence diagram, the lithologies in the 500-Foot Sand
14	are clay, silt, and sand.
15	Q Okay. Is that a simple geologic formation?
16	A It's a complex geological formation both vertically and
17	laterally, in my opinion.
18	Q Thank you.
19	If you would, look at page the next page, 53 of
20	J of Exhibit Joint Exhibit J58. This is a map of West
21	Tennessee, and I just want you to explain generally what we're
22	looking at.
23	A This is a structure contour map at the base of the 500-Foot
24	Sand, and so a structure contour map is not like an isopach
25	map. An isopach map is a thickness map. A structure map shows

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	265
1	the elevation of the specified boundary between geologic units.
2	In this case, these contours tell you the elevation relative to
3	sea level of the base of the 500-foot thick 500-Foot Sand in
4	Western Tennessee.
5	Q And what is the dark gray area?
6	A The dark gray area, once again, is the outcrop area.
7	Q So that's where the water would be coming in within the
8	state of Tennessee?
9	A That's correct.
10	Q Into the 500-foot Memphis Sand?
11	A The preponderance of water to go to the aquifer there.
12	Q Thank you.
13	Now let's move to the next one, which is page 54 of
14	Joint Exhibit 58.
15	A Yes.
16	Q And this appears to be essentially the same map, but is it
17	showing the top or sort of the bottom or something else?
18	A Yes, this is a structure contour map showing the
19	configuration or elevation of the top of the 500-Foot Sand in
20	Western Tennessee.
21	Q Thank you. Thank you.
22	Now let's move to Joint Exhibit 58, page 55.
23	And here we have another map. What's shown in this
24	map?
25	A For the same general area, for the same exact area, it

	266
1	shows a contour map of the potentiometric surface of the
2	500-Foot Sand.
3	Q And is this predevelopment, or is it at the time of this
4	report, do you know?
5	A The report indicates that these data would be based on data
б	from January of 1960.
7	Q Thank you.
8	So in north of Memphis there's a line a dotted
9	line on here. It's hard to read. I think it says, "Line of
10	area influenced by pumpage at Memphis"; is that correct, that
11	little dotted line across there with some words above it? We
12	could have obviously used a bigger slide on this.
13	A I'm just going to have to rely on you. I can see some of
14	these words, but I'm sorry, I can't see the rest.
15	Q Well, it says what it says.
16	A It says what it says.
17	Q North of that water line, is there groundwater available
18	for development according to Moore's study?
19	A Yes.
20	Q How much?
21	A The report indicates that the aquifer is thick and
22	transmissive in this area.
23	Q Above the dotted line?
24	A Above the dotted line.
25	Q Thank you.

1	267 Now, thick would be thickness and transmissive meaning
2	what?
- 2	A Thickness is the distance from the bottom to the top of the
1	and unit and transmiggivity is of a normaphility of the unit
4	sand unit, and transmissivity is of a permeability of the unit
5	times the thickness of the unit.
6	Q Okay. Then if you would, look at the next document, which
7	is page 56 of Joint Exhibit 58. And if you could, tell us what
8	this shows.
9	A This is a map of the surface, the potentiometric surface,
10	of what he calls the unnamed sand unit in Western Tennessee
11	based on data from about 1960, January.
12	Q And north of that area, which was indicated as the dotted
13	line on page 55, the page before this, is there any apparent
14	influence once you go into Tipton County of any consequence, or
15	is there any presence of sand in that area?
16	A I'm sorry. Could you repeat that?
17	Q I'm sorry. I confused it, a bad question. I apologize.
18	The question is, what does this show about the unnamed
19	sand?
20	A It shows the at that time what they would call a
21	potentiometric surface, the piezometric surface, so same
22	concept. And so for this sand layer that he calls the unnamed
23	sand, he's showing values for total hydraulic head that range
24	from 360 feet or so to 200-and-some feet, which would indicate
25	a westward flow pattern in this unnamed sand layer.

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1	Q Water moving from the outcrop to the towards the
2	Mississippi River?
3	A Yes.
4	Q To the west.
5	A Yes.
6	Q I'm going to show you page 57 of Joint Exhibit 58.
7	Would you look at page 57 of Joint Exhibit 58?
8	A Yes.
9	Q Okay. What does this show?
LO	A It shows the the author's mapping, again, of
L1	coefficients of transmissibility, which is an old term
L2	equivalent to transmissivity today. They're synonymous. So
L3	this is a map showing the variation of transmissivity in the
L4	500-Foot Sand.
L5	Q Okay. And did you use this in any way in forming your
LG	opinion with regard to the availability of water in West
L7	Tennessee, North Memphis?
L8	A Yes.
L9	Q How?
20	A Well, the values for transmissivity of the sand unit in
21	this area are are similar to, and in many cases, the same as
22	the value of transmissivity for some parts of the well field,
23	as indicated in other reports that I've read.
24	Q When you say "the well"
25	A The well fields.

	269
1	Q In Memphis?
2	A In the Memphis area.
3	Q Okay.
4	A For example, in the Lichterman study, the author routinely
5	used a value of 200,000 units for transmissivity at the
б	Lichterman well field, and so I see transmissivities in the
7	vicinity of 300,000 and 250,000 well north of the City of
8	Memphis, beyond Tipton County even.
9	Q Thank you.
10	And how does that influence your opinion, that the
11	water was available north of Memphis?
12	A Well, the aquifer is transmissive there. It has a
13	significant transmissivity of several hundred thousand units.
14	It is similar in transmissivity to the geological formation at
15	Lichterman where it's possible, and was predicted even in the
16	19 mid-1960s, that the aquifer there could produce
17	20 million gallons of water per day.
18	Q Thank you.
19	I'm going to show you, this is the last page of J58
20	58. And this is a little different map of that same section of
21	West Tennessee.
22	And just briefly, would you tell me what that's
23	showing?
24	A This shows are we talking about 58 of 58?
25	Q Yes, sir.

260

	270
1	A This is from the US Geological Survey, which shows what are
2	called down-dip changes in the chemical quality of water in
3	500-Foot Sand in Western Tennessee.
4	Q So what does it tell you about the quality of the water in
5	terms of its chemical composition north of Memphis?
6	A Very difficult to read these individual little boxes, but
7	if you read them in detail, you would determine that the water
8	quality is is what I would say high, high water quality,
9	good water quality.
10	Q From the standpoint of a hydrogeologist developing water,
11	this is good water?
12	A Yes, this would be good water. I'm not saying it wouldn't
13	require some treatment, but it's good water.
14	THE WITNESS: Your Honor, may I stand up?
15	THE COURT: Sure.
16	THE WITNESS: Can I stand up?
17	THE COURT: Sure. Do you want a recess?
18	THE WITNESS: I'm good. Water.
19	THE COURT: Do you need some water?
20	THE WITNESS: Yes, sir.
21	THE COURT: Okay.
22	BY MR. ELLINGBURG:
23	Q Dr. Spruill, would you like a brief recess?
24	A I'm good to go if you want to finish.
25	Q Thank you.

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1	271 The next series of illustrations or maps are all taken
2	from Joint Exhibit 22. And I'm going to ask you to summarize
3	essentially what each of them shows
4	A Okay.
5	Q if you could. And we'll start with page 63 of 69. As I
6	said, this is from Joint Exhibit 22.
7	A I found page 63 of 69.
8	Q Yes, sir.
9	A Okay.
10	Q And what is this is from Joint Exhibit 22 22, plate
11	1, and this 22 is the exhibit hydrology and aquifer systems in
12	the Memphis area of Tennessee, to give you context. So this is
13	not all of Tennessee. It's the Memphis area in the report
14	prepared by the USGS.
15	A Yes.
16	Q Have you had a chance to look at it?
17	A Yes.
18	Q Can you tell us what this report is showing what this
19	diagram is showing?
20	A This is another composite diagram that shows in the lower
21	right-hand corner a map, and so this figure is a combination of
22	maps and cross-sections. The lower right-hand figure is a map
23	of Southwestern Tennessee. I think it's mostly Shelby County.
24	And within Shelby County on the map are shown some
25	lines that are lines of section, and you have to visualize that

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1	272 along those lines you can lift up the earth and look at it from
2	the side, and you would see the two diagrams above for A to A
3	prime and B to B prime.
4	Q Thank you.
5	A Okay.
6	Q Now, the next slide of J again, J22, page 64. And it's
7	a structure map showing configuration at the top of the
8	500-Foot Sand in the Memphis area.
9	So does this show the same type of information we
10	talked about earlier geologically for the entire West Tennessee
11	but only in the Memphis area on the top?
12	A That's correct.
13	Q That's the top of the Memphis Sand?
14	A The top of the 500-Foot Sand, which I interpret to be the
15	Memphis Sand.
16	Q Thank you. Okay.
17	And then the next one, J20 Exhibit Joint
18	Exhibit 22, page 65.
19	And is that the bottom?
20	A That is the bottom of the 500-Foot Sand contoured
21	Q Okay.
22	A in terms of elevation.
23	Q Okay. And then the next one, J22, page 66, tell us what
24	this is showing.
25	A This is a map of the same area showing the configuration of

273 the piezometric, which I interpret to be the potentiometric, 1 2 surface of the 500-Foot Sand based on data up to 1960 of the 3 Memphis area. So this would be in 1960? 4 0 5 That is correct. А 6 0 Thank you. Now, the next exhibit is page 67 from J22. 7 8 А Yes. 9 Is this showing something different? 0 10 Yes, it is. Α 11 What is this showing? 0 12 So this map is showing a decline of water level in the Α 13 500-Foot Sand based on data from 1950 to 1960. 14 And so I would -- my understanding of this figure is 15 that if you look at the amount of decline in the water level in 16 the Memphis Sand during the time period 1950 to 1960 and you 17 plot it based on the location where those data were collected 18 and you contour it. And so it shows the amount of water level 19 decline during a specific time frame, and that time frame is 1950 to 1960. 20 21 So how do pages 66 and 67 differ in terms of what they're 0 2.2 intended to show between Plate 4 and Plate 5 from J22? 23 Α Okay. So page 66, first, is the configuration of the 24 potentiometric surface. So it shows the height to which water 25 would rise in nonpumping wells that tap this aquifer.

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	274
1	Q In 1960?
2	A In 1960. So it's a map of the equipotential surface
3	showing the depression of the potentiometric surface in
4	Southwestern Tennessee near Memphis.
5	Q Thank you.
6	And then the next one?
7	A The next one simply says, okay, during a specific time
8	period, 1950 to 1960, how much did the water level in the
9	aquifer that's the pressure in the aquifer decline during
10	the period ten-year period 1950 to 1960.
11	Q Okay. And how does water level decline relate to anything
12	that hydrologically?
13	A One would assume
14	Q Don't assume.
15	A I would interpret that the water level declined because of
16	its position relative to the cone of depression shown on page
17	66, that water level decline is related to the withdrawal of
18	water from wells in the Memphis well fields.
19	Q Thank you.
20	And from the standpoint of groundwater development, is
21	the water level is the drop or decline in the water level
22	related in any way to a cone of depression?
23	A Yes.
24	Q Is it related in any way to total available drawdown?
25	A Yes. The decline in water level in an artesian or confined

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1	275 aguifer system reduces the total available drawdown.
2	0 Thank you.
3	So next is page 57.
4	A Was that a question? I'm sorry.
5	Q No. I'm talking to myself.
6	Do these figures in 1960 relate in any way to the
7	groundwater flow in Mississippi as it existed in 1960 compared
8	to predevelopment?
9	A Can you please repeat that question?
10	Q Yes. We looked at predevelopment flow earlier, right?
11	A Yes.
12	Q Looking in the 1960 in this report by Moore, do you see any
13	changes in predevelopment flow across the state line, which is
14	towards the bottom of these maps, in the State of Mississippi?
15	A Well, page 67, which is the map showing the decline of the
16	water level in the 500-Foot Sand for 1950 to 1960, indicates
17	that a 5-foot decline of the water level in the 500-Foot Sand
18	in DeSoto County, which is south of Tennessee and Mississippi
19	or so the inference, water levels of 4, 3, 2, 1 feet would
20	have occurred in the same county.
21	But that doesn't show flow direction. That shows the
22	amount of reduction in total available drawdown.
23	Figure sorry. Page 68 of 69 shows the
24	potentiometric surface for the 500-Foot Sand in August 1960.
25	And based on contours that I see on this map, flow, almost due

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1	276 south of the City of Memphis, would be from south to north.
2	Q North, northwest?
3	A From south to north in the area right above the word
4	"piezometric" on this figure.
5	Q Okay. Thank you.
6	So having reviewed these materials, just in summary,
7	do you have an opinion of whether pumping in Tennessee had
8	changed the natural groundwater flow direction in Northwest
9	Mississippi?
10	A Based on these figures?
11	Q Based on no, based on everything you've looked at.
12	A Yes.
13	Q And what is that?
14	A Exactly that, that generation of a large cone of depression
15	associated with 100-plus million gallons of water withdrawal
16	per day in the Memphis Sand has produced fundamental changes in
17	flow patterns in Northern Mississippi.
18	Q And based on all of your work, have you developed an
19	opinion as to whether that change in flow patterns in
20	Mississippi caused by the cone of depression has reduced the
21	amount of available water for production within the State of
22	Mississippi?
23	A My opinion is that the total available drawdown in Northern
24	Mississippi has been impacted and reduced by groundwater
25	withdrawals from north of the Mississippi-Tennessee line.

Proceeding - May 21, 2019 277 Now, we talked about total available drawdown, but just for 1 0 2 simplicity, has the amount of water available for production 3 been reduced within that area of total available drawdown, in 4 your opinion? 5 А Yes. MR. ELLINGBURG: Okay. I'll tender the witness. 6 7 THE COURT: Are you through with your witness on direct? Are you through with your witness on direct? 8 9 MR. ELLINGBURG: Yes. I'm sorry. I said I'll tender 10 the witness, but I didn't say it loud enough. I am bad about 11 that. 12 THE COURT: I just wanted to make sure. We'll take a 13 recess, and then you may proceed with your cross-examination. 14 (A recess was taken.) 15 THE CLERK: All rise. This Honorable Court will be back in session. 16 17 THE COURT: You can begin your cross-examination. 18 MR. BRANSON: Your Honor, with your permission, before we start, could we get the display switched over to our 19 20 computer? 21 CROSS-EXAMINATION 2.2 BY MR. BRANSON: 23 Good morning, Dr. Spruill. Q 24 А Good morning. 25 Q We've met before, but let me reintroduce myself. I'm Josh

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1	Branson. I represent the State of Tennessee, and I'm going to
2	ask you a few questions now. Okay?
3	A Okay.
4	Q You testified yesterday that the Middle Claiborne Aquifer
5	is a very important aquifer in the Mississippi Embayment,
6	correct?
7	A I did.
8	Q And you also stated, in response to Mr. Ellingburg, that
9	hydrogeologists have classified the Middle Claiborne Aquifer as
10	a hydrogeologic unit, correct?
11	A Yes.
12	Q The Middle Claiborne Aquifer, as we saw yesterday, is
13	housed within the Mississippi Embayment, correct?
14	A Yes.
15	Q And as we also saw in your slides yesterday, the
16	Mississippi Embayment is physically present in portions of
17	eight states, correct?
18	A Yes.
19	Q And those eight states, just so we're on the same page, are
20	Tennessee, Mississippi, Arkansas, Illinois, Louisiana,
21	Missouri, Alabama, and Kentucky, correct?
22	A Yes.
23	Q The Middle Claiborne Aquifer is laterally extensive within
24	the Mississippi Embayment, correct?
25	A The Middle Claiborne Aquifer Unit, yes.

Proceeding - May 21, 2019 279 And so that means that the Middle Claiborne Aquifer 1 0 2 physically extends beneath the same eight states that we just 3 mentioned, correct? The Middle Claiborne Aquifer Unit extends beneath parts of 4 А eight states. 5 6 And those are the same eight states that we just discussed, 0 7 correct? 8 А Yes. You've heard the term "transboundary aquifer" before, 9 0 10 haven't you, Dr. Spruill? 11 I've heard it. А 12 And you understand that term to mean an aquifer that 0 physically underlies national or international state 13 boundaries, correct? 14 15 Certainly I understand what the definition of a А 16 transboundary aquifer is, but I've not seen a definition of a 17 transboundary aquifer, so if you have one, I'd be glad to look 18 at it. You testified at your deposition that you understood a 19 0 20 transboundary aquifer to mean an aquifer that underlies 21 national or international state boundaries, didn't you? 2.2 А I believe I did. 23 Okay. So you have heard the term before, and you do --Q 24 А I've heard the term before. And you understand it means what I just said it means, 25 Q

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1	correct?
2	A I believe it indicates that the physical aquifer underlies
3	those states.
4	Q And so applying the definition of transboundary aquifer
5	that we just discussed, you would agree that the Middle
6	Claiborne Aquifer is a transboundary aquifer, correct?
7	A If a transboundary aquifer is classified as one that
8	whose criteria is based on its presence under eight states,
9	then, yes.
10	Q And that is the criteria that you understand the term
11	"transboundary aquifer" to mean, correct?
12	A Yes.
13	MR. ELLINGBURG: I'm going to object. He's already
14	testified he didn't know what the definition of that was.
15	THE COURT: I'll overrule it.
16	You may answer the question.
17	BY MR. BRANSON:
18	Q Dr. Spruill, let me clarify. The understanding of a
19	transboundary is physically extending beneath political
20	boundaries, that is the understanding of transboundary aquifer
21	that you have, correct?
22	A If that's the definition of transboundary aquifer, then I
23	understand. It's not my I didn't define it that way.
24	Q But you do understand it to mean that, and you've heard the
25	term before, correct?

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A I've heard the term before.
Q And you understand it to mean what I said it means,
correct?
A I understand, according to that definition, it means it
underlies one or more states.
Q Dr. Spruill, the USGS has also described the Middle
Claiborne Aquifer as physically extending between the same
eight states that I mentioned earlier, correct?
A The Middle Claiborne Aquifer Unit, yes.
Q Okay. Let's go to one of your slides from yesterday.
Let's do slide this was your slide 23, which you showed
yesterday.
MR. BRANSON: Judge Siler, for the record, this is
from Joint Exhibit 36 at PDF page 26.
BY MR. BRANSON:
Q And I'd like to highlight the legend on this USGS figure
that you mentioned yesterday, Dr. Spruill.
A Okay.
Q You see the highlighted part? It says the "Middle
Claiborne Aquifer" on here, correct?
A Yes.
Q It does not say the "Middle Claiborne Aquifer Unit"; it
says the "Middle Claiborne Aquifer," doesn't it?
A Well, if it's a USGS figure, it's stipulated that my
opinion is that it is it means that it's the Middle

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1	Claiborne Aquifer Unit.
2	Q But the words that the USGS actually used on this map which
3	you showed yesterday says "Middle Claiborne Aquifer," correct?
4	A Yes.
5	Q And in this figure it is depicting what the USGS has called
б	the Middle Claiborne Aquifer as extending beneath the same
7	eight states that we discussed, correct?
8	A Yes.
9	Q Dr. Spruill, you testified yesterday about a facies change
10	that occurs in the Middle Claiborne Aquifer near the
11	Mississippi-Tennessee border, correct?
12	A Yes.
13	Q And as you testified, facies change is caused by the lower
14	Claiborne Confining Unit which pinches out in the Middle
15	Claiborne Aquifer, correct?
16	A No.
17	Q Well, let's I'd like to go to your
18	MR. BRANSON: Your Honor, may I walk over to his
19	drawing from yesterday?
20	THE COURT: Sure.
21	MR. BRANSON: Thanks. I think it might be easier. I
22	just want to make sure that we're on the same page.
23	BY MR. BRANSON:
24	Q This is the Lower Claiborne Confining Unit that I'm
25	pointing to, the blue thing sticking out in the middle from the

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1	283 right of your diagram, correct?
2	A It's the Lower Claiborne Confining Unit.
3	Q Okay. That's what I just said, correct?
4	A Yes.
5	Q So and the facies change, as you called you labeled
6	it a transition zone in green at the top of your diagram?
7	A Yes.
8	Q But you labeled it because it's caused by this Lower
9	Claiborne Confining Unit that you've drawn here, correct?
10	A Yes.
11	Q Okay. So just so we're on the same page, the facies change
12	is caused by that Lower Claiborne Confining Unit that you've
13	drawn on this figure, correct?
14	A And the yes. And I objected to the way you stated it
15	earlier because the Lower Claiborne Aquifer also disappears at
16	the transition zone.
17	Q So let's talk about that, Dr. Spruill. I want to make very
18	clear, first of all, you testified that the Middle Claiborne
19	Aquifer on this diagram extends from the very right-hand side
20	above the Lower Claiborne Confining Unit covering this area,
21	moving north into Tennessee, past the facies change, and then
22	down and encompassing everything in Tennessee, correct?
23	A I did.
24	Q That's all called the Middle Claiborne Aquifer, MCA
25	abbreviated on your drawing, right?

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1	A Unit.
2	Q You didn't even write "unit" on here, just MCA.
3	A Okay.
4	Q The Lower Claiborne Aquifer here is the part below the
5	Lower Claiborne Confining Unit, correct?
6	A Correct.
7	Q You've drawn a vertical red line at the northern edge of
8	the Lower Claiborne Aquifer on here.
9	Do you see that?
10	A Uh-huh.
11	Q You're not suggesting, are you, that there's any sort of
12	barrier to flow that would prevent water from flowing naturally
13	from the Lower Claiborne Aquifer into what you've called the
14	Middle Claiborne Aquifer, are you?
15	A No. That vertical line I drew as a part of a box around
16	both the Lower Claiborne Confining Unit and the Lower Claiborne
17	Aquifer when I said that these things undergo a facies change
18	and do not exist north of the transition zone.
19	Q Just so my question is clear, you're not implying that
20	there's any barrier to water flowing naturally from the Lower
21	Claiborne Aquifer to what you termed the Middle Claiborne
22	Aquifer, correct?
23	A There's no physical barrier there. It's a facies change,
24	in my opinion.
25	Q And the facies change means that the sediment in the

1	285 composition changes as you move past that facies change,
2	correct?
3	A As you move through that facies change, not past it.
4	Q As you move through the facies change?
5	A Okay. I'm sorry.
6	Q But there's no physical barrier to flow that prevents water
7	from flowing naturally from one to the other, correct?
8	A No.
9	Q Now, I want to put up slide 22. Actually, before I'm
10	sorry, before we do that, Dr. Spruill, I just want to clarify.
11	You agree that what you've called the Lower Claiborne Confining
12	Unit and the Lower Claiborne Aquifer are all housed within the
13	same major hydrostratigraphic unit that I've been calling the
14	Middle Claiborne Aquifer?
15	A No.
16	Q You don't agree with that?
17	A No.
18	Q Dr. Spruill, do you remember when I took your deposition in
19	September of 2017?
20	A Vividly.
21	MR. BRANSON: Your Honor, may I approach the witness?
22	THE COURT: Yes, you may.
23	BY MR. BRANSON:
24	Q I'm going to hand you a copy of your deposition.
25	MR. BRANSON: Judge Siler, would you like one or

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1	THE COURT: No.
2	BY MR. BRANSON:
3	Q Dr. Spruill, you were under oath when you sat for this
4	deposition, correct?
5	A Yes.
б	Q You knew that you had an obligation to tell the truth,
7	correct?
8	A Yes.
9	Q I'd like you to turn in your transcript to page 19, line
10	19. And I'm going to read your answer from there to the bottom
11	of the page.
12	"A good example would be"
13	A Wait, wait, wait. Sorry.
14	Q Yep. Sure. Page 19, line 19. I'm going to read. This is
15	you talking. "A good example would be the hydrogeological
16	units that you refer to as the Middle Claiborne Aquifer. It
17	actually has a Lower Claiborne Confining Unit and Lower
18	Claiborne Aquifer all within the same major hydrostratigraphic
19	unit."
20	Do you see that?
21	A Yes.
22	Q That was your testimony, correct?
23	A Yes.
24	Q So it is accurate to say that the Lower Claiborne Confining
25	Unit and the Lower Claiborne Aquifer are within the same major

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1	hydrostratigraphic unit, correct, Dr. Spruill?
2	A Regardless of what this says, the major hydrostratigraphic
3	unit can be the embayment system of hydrostratigraphic units.
4	This Lower Claiborne Aquifer and Lower Claiborne Confining Bed
5	is shown on every reasonable geological cross-section as
б	existing below the Middle Claiborne Aquifer, and so my
7	interpretation is that both of those units, the Lower Claiborne
8	Aquifer and the lower Claiborne Confining Layer, exist below
9	the Middle Claiborne Aquifer in Mississippi.
10	Q Okay. And, Dr. Spruill, that's not what you said in the
11	part of the deposition I just read, correct?
12	MR. ELLINGBURG: I'm going to have to object. Counsel
13	has started from the third paragraph of Dr. Spruill's answer in
14	the deposition. He's ignored the context.
15	THE COURT: You'll have a chance to redirect, Counsel.
16	MR. ELLINGBURG: Thank you.
17	THE COURT: You may proceed with a question.
18	BY MR. BRANSON:
19	Q Dr. Spruill, I just asked you a yes-or-no question.
20	A Ask it again, please.
21	Q You testified I read your testimony accurately at your
22	deposition, correct?
23	A You read what's written there, yes.
24	Q And you were under oath when you gave that answer, correct?
25	A I was under oath.

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1	Q Dr. Spruill, I'd now like to put up slide 5.
2	And you just said a moment ago when I was asking you
3	about your deposition that you think every representation
4	you've seen of this system depicts the Lower Claiborne Aquifer
5	as a as somehow separate from the Middle Claiborne. Did I
б	understand you correctly?
7	A That's correct.
8	Q This is your slide that you put up yesterday, slide 22 from
9	Arthur and Taylor. You called these two geologists or these
10	scientists yesterday well-respected, correct?
11	A Yes.
12	Q They don't depict the Lower Claiborne Aquifer on here as
13	separate from the Middle Claiborne, do they, Dr. Spruill?
14	A Yes, they do.
15	Q Where do they say "Lower Claiborne Aquifer" on this
16	diagram?
17	A Lower Claiborne/Upper Wilcox Aquifer is here (indicating)
18	and here (indicating). That's a change in chemistry, not a
19	change in lithology. That's a change in water chemistry.
20	Q Dr. Spruill, that's can we highlight the Middle
21	Claiborne Aquifer on here?
22	Have I highlighted what Arthur and Taylor have
23	depicted as the Middle Claiborne Aquifer accurately?
24	A No.
25	Q According to Arthur and Taylor map I have, correct?

289 Okay. So here is the Lower Claiborne Confining Unit. 1 А 2 0 Yeah. Let's highlight that in pink if we could. 3 I've highlighted that accurately, correct? Yes. This is the lower Claiborne/Upper Wilcox Aquifer, and 4 Α 5 that is not a change in stratigraphy. That's a change from freshwater to saltwater at that location. And so that aquifer 6 7 extends all the way over to here, in my opinion. But that's not how Arthur and Taylor have labeled this map, 8 0 is it? 9 10 It is in my opinion. А 11 On what basis, Dr. Spruill, are you saying that Arthur and 0 12 Taylor labeled this map as having the Lower Claiborne Aquifer 13 extending beneath the facies change? They have a solid black line --14 15 On the same basis -- can you take away the pink, please, А 16 and the yellow? Thank you. 17 The Middle Claiborne Aquifer right here undergoes a 18 change in composition. The Lower Claiborne Confining Unit 19 extends all the way over to there (indicating). But it does 20 not undergo a change in chemistry from freshwater to saltwater. 21 This is a boundary right here between the Lower 2.2 Claiborne Confining Unit -- sorry, the Lower Claiborne/Upper 23 Wilcox Aquifer, it goes to fresher water there and ends there. 24 And on every geological map that's produced by the US 25 Geological Survey, the Lower Claiborne Aquifer ends here

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(indicating).
Q What you just said I understand what you're saying,
Dr. Spruill, but what you just said is not depicted on this map
that we're looking at?
A It is to me.
Q But nothing that you just said is physically drawn on this
map, correct?
A Well, look, the word "Middle Claiborne Aquifer" doesn't
extend all the way up into this area. The word "Upper
Claiborne Aquifer" doesn't extend over it. It's written one
time.
The Lower Claiborne/Upper Wilcox Aquifer extends all
the way over to here. And if you look at any maps depicting
its thickness and aerial extent, it ends here. And then just
look on the big geological cross-sections that you have always
in these figures, and it shows a Lower Claiborne Aquifer and an
Upper Claiborne Aquifer beneath the Middle Claiborne Aquifer
system.
Q To be clear, Dr. Spruill, this is just a very simple
question. There's no vertical line on this map that we're
looking at that depicts the separation between the Lower
Claiborne Aquifer and the Middle Claiborne Aquifer as you just
described it?
A It's a facies change.
Q There's no vertical line on this map that depicts that

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1	change, correct?
2	A Correct.
3	Q Let's let's now go to another slide. I want to do
4	Brahana.
5	MR. BRANSON: For the record, Judge Siler, this is
6	from Joint Exhibit 15, which is the Brahana and Broshears
7	paper.
8	BY MR. BRANSON:
9	Q Dr. Spruill, you've reviewed the Brahana and Broshears
10	paper before, have you not, correct?
11	A Correct.
12	Q And I want to point us to Figure 3 and zoom it in. Could
13	we highlight the Memphis Sand and equivalents?
14	Do you see that, Dr. Spruill?
15	A I see that you've called it yellow, but I don't agree.
16	Q Can we highlight in the confining unit on the left? What
17	I've highlighted in pink, that is the Brahana and Broshears'
18	depiction of the Lower Claiborne Confining Unit, correct?
19	A It yes.
20	Q And on this map again, there's no do you see the area of
21	the Memphis Sand and equivalents that extends beneath the
22	confining unit that I just highlighted?
23	A Yeah. Well, I don't agree with that.
24	Q Okay. Well, according to Brahana and Broshears, they don't
25	label any part of this map Lower Claiborne Aquifer, do they?

1	292 A Well, where's the Lower Claiborne Aquifer, then?
2	Q I guess I should ask you. Is it depicted on this map?
3	A Yes.
4	Q But it's not labeled as such?
5	A Well, I'm I'm sorry, it's not. It should be.
6	Q So this is a USGS map, correct?
7	A Yes.
8	Q And these USGS scientists do not label the Lower Claiborne
9	Aquifer as separate from the Memphis Sand and equivalents,
10	correct?
11	A I agree that they don't label it. It doesn't mean that
12	it's not there.
13	Q Understand I understand your opinion, Dr. Spruill. I'm
14	just trying to establish that these USGS scientists do not
15	label it the way that you think it should be labeled?
16	A I agree that they didn't label it properly. It
17	Q All right.
18	A There's a Lower Claiborne Aquifer there's a Lower
19	Claiborne Aquifer beneath the Lower Claiborne Confining Unit.
20	This is an important point. Geologists name a confining unit
21	with the words for the aquifer below it, so if that's the Lower
22	Claiborne Confining Unit, then there's a Lower Claiborne
23	Aquifer below it.
24	Q Okay. That's not shown on this map?
25	A It's shown on this map. It's not labeled.

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1	Q Okay. Dr. Spruill, let's change gears.
2	You recall your testimony in response to
3	Mr. Ellingburg about the Memphis Sand and the Sparta Sand?
4	A Yes.
5	Q In your expert report in this case, you stated that the
6	terms "Middle Claiborne Aquifer" or "Memphis Aquifer" are
7	considered synonymous with the Sparta-Memphis Sand for purposes
8	of this expert report, correct?
9	A For purposes of the report.
10	Q And you also, in your expert report, treated the Sparta
11	Aquifer, quote/unquote, as synonymous with the Memphis Aquifer,
12	quote/unquote, correct?
13	A I may have generalized that they are a part of an aquifer
14	unit.
15	Q When you introduced the term in your expert report, you
16	literally said Sparta Aquifer, a/k/a, and you listed Memphis
17	Aquifer and Sparta Aquifer as two names for the same thing,
18	correct?
19	A Because it's in the literature, yes.
20	Q And you also used the phrase "Sparta Memphis Sand Aquifer"
21	in your expert report, correct?
22	A Because it's in the literature.
23	Q And you agree that the terms "Memphis Sand" and "Sparta
24	Sand" are often used interchangeably, correct?
25	A I see it in the literature. Doesn't mean I agree with it.

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1	294 Q I'm not asking if you agree with it, Dr. Spruill. I'm just
2	asking if you often see the terms used interchangeably. And
3	you do, correct?
4	A Yes.
5	Q And you also agree that what you called the Sparta Sand in
6	Mississippi and the Memphis Sand in Tennessee are part of a
7	single geological formation, correct?
8	A Say that again.
9	Q You you also agree that what you call the Sparta Sand in
10	Mississippi and the Memphis Sand in Tennessee are part of a
11	single geological formation, correct?
12	A No.
13	Q You don't agree with that?
14	A No.
15	Q You think that they're separate geological formations?
16	A Yes.
17	Q Dr. Spruill, could you turn to your deposition? And I want
18	you to turn to page 9
19	A Okay.
20	Q line 4. And this is you answering my question.
21	"They are part of a single geological formation. The
22	Sparta Sand is not the same unit as the Memphis Sand in terms
23	of its thickness and its aerial distribution."
24	A I'm sorry. I don't know where you are yet. I haven't
25	found it.

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1	295 O I'm on line 9.
2	A You're faster than I am.
3	O I'm on page 9, line 4. Page 9, line 4.
4	And I had just been asking you questions about the
5	Sparta Sand and the Memphis Sand. And you answer: "They are
6	part of a single geological formation. The Sparta Sand is not
7	the same unit as the Memphis Sand in terms of its thickness and
8	its aerial distribution. There are some differences. They are
9	part of the same hydrostratigraphic unit." Correct?
10	A They're part of the same hydrostratigraphic unit, but
11	they're not the same geological formation.
12	Q You said the words, "They are part of the same geological
13	formation." I'm quoting you, aren't I, Dr. Spruill?
14	A On the previous page, I indicate to you that the Memphis
15	Sand and the Sparta Sand are often used interchangeably, but
16	there are regional differences in the two. In terms of what I
17	called hydrostratigraphic interpretations, they are more or
18	less equivalent. And so they are part of the same
19	hydrostratigraphic unit, but they are they're not the same
20	geological formation.
21	Q Okay. So you just you misspoke at your deposition?
22	MR. ELLINGBURG: I'm going to object. He's just
23	ignoring the very last sentence. It says, "They are"
24	THE COURT: You'll get a chance to ask it later.
25	MR. ELLINGBURG: Yes, sir.

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1	BY MR. BRANSON:
2	Q Dr. Spruill, I'm going to stop where you just stopped
3	reading when you said they are more or less equivalent. I
4	asked you
5	A I stopped reading. Tell me the page again. I'm so sorry.
6	Q Page 8. You went back to page 8.
7	And just to give context, I'll start at line 14. And
8	I'm just going to read this whole thing because it seems
9	necessary.
10	I'm going to say question: "Do you understand the
11	names Memphis Sand and Sparta Sand, as used at various times in
12	this case, are both referring to the same aquifer?
13	"Answer: I think the Memphis Sand and Sparta Sand are
14	often used interchangeably, but there are regional differences
15	in the two. In terms of what I would call hydrostratigraphic
16	interpretations, they are more or less equivalent.
17	"Question: When you say 'more or less equivalent,'
18	just to make sure we're on the same page, you understand that
19	they are part of a single geological formation, correct?
20	"Answer: They are part of a single geological
21	formation."
22	And you keep going and you say, "The Sparta Sand is
23	not the same unit as the Memphis Sand in terms of its thickness
24	and aerial distribution. There are some differences. They are
25	part of the same hydrostratigraphic unit."

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1	298 You said that both the Sparta and the Memphis are part
2	of the hydrogeologic unit called the Middle Claiborne Aquifer.
3	I was quoting your testimony yesterday. That's accurate?
4	A The Sparta Aquifer and the Memphis Aquifer.
5	Q Yes. The Sparta Aquifer and the Memphis Aquifer are part
б	of the hydrogeologic unit called the Middle Claiborne Aquifer,
7	correct?
8	A Part of the Middle Claiborne Aquifer hydrogeologic unit,
9	yes.
10	Q And I counted yesterday I just kind of went through the
11	transcript. You said the phrase "Middle Claiborne Aquifer"
12	without any "unit" qualifier over ten times yesterday.
13	Does that sound accurate?
14	A I didn't count it.
15	Q But you do recall saying it, right?
16	A I recall saying it, you know, okay.
17	Q Okay. Dr. Spruill, there is no physical barrier in the
18	Middle Claiborne Aquifer along the Mississippi-Tennessee
19	boundary that impedes groundwater from flowing across the state
20	border, is there?
21	A That impedes? Do you mean stops?
22	Q Well, I'll ask you stops.
23	A There's no boundary that stops the movement of water across
24	the boundary.
25	Q And there's no physical barrier at all that extends

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1	directly along the Mississippi-Tennessee boundary that would		
2	impede groundwater from flowing across the state border, is		
3	there?		
4	A I mentioned before that a reduction in permeability and		
5	grain size and clay content and so forth can impede. Impede,		
6	to me, means something other than stop. So there are lateral		
7	changes in aquifer materials that can impede the flow of water,		
8	and many of them occur at or near the state boundary,		
9	interestingly enough.		
10	Q But there's no physical barrier directly along the		
11	Mississippi-Tennessee boundary that would block water from		
12	flowing across that boundary, is there?		
13	A Do you mean a physical boundary like a man-made wall or		
14	I don't get what you mean, "physical barrier"?		
15	I don't know of any physical barriers in the		
16	subsurface directly beneath the Tennessee state line except a		
17	transition in composition roughly in that area from coarser		
18	sand grains and less clay to finer sand grains and more clay to		
19	the side. That's the only changes that I could relate to a		
20	barrier.		
21	Q And none of those changes block water from flowing across		
22	the border, correct?		
23	A No.		
24	Q And you agree that there was no such barrier in		
25	predevelopment times either, correct?		
		3	00
----	-----	---	----
1	A	Correct.	
2	Q	Now, Dr. Spruill, you have opined that pumping out of the	
3	Mid	dle Claiborne on the Tennessee side of the state boundary	
4	has	affected groundwater flow on the Mississippi side of the	
5	aqu	ifer, correct?	
6	А	Correct.	
7	Q	And that's true even though the MLGW wells doing the	
8	pum	ping are all physically on Tennessee's side of the state	
9	bou	ndary, correct?	
10	А	They are on Tennessee's side of the state boundary.	
11	Q	None of those wells physically cross the state boundary	
12	int	o Mississippi, do they?	
13	А	No.	
14	Q	And as far as you know, there is no MLGW well screen that	
15	phy	sically touches Mississippi territory, correct?	
16	A	Correct.	
17	Q	Now, you also agree that pumping on the Mississippi side of	f
18	the	Middle Claiborne Aquifer can affect groundwater flow on the	е
19	Ten	nessee side of that aquifer, correct?	
20	А	Yes.	
21	Q	Beyond the Middle Claiborne, the Mississippi Embayment,	
22	whi	ch you've talked about, also houses the Wilcox Aquifer	
23	sys	tem and the Shallow Alluvial Aquifer system?	
24	A	And others.	
25	Q	And others.	

	201
1	And, generally speaking, you would agree that the
2	Middle Claiborne Aquifer is hydrologically connected to those
3	other aquifers, correct?
4	A The different aquifers are classified in my mind and
5	categorized as mostly leaky, confined aquifers, and so there is
6	exchange of groundwater from one aquifer to another, and
7	especially in discharge areas.
8	Q So the answer is yes, you do agree that groundwater in the
9	Middle Claiborne Aquifer is hydrologically connected to the
10	groundwater in the other aquifers in the Mississippi Embayment
11	System, correct?
12	A Well, I've always had trouble with the term "hydrologically
13	connected."
14	I'll say again that the aquifers are leaky. They have
15	leaky confining beds. So hydrogeologists call them leaky
16	aquifers. And we define the confining beds as leaky confining
17	beds. So it allows interchange of water between aquifers. And
18	that's what we mean by hydrologically connected, water can flow
19	from one aquifer to another, albeit at a slow rate.
20	Q And there are also places where, in your terminology, the
21	aquifers are hydraulically connected, correct?
22	A I don't know the difference between those two,
23	hydraulically connected and hydrologically connected.
24	Q So when you said in your deposition that there are places
25	where the offers in the Mississippi Embayment are hydraulically

	302
1	connected, you understand that to be referring to the exchange
2	of water that you just mentioned, correct?
3	A Yes, I do.
4	Q And so using that definition, you also understand that
5	groundwater in the Middle Claiborne Aquifer is hydrologically
6	connected to surface waters in the area, correct?
7	A Would you ask that again?
8	Q I said, Would you also agree, using that same definition we
9	just asked we just talked about, that groundwater in the
10	Middle Claiborne is hydrologically connected to some surface
11	waters in the area?
12	A The water in the Middle Claiborne Aquifer and the outcrop
13	areas clearly interchanges and interacts with surface water
14	where it flows, as I showed yesterday, from areas of recharged
15	areas of discharge.
16	But once water enters the deep parts of the
17	groundwater system in the confined aquifer system, water can
18	interchange can discharge to streams, but it discharges to
19	streams by the slow migration upward in discharge areas across
20	a series of confining beds, aquifers, other confining beds, and
21	so forth.
22	And so I think it's confusing to say that the aquifer
23	and the water in the aquifer is hydrologically connected to the
24	river to a river system without understanding that we're
25	talking about thousands of years of travel time as water moves

	303
1	from this deep aquifer to the river.
2	I say that the water in the Middle Claiborne Aquifer
3	is hydrologically connected to the confining bed above it. And
4	the confining bed above it is hydraulically connected to the
5	aquifer above it and, ultimately, there's discharge to surface
6	water.
7	Q So you agree taking you know, taking as correct for the
8	time being your description of the slow travel time, you do
9	agree there can be a long-term exchange of water between the
10	Middle Claiborne Aquifer and surface waters in the area,
11	correct?
12	A Long term, yes.
13	Q And you also agree, just to be more specific, that there
14	could be a long-term exchange of water between the Middle
15	Claiborne Aquifer and the Mississippi River, correct?
16	A Long term, yes.
17	Q So under natural conditions in the Middle Claiborne
18	Aquifer, Dr. Spruill, every molecule of groundwater in that
19	aquifer was moving to some extent, correct?
20	A Yeah. What flashed through my mind immediately is this
21	idea that there are special places in the groundwater system
22	where theoretically the water is not moving. But what we're
23	talking about here is a regional scale systems in which water
24	is moving from recharge areas to discharge areas and it's
25	continually moving.

-	304
1	Q Just to make sure that the record is clear, under natural
2	conditions in the Middle Claiborne Aquifer, every molecule of
3	groundwater in that aquifer, under natural conditions, was
4	moving to some extent, correct?
5	A With an absolutely odd occurrence where a few molecules of
6	water might not be moving, the answer is yes.
7	Q And you agree, Dr. Spruill, that under predevelopment
8	conditions, at least some of the groundwater in the Middle
9	Claiborne Aquifer flowed naturally from Mississippi into
10	Tennessee, correct?
11	A Yes.
12	Q I want to now put up a slide, slide 9.
13	MR. BRANSON: And, Judge Siler, for the record, this
14	is Defense Exhibit 112. I'm happy to give you a paper copy if
15	that would be easier.
16	THE COURT: I don't need it. Thank you.
17	BY MR. BRANSON:
18	Q Dr. Spruill, this figure was generated by David Wiley, one
19	of Mississippi's experts in this case, correct?
20	A Yes.
21	Q And you included this figure in your expert report,
22	correct?
23	A Yes.
24	Q And this is depicting predevelopment conditions in the
25	Middle Claiborne Aquifer near the Mississippi-Tennessee border,

1	305
T	correct?
2	A Yes.
3	Q And you see the yellow triangle on here just south of the
4	state line towards the center right of the diagram?
5	A Yes.
б	Q And it's labeled "Area of Limited Natural Flow from
7	Mississippi to Tennessee (Interstate Flow)."
8	A Yeah.
9	Q Do you see that?
10	A I do.
11	Q Water in Mississippi within this yellow triangle would have
12	flowed naturally from Mississippi into Tennessee under natural
13	predevelopment conditions, correct?
14	A A molecule of water entering the groundwater system at this
15	location would flow, according to this flow line, over this
16	distance of 6 miles in hundreds of years in the direction of
17	Mississippi I'm sorry, Tennessee.
18	Q And it would have crossed the state boundary into
19	Tennessee, correct?
20	A Ultimately.
21	Q And you see two flow lines showing an example of that on
22	this chart are drawn in green, correct? Do you see that, two
23	green arrows?
24	A There's a glare on it from where I'm sitting. Oh, yeah,
25	sure.

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1	MR. BRANSON: Judge Siler, can you see the colors
2	okay?
3	THE COURT: Yes.
4	BY MR. BRANSON:
5	Q Okay. So those two green arrows are demonstrating an
6	example of that interstate flow under predevelopment conditions
7	that we just talked about, correct?
8	A Yes.
9	Q And Mr. Wiley, if you can see in the legend and if we
10	could zoom in on the bottom of the legend he has labeled
11	those green lines "interstate flow."
12	Do you see that?
13	A I do.
14	Q Now I want to talk about the well, I guess, first of
15	all, I should also ask, many of the flow paths drawn on this
16	figure also extend into Arkansas, correct?
17	A Yes.
18	Q Now I want to focus on the blue shading, the other eight
19	areas on here shaded in blue which Mr. Wiley has labeled
20	"Intrastate Flow."
21	So you see the rest of those areas?
22	A Yes.
23	Q At least some of the water flowing along these so-called
24	intrastate flow paths would have left Mississippi and flown
25	into Arkansas under to natural conditions, correct?

	30	17
1	A According to these lines, yes.	''
2	Q And you're also fond of saying, I think you said yesterday,	
3	that what goes down, must come up, correct?	
4	A Yes.	
5	Q And so that means that eventually, over a long enough time	
6	horizon, all of the groundwater in the Middle Claiborne beneath	1
7	Mississippi is going to leave the system, correct?	
8	A Given enough time.	
9	Q Given enough time, the answer is yes?	
10	A The answer is yes.	
11	Q Now, Dr. Spruill, you think that Mr. Wiley generated this	
12	map by importing the model developed by Brahana and Broshears,	
13	correct?	
14	A That's my understanding.	
15	Q And Brahana and Broshears were the authors of that diagram	
16	of the Middle Claiborne that you thought mislabeled the absence	ĩ
17	of the Lower Claiborne Aquifer, right?	
18	A Right.	
19	Q You personally did not rerun Brahana's model to check this	
20	map, did you?	
21	A No.	
22	Q You didn't run any model yourself in preparing your	
23	opinions in this case, did you?	
24	A No.	
25	Q You did not go back and compare this figure generated by	

1	308 Mr. Wiley to the results published by Brahana, did you?
2	A I would have looked at maps in the Brahana and Broshears
3	output and compared it with what Dave Wiley produced.
4	Q Dr. Spruill, let me try that again.
5	You did not look specifically at this map and compare
6	it to a similar map in the Brahana model, did you?
7	A I recall that I did.
8	Q Okay. Dr. Spruill, I'd like you to turn to your
9	deposition, and this is going to be page 141.
10	And I want to start at
11	A Let me get there.
12	Q Yeah. Sure.
13	And I want to start at line 21. And we're discussing
14	Figure 17. That was just the number for this figure in your
15	expert report. You renumbered it?
16	A Uhm-uhm.
17	Q So I'm going to say, "Did you go back and compare the
18	Figure 17 generated by LBG, which is Mr. Wiley's firm, to the
19	results published by Brahana?
20	"Answer: I don't believe I looked specifically at
21	this map and compared it to a similar map in the Brahana model,
22	nor do I know whether or not LBG improved the Brahana model
23	with any data input. I don't know."
24	That was your answer, correct?
25	A Yes.

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1	Q That was accurate testimony, correct?
2	A Yes.
3	Q So you did not go back and compare this figure that we're
4	looking at on the screen, Defense Exhibit 112, to the results
5	published by Brahana, did you?
6	A I guess at the time of my deposition, I did not. But I
7	obviously have done it. So in my mind, I'm not sure when I
8	looked at the Brahana and Broshears map and the LBG one. I
9	stated in my deposition that I don't believe I looked at it.
10	Q Okay. So you're now saying that you think you did look at
11	it; you don't know when, if it was before or after your
12	deposition?
13	A I don't.
14	Q And what did you did you notice that there are
15	differences here between Mr. Wiley's map and the Brahana map?
16	A Sure.
17	Q What differences did you notice?
18	A I don't recall them, but if you'd show me the
19	differences you'd show me the other map. I've looked at
20	thousands of maps. If you ask me to recall specific
21	differences between two maps, I can't do that.
22	Q And, Dr. Spruill, you don't know what, if any, actual
23	control data was used to draw any of these contours on this
24	map, do you?
25	A No.

Q Do you know whether it was generated by a model or by some
other means?
A This was generated by a model.
Q This figure?
A This figure by LBG, by Dave Wiley, was produced by model
output, I believe.
Q So if Mr. Wiley gets in here and testifies later today that
these contours on his figure were not generated by a
groundwater model, you're saying he's going to be wrong?
A No.
Q So you don't know one way or the other, do you, how he
generated this map?
A I don't know with certainty whether this 1886 estimated
potentiometric surface map for predevelopment conditions was
generated by his model or generated by some other aspect of his
system of developing the data.
Q So if he comes in here later today and testifies that this
was not generated by a model, you don't have any basis to
disagree with that, do you?
A I don't, no.
Q Dr. Spruill, when you first came to this case, you had
never defined an interstate aquifer before, had you?
A No.
Q You did not come to your work on this case with any
definition of an interstate aquifer in mind, did you?

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1	A I had thought about it in the past, but I didn't come with
2	any definition in my mind.
3	Q And your initial charge in this case was not to offer any
4	opinion about whether water in the Middle Claiborne Aquifer is
5	interstate or intrastate, was it?
6	A That's correct.
7	Q And, in fact, when you submitted your first expert report
8	in this case, you hadn't found any criteria that you thought
9	could be used to make a determination about whether groundwater
10	in the Middle Claiborne Aquifer was interstate or not, correct?
11	A Correct.
12	Q So when you were developing your opinions in this case, Dr.
13	Spruill, you didn't think you could answer the interstate
14	versus intrastate question by considering, for example, the
15	hydrological and geological connections between the groundwater
16	in Tennessee and the groundwater in Mississippi, correct?
17	A I would have considered that as part of development as a
18	criteria.
19	Q But you didn't you just testified you didn't have any
20	criteria in your mind about how you thought you could decide
21	the intrastate versus interstate question?
22	A Well, that doesn't mean I wouldn't develop criteria if I
23	began to think about the subject.
24	Q And I'm not asking what you may have later developed. I'm
25	asking what you did when you came to this case and offered your

	312
1	expert report.
2	MR. ELLINGBURG: Your Honor, I'm going to object
3	because our position is, and has been, that whether it is an
4	interstate aquifer and, separately, whether the water in it is
5	inter an interstate natural resource is a determination to
6	be made by the Court. There is no fixed definition. I think
7	that's a conclusion of law.
8	THE COURT: Well, it will be. He can ask him the
9	question, and the Court will not be bound by it.
10	You may ask him the question.
11	BY MR. BRANSON:
12	Q So, again, I'm just asking, you didn't consider the
13	principle in answering when you came to your expert report
14	in this case, you didn't have a definition of interstate
15	aquifer in mind that you thought you could answer by
16	considering the hydrological and geological connections between
17	the water in the two states, correct?
18	A I wouldn't I wouldn't develop any concept of intrastate
19	and interstate based on the hydrologic connection between the
20	aquifers in two states, as a single criteria, would be
21	something that would be part of the part of the concept of
22	developing.
23	Q In developing your opinion in this case, your opening
24	expert report, you didn't consider the principle, did you, that
25	if a body of water is such that the removal of water within a

	313
1	state's borders can have a direct effect on the availability of
2	water in another state, the resource is likely interstate in
3	nature?
4	A I didn't understand the question. I'm sorry.
5	Q So the principle I'm asking you about is if a body of water
б	is such that the removal of water within a state's borders can
7	have a direct effect on the availability of water in another
8	state that's the principle if that's true, then the
9	resource is likely interstate in nature?
10	A Well, that's the definition of an interstate resource that
11	you're proposing?
12	Q I'm just asking you, did you consider that definition when
13	you were coming up with your expert reports in this case?
14	A That could be part of criteria that someone could develop
15	when they thought about a definition of interstate resource.
16	Q Dr. Spruill, I'm not asking you if that could potentially
17	be a criteria. I'm asking did you, Dr. Spruill, consider that
18	principle when you were drafting your expert reports in this
19	case, yes or no?
20	A I certainly thought about the flow of water from one state
21	to another.
22	Q But do you agree with the principle that if body of water
23	is such that the removal of water within a state's borders can
24	have a direct effect on the availability of water in another
25	state, then, if that's true, the resource is likely interstate

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1	in nature? 314
2	A That's not the definition of an interstate resource.
3	Q It's not?
4	A No. I don't know what the definition of an interstate
5	resource is.
6	Q But you think that's not an accurate definition of
7	interstate resource?
8	A It may be part of the definition of an interstate resource.
9	THE COURT: We have an objection.
10	THE WITNESS: I'm sorry, Your Honor.
11	THE COURT: Are you objecting?
12	MR. ELLINGBURG: Yes. I object to his effort to force
13	him to give an agreement with a definition he proposes that
14	he's already said that he hasn't developed or have and doesn't
15	propose to develop because he's a groundwater hydrogeologist,
16	not a lawyer.
17	THE COURT: Well, I think he kind of beat the around
18	enough. The witness obviously doesn't have an opinion about
19	whether it's interstate or not, so we can go on to another
20	topic.
21	MR. BRANSON: Okay. I'll move on.
22	BY MR. BRANSON:
23	Q Dr. Spruill, you didn't know that the principle I just read
24	that I was trying to get you to answer, you didn't know that
25	that was a quote from Judge Siler's August 2016 opinion, did

A No. Q And you didn't know that because, in preparing your expert reports in this case, you didn't review Judge Siler's opinion, did you? A I don't recall.
<pre>A No. Q And you didn't know that because, in preparing your expert reports in this case, you didn't review Judge Siler's opinion, did you? A I don't recall.</pre>
Q And you didn't know that because, in preparing your expert reports in this case, you didn't review Judge Siler's opinion, did you? A I don't recall.
reports in this case, you didn't review Judge Siler's opinion, did you? A I don't recall.
did you? A I don't recall.
A I don't recall.
Q You don't recall whether you reviewed it or not?
A I don't recall whether I reviewed at this time legal
opinions. I just don't recall.
Q Okay. Dr. Spruill, I'd like you to turn in your
deposition, page 28, line 1. I put this one up on the screen
so you can see it a little bit clearer.
"Question: Did you review Special Master Siler's 2016
memorandum in preparing your report in this matter?
"Answer: I really did not see it.
"Do you consider Judge Siler's opinion relevant to
your opinion that you have offered in this case?
"Answer: I really don't know what is in that
particular document. That's not something I looked at."
A Okay. I stated that.
Q And that testimony was truthful, correct?
A Yes.
Q So you did not review Judge Siler's opinion before
developing your expert reports in this case?
A I don't believe I did, according to this.

1	316 O And when I at your deposition you also testified that,
2	when you finally scanned Judge Siler's opinion after you
3	prepared your opinions, you thought it was, quote, so filled
4	with legal jargon, unquote, that you couldn't understand it.
-	correct?
6	A Yes. I said that
7	0 So. Dr. Spruill. I just want to be
, 8	THE COURT: I have an understanding about you saving
9	that Go ahead
10	THE WITNESS: Thank you
11	BY MR BRANSON:
12	0 Dr Spruill I just want to make sure the record is clear
12	You did not offer any opinion in response to Mr. Ellingburg's
14	questioning about whether the groundwater at issue in this case
15	ig interstate in nature did you?
16	Nogtorday2
10	A Yesterday?
10	Q Yesterday or this morning.
18	A NO.
19	Q Nor did you offer any opinion about whether the groundwater
20	at issue is intrastate in nature, did you?
21	A Not yesterday or this morning, no.
22	Q And you're not offering an opinion on those principles for
23	purposes of this evidentiary hearing, are you?
24	A No.
25	Q Dr. Spruill, I'd like to turn now to Defendant's Exhibit

317 129. This is tab 9. I'm sorry. PowerPoint slide 10. And I'm 1 2 going to put it up on the screen. 3 MR. BRANSON: We also have paper copies, Judge Siler, 4 if you'd like them, but I'm assuming this is okay. 5 BY MR. BRANSON: Dr. Spruill, this was a figure that you prepared and 6 0 7 included in your opening expert report in this case, correct? 8 А Yes. Yes. 9 0 And this is a hypothetical aquifer that you're depicting, 10 correct? 11 A Right. 12 Q And let's zoom in on it. 13 MR. ELLINGBURG: Your Honor, I'm going to enter an 14 objection for the record at this point in that we did not cover 15 this in direct and also that it is, by definition in his 16 report, a hypothetical and doesn't really have any direct 17 relation to this case. 18 THE COURT: I'll overrule. You may ask questions about this. 19 20 MR. BRANSON: Okay. 21 BY MR. BRANSON: 2.2 And just to be clear, Dr. Spruill, you chose to include 0 23 this in your opening expert report in this case, correct? 24 А I did. 25 Okay. So I just want to lay some principles. You -- I Q

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1	showed this to you at your deposition, and you underlined
2	"interstate aquifer" at top?
3	A Uh-huh.
4	Q And just to make sure we're on the same page, the gray area
5	that's kind of unevenly shaded in, that's the extent of the
6	hypothetical aquifer, correct?
7	A That's correct.
8	Q And you used the word "interstate aquifer" in this figure
9	because the aquifer exists beneath both of these states,
10	correct?
11	A That's correct.
12	Q In applying that very same definition of interstate aquifer
13	to this case, the Middle Claiborne Aquifer would be an
14	interstate aquifer because it physically exists beneath
15	multiple states, correct?
16	A Yes.
17	Q You also used the words "interstate flow" on this figure,
18	correct?
19	A Right.
20	Q And you used the words "interstate flow" because the water
21	in this case 1 aquifer is flowing across state boundaries,
22	correct?
23	A Right.
24	Q And that's true even though the groundwater depicted by
25	these blue flow lines would be moving very slowly, as

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1	groundwater inherently does, correct?
2	A Yeah. That was a whole conclusion that I reached with
3	respect to this concept is that what's important here is not
4	whether the aquifer underlies major states, large numbers of
5	states, but you have to focus on the flow. It's the water at
6	issue here, not the aquifer.
7	If you remove the water from an aquifer, you don't
8	have an aquifer. You have a formation. And so all of this
9	illustration and the next one that I drew, if I remember
10	correctly, all had, in my mind, to do with groundwater as
11	which I call that intrastate, flowing within the state for a
12	really, really long period of time. Even those flow lines for
13	a molecule of water near the word "State A" would require, in a
14	typical confined aquifer, thousands of years to make it to
15	state B. So it's part of the groundwater system in the state.
16	Even in this case, I focused on water, groundwater, as
17	the inter as the resource, not the aquifer.
18	Q But you underlined at the top and you acknowledge that this
19	is an interstate aquifer, correct?
20	A Yes.
21	Q And then when you drew those flow lines, I just want to be
22	very clear, you've characterized that as interstate flow even
23	though the water is moving very slowly and will take a long
24	time to flow across the boundary, correct?
25	A My intent there was to say water will flow from one state

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	320
1	to the other in the groundwater system in this scenario, this
2	hypothetical scenario.
3	Q And that's why you label it "interstate flow," correct?
4	A From one state to another.
5	Q And, Dr. Spruill, because of that interstate flow within an
6	interstate aquifer, you have opined that the groundwater in
7	this case 1 aquifer, case 1 hypothetical, is a shared natural
8	resource under natural conditions analogous to an interstate
9	river, correct?
10	A I'm sorry. You were quoting from my report or
11	Q I am quoting from your report. I'm just reading from your
12	report.
13	MR. ELLINGBURG: I'm going to object. I'm not looking
14	at the report, but did he offer a specific opinion? Did he
15	say, "It's my opinion"? I object to the "opined." I believe
16	he was trying to give him more brevity.
17	THE COURT: I'll overrule your objection. The witness
18	can say whether he opined it or not.
19	THE WITNESS: Well, could I not see what you're
20	talking about?
21	THE COURT: Yes, you may see that.
22	MR. BRANSON: I've got it right here.
23	Judge Siler, you don't need a copy, right?
24	THE COURT: No.
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1	321 BY MR. BRANSON:
2	Q So, Dr. Spruill, I was reading a direct quote from page 32.
3	And you see the bullet entitled "Case 1"?
4	A Yes.
5	MR. ELLINGBURG: Your Honor, could I just have a
б	continuing objection to this line of questions?
7	THE COURT: All right. You may have that. It's
8	overruled.
9	MR. ELLINGBURG: Thank you.
10	BY MR. BRANSON:
11	Q And, Dr. Spruill, I just want to read the very last
12	sentence on this page that spills over to page 33.
13	You write, "In this case, case 1, the groundwater
14	accumulates within and flows through both states under natural
15	conditions. Thus, the groundwater is a shared natural resource
16	under natural conditions analogous to an interstate river."
17	You did say that, correct?
18	A I said that.
19	Q Thank you, Dr. Spruill. You can put that away.
20	I'd like to now
21	A Well, I would like to I would like to comment, however,
22	that you only showed one of my hypothetical cases, not the
23	other. And my other hypothetical case, which in my mind was
24	more relevant to the situation that I was evaluating at the
25	time, was my case 2 that showed flow within the states. And I

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1	opined that the groundwater accumulation of flows from
2	millennia through one state under natural conditions to its
3	discharge area located within that state, therefore, the
4	groundwater, is that state's natural resource under natural
5	conditions and the groundwater is analogous to water in an
6	intrastate river. And so so it was more than the one
7	hypothetical case in my report that you pointed out.
8	Q Well, we're about to get to that, Dr. Spruill. I just
9	wanted to make sure the record is clear on this case 1.
10	And just to make clear, you agree that the case 1
11	involves an interstate aquifer, correct?
12	A An interstate aquifer in that the aquifer underlies
13	multiple states.
14	Q And that's the sense of the term "interstate aquifer" in
15	which you used the terms in your report, correct?
16	A In the simple case, yes.
17	Q And it also has interstate flow, correct?
18	A Yes.
19	Q And you characterized that flow as interstate even though
20	the water is flowing very slowly, taking a long time to get
21	across the border, correct?
22	A Yes.
23	Q And, thus, because of that, you stated in your opening
24	expert report that you considered the groundwater in this case
25	1 to be a shared natural resource under natural conditions

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323 analogous to an interstate river, correct? 1 2 А I made that statement. Okay. Now let's do case 2. This is the next slide. 3 0 4 This was the other hypothetical that you just invoked, 5 correct, Dr. Spruill? 6 А Yes. 7 And, again, this is -- the gray shaded area, that's the Q extent of this case 2 hypothetical aquifer, correct? 8 9 Α Yep. Right. 10 And you used the term "interstate aquifer" at the top in 0 11 the same sense as you did with case 1, to depict that the 12 aquifer underlies both states, correct? 13 А Yes. 14 Q And, again, just so the record is clear, if we were to 15 adopt that same definition of the term interstate aquifer in 16 this case and apply it to the Middle Claiborne, the Middle 17 Claiborne Aquifer would be an interstate aquifer, correct? 18 Α Because it underlies multiple states? 19 The same way you've used that term on this chart. Yes. 0 20 А Yes. 21 And the squiggly dark blue line in the middle, do you see 0 2.2 that? 23 А Yes. You're depicting a river? 24 0 25 А A hypothetical river.

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Q This is all hypothetical. I understand that.
And from a geological perspective, you would consider
the surface water flow in this river you depicted to be
interstate flow, correct?
A In the river?
Q In the river, that's what I said.
A Yes.
Q And you also agree that over a long time horizon, again, in
this depiction of a hypothetical aquifer, the groundwater is
going to migrate into the river and then eventually flow in the
interstate river out of both of these states, correct?
A In the the way I depicted these flow directions, the
implication is that water would flow from interstate within the
aquifer system; reside for a very, very long time period within
the aquifer system; and, according to this diagram, would
ultimately discharge upward across other layers to the
hypothetical river that's shown in the middle of the diagram.
Q And then once it's in the river, it will flow out of both
states, correct?
A Yes.
Q So the answer to my question is yes, over a long enough
time horizon, the groundwater in this aquifer in both states
will migrate up to the river and leave both of these states,
correct?
A Over really long periods of time.

	325
1	Q Over really long periods of time, the answer is yes?
2	A Measured in thousands of years, yes.
3	Q Dr. Spruill, I now want to change gears here, and I want to
4	discuss your testimony about MLGW's pumping. Okay?
5	A Okay.
6	Q Given current water demand in DeSoto County, water
7	purveyors in Mississippi are currently able to meet demand for
8	water from Mississippi's side from the Middle Claiborne
9	Aquifer, correct?
10	A As far as I know, they are.
11	Q You also have no direct evidence of any degradation in
12	water quality in well fields in Mississippi, do you?
13	A I do not.
14	Q And, in fact, you have not opined that MLGW is withdrawing
15	groundwater at a rate greater than the recharge rates in the
16	Middle Claiborne, have you?
17	A No.
18	Q Nor have you provided us with any calculations of any
19	reduction in the total available drawdown in the Middle
20	Claiborne Aquifer, have you?
21	A I haven't done specific calculations. I've tried to
22	generalize, based on drawdown maps that I've seen, how much
23	reduction in total available drawdown has occurred.
24	Q But you have not provided us with any calculations, have
25	you?

	326
А	No.
Q	You testified yesterday and this morning, I think, that you
tho	ught Tennessee could move its wells north away from the
bor	der to lessen the cone of depression along the state line,
cor	rect?
А	Did you say "could"?
Q	Yeah, could?
А	Yeah, could.
Q	But you acknowledge that moving MLGW's wells away from the
bor	der would not be a cheap fix, correct?
А	I certainly understand that.
Q	You have not calculated how much it might cost, have you?
А	No.
Q	In fact, you have not offered any opinion in this case
abo	ut the economic cost of any of the factors that you
dis	cussed relating to well field planning for MLGW's wells,
hav	e you?
А	No.
Q	And you don't actually know, Dr. Spruill, whether
rel	ocating MLGW wells to the north would eliminate the cone of
dep	ression, do you?
А	I have not said it will eliminate the cone of depression.
I'v	e said it would relocate the cone of depression further away
fro	m the Tennessee-Mississippi border. I've never said that it
wou	ld eliminate the cone of depression.
	A Q tho bor Cor A Q A Q bor A Q bor A Q abo dis hav A Q dis hav A Q trel dep A I'v fro wou

Proceeding - May 21, 2019 327 So depending on where Tennessee were to move the wells, it 1 Q 2 might just move the cone of depression and extend it into 3 Arkansas, correct? It might if it wasn't designed properly with elimination of 4 А 5 that problem in mind. Dr. Spruill, I want to put up slide 12. This is 6 0 7 Plaintiff's Exhibit 157 that you read off of at some length 8 yesterday. 9 А Right. 10 Do you remember this? 0 11 A Yes, sir. 12 This was not in either of your expert reports, was it, 0 13 Dr. Spruill? 14 А No. 15 This was an exhibit to Mr. Wiley's deposition, correct? 0 16 А Correct. 17 That's Mississippi's other expert, correct? Q 18 А Correct. 19 It was prepared by Mr. Wiley, not by you, correct? 0 20 А That's correct. 21 And you didn't mention this chart at your deposition, did 0 2.2 you? 23 А I don't think so. 24 You weren't involved in the creation of this chart, were 0 25 you?

	328
1	A No.
2	Q You don't have any independent knowledge of the numbers on
3	this chart other than what you're seeing in the table Mr. Wiley
4	put together, correct?
5	A That's correct.
б	Q So when when Mr. Ellingburg was asking you questions
7	about this yesterday, all you were doing was reading numbers
8	off of a chart that Mr. Wiley had given you, correct?
9	A That's correct.
10	Q Okay. I want to now go to slide 13. This is tab 25. I'm
11	going to put this up on the screen, and I'm going to hand it to
12	you in a moment, Dr. Spruill. I have a paper copy for you.
13	A Oh.
14	Q Dr. Spruill, have you reviewed this memo before?
15	A I don't remember seeing it.
16	Q This is a memo by David Wiley, Mississippi's other expert
17	in this case, correct?
18	A Yes.
19	Q And so when you were opining yesterday about the
20	possibility of Tennessee moving its wells north away from the
21	border, you weren't aware of this memo, were you?
22	A No.
23	Q I want to focus on the second sentence of this first
24	paragraph. I'm going to read it. "This modeling exercise
25	began by moving the southernmost MLGW well fields (Davis,

	320
1	Palmer, and Lichterman) located in the Memphis area up to the
2	northern part of Shelby County. This new configuration showed
3	very little change in the cone of depression."
4	I read that accurately, correct?
5	A You read it accurately.
б	Q And Davis, Palmer, and Lichterman, those were the three
7	MLGW well fields that were closest to the state line that you
8	talked about yesterday, correct?
9	A Yes.
10	Q And Mr. Wiley is stating here that he ran a model to test
11	what would happen if you moved those wells that are close to
12	the border up to northern Shelby County, and he concluded that
13	there would be very little change in the cone of depression in
14	Mississippi, correct?
15	MR. ELLINGBURG: I'm going to object to him
16	characterizing a document he hasn't even fully identified,
17	which is a May 25, 2007, memo by Dave Wiley. And I believe it
18	contains more content, but I'll cover it on redirect.
19	THE COURT: I'll overrule that. He can say if he
20	agrees with it or doesn't agree with it or what his position
21	is.
22	BY MR. BRANSON:
23	Q Do you need me to ask that again?
24	A Yes.
25	Q It's been awhile.

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1	So Mr. Wiley is stating here that he ran a model to
2	test what would happen if you moved those three wells that are
3	close to the Mississippi-Tennessee boundary to the northern
4	part of Shelby County, and he concluded that there would be
5	very little change in the cone of depression in Mississippi,
6	correct?
7	A That's what it says.
8	Q And you never reviewed this before, so you have no basis to
9	disagree with that conclusion, right?
10	A No. No.
11	Q So you're not offering Judge Siler any opinion that MLGW
12	could materially reduce the cone of depression in Mississippi
13	by moving its wells into northern Shelby County?
14	MR. ELLINGBURG: I object to that question based on
15	his effort to compare it to the 2007 memo.
16	THE COURT: Overruled. He may answer the question.
17	THE WITNESS: I'd like to take a second to read this
18	document.
19	Okay. So I'm just going to focus on the sentence here
20	that says, "Based on these exercises, it became obvious that,
21	in order to minimize or eliminate the cone of depression in
22	Mississippi, most of the MLGW well fields would need to be
23	moved a significant distance to the north outside of Shelby
24	County, essentially requiring the design and construction of
25	hundreds of new wells and many miles of pipelines. The cost

1 would be enormous."

2 He didn't say that it couldn't be done. He certainly
3 said it would cost a lot of money.

4 BY MR. BRANSON:

5 So I want to be clear what I was asking you, Dr. Spruill. 0 The specific question that I just asked you was whether MLGW 6 7 could move its wells into northern Shelby County and materially reduce the cone of depression in Mississippi. And the answer 8 9 to that, you have no basis to disagree with this memo's 10 conclusion that the answer to that is no, correct? 11 This memo doesn't say what you're saying. This memo says А 12 that it became obvious that in order to minimize or eliminate 13 the cone of depression in Mississippi, you'd have to move the 14 wells to the north. It's a -- it's not what you're saying, in 15 my mind.

16 Q Okay. I want to stop -- I want to continue reading right 17 where you just stopped. You said you have to "move the wells 18 to the north outside of Shelby County, essentially requiring 19 the design and construction of hundreds of new wells and many 20 miles of pipeline."

21 A Most of the well fields. He didn't say "all." He said 22 "most of the well fields."

23 Q Do you have any basis to disagree with this conclusion?

24 A Which conclusion?

25 Q Let's start with -- let's start with the one --

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332 A So let me just say, first, focus on the sentence, "This new
configuration showed very little change in the cone of
deproggion in Miggiggippi " So there wag a ghange albeit
ampl]
Small.
So that's is that is that the conclusion you're
talking about?
Q That is one of the conclusions, I want to make sure that
you're not offering any opinion that you would disagree with
that conclusion, correct?
A I haven't seen the data that he used to reach this
conclusion.
Q So the answer is no, you have no basis to disagree with
that conclusion, do you?
A I have no basis to agree or disagree with it.
Q Okay. Now let's do the next sentence that you highlighted.
You have no basis to disagree with Mr. Wiley's
conclusion that moving MLGW's well fields north outside of
Shelby County would require the design and construction of
hundreds of new wells and many miles of pipeline? You don't
have any basis to disagree with that, do you?
A Once again, you only read part of the sentence. It became
obvious that, in order to minimize or eliminate the cone of
depression in Mississippi, most of the wells are going to be
moved north, and I agree with that.
Q And you don't and you agree that, if MLGW were to do

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1	333 what you just said, it would require the design and
2	construction of hundreds of new wells and many miles of
3	pipeline?
4	A Absolutely.
5	0 And you agree that the cost would be enormous, correct?
6	A Yes.
7	Q Now, this morning you cited at some length Moore in 1965 as
8	the basis for your analysis of the supposed availability of
9	groundwater north of Memphis, correct?
10	A Correct.
11	Q This memo done by Mr. Wiley, that was some 40 years after
12	the Moore report on which you relied, correct?
13	A Correct.
14	Q And you did not cite Moore in 1965 in either of your expert
15	reports, did you?
16	A I did not.
17	Q It's not on your references list, is it?
18	A No.
19	Q Now, you agreed this morning, in response to a leading
20	question from Mr. Ellingburg, that you relied on Moore 1965 in
21	formulating your opinions, right?
22	A In formulating my opinions?
23	Q That's what you
24	A My opinions or opinions?
25	Q In formulating your opinions, you said you relied on Moore

	334
1	1965, correct?
2	A Correct.
3	Q When I asked you, Dr. Spruill, at your deposition whether
4	there were any other significant sources that you relied on
5	other than the ones listed in your expert reports, you said no,
6	correct?
7	A Correct.
8	Q And you did not mention Moore in 1965 at your deposition,
9	did you?
10	A I did not, but I also indicated that this is not a
11	comprehensive comprehensive list of resources and documents.
12	Q And I asked you specifically about that statement that you
13	just read and asked you whether there were any other
14	significant sources that you relied on other than the ones that
15	were on that list, and you said no, correct?
16	A It's not in my references.
17	Q Yeah. And your answer to that question was no, just to be
18	clear, correct?
19	A My answer to the question is it in my reference list?
20	Q No.
21	A Okay. Sorry.
22	Q The question in the deposition was, looking at the
23	reference list, reading the sentence that you just read to me,
24	and asking you whether there were any other significant sources
25	on which you relied other than the ones in your reference list,

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1	and the answer was no, correct?
2	A I'd like to see the deposition, but I assume that I said no
3	to that question. There weren't any other significant sources,
4	but I have relied on the Moore report through time.
5	Q So are you saying you started relying on Moore after your
6	deposition?
7	A Probably during that time and then after my deposition,
8	yeah.
9	MR. BRANSON: Your Honor, I'd like to reserve our
10	right to move to strike on that basis later.
11	THE COURT: All right.
12	MR. ELLINGBURG: And I'll object to the form of the
13	question, the inclusion of him lying at that point.
14	THE COURT: Objection overruled. You may reserve his
15	right to ask to strike later.
16	BY MR. BRANSON:
17	Q And, Dr. Spruill, you have not offered any opinion in this
18	case about the cost associated with the cone of depression in
19	the Middle Claiborne Aquifer, have you?
20	A The cone of depression doesn't have a cost. I don't know
21	what you mean. Would you ask me again?
22	Q Yeah. Have you estimated the cost associated with the
23	impact of the cone of depression
24	A Oh.
25	Q that you testified about, and the answer is no?
Γ

	33	36
1	A No.	
2	Q Correct? The answer is no?	
3	A Correct answer.	
4	Q Okay. Dr. Spruill, I want to apply some of the same	
5	concepts that you've talked about this morning to wells in	
6	Mississippi.	
7	In preparing your opinion in this case, you did not	
8	determine whether or not Mississippi is pumping from, let's	
9	say, Southaven well field in DeSoto County was consistent with	
10	your principles of good well design, did you?	
11	A No.	
12	Q And at your deposition, you didn't know how many wells	
13	there were in Mississippi pumping within one mile of the	
14	Tennessee-Mississippi border, did you?	
15	A No.	
16	Q And, Dr. Spruill, you testified yesterday about well	
17	interference, correct?	
18	A Yes.	
19	Q Mississippi's wells on its side of the border are also	
20	generating well interference, correct?	
21	A Correct.	
22	Q And if I were to tell you that one well field in Southaven,	,
23	Mississippi, right on the border wells that are an average of	
24	383 feet apart, would you have any basis to disagree with that?	?
25	A No.	

	337
1	Q And you would acknowledge that those wells are much closer
2	together than the wells that you testified about on in
3	Tennessee yesterday, correct?
4	A They are.
5	Q And when preparing your opinions in this case, then, you
6	did not set out to assess whether Mississippi's wells that are
7	pumping out of the Middle Claiborne Aquifer are consistent with
8	your principles of good well design, did you?
9	A No.
10	Q Dr. Spruill, I think we've covered this earlier, but you do
11	not have a good understanding of the Federal Doctrine of
12	Equitable Apportionment, do you?
13	A No.
14	Q And are you aware that the purpose of this hearing was to
15	determine whether equitable apportionment should apply to
16	Middle Claiborne?
17	MR. ELLINGBURG: I'll object to that. That's not
18	what
19	THE COURT: Objection sustained on that. It's a legal
20	question.
21	BY MR. BRANSON:
22	Q Let me ask it this way, Dr. Spruill. You've not offered
23	any opinions, in your view, about whether equitable
24	apportionment would be a good way of regulating wells in the
25	Middle Claiborne Aquifer, correct?

Γ

	338
1	A No.
2	Q Correct?
3	A No.
4	MR. BRANSON: So, Your Honor, it's five to noon. I'm
5	about to transition into a new subject. I'm happy to keep
б	going, or I thought if you wanted to break now, that would be
7	fine. I defer to you.
8	THE COURT: We'll go on for another 15, 20 minutes,
9	something like that. Then we'll take a break.
10	BY MR. BRANSON:
11	Q Dr. Spruill, you've testified that, under predevelopment
12	conditions, you think water within the Middle Claiborne Aquifer
13	in Mississippi was generally flowing in a westerly direction,
14	correct?
15	A Yes.
16	Q But you yourself have not run any models to verify that,
17	have you?
18	A That's correct.
19	Q You testified yesterday, I believe, that if you want to
20	determine the direction of groundwater flow, you generally need
21	at least three wells measuring water elevations, correct?
22	A Well, that would give you the direction of groundwater flow
23	with a degree of certainty in the triangle between those three
24	wells.
25	Q So if you want to draw if you want to kind of create

	339
1	a one contour line, you generally are going to need three
2	wells to triangulate the measurement, correct?
3	A You can get more than one contour line and three wells to
4	triangulate.
5	Q But you would agree that generally you need at least three
6	in order to start getting an accurate assessment of the
7	groundwater flow?
8	A Unless you fortuitously drilled two wells at the same head.
9	Then you could at least determine a lot of equal pressure,
10	but you couldn't determine direction of groundwater flow.
11	Q And I believe you also said yesterday that if you want to
12	determine groundwater flow with any reasonable degree of
13	accuracy, you need a fairly large number of monitoring wells.
14	Did I hear you correctly?
15	A Yes.
16	Q Now, Dr. Spruill, you testified this morning in response to
17	Mr. Ellingburg's question about the predevelopment map of the
18	Middle Claiborne Aquifer created by Criner and Parks, 1976,
19	correct?
20	A Correct.
21	Q I'm going to put this up on the screen. For the record,
22	everybody, this is Plaintiff's Exhibit 205 as Mr. Ellingburg
23	handed it up today.
24	And this was a map that you briefly discussed with
25	Mr. Ellingburg, correct?

1	340
T	A Yes.
2	Q And you opined in your expert report that this Criner and
3	Parks map employed data from reliable sources and provides a
4	reasonably sound basis for estimating the predevelopment
5	surface, correct?
б	A Yes.
7	Q When you were evaluating the documentation for this Criner
8	and Parks figure, you didn't look at anything beyond the Criner
9	and Parks report itself, correct?
10	A You mean did I evaluate the actual data used in no.
11	Q Yeah. The answer is no, you did not evaluate the actual
12	data that Criner and Parks used, correct?
13	A Correct.
14	Q And so you opined in your expert report, Dr. Spruill, that
15	you thought this map was reasonably sound even though you did
16	not go and look at the scientists' underlying data, correct?
17	A Correct.
18	Q Now, Dr. Spruill, I want to put up on the screen here, I
19	want to circle and label the four control points that Criner
20	and Parks used.
21	Do you see how I've put red circles around the four
22	things that they've denoted as an observation well on here?
23	A Yes.
24	Q Do you have any reason to disagree with the identification
25	of the control wells that Criner and Parks used?

341 All of those -- all of those wells, in my opinion, 1 А No. 2 would be in the confined portions of the groundwater system. 3 Dr. Spruill, all I asked you was do you have any reason to 0 4 disagree with the labeling that I put to the four wells on Criner and Parks' report. 5 6 А No. 7 I'm sorry. What did you say? Q А 8 No. 9 0 So let's go to slide 24. I'm going to darken in the state 10 boundary here just so we can all see it. 11 You see how I put a black line around the 12 Tennessee-Mississippi border? 13 А Right. 14 0 Criner and Parks do not have any control data at all on 15 Mississippi's side of the border, do they? 16 Α They do not. 17 Q Now, you've previously testified when I asked you about 18 this that it was important to you that Criner and Parks only 19 used observation wells that were away from the center of 20 pumping, correct? 21 There was no center of pumping at this time. Α 2.2 Do you even know when the measurements were taken from 0 23 these four control wells? 24 Well, it's depicting the potentiometric surface of the Α 25 Memphis Sand in 1886, and so I assume that there were some

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1	342 measurements taken prior to prior to pumping because I don't
2	see a cone of depression here.
3	Q You assume that, but you don't know that, correct?
4	A I don't know that, correct.
5	Q You didn't go and look at the actual data Criner and Parks
6	actually used to determine when they might have taken these
7	measurements?
8	A I don't know if there's a model or a location or not. I
9	don't recall.
10	Q So if I were to tell you that some of these control points
11	took measurements 40, 50, 60 years after predevelopment, you'd
12	have no basis to disagree with that, correct?
13	A I don't know when they were when these measurements took
14	place.
15	Q Okay. So I want to ask my previous question again.
16	You previously opined that it was important to you
17	that Criner and Parks used only observation wells that were
18	away from the estimated center of pumping, correct?
19	A If you want to determine the predevelopment potentiometric
20	surface, by definition, there is no substantial development.
21	That's the definition of predevelopment.
22	Q So let me focus on the observation wells part of the
23	question. It was important to you, I think you said, that
24	Criner and Parks only used observation wells, correct?
25	A Correct.

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1	Q And I want to focus on control point SHO-124. Do you see
2	that?
3	A Yes.
4	Q That's an inspection shaft to an underground tunnel,
5	correct, Dr. Spruill?
б	A I don't know.
7	Q It's not an observation tunnel, is it?
8	A I don't know.
9	Q So you said it was important to you that Criner and Parks
10	used only observation wells, you said that even though you have
11	no idea if that thing that we've marked in downtown Memphis is
12	actually an observation well?
13	A I don't know if it's an observation well or not.
14	Q So when you said that it was important to me that Criner
15	and Parks used observation wells, you don't know if they
16	actually used those, do you?
17	A I don't know whether it's an observation well or not. But
18	it's important, if you understand how groundwater flows, to use
19	observation well data. That is reliable.
20	Q So if I were to establish to you that this is an inspection
21	shaft to an underground tunnel and not an observation well,
22	then you would think this map is not reliable?
23	A I would want to look at the criteria that this highly
24	qualified geologist working for the US Geological Survey looked
25	at to determine that this gives a reliable measure of

344 1 equipotential surfaces or values at that location. 2 0 And you'd want to look at that, but that's not something you've looked at for this case --3 4 Α No. 5 Q -- correct? Let's focus on SHU-2. 6 7 А Okay. Have you checked to see whether that's actually an 8 0 9 observation well? 10 Α No. 11 If I were to tell you that that well has an 80-foot screen 0 12 length, would you have any basis to disagree with that? 13 I wouldn't -- I wouldn't know what the screen length is А 14 just sitting here. 15 And if a well has an 80-foot screen length, it's a 0 16 production well, right? 17 Α No. 18 0 So you think that there could be an observation well with 19 an 80-foot screen length? 20 А In a confined aquifer, yes. 21 But do you know SHU-2 is actually an observation well? 0 2.2 А No. 23 So if I were to tell you it's a production well, you'd have Q 24 no basis to disagree with that? 25 Α Well, is it a production well that had a pump in it? You

345 can have a production well that has a pump in it and take a 1 2 water level measurement as long as the pump is not running and it's an observation well. 3 4 And you have no idea whether the pump was running in 0 5 that --I don't. I don't. I don't, no. 6 А 7 And, Dr. Spruill, I want to look at this map. I want to Q 8 focus on the contours right along the black line, the state 9 line. 10 Do you see that? A Yes. 11 I want to focus on the 220, 230, 240, and 250. And I've 12 0 13 tried to zoom in. I was counting the lines starting from the left. 14 15 Do you see me? 16 А Yes. Do you see how those lines go south of Memphis; they're 17 0 18 coming in at a northeast-to-southwest orientation? 19 А Yes. 20 And you see how, as they approach the state boundary, they 0 21 curve and become vertical? 2.2 Do you see that? 23 A Yes. You don't see any control data on this figure that would 24 0 25 justify that north-south bend in the contours, do you?

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1	A No. But these challenges don't live in a vacuum. I mean,
2	they're looking at things other than just this particular area.
3	So I can't say whether they had any information to the south,
4	either just general understanding, other reports and so forth,
5	to make this transition that you see from northeast to more
6	northerly across the border.
7	Q So what you just said, Dr. Spruill, you have no idea if
8	Criner and Parks actually had any other information that they
9	used to justify this bend, do you?
10	A No.
11	Q And so without any actual control data that you as a
12	scientist have evaluated that would justify that bend in the
13	contours, you can't opine one way or the other on whether those
14	contours at the state line are accurate, can you?
15	A No. All I can say is that those those contour lines
16	deflect more to the north-south from the northeast beginning at
17	about the state border to the south.
18	Q They do that, and I'm not I agree with you that they do
19	that.
20	I'm asking you, without any actual data you've looked
21	at, you can't opine on whether those contours are accurate, can
22	you?
23	A No, I can't. I mean, those are contour lines drawn by very
24	competent US Geological Survey individuals. And this report,
25	because I know a lot about the survey, has gone through

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1	rigorous review. And, to me, there must be evidence that this
2	report is done using standard geological practices that meet
3	the rigorous demands of the US Geological Survey. And that's
4	all I can say about that.
5	Q So you assume it must have gone through that process, but
б	you don't know, do you?
7	A No. I certainly hope it's gone through that process.
8	Q And without knowing what the data is that may or may not
9	justify these contour lines all along the state border, you as
10	a scientist, you can't opine on their accuracy, can you?
11	A No.
12	Q Okay. Dr. Spruill, let's go on, and I want to focus now on
13	slide 16. This is for the record, everybody, this is
14	Plaintiff's Exhibit 206. And this is from Reed in 1972. I'm
15	going to blow this up. There you go.
16	This is a figure that you have provided in your expert
17	report. I didn't take your version, but this is the underlying
18	document, correct, Dr. Spruill?
19	A Correct.
20	Q In preparing your reports, you did not take any steps to go
21	back and look at any underlying control data that Reed may have
22	used to generate this map, did you?
23	A No.
24	Q So you don't even know whether Reed had a single control
25	well justifying any of these contours, do you?

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1	A I don't know how many wells he may have had to generate
2	this this map.
3	Q So could you don't know if he had any wells, do you?
4	A I don't know how many he had.
5	Q Could have been zero; could have been five?
6	A I don't know.
7	Q Certainly there's nothing on this map that would give any
8	indication that Reed has met the Dr. Spruill test of needing at
9	least three control wells to draw the contour line or determine
10	flow direction, correct?
11	A Well, my interpretation is that these potentiometric
12	surface maps predevelopment that were drawn by scientists in
13	the 20th Century have to be based on something other than
14	measurements in that a large number of wells because they
15	didn't exist in predevelopment times. So geologists relied on
16	basic geologic knowledge of how aquifers work and so forth to
17	draw lines of equitotal hydraulic head on maps in the
18	absence in the absence of actual monitoring well data.
19	Q So but what you just said, I just want to be clear,
20	you're speculating; you have no idea how Reed drew this map, do
21	you?
22	A I don't know what his control points were, if any.
23	Q Let's do another one. I don't think I have a slide for
24	this one, but I want to focus on Arthur and Taylor, Plate 5,
25	which was P199. Mr. Ellingburg handled it to you this morning,

1 I believe. I can give you another copy if that would be 2 useful, Dr. Spruill. 3 Α Sure. 4 0 What was it? I'll hand you another copy just so we're not 5 lost. MR. BRANSON: Judge Siler, since I don't have a slide 6 7 for this one, do you want a paper copy to --THE COURT: I don't need one. 8 9 MR. BRANSON: You don't need one? 10 THE COURT: No. 11 BY MR. BRANSON: 12 So this was another USGS estimated predevelopment map that 0 13 you've cited, correct, Dr. Spruill? Uh-huh. Yes. 14 А 15 When you offered your expert reports, you didn't have any 0 16 understanding of the control data Arthur and Taylor used to 17 generate these contours, did you? 18 Α No. There's no discussion of Arthur and Taylor's control data 19 0 20 in either of your expert reports, is there? 21 Α No. 2.2 So, for example, you don't know whether Arthur and Taylor 0 23 relied on any observation wells, do you? 24 А I do not. 25 You certainly don't know the construction details of any Q

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1	wells that Arthur and Taylor might have had, do you?
2	A I do not.
3	Q You don't know what time period Arthur and Taylor's
4	measurements might have been taken from, do you?
5	A Well, if it's predevelopment, I would assume it's 18 the
6	concept is what does it look like in the 1800s.
7	Q Dr. Spruill, I'm not asking what you're assuming. I'm
8	asking what you actually know from studying this paper. And
9	the answer is you don't know, correct?
10	A I don't know what?
11	Q You don't know what time period Arthur and Taylor took any
12	measurements they might have had from?
13	A No. I don't think Arthur and Taylor took any time
14	measurements during the 1800s.
15	Q So we have no idea as you're sitting there on the
16	witness stand right now, you have no idea when Arthur and
17	Taylor's measurements may or may not have been taken?
18	A I don't know whether others took measurements that Arthur
19	and Taylor used. I don't I don't know.
20	Q And because you don't know that, again, you can't opine on
21	the accuracy of these contour lines, can you?
22	A What I can opine on is that these are lines drawn on a map
23	by the US Geological Survey. It's their best estimate of the
24	predevelopment configuration of the equipotential surface.
25	Q Do you know whether this map estimating the predevelopment

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1	surface was the purpose of Arthur and Taylor's article?
2	A I don't remember what the stated purpose of this was.
3	Predevelopment maps are often used as the basis for calibrating
4	a model, for example.
5	Q You have no idea whether Arthur and Taylor calibrated any
6	model using this Plate 5, do you?
7	A I don't remember.
8	Q And so, again, I'll ask you, without having any knowledge
9	of the data used to generate this chart, you, Dr. Spruill, as a
10	scientist, cannot opine on the validity of these contours, can
11	you?
12	A No. I have to take them at face value.
13	MR. BRANSON: Judge Siler, I'm at another
14	changing-gears spot. I'm happy to keep going.
15	THE COURT: I will declare a recess until 1:30.
16	(A lunch break was taken.)
17	THE CLERK: All rise. The Court is back in session.
18	United States Supreme Court Special Master Eugene Siler, Jr.,
19	presiding. You may be seated.
20	MR. BRANSON: Your Honor, I am happy to rest and pass
21	the witness.
22	THE COURT: Okay. Let me bring up one thing, that's
23	just a matter of our plans. If we have to go next week, are we
24	in agreement that we would go on Tuesday and we'd finish on
25	Tuesday if we go on Tuesday?

352 MR. BRANSON: That's certainly our position, Your 1 2 Honor. 3 THE COURT: Okay. 4 MR. ELLINGBURG: Mississippi agrees. 5 THE COURT: Okay. Agree? MR. L. BEARMAN: Yes. 6 7 THE COURT: Can we do it in one more day after this 8 week? 9 MR. BRANSON: I certainly think so. 10 MR. ELLINGBURG: I think that's probable. 11 THE COURT: The problem, I think, is Mr. Frederick. 12 MR. FREDERICK: Your Honor, our instructions from the State of Tennessee are to finish the hearing when we finish the 13 14 hearing. And we have a strong preference to finish on Tuesday. 15 We would ask our colleagues from Mississippi to proceed 16 efficiently so that we can do that. We have endeavored to 17 present our case, and we will, efficiently. We'd like to 18 finish on Tuesday, and if we can't, we'd like to finish on 19 Wednesday. 20 THE COURT: I've set aside that time for myself, but I 21 wanted to make sure it's agreeable with everybody and we can 2.2 work it in. If we finish before then, fine. 23 MR. L. BEARMAN: I was going to say, Your Honor, my 24 strong preference is to finish this Friday, but --25 THE COURT: Well, I would, too, if we could, but --

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353 MR. L. BEARMAN: I thought I better be on record --1 2 THE COURT: Okay. 3 MR. L. BEARMAN: -- with that. 4 THE COURT: You've got a trip planned by your wife? 5 Is that the idea? MR. L. BEARMAN: No, sir. No, sir. 6 7 THE COURT: Okay. I won't ask. You may cross-examine the witness. 8 9 CROSS-EXAMINATION 10 BY MR. L. BEARMAN: 11 Thank you. Dr. Spruill, my name is Leo Bearman, and I 0 12 represent the City of Memphis and the Memphis Light, Gas & 13 Water Division. 14 I'm going to ask you just a few questions. If you 15 don't understand one, want it repeated or clarified, all you 16 have to do is ask me. 17 Do you understand that? 18 A Yes, sir. 19 O Can you hear me? 20 Yes, sir. А 21 MR. L. BEARMAN: Your Honor, I'm kind of confounded by 22 these microphones. Can Your Honor hear me? 23 THE COURT: Yes, I can. 24 BY MR. L. BEARMAN: 25 Q Dr. Spruill, you were in the courtroom when we opened this

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1	case, were you not?
2	A Yes, I was.
3	Q Okay. And you remember in opening statements the
4	attorneys, and I'm just going to talk about me, but we all
5	or I talked and Mr. Frederick talked about the factors involved
6	in proving what we understood the Court had delineated as the
7	appropriate issue in the case.
8	And then before we started doing that, I talked a
9	little bit about nomenclature as what these aquifers are
10	called. Let me see if you agree with me, if you will.
11	Do you agree that in Tennessee the names Memphis Sand
12	or Memphis Aquifer are synonymous with the Middle Claiborne
13	Aquifer; in Mississippi, the upper part of the Middle Claiborne
14	Aquifer is called the Sparta Sand? Do you agree with that?
15	A Yes.
16	Q Good. That comes right out of your report.
17	A Good.
18	Q Do you recognize it?
19	A Well, I yes.
20	Q All right. Now, what I want to talk about are the factors
21	that at least we felt were significant in determining whether
22	or not this aquifer in question, the Middle Claiborne, was and
23	is an interstate resource, the aquifer and the water in it.
24	One the first factor that we talked about, that I
25	talked about, was that the Middle Claiborne lies between eight

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1	different states.
2	You agree with that?
3	A The Middle Claiborne Aquifer Unit lies
4	Q Beneath eight different states.
5	A I agree.
6	Q Okay. I'm going to you're going to agree on everything.
7	I'm just confident.
8	The second factor that I suggested was that pumping
9	groundwater in one state, that is, Tennessee, affects
10	groundwater flow across the state line into Mississippi.
11	You agree with that, don't you?
12	A I'm not going to just agree with that. I'm going to want
13	to know what you mean by "affects."
14	Q By what, sir?
15	A Affects groundwater flow.
16	Q All right. Well, let me read you your deposition answer.
17	You understand the importance of a deposition, don't
18	you, sir?
19	A Yes, sir, I do.
20	Q Have you ever given one before this one?
21	A Yes.
22	Q Hundreds of times?
23	A Not hundreds.
24	Q Dozens of times?
25	A Perhaps.

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1	Q All right. You understand the significance is that the
2	attorneys who are asking questions want specific and truthful
3	answers, correct?
4	A Correct.
5	Q Okay. Do you understand you're under oath and that you
6	have the opportunity, as I just gave you, that if you don't
7	understand a question or you want it repeated or clarified, all
8	you have to do is ask?
9	A I understand.
10	Q Okay. One of the questions asked apropos of this pumping
11	was, "I believe you have opined," says the questioner, "that
12	groundwater pumping out of the Middle Claiborne on the
13	Tennessee side of the state boundary has affected groundwater
14	flow on the Mississippi side, correct?"
15	Your answer was
16	MR. ELLINGBURG: Excuse me. Could you direct me so
17	I'll know
18	MR. L. BEARMAN: Certainly. Page 38. I apologize.
19	MR. ELLINGBURG: and can refer to it.
20	BY MR. L. BEARMAN:
21	Q Do you want to look at it, sir?
22	A I do.
23	Q Okay. This doesn't have a line number, so it's right in
24	the middle of the page. That was your opportunity do you
25	want to take a look at it?

357 Where are you on this page? 1 А Right in the middle. "I believe you have opined" --2 0 3 А Okay. -- "that groundwater pumping out of the Middle Claiborne on 4 0 the Tennessee side of the state boundary has affected 5 6 groundwater flow on the Mississippi side, correct?" 7 And you didn't say, "It depends on what you mean by affected." 8 9 All you said -- just a minute, sir. I'm going to ask, 10 and then you can respond if you want to. 11 You said, "Yes." 12 Is that the correct answer? 13 A Yes. 14 Q Okay. Now, the next question -- and you agree with that? 15 I thought you were going to give me an opportunity to А 16 speak. 17 All right, sir. If you -- if His Honor feels that this 0 18 could be responsive, it's up to His Honor. I don't give 19 opportunities. I'm not authorized to give opportunities. THE COURT: You can explain it if you have an 20 21 explanation. 22 THE WITNESS: You started off this discussion by 23 saying that -- and you gave me this impression that that 24 question wasn't relative to a -- the specific case of water 25 pumping in Mississippi affecting water levels in Tennessee and

358 1 vice versa. What I heard in the opening statement was that 2 this might be some part of a criteria for a definition. And so 3 when you said -- when you asked your question, I related it to the general, not the specific case here. 4 BY MR. L. BEARMAN: 5 6 0 Dr. Spruill, you're telling me that a question that says "I 7 believe you have opined" --No. I'm talking about the previous statement. 8 А Listen to my question, please, sir. 9 0 My question was, "I believe you have opined that 10 groundwater pumping out of the Middle Claiborne on the 11 12 Tennessee side of the state boundary has affected groundwater flow on the Mississippi side, correct?" 13 14 А Yes. O And you said, "Yes." 15 All I want to know is, did you answer that question 16 17 truthfully? 18 Α Yes. Okay. Fine. 19 0 20 Let's go to -- and let's go to the next question or 21 next factor. 22 The next factor that I want to ask is, would you also 23 agree -- are you with me, sir? 24 Yes, I'm listening. А 25 "Would you also agree that groundwater in the Middle Q

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T	Claiporne is hydrologically connected to some surface waters in
2	the area?"
3	And your answer was
4	MR. ELLINGBURG: Could you give us a page reference?
5	MR. L. BEARMAN: Page 40.
6	MR. ELLINGBURG: That helps.
7	BY MR. L. BEARMAN:
8	Q Your answer was, sir?
9	A I'm looking. You're ahead of me.
10	Q Right in the middle. Don't get ahead of me. Stay with me,
11	if you will.
12	MR. ELLINGBURG: He's entitled to look at his
13	testimony.
14	MR. L. BEARMAN: I understand that. I just want to
15	get the answer first, if you will.
16	THE WITNESS: The answer was, "In the unconfined
17	portions of the system, I think they are hydraulically
18	connected, and some recharge takes place there. I also think
19	they are hydraulically connected through the system," through
20	the system.
21	BY MR. L. BEARMAN:
22	Q "Throughout the system," sir.
23	A "Throughout the system, even in the confined portions of
24	the groundwater system."
25	Q All right. So that's your answer, is it not? That is,
23 24 25	A "Throughout the system, even in the confined portions of the groundwater system."Q All right. So that's your answer, is it not? That is,

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1	would you agree that groundwater in the Middle Claiborne is
2	hydrologically connected to some surface waters in the area?
3	Your answer was basically I agree. In the unconfined
4	portions of the system, you think they are hydrologically
5	connected and some recharge takes place there.
6	Then you said, "I also think that they are
7	hydrologically connected throughout the system even in the
8	confined portions of the groundwater system."
9	And that's an accurate statement by you, is it not?
10	A Yes, it is.
11	Q And you agree with the statement you made; it's an accurate
12	statement?
13	A I'm agreeing that I wrote this statement.
14	Q All right, sir. Now, the next point I want to make, which
15	was the fourth point, was that it's hang on, if you will,
16	please.
17	MR. L. BEARMAN: I'm sorry, Your Honor. It's hard for
18	me to read with these glasses, but I'm going to get there.
19	THE COURT: That's fine. Take your time.
20	BY MR. L. BEARMAN:
21	Q You'll also agree with the fourth factor, would you not,
22	that it's absolutely clear that a small amount a small
23	amount of water, but some amount of water, crosses the border
24	from Mississippi to Tennessee in predevelopment, that is,
25	prepumping, times? You acknowledge that, right?

1 А Yes. 2 0 In fact, you said that specifically. So we're in agreement 3 on those four points. 4 Now, the next point I want to ask is, these are two that I added gratuitously, and that is that there is no -- you 5 would agree, would you not, sir, that there is no physical 6 7 barrier at all that extends along the Mississippi-Tennessee boundary that would impede groundwater from flowing across the 8 border? You agree to that, don't you? 9 10 I'm sure that I would agree to the concept of a physical Α 11 boundary like a wall or something like that, but I've stated so 12 today that impede can mean the slowing of water in that general 13 area by facies change, for example. 14 0 And that, sir, is what you pointed out, was it, to the questioner when he asked this crucial question? 15 16 Α I don't remember, so I'm sure you'll point me to it. 17 Well, I will point you to it. Take a look at page 37, the 0 18 last line, and page 38 at the top. 19 А Uh-huh. Your answer was not, It depends on this and it depends on 20 0 21 that. Your answer was, sir, "I agree," correct? 2.2 I can't hear you. 23 А Sir? 24 I said your answer was not, Well, it depends on this or it 0 depends on that. 25

362 MR. ELLINGBURG: Your Honor, I want to interpose an 1 2 objection. This is not a proper way to impeach when you read 3 part of a question. 4 THE WITNESS: Exactly. So --THE COURT: All right. Read him the full question and 5 he can answer whether he said that. 6 7 BY MR. L. BEARMAN: We'll talk about complexity in a minute. The question 8 0 is -- I want to make sure the record is clear. "You initially 9 10 said in response to my question that there was no significant 11 physical barrier, I think, along the Mississippi state 12 boundary. I want to make clear that there is no physical 13 boundary -- barrier at all that exists -- that extends directly 14 along the Mississippi-Tennessee boundary that would impede 15 groundwater from flowing across the border, right, " says the 16 questioner. 17 And your answer was, "I agree," correct? 18 А Correct. But that's all misleading and -- and it is out of 19 context. And so being an experienced deposition giver, sir, dozens 20 0 21 of times and knowing that you were in the room giving a 2.2 deposition under oath for the purpose of determining exactly 23 what your position was as an expert, you said to the 24 questioner, Wait a minute now, that's out of context; that's --25 you have -- you have not been ingenuous?

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1	You didn't do any of that? All you said was I agree.
2	A Sir, that's one question that dealt with the issue of
3	physical barriers. I stated on page 38 37 that there are
4	lateral and vertical changes in the Claiborne Aquifer System
5	that caused significant variations in the rate of groundwater
б	movement, which is incredibly slow, and the direction of water
7	movement at both the lateral and vertical sense.
8	So while there are no physical barriers that would
9	prevent the movement of water downgradient in response to
10	decreasing total hydraulic head in this aquifer system, there
11	is amazing complexity.
12	Q And so you said, in response to Mr. Branson's question,
13	Look, you've got to think about I've got to think about all
14	those complexities and facies and everything else?
15	All you said was, sir, being an experienced deposition
16	giver, you said, "I agree." And you still do agree to that, do
17	you not?
18	And look at the next question before you answer that.
19	The next question was, "There was no barrier in predevelopment
20	times, right?" I'm sorry, "either."
21	And you said, "I agree."
22	A I had already made my position clear on this, and that is
23	that I was thinking about some sort source some sort of
24	subsurface geological barrier that exists. And my point was
25	there is no such subsurface geological barrier, like a wall and

364 so forth, but there are mechanisms that impede the movement of 1 2 water in that particular location, and that's the significant 3 facies change that occurs there. 4 And you explained all that in the answer where you say "I 0 5 agree"? 6 А I explained it in the verbiage that I read before that. 7 I see. And you referred to your previous answer when you 0 said "I agree"? You didn't, did you? 8 We're talking about two different things. We're talking 9 Α about a physical barrier that you want to impose on me, and I'm 10 11 talking about a lateral change in composition of the material, 12 sir. Did you give -- let's try it this way. Did you say in the 13 0 deposition, sir, "I agree"? 14 15 Well, yes. Α 16 0 Thank you. 17 Now, here's the next question. Under natural 18 conditions in the Middle Claiborne Aquifer, every molecule of 19 groundwater in that aguifer, under natural conditions, was 20 moving to some extent, correct? 21 Α Yes. 2.2 And that's exactly what you said, and you agree to that? 0 23 А Yes. 24 Okay. Fine. 0 25 Now, a couple of more points, sir, on a transboundary

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365 aquifer, okay? If you're hurting, I'll stop. 1 2 А I'm fine. I just need to stand for a second. 3 Okay. You gave the deposition -- the definition, sir, did 0 4 you not, on what a transboundary aquifer is when you were 5 questioned? I remember talking about it, but I don't remember the 6 А 7 specifics, though. 8 0 All right. Take a look at page 76. 9 A Okay. O Are you with me? 10 I am. 11 А 12 Mr. Branson said, "Question: You've heard the term 0 'transboundary' aquifer before? 13 Your answer was, was it not, if I'm reading it 14 correctly, "It is not a term I use, but I have heard it," 15 16 correct? 17 A Correct. 18 0 Then he said, What do you understand, sir? And my -- "What 19 do you understand it to mean?" In other words, Mr. Branson's not asking a definition 20 21 that he created. He is asking your definition. And you said, 2.2 "An aquifer that underlies national or international state 23 boundaries." 24 That's my statement. А Okay. And then he said, "When you say 'underlies,' you're 25 Q

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T	talking about physically underlies the geographical extent of
2	the aquifer?"
3	All right. The next question that I want to ask is,
4	"On the Middle Claiborne," which was the next question asked,
5	"is the Middle Claiborne," said Mr. Branson, "a transboundary
6	aquifer?"
7	Now, by "transboundary," you defined it as an aquifer
8	that underlies national or international state boundaries.
9	A national state boundary would certainly be the
10	boundary between Tennessee and Mississippi, right?
11	A Yes.
12	Q Okay. And then he says, "Is the Middle Claiborne a
13	transboundary aquifer? That's the aquifer we're talking
14	about."
15	And you said, "The Middle Claiborne underlies multiple
16	states in this region."
17	That's correct, isn't it?
18	A Yes, that's what I said.
19	Q Sir?
20	A That's what I said.
21	Q My question was not what you said. That's correct, isn't
22	it?
23	A The Middle Claiborne, I said then and I'll say now,
24	underlies multiple states.
25	Q Thank you.

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1	And then the question was, "It does meet your
2	understanding of what a transboundary aquifer is?"
3	And your answer was, "If a transboundary aquifer is
4	simply one that is defined as a physical aquifer system
5	underlying multiple states, then the Middle Claiborne fits the
6	definition of a transboundary aquifer."
7	You agree with that, right?
8	A I made that statement.
9	Q Okay. Well, you wouldn't have made a statement under oath
10	if you didn't agree with it, would you, sir?
11	A Well, I'm saying in that statement that a trans if a
12	transboundary aquifer has no other characteristics than it
13	simply occurs beneath multiple states, then it's a
14	transboundary aquifer because it meets that single criteria.
15	Q All right. And the Middle Claiborne is one such?
16	A It underlies multiple states.
17	Q And the Middle Claiborne, therefore, is one such aquifer?
18	MR. ELLINGBURG: Objection to form. He's answered the
19	question.
20	MR. L. BEARMAN: I can't get an answer, if the Court
21	please.
22	THE COURT: Overruled. He can answer it again.
23	THE WITNESS: The question is?
24	BY MR. L. BEARMAN:
25	Q And the Middle Claiborne Aquifer is one such transboundary

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1	300 aquifer as you defined it?
т Т	Aquiter, as you derined it:
2	A I'll repeat my statement. It a transboundary aquiter is
3	simply one that is defined as an aquifer system that underlies
4	multiple states, if that's the definition, then the Middle
5	Claiborne fits the definition of a transboundary aquifer.
6	Q Thank you, sir.
7	Now, finally finally, you agree, do you not, that
8	the Memphis-Sparta Aquifer would be a major water-producing
9	aquifer system in the Memphis I'm sorry, in the
10	Mississippi-Tennessee border region because the citizens of
11	Tennessee rely on that for a public water source, right?
12	A Yes.
13	Q But you not only said yes, sir, you said, "as do citizens
14	of Mississippi and other areas," correct?
15	A Yes. Citizens in Mississippi and other areas do rely on
16	parts of the Middle Claiborne Aquifer Hydrologic Unit.
17	Q And then the question was, "Including Arkansas?"
18	And your answer was?
19	A "Yes."
20	MR. ELLINGBURG: Excuse me. Could you please help me
21	again catch up with where you are?
22	MR. L. BEARMAN: 245.
23	MR. ELLINGBURG: I see. You jumped from page
24	70-something to 245.
25	MR. L. BEARMAN: One second, Your Honor.

369 1 I'm sorry. I apologize. Thank you. 2 THE COURT: Does Mississippi have any redirect? 3 MR. ELLINGBURG: Yes, Your Honor. 4 **REDIRECT-EXAMINATION** 5 BY MR. ELLINGBURG: We should be finished soon, Dr. Spruill. 6 0 7 А Oh, good. If we finish on Friday, I vote for Bearman for president. Off the record. 8 MR. L. BEARMAN: Your Honor, if nominated, I will not 9 10 accept, and if elected, I will not serve. 11 THE COURT: There you go. 12 THE WITNESS: That's good. BY MR. ELLINGBURG: 13 14 Q That encourages me. 15 Dr. Spruill --16 А Yes. 17 -- you were -- I'm going back to Mr. Branson's examination, 0 18 and I'm going to hit a few points. 19 You were asked a lot of questions going back to this whole question about whether the Middle -- the Memphis Sand 20 21 Aquifer and the Sparta Aquifer are, in fact, distinct aquifers 22 within a larger system; is that correct? 23 А That's correct. 24 Okay. Now, to put that in some context, the -- would you 0 25 pull up slide 21?

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370 So he showed you this figure, right? Mr. Branson, 1 2 now, are we there now? Now, this is --3 MR. BRANSON: Objection. I did not show this slide to 4 him so --5 MR. ELLINGBURG: No, you didn't, but it addresses your issue. And the issue is what we're talking about. 6 7 BY MR. ELLINGBURG: So my question is, we looked at that earlier. Is that a 8 0 9 table from the MERAS report prepared by the US Geological 10 Survey, I believe in 2009? 11 Yes, it is. А 12 Does that report show that there are separate aquifers 0 13 within the larger hydrogeological units? 14 MR. BRANSON: Objection. Leading. 15 MR. ELLINGBURG: No, it's a question. 16 THE COURT: Okay. Just ask him what it shows there. 17 BY MR. ELLINGBURG: 18 0 Okay. What does that show with regard to aquifers? 19 This diagram shows a lot of information about geologic А units, but with -- specifically with respect to aquifers, it 20 21 shows that within the Mississippi Embayment region, there are 2.2 multiple aquifers that are referred to as aquifer units that 23 are hydrogeologic units. And what does it show with regard to what appears in 24 0 25 Tennessee and what appears in Mississippi.

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1	371 A In Tennessee, it shows several different aquifer units and
2	confining units in both Tennessee and Mississippi.
3	Are you asking specifically with respect to
4	Q Is there a difference in the aquifers found in the two
5	states?
6	A Yes.
7	Q What is it?
8	A There are lots of different examples of different
9	formations that make up the same aquifer make up the same
10	aquifer unit. For example, in Tennessee, there's a formation
11	called the Flower Island. Similarly, there is an
12	undifferentiated one because they've not been able to describe
13	it yet. And I can't begin to pronounce that word, but I'll
14	take a stab at it. I won't take a stab at it; I'll spell it.
15	H-A-T-C-H-E-T-I-G-B-E formation.
16	Q In Mississippi?
17	A In Alabama. And I pointed out that the similar formations
18	are undifferentiated, not been able to subdivide them yet into
19	the State of Mississippi. And other examples certainly exist
20	throughout the system called the Mississippi Embayment
21	Hydrologic System.
22	Q Does this show a Lower Claiborne Aquifer?
23	A Yes.
24	Q And where does it show it?
25	A It shows it on in the column labeled "Hydrogeologic
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1	Units, Lower Claiborne Aquifer."
2	Q And do you see that in Tennessee?
3	A My opinion is that you definitely do not see that in
4	Tennessee.
5	Q Thank you.
6	Now, if you would, go to the next slide. That is
7	would be 26, I think.
8	A Yes.
9	Q Now, this is the slide we looked at earlier.
10	Can you blow up the text up in the left-hand corner?
11	Can you read that? I thought we could blow it up.
12	A Yes.
13	Q What does it say?
14	A It says, "The approximate" are you talking about the
15	explanation?
16	Q Yes, sir.
17	A The approximate area of outcrop of the Sparta Sand or
18	Memphis Aquifer outcrop, areas covered by quaternary deposits
19	in places, that's the first pattern, which would be indicative
20	of this pattern.
21	And then it says, for the next pattern which is shown
22	there, and it's shown as this linear feature paralleling just
23	south of the Tennessee-Mississippi border. And the verbiage
24	associated with it says, "To the best of my ability,
25	approximate zone of transition where Cane River formation or

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1	equivalents change facies from clay to sand. Zone marks
2	southern limit of Memphis Aquifer."
3	Q Okay. Now, would you point to where the southern limit of
4	the Memphis Aquifer is?
5	A The southern limit of the Memphis Aquifer is this facies
6	change, which, remember, is a change in the subsurface of
7	materials from one composition to materials of another
8	composition.
9	Q Thank you. One moment.
10	Now, have you seen any USGS documentation that would
11	deject that there is not a separate Sparta or Lower Claiborne
12	Confining Unit in the State of Mississippi?
13	MR. BRANSON: Objection. Leading.
14	THE COURT: Overruled. You may answer the question.
15	THE WITNESS: The the literature is quite clear
16	that there is a Lower Claiborne Aquifer and a Lower Claiborne
17	Confining Layer in the State of Mississippi that covers a large
18	area.
19	BY MR. ELLINGBURG:
20	Q Does it appear in Tennessee?
21	A No.
22	Q Thank you.
23	Now, I don't have it, but you may recall that counsel
24	for Tennessee put up a slide where they had circled in red and
25	put some large letters and said these are the observation wells

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1	with regard to the Criner and Parks report.
2	Do you recall that?
3	A Yes, I do.
4	Q And you were asked a lot of questions about whether you had
5	verified the accuracy of everything in Criner and Parks.
б	Do you recall that?
7	A Yes.
8	Q Is it uncommon for any expert to rely on published
9	scientific information provided by the United States Geological
10	Survey?
11	A My opinion of the US Geological Survey is high. I hold
12	them in phenomenally high regard. I understand the complexity
13	of their process of data evaluation, report writing, and
14	review, and I simply trust what I see from that organization
15	more than any other organization that exists to do this kind of
16	work, not just in this country but in the world.
17	Q Thank you.
18	Now I'm going to show you something. You were shown
19	one a blowup of one slide out of the Criner and Parks
20	report. And I'm going to hand you a copy of that report, which
21	is Exhibit J24.
22	Do you have it already?
23	A I think so.
24	Q Do you have a copy of it?
25	A I'm looking. Just a second. Is it a specific figure from

it? 1 2 0 No, just the report itself. 3 I have J22, J59, J58. Α You don't have J24 in front of you? Okay. That's fine. 4 0 5 I do not. А 6 MR. ELLINGBURG: May I approach the witness, Your 7 Honor? 8 THE COURT: Yes, you may. 9 MR. ELLINGBURG: Thank you. 10 BY MR. ELLINGBURG: 11 I'm going to hand you a copy of J24, and I'd like you just 0 12 to take a moment and look at it and tell me if there is any basis, other than those four observation wells, in this report 13 14 for the conclusions reached by Criner and Parks, including past 15 studies, if there are any. 16 MR. BRANSON: Your Honor, it just looks like 17 Mr. Ellingburg is handing him a marked-up copy that has sticky 18 notes. 19 THE COURT: You can come over here and look at it if 20 you want to. 21 MR. ELLINGBURG: It isn't marked. I will direct you 2.2 to page 10. 23 THE COURT: Let him look at it. 24 MR. BRANSON: Well, I have an absolutely clean version of Criner and Parks. 25

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376 1 So do I. MR. ELLINGBURG: 2 MR. BRANSON: So there's no markings on there? 3 MR. ELLINGBURG: No, sir. That wouldn't be right to do that. 4 5 Okay. MR. BRANSON: 6 THE COURT: Okay. You may ask the question. 7 BY MR. ELLINGBURG: I'm going to ask you to read the paragraph on page 10 that 8 0 starts with "This report reviews." 9 10 "This report reviews the historic changes of water levels Α 11 in the Memphis area with emphasis on the period after 1960. Ιt 12 also presents information on pumpage from the Memphis Sand since 1886 and from the Fort Pillow Sand since 1924, and it 13 14 discusses the relationship between pumping rate and water level 15 decline to 1975. The report is intended to provide basic data 16 and interpretive information for use by water managers, 17 planners, and other persons interested in the groundwater 18 resource and to update prior publications discussing the water 19 level changes in the Memphis area." 20 Thank you. 0 21 It says "update prior publications." And does it 2.2 identify any specifically? 23 Α "General aspects of the aquifer systems in the Memphis area are described or discussed in reports by Schneider and 24 25 Cushing -- that's with a C -- 1948; Criner and Armstrong, 1958,

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1	Criner, Son, and Nyman, 1964; and Bell and Nyman, 1968, "and
2	other reports which contain pertinent information about pumping
3	rates and water levels where the principal aquifers are
4	included in the selected references."
5	Q And I'm going to just ask you to look at page 32 and 33 and
6	tell me if that's a list of selected references referred to by
7	the author of that report of the authors of that report that
8	are supporting and providing information for their conclusions?
9	A Yes.
10	Q Okay. Thank you.
11	Now I'm going to ask another question or two, and then
12	I'm going to move on.
13	Now, is it uncommon for the USGS to build on their
14	past studies in a specific area rather than just starting all
15	over again?
16	A It would not be uncommon. It would be in my opinion, it
17	would be expected of their behavior.
18	Q Is it a fact that, based on the published reports, the USGS
19	has been collecting water data from the Memphis Sand, the
20	500-Foot Sand, since the early 1900s?
21	MR. BRANSON: Objection. Leading, Your Honor.
22	THE COURT: Well, overruled. You may answer the
23	question.
24	THE WITNESS: Yes. I've seen even in that list of
25	selected references data that support their involvement for a

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1	long period of time.
2	BY MR. ELLINGBURG:
3	Q And just to make the point, and I believe the text of this
4	report refers to earlier, but could you tell me what the
5	citation is with regard to Wells in 1931?
б	A The specific reference is Wells, F.G. The publish date
7	would be 1931, "A Preliminary Report on the Artesian Water
8	Supply of Memphis, Tennessee." It's a US Geological Survey
9	water supply paper, 638-A, 34 pages in length.
10	Q Thank you.
11	Now, do you know whether Criner and Parks' work was
12	later rejected by any other USGS groundwater hydrologists
13	studying the groundwater system in the Memphis area?
14	A I've seen no evidence to support that statement.
15	Q Now, do you know if it's been subsequently cited by other
16	USGS official reports?
17	A Yes.
18	MR. ELLINGBURG: Josh, I have a few marked here. Do
19	you have one I could just show him and give back to you?
20	BY MR. ELLINGBURG:
21	Q Dr. Spruill, I'm going to show you a report that's been
22	marked as Joint Exhibit 10, which is titled "Digital
23	Groundwater Model of the Memphis Sand and Equivalent Units,
24	Tennessee, Arkansas, and Mississippi."
25	I believe we've referred to that before, but I only

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1	want to ask you one question about this one. Okay?
2	A Okay.
3	Q Would you please turn to page 26?
4	A Is that J26 or their page 26?
5	Q It's J10, page 26 of 80.
6	A I see it now. I understand. I found that page.
7	Q Okay. Thank you.
8	Would you just read for us the final paragraph on that
9	page?
10	A You're talking about page 26 of 80?
11	Q Yes, sir, where it starts with "Transient conditions."
12	A That paragraph reads, "Transient conditions associated with
13	pumping are thought to have dominated the system since 1886
14	when the first wells were drilled and pumped. From 1886 to
15	1975, pumpage at Memphis has gone down to the original
16	potentiometric surface by as much as 150 feet and the major
17	pumping center and reversed the original gradient which was to
18	the west (Criner and Parks, 1976). Flow that moved through the
19	area towards natural discharge points to the south and west
20	before 1886 is now diverted and captured by pumpage at
21	Memphis."
22	Q So at least at this point in time, the Criner and Parks
23	paper you were cross-examined on still is being accepted.
24	That's 1981, right?
25	A Correct.

Proceeding - May 21, 2019 380 1 MR. BRANSON: Objection. Leading. 2 THE COURT: Overruled. Don't lead your witness. 3 MR. ELLINGBURG: Thank you. 4 BY MR. ELLINGBURG: 5 One more on this. Dr. Spruill, I'm going to hand you 0 Exhibit J15. And I believe this has also been discussed during 6 7 your testimony, but I'd just like to ask you one question about it. 8 9 Α Do you want this back? Or a couple of questions, actually. One is not true. 10 0 11 First, what is the date of this report? 12 А The year 2001. 13 So this was published in 2001; is that correct? 0 14 А That's correct. 15 Now, if you would, look over to page 10 of 64 of J15. 0 16 А I found page 10 of 64. 17 Okay. Do you see an area that starts "Previous 0 18 investigations"? 19 А Yes. 20 Now, do you see the -- and I'm not asking you to read it 0 21 all, but do you see a list of prior USGS investigations in this 2.2 area that this report is building on? 23 А Yes. 24 Okay. And among that list of reports, do you see Criner 0 and Parks? 25

1	381 A I see Criner and Parks, 1976, and Parks and others and
2	other authors combined. But I see Criner and Parks in 1976
3	listed.
4	Q Thank you.
5	So is that the procedure that was is generally
6	followed by United States Geological Survey now for decades?
7	A That would be my understanding of how they work, having
8	studied with a USGS hydrogeologist.
9	Q Do they have any particular high standards of what they
10	will allow to be published based on the work they do?
11	A Again, I have phenomenal confidence in them, and I believe
12	they have their standards are the highest caliber
13	imaginable.
14	Q Thank you.
15	And if you would, turn to page 61 of 64 of that
16	report, if I'm looking at the right one.
17	Have you found it?
18	A Yes, I have.
19	Q Now, in the lower right-hand corner, it starts off with
20	"Selected references."
21	Do you see that?
22	A Yes, I do.
23	Q And could you tell us, just so we can understand, what the
24	US Geological Survey uses as support for their papers and their
25	publications? Essentially, how many pages do we have of

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1	reports? 382
2	A So on page 61, roughly a fourth of a page of references, a
3	full page on 62, a full page on 63, and 80 percent of a page on
4	64.
5	Q And we're talking about two columns, right?
6	A We're talking about two columns on three of the four pages.
7	Q Thank you.
8	Now, you've been asked a fair number of questions
9	about this physical boundary that exists or does not exist or,
10	for that matter, any impediment at all at the
11	Mississippi-Tennessee border. And I believe that you have
12	clearly testified that some water moves across the border,
13	right?
14	A That some water
15	Q Some water is moving across the border?
16	A I have.
17	Q Molecules, we talked about molecules this morning.
18	A Yes.
19	Q Okay. There is but you've said there are differences in
20	the geology within that area of the facies change from north in
21	Memphis; is that correct?
22	A Correct.
23	Q Okay. Why are those differences important, briefly?
24	A Okay. The importance of those differences are, or the
25	importance is, that a change from more permeable material to

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1	lower permeable material, facilitated by a reduction in grain
2	size from north to south and an increase in clay content in the
3	aquifer system from north to south, results in a reduced
4	capacity of the groundwater system to transmit water. It slows
5	it down.
6	And so, to me, that's a form of a barrier. But I felt
7	like there was some discussion about things like this. The
8	geologists know how to put in a physical barrier. We can call
9	them grout barriers. I wanted to make sure we weren't talking
10	about that. There's no sort of man-made barrier there.
11	There's a transition in aquifer materials to the south.
12	Q Thank you.
13	Now, what determines the natural direction and flow of
14	groundwater within a specific area where there is no pumping?
15	So on a high level, what determines that?
16	A The composition of the materials will help to determine the
17	rate of flow, and the inclination of the aquifer system and the
18	configuration of layers above and below it relative to the
19	recharge area control, in large part, the direction and
20	gradients of the groundwater flow.
21	Q Is what you have determined in your studies with regard to
22	the composition of the earth beneath the surface in the Middle
23	Claiborne I mean, in the confined Sparta Sand in Mississippi
24	and the Memphis Sand in a little bit of Mississippi, is that
25	consistent with the direction of groundwater flow that you have

Proceeding - May 21, 2019 384 1 seen in the USGS reports? 2 Α Yes. MR. BRANSON: Objection. Leading. 3 4 THE COURT: Well, overruled. You may answer. BY MR. ELLINGBURG: 5 Now, the fact there's no hydrological barrier there means 6 0 7 it's possible to pump water out of Mississippi by reducing the 8 pressure significantly within those two formations, isn't it? 9 MR. BRANSON: Objection. Again, I'm sorry, Your 10 Honor, but he's leading. 11 THE COURT: Don't lead your witness. 12 MR. ELLINGBURG: Thank you, Your Honor. I was just 13 trying to hurry us along to make everybody happy. 14 THE COURT: I understand. 15 THE WITNESS: Especially me. BY MR. ELLINGBURG: Especially you. 0 Would it be possible to pump water out of Mississippi into Tennessee if there were a complete physical barrier, like a Great Wall of China, below the ground? Not as long as it was intact. Α 22 So this hydrogeologic connection they're talking 0 Okay. 23 about, how does that relate to making it possible for someone 24 in Tennessee to pump water across the state line or vice versa? 25 Α In spite of the fact that the -- in my opinion, the

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1	aquifers are different because they have different
2	characteristics, there is a transition zone there in the
3	composition of the materials; hence, a change in the
4	permeability of the materials, so there's not a preclusion of
5	water. There's a change in the ability of that aquifer zone in
б	that part of the world to transmit water.
7	Q Thank you.
8	So it makes it possible to pump it into Tennessee from
9	Mississippi?
10	A It certainly does.
11	Q Thank you.
12	Now, you've made this comment several times, so I'm
13	only going to ask it once, and you just give a short answer.
14	Assuming a molecule of water, which was the reference
15	used by Mr. Branson, enters into the confined portion of the
16	Sparta Sand in Mississippi, or even that little bit of the
17	Memphis Sand in Mississippi, how long would it take that
18	particle of water to follow its natural flow path and
19	ultimately be discharged?
20	A I've stated already that groundwater velocities are in the
21	order of a few inches per day, and so given the particular flow
22	path that you're talking about through the aquifer and then
23	upward across any confining layers along the axis of the
24	Mississippi Embayment, it could take literally thousands of
25	years for that water molecule to complete that travel path.

Proceeding - May 21, 2019 386 Now, each of those individual molecules wouldn't follow 1 0 2 exactly the same path, would it? Similar, but not exactly the same paths. 3 Α 4 0 And why is that? 5 That's because the groundwater system is complex, and there Α are lots of fine-grain particles there that are incredibly 6 7 small. They all can't follow the same flow path. They have to diverge and go downgrade in the direction of the decreasing 8 total hydraulic head. 9 10 Now, Mr. Branson used the phrase in one of his questions, 0 11 and I want to make sure that phrase isn't taken out of context. 12 Is the groundwater within the State of Mississippi 13 that is at issue in this case in the confined aquifer, is it a 14 body of water? 15 I think that's a terrible way to describe the groundwater А system. A body of water gives the connotation of a lake, a 16 17 pond, a river, and so it's not a body of water. It's an amount 18 of water stored in the pore spaces of the naturally-occurring 19 sedimentary materials that make up that part of the system. Does that water residing under pressure in the confined 20 0 21 aquifer have any role in what's going on at the surface? I 2.2 mean, does it -- is it part of the earth? It's absolutely a fundamental part of the earth. I'm not 23 Α 24 sure what you're asking me. I'm sorry. 25 Q Well, okay. So you mentioned earlier that, if you take all

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1	387 the water out of it, what do you have?
2	A If you take the water out of an aquifer, you have a
3	formation, a geological formation, not an aguifer, because an
4	aguifer is a group of some sort of material that can transmit
5	usable quantities of water. So an aquifer is a two-part thing.
6	Take the water away, you no longer have an aquifer; you have a
7	formation, a geological formation.
8	Q Thank you.
9	And the the water is what we're talking about in
10	terms of hydrogeology in this case, is it not?
11	A The water is a resource, from my perspective, because it's
12	what we consume. It's what you can use an aquifer for is the
13	water. A 500-foot-deep layer of sand that has no water in it
14	doesn't is not much of a resource unless you can drill and
15	mine at those depths. The resource is the water in the
16	aquifer.
17	Q Now, your testimony has been directed to the science or
18	has your testimony been directed to the science of geology and
19	hydrology?
20	A Yes.
21	Q Do you consider yourself qualified to give any legal
22	opinions?
23	A No.
24	MR. ELLINGBURG: That's it. We thank you. We have
25	completed with this witness.

388 1 THE COURT: Okay. Any recross? 2 MR. BRANSON: Just very briefly, Your Honor, if I may. 3 RECROSS-EXAMINATION BY MR. BRANSON: 4 5 Dr. Spruill, whenever you're ready. Q 6 А I'm ready. 7 Okay. Do you recall when Mr. Ellingburg just asked you Q 8 about what you have termed the Lower Claiborne Aquifer, 9 correct? 10 The Lower Claiborne Aquifer. Α 11 You recall that testimony, correct? 0 12 А Yes. Yes. MLGW does not have any well screens that are touching the 13 0 14 Lower Claiborne Aquifer, as you framed it, correct? 15 It doesn't exist in that part of the world. Α 16 0 So the answer is no? 17 The answer is no. А 18 0 MLGW is pumping, for purposes of this case, out of the 19 Middle Claiborne Aquifer, correct? 20 А Yes. 21 And there's no barrier, again, that's going to block water 0 2.2 from flowing from what you've termed the Lower Claiborne 23 Aquifer into what you've termed the Middle Claiborne Aquifer, 24 correct? 25 Α There's no barrier that will prevent it from flowing.

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1	Q And the same the converse is true as well. There's no
2	barrier that would prevent flow naturally from going from the
3	Middle Claiborne Aquifer into what you've termed the Lower
4	Claiborne Aquifer, correct?
5	A There's nothing that prevents it from flowing.
6	Q Either direction, from the Middle Claiborne Aquifer to the
7	Lower Claiborne Aquifer or vice versa?
8	A Correct.
9	Q Dr. Spruill, I'd like to put plaintiff's slide 26, our
10	slide 16, back up. And let's blow it up, and let's look at the
11	Reed in 1972 map.
12	Do you see that, Dr. Spruill? And do you recall your
13	testimony about it?
14	A Yes.
15	Q Now, I want to focus on what you called the facies change,
16	which is that gray horizontal line. If we can zoom in a little
17	bit. It's south of the state border.
18	Do you see that?
19	A Yes.
20	Q On this chart, that facies transition zone, as Reed has
21	depicted it, is entirely south of the Mississippi-Tennessee
22	state line, correct?
23	A That's what's shown on this diagram.
24	Q And, Dr. Spruill, when you drew the transition zone earlier
25	in your chart over here, you also drew the transition zone as

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1	south of the Tennessee-Mississippi border, correct?
2	A Yeah. I sketched it that way and indicated that it's based
3	on this general concept of a facies change in the subsurface,
4	which is not a sharp line but, rather, a transition from one
5	material to the other so that this is not a sharp boundary.
б	Q It's not a sharp boundary, but that's why you created the
7	transition zone on your chart, the two green diagonal lines at
8	the top, to depict that zone of transition, correct?
9	A Yes.
10	Q And that zone of transition, as you drew it on your own
11	chart, is entirely south of the Tennessee-Mississippi state
12	border, correct?
13	A On this particular figure.
14	Q And on the chart that you drew in this courtroom?
15	A Well, I have it slightly south of the Mississippi-Tennessee
16	border.
17	Q So the answer is yes, the way you drew it, the transition
18	zone, in its entirety, is south of the border?
19	A The way I drew it.
20	Q So according to Reed, which we have on the screen here, I
21	believe you testified, in your view, at least in this
22	evidentiary hearing today, that the portion of this Middle
23	Claiborne Aquifer that's north of the facies change, you've
24	called that the Memphis Aquifer, correct?
25	A Yes.

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1	391 Q And even if you accept for a second that the Memphis
2	aquifer is separate from the Sparta, according to Reed's
3	figure, the Memphis Aquifer also crosses state lines, correct?
4	A According to this diagram, yes. In other more recent
5	work I believe it's more recent work detailed more
6	detailed maps of the thickness of the Sparta and Memphis show
7	the line essentially at the border, sometimes crossing the
8	border. So I just try to emphasize that.
9	This is something that's occurring in the subsurface
10	that is a transition zone over some distance, and geologists
11	just see it as what it is, like facies change from one material
12	to another that occurs over some reasonable horizontal
13	distance.
14	Q And according to Reed, that transition zone occurs south of
15	the border, correct?
16	A According to Reed, that's where it occurs.
17	Q And Reed worked for the USGS, correct?
18	A Yes.
19	Q And you have opined at some length that you trust what the
20	USGS does, correct?
21	A That doesn't mean that interpretations can't change and
22	become refined, but I trust the USGS at the time.
23	Q But you acknowledge, for example, that the interpretation
24	the USGS might have had in 1976 might change over time as newer
25	data become available, correct?

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1	A It can change subtly. It changed subtly, especially in
2	this area, according to the data I've seen.
3	Q And you have not seen any data, Dr. Spruill, that would
4	suggest there's a hard facies change line between the
5	Mississippi-Tennessee boundary?
6	A That's not what a facies line is, sir.
7	Q Correct. So you have not seen any at the state boundary,
8	correct?
9	A Yes.
10	Q Mr. Ellingburg had you read a series of reports on page 10
11	of that article, Schneider and Cushing; Criner and Armstrong;
12	and Criner, Son & Nyman, and Bell and Nyman.
13	Do you remember reading that?
14	A I do.
15	Q You hadn't reviewed any of those articles for the purpose
16	of evaluating Criner and Parks' predevelopment map, have you?
17	A I don't recall doing that.
18	Q You didn't mention any of those papers at your deposition,
19	did you?
20	A I don't think so.
21	Q You didn't cite them in your expert reports, did you?
22	A No.
23	Q On page 10 of that article that Mr. Ellingburg had you
24	read, Criner and Parks don't say anything about predevelopment
25	groundwater flows, do they?

	393
1	A I don't remember.
2	Q Well, you can refresh your memory if you'd like.
3	A Someone will have to give me the article.
4	Q Here you go. I've got a fresh copy for you, Dr. Spruill.
5	A So can you repeat the question?
6	Q Sure. On page 10, which Mr. Ellingburg had you read a
7	laundry list of citations, that page does not discuss the
8	specific predevelopment potentiometric surface that we have put
9	up on the screen today?
10	MR. ELLINGBURG: Objection to form. Objection to I
11	don't understand what he means by "put up on the screen."
12	MR. BRANSON: That's what I've put on the screen right
13	now.
14	THE COURT: If the witness doesn't know, he can say
15	so. If he does, he may answer.
16	BY MR. BRANSON:
17	Q Do you remember discussing this map, Dr. Spruill?
18	A I do, yes.
19	Q This is the predevelopment equipotential surface?
20	A Yes.
21	Q Do you have any idea whether any of those citations
22	Mr. Ellingburg had you read in court say anything about this
23	specific figure?
24	A I wouldn't I would have to really dig into it to answer
25	a question like that.

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1	Q And you have not dug into it, correct?
2	A What?
3	Q And you have not dug into it, correct?
4	A I didn't say that. I would just have to dig into it to
5	refresh my memory of what data he used to generate this report,
б	this particular figure. So hold on while
7	I don't see any reference to use of a previous report
8	to generate the figure that you're showing by Criner and Parks,
9	1976.
10	Q So of all of the citations Mr. Ellingburg asked you to
11	read, you have no idea whether anything in there supports the
12	figure that I put on the screen, do you?
13	A Well, none of this work is done in a vacuum. All of these
14	that USGS geologists rely on knowledge gained in previous
15	reports to help them do the things they're doing now. So it's
16	not like they've walked out there and they didn't know anything
17	and they didn't focus on any reports that were in the past.
18	But to answer your question, I don't know if he used
19	specific reports done in the past to generate this figure.
20	Q And, conversely, you also don't know whether anything in
21	any of those reports you cited say anything about the
22	predevelopment equipotential surface of this region that we
23	have on the screen, do you?
24	A No.
25	Q Dr. Spruill, you also discussed a Joint Exhibit 10 in

Proceeding - May 21, 2019 395 response to Mr. Ellingburg just now. This was the Brahana 1 2 paper entitled "Digital Groundwater Model of the Memphis Sand 3 and Equivalent Units." 4 Do you recall that testimony? 5 Yes. Yes. А This was not on your reference list in either of your 6 0 7 expert reports either, was it? Brahana? 8 А This specific Brahana paper that he had you read, Joint 9 0 10 Exhibit 10. 11 Could I see it, please? А 12 Yeah. Unfortunately, this is my only copy because I --0 13 I'll give it back. А 14 Q I'm sure you've got it in there. 15 No, I think they took it back. А 16 0 That's fine. Take a look. 17 You can keep that, Dr. Spruill. I procured myself 18 another one. 19 This wasn't in your reference list in your expert 20 reports, was it? 21 I don't think so. А 2.2 So you didn't review this in connection with evaluating 0 23 Criner and Parks' predevelopment map, did you? 24 А No. 25 So what you were doing earlier on redirect, you were just Q

396 1 reading aloud from a document that Mr. Ellingburg placed in 2 front of you, correct? 3 I was answering Mr. Ellingburg's guestion. Α 4 Dr. Spruill, you never worked at the USGS before, have you? 0 5 No. А I also want to now focus on Joint Exhibit 15. That's the 6 0 7 other Brahana paper, the 2001 paper that Mr. Ellingburg placed in front of you on redirect. 8 9 Do you recall that testimony? 10 А I'm sorry. Which paper now? 11 Joint Exhibit 15, the Brahana and Brashears 2001 -- you got 0 12 it? 13 А Uh-huh. Okay. 14 Q Do you know, Dr. Spruill, what Brahana and Brashears say about the reliability of Criner and Parks' predevelopment 15 16 equipotential map in this paper? 17 I do not. А 18 0 Okay. That's -- that's my only question on that. 19 Okay. А 20 MR. BRANSON: I think that's it, Your Honor. I 21 appreciate it. 2.2 THE COURT: We'll take a short recess before we go on. 23 We'll take a recess. 24 (A recess was taken.) THE CLERK: All rise. The Court will be back in 25

397 1 session. You may be seated. THE COURT: All right. Who is our witness? 2 3 MR. McMULLAN: Yes. The State of Mississippi calls 4 Dave Wiley. 5 THE COURT: Okay. Everybody finished with Dr. 6 Spruill? 7 MR. ELLINGBURG: Yes, Your Honor. MR. BRANSON: Yes, Your Honor. 8 9 MR. D. BEARMAN: Yes. I'm sorry, Your Honor. MR. McMULLAN: May it please the Court. Your Honor, 10 my name is David McMullan. I've not yet spoken, I believe, in 11 12 court today. I wanted to introduce myself. 13 THE COURT: Okay. Glad to have you? 14 MR. McMULLAN: Thank you. 15 DAVID WILEY, 16 having been first duly sworn, was examined and testified as 17 follows: 18 DIRECT EXAMINATION BY MR. McMULLAN: 19 20 Mr. Wiley, can you hear me okay? 0 21 Yes, I can. А 22 Okay. If you cannot at some point, please tell me. We're 0 23 all here to hear your very important testimony, so it's clearly 24 important that we hear what you have to say. So take it slow, 25 take it easy, and make sure that what you say can be heard in

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1	the courtroom.
2	Mr. Wiley, what's your full legal name, sir?
3	A David Allen Wiley.
4	Q What do you go by?
5	A Dave most of the time.
6	Q And if I may, I may address you as Dave at times, and I
7	don't mean any disrespect to the Court, but I may refer to you
8	as Dave.
9	Mr. Wiley, tell me where you're from.
10	A I live in Denton, Florida, which is near St. Petersburg,
11	Florida.
12	Q And tell me, are you married?
13	A Yes.
14	Q And I understand you have another passion in your life that
15	may involve cycling; is that correct?
16	A Yes, I did, until about seven or eight months ago.
17	Q And are you okay to make it through and sit and deliver
18	your testimony today in spite of that injury?
19	A Yes.
20	Q If at any point in time you become uncomfortable and you
21	need to take a rest or stand up, will you please let us know.
22	I'm sure the Court will allow that. Okay?
23	A Okay.
24	Q Mr. Wiley, tell us, where do you work?
25	A I work for WSP USA.

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1	399 That's a mouthful. What is WSP USA?
2	A It's an international engineering consulting firm.
3	0 Tell me the types of work that the firm handles.
4	A The firm handles a variety of work, from anywhere from
5	transportation consulting, design and consulting, to water and
6	environmental consulting.
7	0 Yes, sir. What is your title with the company?
8	A I am the Tampa area manager for the water and environment
9	group.
10	Q All right. And how long have you been with WSP?
11	A It's a little more than a year and a half. WSP acquired my
12	old firm, Leggette Brashears & Graham, in August of 2017.
13	Q All right. Tell us about Leggette Brashears. What was
14	Leggette Brashears?
15	A Leggette, Brashears & Graham was a groundwater consulting
16	firm that had been in existence since about 1944 that
17	specialized in groundwater consulting, and I've been working
18	with that firm since 1985.
19	Q Okay. 1985. Were you with Leggette Brashears when you
20	first started working on this case in 2006? Is that right?
21	A Yes.
22	Q Okay. And were you a partner at Leggette Brashears?
23	A Yes, I was.
24	Q Did you manage others at Leggette Brashears
25	A I'm sorry?

	400
1	Q did you manage other personnel at Leggette Brashears?
2	A Yes.
3	Q As part of your work?
4	A Yes.
5	Q And your title, again, was what at Leggette Brashears?
6	A Well, I was a principal in charge.
7	Q Okay.
8	A Senior vice president, like being an owner.
9	Q And as far as your area of expertise while you were with
10	Leggette & Brashears, what is that area or what are those
11	areas?
12	A Groundwater consulting.
13	Q Okay. Are you a registered professional geologist?
14	A Yes, I am, in the state of Florida and several other
15	states.
16	Q Are you licensed or licensed as a professional geologist
17	in Tennessee?
18	A No. Oh, I'm sorry. Yes.
19	Q Okay. I know you have an aversion to associating with
20	Tennessee at the moment, but let's just go with it.
21	Nevertheless, tell me a little bit about we've
22	heard some discussion in court, and I know you were present for
23	some of the testimony and the opening statements.
24	We've heard a lot about hydrogeology. I'd like for
25	you to remind the Court what your view of what that discipline

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1	is. What is hydrogeology?
2	A It's the it's the with respect to the discipline of
3	geology and the science of geology, hydrogeology specializes in
4	the study of groundwater within geologic systems.
5	Q And when you say "within geologic systems," are you
6	including in that definition of hydrogeology both groundwater
7	and surface water?
8	A Yes.
9	Q Okay. And tell me about or, more accurately, tell all of
10	us about your duties presently at WSP as a hydrogeologist?
11	A Well, my first duty, I'm managing the staff in the Tampa
12	area in the water and environmental division, but my
13	responsibilities are to get work and do work.
14	Q Okay. Who do you get work from and do work for?
15	A With respect to our water resources work
16	Q Yes, sir.
17	A many of the clients are municipalities, water agencies.
18	And there's quite a bit of private industry.
19	The environmental work, mostly private industry, but
20	also with municipalities.
21	Q Okay. That's who you get the work from or you seek to get
22	work from.
23	What kind of work do you do for those entities, in a
24	little more specific a little more detail?
25	A For example, with respect to municipality water utility

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1	departments, we help them develop, permit, design, manage their
2	well fields or groundwater systems in their well fields.
3	Q Would that include do you do any advising of those
4	entities with respect to how they operate water systems?
5	A Yes.
6	Q Do you do any work with respect to advising those entities
7	in terms of analyzing prospective or planned groundwater
8	withdrawal systems?
9	A Yes.
10	Q In more layman's terms, do you talk to your clients about
11	where to put their wells?
12	A Some of the clients, yes, they ask us to help them with the
13	well field, well location, and design.
14	Q Yes, sir. And I believe you've got in front of you I
15	don't want to test your memory too much unnecessarily.
16	MR. McMULLAN: We have had a submission, Your Honor, a
17	joint submission of the credentials, including Mr. Wiley's, as
18	docket 73, I believe. 78 or 73.
19	BY MR. McMULLAN:
20	Q But you've got a copy. You've got that in front of you if
21	you need to reference that, but I want to talk to you a little
22	bit about some of the particular projects you've been doing or
23	have done over the course of your career.
24	So take me back. So how long have you been actually
25	doing the work you just described of advising clients about

403 where to put well systems, how to operate them, and analyze 1 2 those issues? How long has that been? 3 THE COURT: Is there any objection to the credentials of this witness? 4 5 MR. D. BEARMAN: No, Your Honor. 6 MR. McMULLAN: Your Honor, I'd be happy to tender the 7 witness. 8 MR. D. BEARMAN: I'm sorry. Your Honor, subject to 9 our -- we have motions. 10 You're asking about the CV? 11 THE COURT: Yes. 12 MR. D. BEARMAN: Not the CV, but we have our pending 13 motions, so we reserve. 14 THE COURT: Okay. You may proceed. 15 MR. McMULLAN: Thank you, Your Honor. BY MR. McMULLAN: 16 17 Let's talk a little bit more about some of the specific 0 18 projects, some examples, if you would, of where you have worked with clients to develop well fields in, I understand, Florida 19 20 or other places. Tell us about where you worked. 21 Mostly in Florida. Α 2.2 What other states besides -- you mentioned Tennessee. 0 You're registered in Tennessee as a licensed geologist. Have 23 24 you done work in the area of groundwater well field planning in states besides Florida? 25

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1	A I worked quite a few years back, it was in the I think
2	it was early '90s late '80s, early '90s. Assisted the State
3	of Mississippi with the state water plan.
4	Q All right. And in your career, would you say that the
5	balance of your work in the area of hydrogeology has been more
б	towards the groundwater issues or surface-water issues?
7	A Groundwater issues.
8	Q Can you and we're not going to belabor the point, but a
9	lot of us have heard about the differences between groundwater
10	and surface water.
11	Is it your view that there's some fundamental
12	differences between issues that are to be analyzed with respect
13	to groundwater and surface water?
14	A It's completely different.
15	Q How so?
16	A Surface water, you can see it. It's it's exposed. It's
17	in it's contained and it doesn't have to flow through a rock
18	system like groundwater does. So for groundwater, you need to
19	understand the hydrogeologic character of the formations that
20	the water is moving through.
21	Q And groundwater?
22	A Yes.
23	Q What characteristics would you ascribe to the analysis of
24	groundwater issues? Is it complex?
25	A Oh, very complex.

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1	Q Is it more difficult, in some means, to measure what's
2	happening with groundwater versus surface water?
3	A Well, they both have their complications. But there are
4	certain tools we use to develop an understanding of
5	hydrogeologic system or aquifer system, such as putting in test
6	wells, monitor wells, performing some pumping tests to measure
7	the character of the aquifer system
8	Q Yes, sir.
9	A in the confined units.
10	Q And the term "flow" has been used in the courtroom in this
11	case a number of times. Could you please describe for the
12	Court and for all of us what you mean by "flow" in the context
13	of groundwater versus surface water, generally?
14	A Well, groundwater moves very slow. Surface water moves at
15	a speed of miles per day. Whereas, groundwater is inches per
16	day.
17	Q Yes, sir. Thank you.
18	And I believe you made reference to working with
19	clients with regard to groundwater withdrawal systems.
20	Did you use that phrase? Or maybe I'm thinking about
21	it. Is that a phrase you've heard before, "groundwater
22	withdrawal systems"?
23	A Yes.
24	Q What's a lay term for that?
25	A The well field.

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1	Q Okay. And so you worked with well fields. And are well
2	fields the principal vehicle which you've worked with in terms
3	of how water is removed from groundwater is removed from
4	aquifers?
5	A Yes.
6	Q And your experience with in the area of hydrogeology and
7	working with public entities, do all public entities rely on
8	surface water?
9	A No.
10	Q Do all public entities rely on groundwater?
11	A No.
12	Q Let me back up a little bit, and just from and you can
13	do this from memory, but you're welcome to refer back to your
14	CV if you need to.
15	Tell us about where you attended college.
16	A University of South Florida in Tampa, Florida.
17	Q Okay. And what program did you take, and what degree did
18	you obtain there?
19	A Bachelor's degree in geology.
20	Q And what year did you obtain that?
21	A 1980.
22	Q Did you have any coursework in hydrogeology during the
23	course of your time in college?
24	A Yes.
25	Q Okay. What types of courses did you have?

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1	407 A I took the basic hydrology course that they teach as part
2	of the curriculum for geology there.
3	Q All right. Mr. Wiley, are you a member of any professional
4	organizations?
5	A Yes. American Institute of Professional Geologists, AWWA.
6	Q What is AWWA?
7	A American Water Works Association.
8	Q Thank you.
9	A lot of folks hate acronyms, and I do too, so thanks
10	for explaining that.
11	Before you worked at Leggette Brashears well, let
12	me make sure I take this in more logical order.
13	When you finished your degree at the University of
14	South Florida, where did you go to work?
15	A I went to work at the Southwest Florida Water Management
16	District, which is in the Tampa Bay area.
17	Q That's a mouthful. I will not use an acronym, but may I
18	refer to them as Southwest for purposes of my question?
19	A Yes.
20	Q Thank you.
21	Tell us about what kind of work that you do at
22	Southwest.
23	A I worked in the regulatory department, and my work included
24	evaluating water-use permit applications for groundwater
25	withdrawals.
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1	Q Okay. I think I skipped over something. What is
2	Southwest?
3	A Southwest Florida Water Management District is a state
4	regulatory agency that manages and regulates the use of water,
5	whether it's groundwater or surface water. And it's an arm of
6	the Department of Environmental Protection.
7	Q Okay.
8	A Who is the sort of the umbrella agency in the state.
9	Q Is there a federal agency that does that type of regulatory
10	work in Florida that's corollary to Southwest?
11	A No.
12	Q Okay. The state handles that?
13	A Right.
14	Q Adopts its own laws and regulations, would that be correct?
15	A That's correct.
16	Q And that's how it carried out that function; is that
17	correct? Using the laws of Florida and regulations of Florida,
18	that's what your agency carried out?
19	A Yes.
20	Q How many regional agencies are there in Florida?
21	A Five.
22	Q And you're one of five. Which one of the five are you
23	with?
24	A Southwest Florida Water Management District, which it does
25	have an acronym and they call themselves SWFWMD. The mud

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1	doesn't relate, but
2	Q Okay. Great. I'm going to skip that acronym for sure.
3	All right. And tell us about exactly well, not
4	exactly. Give us some examples of what your duties were and
5	how you carried them out at Southwest?
6	A Well, as I mentioned a few minutes ago, I evaluated
7	water-use permit applications for groundwater withdrawals, and
8	many of those that I worked on were municipal municipal
9	supply applications for city and county well fields.
10	Q All right. And when you worked with Southwest, were you
11	involved in any way with testing with regard to groundwater
12	control?
13	A Yes. I was involved with testing design. In some
14	instances we would require the permit applicant to provide
15	supporting information for their permit application, and if it
16	was especially if it was a new facility. And back in those
17	days that was '80 to '85 Florida was growing vastly. And
18	there was a lot of new development, so a lot of new groundwater
19	supplies were being developed.
20	So we were requiring those folks to go out and collect
21	data by putting in test wells. Then we would require them to
22	prepare a test plan. We'd review it and approve it and
23	sometimes help participate.
24	Q Were you involved in the performance of testing while you
25	were with Southwest?

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1	A Not directly but indirectly through observation of the
2	applicants doing their testing.
3	Q So you would analyze the results of the testing to
4	determine whether it was sufficient?
5	A Yes.
6	Q Were you involved in the analysis of the testing to see if
7	it was rigorous?
8	A Well, if it met the requirements that we were that were
9	included in the approved test plan.
10	Q And you're welcome to refer back to your CV, but I would
11	like for you to give us just a couple of examples, if you don't
12	mind, of some typical types of projects that you handled while
13	with Southwest. Or you can do it from memory if you'd like.
14	A Well, the City of St. Petersburg has had three well
15	fields that I had to evaluate their the permit renewals and
16	modifications for those permits. And it actually they
17	were they were looking to re-manage the well fields. And
18	there were some politics going on. A new agency was being
19	invented called the West Coast Regional Water Supply Authority,
20	and they were going to take over those well fields. So I was
21	in the middle of evaluating their permits and amongst while
22	this transfer was going on, so that was an interesting
23	interesting angle there.
24	There were many of the permits I was renewing at
25	that time were renewals and modifications.

1	411
- -	Q Oray.
2	A But once once i feit the district, then i got into doing
3	the work you know, doing more of the design work myself.
4	Q Okay. Let me take you forward in time a bit and ask you
5	just for maybe one or two examples of projects that you handled
6	while with Leggette Brashears that involved groundwater.
7	A Okay. Probably one of the more interesting ones recently
8	was City of Tarpon Springs, which is along the Gulf Coast of
9	Florida, north of Clearwater, St. Pete.
10	They were looking to develop a new groundwater supply.
11	Historically, they had been buying water from a regional water
12	supply. The prices were going up, and they decided they were
13	going to develop their own supply. They obtained fund state
14	funding that helped them do that or they would not have been
15	able to do it.
16	But they developed a brackish groundwater supply, and
17	I was a project manager at Leggette Brashears & Graham that
18	designed, permitted, tested that project. And it actually
19	the permit received objections, and it had to go to an
20	administrative hearing before a state hearing officer in the
21	state. I won't get into what the objections were because
22	it's it's really not relevant to anything.
23	Q Okay. Let me ask you, if I may, while you're on that
24	topic, have you testified in relation to groundwater issues as
25	an expert in any of your prior employment with Leggette

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1	Brashears or Southwest?
2	A Yes. I testified once while I was with the Southwest Water
3	Management District in a hearing that involved the renewal of a
4	major well field by the regional water supply authority, and at
5	the same time a private property owner that was actually
6	adjacent to that well field that owned a big ranch wanted to
7	develop his own well field and sell the water to the same
8	people that were buying the water from the regional authority
9	well field.
10	So it went to a hearing, and I was evaluating the
11	permit for the regional well field that was being being
12	renewed, so I testified regarding the renewal of that
13	particular permit.
14	Q With respect to your work in the area of evaluating
15	water-use permits, did that evaluation include development or
16	consideration of safe yields?
17	A The water management district had a set of rule criteria
18	that every water supplier had to meet, and as we evaluated
19	permits, we would follow those rule criteria to see if their
20	pumpage we'd run groundwater models to see if their pumpage
21	would and the effects of that pumpage would meet the rule
22	criteria.
23	Q And I used the term "safe yield." Perhaps you should tell
24	us if that has any particular meaning in your work.
25	A Safe yield?

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Q Yes, sir.
A It yes, it does. It has it could have several
meanings.
Q What was the meaning it was given in terms of the criteria
that you mentioned you applied in evaluating the permitting of
water?
A To either minimize or not impact items that were addressed
in the rule criteria, such as effects on other water users I
should say unacceptable effects on other water users;
unacceptable effects on wetland systems.
The Tampa Bay area, especially to the north, is
characterized dramatically with wetlands and lakes, and so
the and the groundwater system is fairly leaky from the
surface, so we had to evaluate effects on wetlands and lakes to
ensure that groundwater withdrawals were not exceeding the
requirements there. So that that's where you that's
where I would relate safe yield there.
Q Yes, sir. Did you also have occasion, in your work with
those with Southwest and with Leggette Brashears, to
evaluate safe yield with respect to impacts of aquifers?
A As a matter of fact, I mentioned earlier the City of St.
Petersburg well fields. I had when I was with Leggette
Broshears & Graham, I performed a safe yield analysis of one of
their well fields. And, again, it was based on regulatory
criteria from the Southwest Water Management District to

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1	determine what that safe yield from the well field would be.
2	Q Did the evaluation in those instances include evaluations
3	of how much was going to be pumped from the aquifer?
4	A Yes.
5	Q Other than what you've described, I think you mentioned in
6	your CV that you'd done some work for other areas. Did you
7	mention Parkland Springs already?
8	A Yes.
9	Q And Upper Floridan Aquifer. Have you done any work with
10	the Upper Floridan Aquifer?
11	A Pretty much all of the work in Florida deals with the Upper
12	Floridan.
13	Q So permitting and consideration and the analysis you're
14	talking about had to do with aquifers; they all related to the
15	Upper Floridian?
16	A Upper Floridan.
17	Q Upper Floridan. Excuse me.
18	In your work in your time with Leggette Brashears and
19	with Southwest and now with WSP, have you had occasion to
20	analyze the issues relating to groundwater flow?
21	A Yes.
22	Q One time? Many times?
23	A Pretty much everything we do deals with groundwater flow.
24	Q Okay. And in among the examples on your CV, are there
25	any examples that come to mind in which you analyzed flow?

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Well, pretty much every permit I've worked on, every 1 А 2 municipal water supply system that has a well field, we've had 3 to do groundwater flow modeling to assess impacts to make sure that we meet rule criteria with the Southwest Water Management 4 5 District.

While you were at Leggette, did you do any work in other 6 0 7 aquifers outside of Florida? For instance, in North Carolina. Yes. Long-term project in coastal North Carolina. 8 А It's a very large phosphate mining operation, and they -- the mining 9 10 operation is -- it's a dry mining operation where large 11 draglines are used to get the ore body out of the earth, which 12 is -- I forget the exact depth to the ore body. But there's a 13 confined aquifer below that ore body, and it's under -- it's under pressure, so for the mine to be able to safely dry mine, 14 15 they have to de-pressurize the aquifer in the area where 16 they're digging.

17 And we've been helping them since -- well, my former 18 boss at Leggette Brashears & Graham was working there in 19 the '60s, and I inherited that when I came to Leggette, 20 Brashears & Graham, and we were still helping them design and 21 de-pressurizing wells, design and locate those wells so they 2.2 can adequately pressurize the aquifer. And we do that through 23 use of groundwater models.

24 That was going to be my next question. 0

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In your work in analyzing groundwater flow, you work

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1	with models. Is there more than one type of model that you
2	work with? Or can you give us an example of what you're
3	talking about or an explanation of what you're talking about?
4	When you say modeling, what do you mean?
5	A Groundwater flow modeling, for the most part, on all these
б	water resource projects. And groundwater model, it's a it's
7	a tool that hydrogeologists and engineers use. It's a computer
8	tool with made up of mathematical calculations to simulate a
9	groundwater system. And it's used we developed these models
10	to use to help assess what what the groundwater system is
11	doing, what's happening to it based on stresses that are placed
12	on the system.
13	MR. McMULLAN: Your Honor, if it hasn't already been
14	admitted, I'd like Mr. Wiley's updated CV to be admitted into
15	evidence as part of Docket Number 73. Any objection to that?
16	MR. D. BEARMAN: No objection, Your Honor.
17	THE COURT: All right. No objection. It may be
18	entered in.
19	MR. McMULLAN: Thank you, Your Honor.
20	MR. BRANSON: Based upon the testimony so far and
21	based upon the CV, I'd like to tender Dave Wiley as an expert
22	in the area of geology and hydrogeology.
23	MR. D. BEARMAN: Your Honor, we reserved our
24	objections in the form of our motions.
25	THE COURT: All right.

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1	MR. HILL: Yes, we have the same objections.
2	THE COURT: I will overrule it for this time but
3	without prejudice for it to be raised later. So you may
4	testify as an expert, but you still preserve your objection.
5	We'll take it up later, if necessary.
б	MR. D. BEARMAN: Thank you, Your Honor.
7	THE COURT: You may proceed.
8	MR. McMULLAN: Thank you, Your Honor.
9	BY MR. McMULLAN:
10	Q Dave let me refer to you as Mr. Wiley. I'll be a little
11	more formal.
12	Tell us about how you became involved in this case,
13	now, from I understand, 13 years ago?
14	A Yeah. I believe it was 2006, I was asked to look into this
15	issue with respect to the groundwater conditions in the DeSoto
16	County, Mississippi, area.
17	Q Who asked you to look into the conditions in the DeSoto
18	County, Mississippi area, the best you recall?
19	A The State of Mississippi.
20	Q Thank you.
21	Before that point in time, did you have any personal
22	involvement in any of the issues that have been discussed in
23	this litigation or that you've been asked to give opinions
24	about?
25	A No.

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1	418 O Okay And is that correct? I'm assuming I'm correct but
т С	L believe that you or your firm yore retained in 2006 Deer
2	i berreve that you or your firm were retained in 2006. Does
3	that sound about right?
4	A I think it was about that time. I don't know the exact
5	date, but it was 2006. It had to have been 2006 because our
6	first report was 2007.
7	Q Yes, sir. And you can put this in lay terminology and not
8	necessarily in hydrogeological terms.
9	But can you tell us what Mississippi asked you to do
10	when they retained you and asked you to look at these issues?
11	A We were asked to evaluate the groundwater conditions in the
12	northwest Mississippi area/DeSoto County area with respect to
13	pumpage coming from Memphis.
14	Q Were you asked to do anything else when you were initially
15	retained?
16	A Yeah. We were asked if we could determine how much water
17	that was being captured from Mississippi by pumping in the
18	Memphis area.
19	Q Have you, in the course of your investigation, referred to
20	the concept of diversion at any point in time?
21	A Yes.
22	Q And, if you would, could you explain what diversion means?
23	A It would be the capture of water from DeSoto County,
24	Mississippi, and inducement of it to move into the Memphis area
25	as a result of groundwater pumpage.

1	419 Q Was that the result of any particular condition? Was it a
2	natural situation or was it unnatural?
3	A Well, of the the diversion would be caused by pumping,
4	so that's not a natural situation.
5	Q Were you asked to excuse me. Were you asked to estimate
б	how much water had been diverted?
7	A Yes.
8	Q Do you recall approximately what period of time that you
9	were initially asked to calculate the amount of diverted water
10	from Mississippi?
11	A Yes. 1965 originally through 2006. And then eventually
12	through 2016.
13	Q And since you've been involved in this case and I
14	understand you've been involved since 2006. And over the
15	course of the 13 years, I understand that you've had more than
16	one round, if I can use that term, of work that you've done in
17	the case; is that correct?
18	A We've we've prepared three different reports.
19	Q So let me ask you this. In each instance where you
20	prepared reports, were you able to complete the assignments
21	that you had been given by the State of Mississippi?
22	A Yes.
23	Q All right. Let me talk to you about, first, the first
24	round, for lack of a better term, the first initial work that
25	you did in 2007.

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1	And I think you mentioned that the assignment was to
2	evaluate the effects on the groundwater conditions in
3	Mississippi, particularly in DeSoto County, as a result of
4	groundwater pumpage by MLGW; is that correct?
5	A Yes.
б	Q Okay. Tell us and we'll get more into detail in a few
7	minutes, but can you give us a 30,000-foot explanation as to
8	the steps that you took to evaluate that question put to you by
9	Mississippi?
10	A Yes. I guess the first thing would be that we would review
11	existing available reports on the hydrogeology and groundwater
12	conditions in the DeSoto County, Memphis area.
13	Q Let me stop you there and ask you this. Is that standard
14	procedure for hydrogeologists to examine literature of studies
15	by prior hydrogeologists?
16	A Yes.
17	Q Okay. Can you just give us one or two examples of the
18	types or categories of existing literature that you turned to
19	to begin to investigate this issue? Is there a category
20	A Well, we the United States Geological Survey would be
21	always the first place we go.
22	Q Is the USGS and I may use an acronym, if I may. I'm
23	going to break my own rule.
24	Is the USGS, pardon me, considered authoritative as a
25	source of information by hydrogeologists?

_	421
1	A Yes.
2	Q What is the second thing that you did in the course of your
3	initial analysis?
4	A We we performed a flownet analysis.
5	Q Let me stop you there and ask you to explain what that is.
б	Is that a type of groundwater modeling?
7	A It's a it's an analytical model that hydrogeologists
8	did it's a methodology hydrogeologists use to calculate flow
9	through a given geographic area.
10	Q And before I move to the next step, is that also a common
11	methodology, or is that something you had to invent?
12	A No. That's that's it's one of the first things you
13	learn in hydrology class.
14	Q Is there another step that you took in your analysis
15	initially?
16	A Groundwater flow modeling. Computer groundwater.
17	Q And I apologize, Madam Court Reporter. I'm going to do my
18	best not to speak over the witness.
19	And, likewise, let me finish my question. You may
20	know exactly what I'm going to ask you but let me finish it for
21	a clearer record.
22	A All right.
23	Q Thank you.
24	Okay. So we talked about computer groundwater
25	modeling. Was there another step that you took in your initial

1	analysis? 422
2	A Yeah. Groundwater budget analysis to help us to determine
3	what the diversion amounts were that we were talking about a
4	little while ago.
5	Q How is that different from modeling, if at all?
6	A Well, groundwater budget is a part of the modeling.
7	Q Is that a way to say that you calculated totals?
8	A I'm sorry. I didn't hear.
9	Q Is a water budget analysis the way you calculated the
10	totals of the diversion?
11	A Yes.
12	Q All right. Let's go back to the first step that you took.
13	I want to ask you, you mentioned that you had looked for
14	authoritative existing literature on the subject matter.
15	Did you find specific subject matter literature about
16	the issues in the area around Memphis already in the
17	literature?
18	A Yes.
19	Q Was that USGS material?
20	A Yes, it was.
21	Q Do you recall seeing any other reports from the existing
22	literature about the MLGW pumping in the area of Memphis other
23	than from the USGS?
24	A Yeah, there were the State of Tennessee and the University
25	of Memphis.

	423
1	Q Okay. Any particular entity within the University of
2	Memphis that was involved?
3	A Groundwater Institute.
4	Q Okay. Is that where Dr. Waldron works?
5	A He did back in 2007. I
б	Q He's not that old.
7	A I assume he's still there.
8	Q All right. And did you find any information in the
9	literature where there had been any sponsorship by any of the
10	other parties in the case?
11	A Well, there were quite a few USGS reports that were
12	cosponsored by MLGW.
13	Q Memphis Light, Gas & Water, the defendant in this case?
14	A Yes.
15	Q In what period of time did you find that there were
16	sponsorship studies of the groundwater conditions in
17	Mississippi as a result of the Memphis area pumping that were
18	sponsored by MLGW?
19	A I don't know if I can recall exactly those kind of dates,
20	but we had we reviewed reports back from the '60s. As early
21	as the '60s, 1960s.
22	Q Okay. And did the range, the chronological range of the
23	literature that you looked at in 2007, did it stop in the
24	1960s? Did it decide to stop looking at the issues and stop
25	publishing about it?

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2	Q How far into the future did you find that the literature
3	continued?
4	A Well, the one of the primary, excuse me, reports that
5	we we relied on in our analysis was the report by the USGS
б	in 2001 by Brahana and Brashears.
7	Q Is that the same I believe you've been in the courtroom
8	while there's been pretty extensive testimony about different
9	reports from Brahana. Is that the Brahana we're talking about?
10	A Yes.
11	Q We'll get back to that in a few minutes.
12	Do you recall any papers from the 1960s area era,
13	excuse me, from the USGS that were authored by anyone named
14	Gerald K. Moore?
15	A Yes.
16	Q And do you recall what, if anything, was significant about
17	the Moore study that you looked at, if you recall?
18	A Well, we were one of our tasks was to determine how much
19	water was being diverted from Mississippi to Tennessee, and
20	Moore had in his report in 1965, he had indicated that there
21	was approximately 25 million gallons a day that was estimated
22	to flow from the south of Memphis into Memphis, into their
23	groundwater system. And that date, I think, he he related
24	that to the year 1960, I believe.
25	Q Okay. Did that article have any other information that you

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1	considered to be particularly interesting in your initial
2	analysis?
3	A Well, there was obviously information in there regarding
4	the impacts or the drawdown effect occurring from the Memphis
5	area and the surrounding area.
б	Q What do you mean by "surrounding area"?
7	A Well, the Memphis area down into Northern Mississippi.
8	Q All right. So that article had some expressed some
9	concern about the development
10	MR. D. BEARMAN: Objection. Leading.
11	THE COURT: No leading.
12	MR. McMULLAN: I'll rephrase, Your Honor. Thank you.
13	BY MR. McMULLAN:
14	Q Did that article have any statements that related to any
15	impacts in Mississippi?
16	A Yes. As I mentioned, he identified 25 million gallons a
17	day of flow in the groundwater system from the south into the
18	Memphis area.
19	MR. McMULLAN: Your Honor, I've got an exhibit I'd
20	like to show the witness. I can share with counsel, if I may,
21	please.
22	THE COURT: All right.
23	MR. McMULLAN: Your Honor, I'll be turning to
24	electronic copies after a couple of these exhibits, so it will
25	make it a little bit quicker.

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1	426 Your Honor, may I approach?
2	THE COURT: Sure.
3	MR. McMULLAN: And this is a copy of several exhibits
4	that I'll be using.
5	BY MR. McMULLAN:
б	Q Mr. Wiley, I'm going to hand you what's been marked as J58,
7	a Joint Exhibit. I don't need you to read the entirety of that
8	large document, but could you identify Exhibit J58 for us,
9	please?
10	A "Geology and Hydrology of the Claiborne Group in Western
11	Tennessee, Geological Survey, Water Supply Paper 1869-F."
12	Q Is that the is that the Moore report you've been talking
13	about?
14	A Yes.
15	Q All right. Can you tell me and you may be able to do
16	this from memory. If you can, I don't want to belabor this,
17	but is there any mention of the existence of a cone of
18	depression in that report?
19	A I believe there is.
20	Q We'll talk more about that in a bit.
21	How about other reports that you considered in your
22	analysis initial analysis of the existing literature about
23	the issues in North Mississippi arising out of Memphis's
24	pumping? Do you recall any other names of any other authors?
25	A Well, I mentioned Brahana and Broshears. There was also

Arthur and Taylor. MR. McMULLAN: All right. Your Honor, may I approach the witness and show him J10, which is Brahana? THE COURT: Yes, you may. BY MR. McMULLAN:
MR. McMULLAN: All right. Your Honor, may I approach the witness and show him J10, which is Brahana? THE COURT: Yes, you may. BY MR. McMULLAN:
the witness and show him J10, which is Brahana? THE COURT: Yes, you may. BY MR. McMULLAN:
THE COURT: Yes, you may. BY MR. McMULLAN:
BY MR. McMULLAN:
Q There you go.
Mr. Wiley, what is that document?
A "Digital Groundwater Model of the Memphis Sand and
Equivalent Units, Tennessee, Arkansas, Mississippi," by J.V.
Brahana.
Q And did you consider that report to be significant in your
initial analysis?
A Yes.
Q And do you recall why you gave it some significance in your
initial analysis?
A It it was identifying the impacts in the Memphis area.
Q All right. And I've got one more paper copy. I'm going to
make the walk one more time. J3.
A By the way, David, this is
Q Yes, sir.
A this is not the 2001 Brahana report.
Q What year did that come from?
A 1981.
Q All right. And I think I handed you J3. Is that right?
A Yes.

1	428 And what is J3?
2	A "Definition of the Geohydrologic Framework and Preliminary
3	Simulation of Groundwater Flow in the Mississippi Embayment
4	Aquifer System, Gulf Coastal Plain, United States," by J. Kerry
5	Arthur and R E Taylor. United States Geological Survey, Water
5	Resources Investigations Report 86-4364
7	0 Okay And how was that report significant in your initial
, 8	analysis of the existing literature on the issues of the
a	analysis of the existing fittlature on the issues of the
10	A It was an overall accessment within the Mississippi
11	Embayment that included the Memphis area, which was the area we
10	use interested in for this project
12	were interested in for this project.
13	Q Let me ask you that right there. You said these studies
14	were on the area in northeast Mississippi and Memphis; is that
15	correct, all these studies we're talking about?
16	A Yes.
17	Q Were they these studies were not studies let me
18	rephrase.
19	Were these studies of the entirety of the Mississippi
20	Embayment?
21	A No.
22	Q All right. And with respect to the existence of a cone of
23	depression emanating from Memphis and affecting groundwater in
24	Mississippi, were these studies consistent or were they at odds
25	with one another about the existence of such a cone of

1	depression? 429
2	A No. They all identified that there were there was a
3	cone of depression in the Memphis and surrounding area.
4	Q Was there any indication in the literature review that you
5	did of any experts in the area of hydrogeology doubting the
6	existence of such cone of depression existing from the Memphis
7	pumping extending into Mississippi?
8	A No.
9	Q All right. Let's talk a little bit about the second step.
10	We've covered generally in your first assignment your first
11	step, which was looking at the existing literature. You've
12	done that.
13	The second step, you remind us again what you did in
14	your second step? Did you do your own work, or did you do
15	something different?
16	A The flownet analysis, we performed our own and compared our
17	results with others that had done similar analysis.
18	Q And I think I've asked you, but I want to return to it. Is
19	the flownet analysis a standard methodology used by
20	hydrogeologists to calculate the amount of groundwater that
21	flows through a defined geographic area?
22	A Yep. That's what I said a few minutes ago.
23	Q You said it better too.
24	And why did you use the flownet analysis?
25	A To help determine the amount of water that was flowing from

	430
1	Mississippi to the Memphis area as a result of pumpage in the
2	Memphis area, primarily from MLGW.
3	Q All right. In performing your flownet analyses, did you
4	have to utilize any existing materials to begin that process?
5	How do you do that?
6	A Well, yeah, the standard process, you utilize
7	potentiometric surface maps. So we were able to obtain a
8	number of potentiometric maps from the United States Geological
9	Survey, and those maps were based on existing measured
10	groundwater level data.
11	And then you take those maps and you construct flow
12	flownets on those maps by drawing flow lines perpendicular to
13	the potentiometric surface lines that are on the map.
14	Q Okay.
15	A Your downward flow is always perpendicular to
16	potentiometric surface. So we drew the flow lines on the map
17	and in the direction of Memphis and the well fields up there.
18	And then there's you use Darcy's law, a primary law in
19	hydrology, to calculate flow through these this flownet.
20	Q Let me stop you and ask you this. I'm not going to ask you
21	to explain Darcy's law, but is Darcy's law standard methodology
22	for calculation of these flownets?
23	A It's a standard calculation for flow in the underground.
24	Q And the potentiometric maps that you utilized from the
25	USGS, did you just pick one year, or did you pick a bunch of

1	years?
2	A We picked a few years. I believe there was about six years
3	we were able to get at that time.
4	Q Do you recall generally the spacing or the span of the
5	years in which you examined those, generally?
6	A I think we were 1980. And a couple of them were in
7	the '80s, a couple in the '90s, and then the early 2000s.
8	MR. McMULLAN: Okay. Dawn, would you put up slide
9	Number 25, please.
10	MR. D. BEARMAN: Excuse me, Your Honor. I'm sorry.
11	I'm sorry to interrupt. Our screen is not working, so I just
12	want to make because that's the only way we can see.
13	MR. McMULLAN: What do you want to do?
14	THE COURT: Is it working now?
15	MR. D. BEARMAN: Not yet, Your Honor. I'm sorry.
16	THE COURT: We'll take a short recess while you do
17	that.
18	(A recess was taken.)
19	THE CLERK: All rise. The court will be back in
20	session. You may be seated.
21	THE COURT: I've been advised that you're willing to
22	go ahead, but we still don't have any contact here.
23	MR. D. BEARMAN: That's correct, Your Honor. We have
24	paper copies, and we're happy to push forward.
25	THE COURT: Okay. We're going to see if we can find

an IT specialist. I'm not too familiar with the facilities, 1 2 but we'll try and help you out. 3 MR. D. BEARMAN: Thank you. 4 MR. McMULLAN: May I proceed? 5 THE COURT: Yes. BY MR. MCMULLAN: 6 7 Mr. Wiley, I want to double back around and ask you about a 0 document before you. I asked you some questions about the 8 9 various studies, existing studies in the literature that you 10 examined in your initial analysis of the issue of the effects 11 of MLGW pumping on Mississippi. I asked you about a Brahana 12 study, and I want to ask you perhaps if you looked at this 13 study. This has been previously marked as J15. 14 MR. McMULLAN: May I approach, Your Honor? 15 THE COURT: Yes. 16 MR. McMULLAN: You have copies. I don't have extra 17 copies. 18 BY MR. McMULLAN: Mr. Wiley, have you had a chance to look at that document? 19 0 20 А Yes. 21 What is that document? 0 "Prepared in Cooperation with City of Memphis, Memphis 2.2 А 23 Light, Gas & Water Division and the Tennessee Department of" 24 Environmental -- "Environment Conservation, Division of Water 25 Supply, Hydrogeology and Groundwater Flow in the Memphis and

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1	433 Fort Pillow Aquifers in the Memphis Area, Tennessee, Water
2	Resources Investigation Report 89-4131."
3	0 Who's the author?
4	A Brahana and Broshears.
-	0 And I think you may have mentioned Brahana and Broshears.
6	Is that the one you were talking about?
7	A Yes.
8	0 Okay. And I believe the other one you mentioned, the other
9	Brahana, was an earlier study, the other exhibit you've got in
10	front of you that's an earlier study by Brahana?
11	A Yeah it J10 is dated 1981 J16 is dated 2001
12	O The 1981 study was it also part of your initial literature
12	which you reviewed?
1 /	
15	MR McMULLAN: I'd like to move to have admitted into
16	evidence each of those exhibits That's J58 J15 J10 and J3
17	THE COUPT: Any objection to those?
1 Q	MP HILL: No Your Honor Those have all been
10	admitted conditionally subject to our outstanding relevance
19	admitted conditionally subject to our outstanding relevance
20 51	UDJECTION.
21	MD MaMILLIN: I'm same I didn't brow that we had
22	MR. MCMULLAN. I'M Sorry. I didn't know that we had
23	an agreement. I apologize.
24 25	THE COURT: Yes. Thank you. I thought we ald.
45	MR. MCMULLAN: Yes, SIr. I'm defaulting in my

434 1 mechanics, and so I thank you. 2 THE COURT: You're doing fine. Thank you, sir. 3 BY MR. McMULLAN: 4 Let's go back to the slides. We may --0 5 MR. McMULLAN: And, David, this is P170. David Bearman, this is P170. 6 7 BY MR. McMULLAN: Mr. Wiley -- if you could go to slide 25, Dawn. 8 0 9 Mr. Wiley, can you see that on the monitor? 10 А Yes. 11 All right. And what are we looking at in Exhibit Number 0 12 P170? Is that a USGS potentiometric surface map we've been 13 talking about, or is it something different? 14 А It's a USGS potentiometric surface map for 2000 in the 15 Greater Memphis -- or the area there. 16 Okay. This is one -- is this one of the USGS -- is this 0 17 one of the USGS potentiometric surface maps that you used to 18 perform your flownet analysis in your second step in your initial work? 19 20 А Yes. 21 Okay. And if you would, could you explain to us what this 0 22 shows generally and explain how you reached a conclusion about 23 what it shows? 24 Well, it shows the potentiometric surface elevations in А 25 2000, and it -- what it shows is a cone of depression in the

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1	Memphis area. You see the little bulls-eyes here and there.
2	Those are cones of depression, individual cones of depression.
3	Then you see a larger cone of depression outside of the Shelby
4	County, Tennessee, area.
5	Q Let me stop you there and ask you a couple of questions
6	about the little bulls-eyes.
7	Do you see the little bulls-eyes you just mentioned?
8	A Yes.
9	Q There's one that's pretty close to Davis. What is that?
10	A Well, that is a small cone of depression that would be
11	related to the Davis well field.
12	Q Okay. And similarly, I guess I see Allen and Lichterman.
13	Are those also well fields?
14	A Those are MLGW well fields.
15	Q And you said that these individual bulls-eyes what is
16	the significance of the individual little bulls-eyes? How do
17	they have any relationship, if any, to the overall cones of
18	depression?
19	A Well, all of these well fields have their own cone of
20	depression, but when you mix them all together, you have a
21	large regional cone of depression.
22	Q Okay. And does the cone of depression, as depicted on
23	P170, indicate whether the cone of depression extends into
24	DeSoto County, Mississippi?
25	A Yes, it does.

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1	Q And tell us and I don't want to make this too
2	complicated, but I want to make it clear in the record how you
3	used this map in your flownet analysis. Take us through what
4	you did when you got the map, and each of these maps. What is
5	the next step in your methodology to complete the flownet
6	analysis?
7	A The groundwater gradient goes from higher potentiometric
8	surface elevation to lower potentiometric surface elevation,
9	and on this map, as you sort of move from east to west, the
10	potentiometric surface levels decrease until you get around the
11	well fields.
12	In order to groundwater flow is always
13	perpendicular to or at 90 degrees with potentiometric
14	surface elevations. So what we do to determine to make a
15	flownet, we draw lines perpendicular to these black
16	potentiometric surface lines everywhere.
17	From and our interest was starting them in DeSoto
18	County, starting those lines in DeSoto County, and following
19	and drawing them until they reach into Shelby County at the
20	well field areas.
21	And you draw a number of those flow lines across there
22	until you have a net, so to speak, and then you calculate the
23	amount of flow based on Darcy's law to get to get from
24	DeSoto County into the well fields at Shelby County.
25	Q Okay. Let me stop you and ask you a couple of questions

437
about that process.
And what we're looking at on P170, this is something
you prepared at Leggette Brashears, or is this a USGS document?
A This map was prepared by the United States Geological
Survey, the potentiometric surface contours were.
Q Your reference to USGS, is that a source?
A Yes.
Q But it's got a name on the bottom, Leggette, Brashears &
Graham, so this shows it was prepared by your firm, right?
A Right.
Q So is it correct that you took a USGS map and you utilized
that and it became what we're seeing in P170?
A Yes.
Q And I make sure I'm clear on this also. We've got
lines. The lines that you mentioned that you draw in
perpendicular to the potentiometric surface lines, they're not
on this one yet?
A No.
Q All right. And I think you said earlier that flownet
analysis was done to calculate the amount of groundwater
flowing from Mississippi into Tennessee and that you used a
number of different potentiometric maps for a number of
different years. Is that correct?
A That's correct.
Q And do you recall, what are the years generally that you

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1	looked at besides and what year is this? This is a 2000, I
2	believe, right?
3	A Yes.
4	Q Do you remember what other years you looked at?
5	A There were several in the '80s, several in the '90s, 2000,
б	and I think 2005.
7	Q Okay. We'll come back around to this in a few minutes in a
8	little more detail. But let me ask you generally, your
9	analysis of the flownet that was based on these different
10	potentiometric surface maps, what did you conclude, if
11	anything, about flow of groundwater from Mississippi into
12	Tennessee?
13	A We calculated about an average of 33 to 43 million gallons
14	a day from those flownets going from DeSoto County into Shelby
15	County.
16	Q And for what period of time are you talking about that
17	these maps and the resulting flownets
18	MR. D. BEARMAN: Your Honor, can we we want to
19	renew our objection with respect to relevance. Your Honor
20	asked us to address whether this is an interstate resource, and
21	now we're talking about amounts diverted, which we assert is
22	not relevant to the issue and the factors that Your Honor
23	identified.
24	MR. McMULLAN: If I may respond. Your Honor, all of
25	this testimony and the documents which we intend to introduce

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1	go to the characteristics of the water that's at issue in the
2	aquifer, and so it's relevant to the issue of whether the water
3	was interstate in nature or was, in fact, mobilized unnaturally
4	to become interstate. And that's critically important to the
5	core issues in this case, so it's it's of the most highest
6	relevance that I can imagine.
7	THE COURT: What do you want to say about the state?
8	MR. HILL: Your Honor, we join in the continuing
9	objection. We think that pumpage and diversion are not
10	relevant to the core characteristics of the aquifer that would
11	make it an interstate resource or not.
12	Also note that we think we're prejudiced because we
13	closely followed Your Honor's discovery order and did not take
14	discovery on this subject.
15	MR. McMULLAN: May I respond to that last point? We
16	engaged in extensive pretrial, and there's no surprise in any
17	of this, so there's no prejudice.
18	THE COURT: I'm going to overrule the objection
19	subject to it be stricken later on.
20	MR. D. BEARMAN: Thank you, Your Honor.
21	THE COURT: Your objection has been preserved.
22	You may proceed.
23	MR. McMULLAN: Thank you, Your Honor.
24	BY MR. McMULLAN:
25	Q Let's get back to where we were talking a moment ago before

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the objection. Let me restate the question or reask the
question to make sure I'm clear about this.
I think you indicated that there was some calculation
that you'd derived about the amount of groundwater that was
diverted from Mississippi into Tennessee; is that right?
A That's right.
Q And what was the range again?
A I believe it was approximately 33 to 43 million gallons a
day for those years that we looked at. I don't recall the
amount for each year, but I know that was the range.
Q And the range that you just mentioned was the output of the
model of the flownet analysis that you conducted?
A Yes.
Q Okay. And I think you said earlier that you had considered
in the literature, among the literature that you looked at,
were sources that included one from 1965 by Moore.
Do you recall that? We talked about that.
A Yes.
Q Do you recall I believe you may have mentioned there was
some figures or were there any figures mentioned about the
estimated amounts of groundwater that was being diverted from
Mississippi into Tennessee by Moore in 1965?
A Yes. I mentioned earlier that he reported
25 million gallons a day.
Q And how does that figure compare to the range that you

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- -	Nelle binner ben en enterlin 10 - ef 1000
2	A well, his number was generated in 19 of 1960
3	information. There wasn't as much pumping as there was later.
4	Q Okay.
5	A So it's it does his number sounds reasonable with
б	respect to the numbers we calculated. It was just earlier on
7	when there was less pumping occurring.
8	Q Okay. I want to go back to the Brahana and Broshears model
9	or the Brahana and Broshears study that you have before you,
10	I believe the 2000.
11	Do you have that?
12	A 2001.
13	Q 2001. Excuse me.
14	Can you take a look at that again and tell us what the
15	significance was in that report with respect to any information
16	concerning groundwater flow that was modeled in that study?
17	A Well, this this study was a Brahana and Broshears
18	developed a groundwater flow model to simulate the hydrologic
19	system around the Memphis and surrounding area.
20	Q How did the methodology that was employed by Brahana and
21	Broshears compare to the methodology that you utilized in your
22	flownet analysis?
23	A Well, he used a numerical groundwater flow model. Whereas,
24	this flownet was not a numerical model.
25	Q Which which would be more sophisticated?

	AA2
1	A The numerical groundwater flow model.
2	Q And why was the Brahana model and Broshears model
3	significant to you when you considered the results of your
4	study, if it was significant?
5	A Well, it addressed, again, as I said, the groundwater
б	conditions in and around the Memphis area, that it showed that
7	there was a cone of depression extending down into DeSoto
8	County, and it was a calibrated groundwater flow model to 1980
9	conditions.
10	Q Okay. To 1980. So did the range consider the groundwater
11	flow level conditions from predevelopment?
12	A Yes.
13	Q And generally, what do you mean when you say
14	"predevelopment conditions"?
15	A Conditions where there's no pumping going on, where there
16	was no pumping in the aquifer.
17	Q Okay. And in the Brahana model that you're talking about,
18	there's some discussion about predevelopment conditions; is
19	that correct?
20	A Yes. There's a a map presented, a predevelopment map,
21	an estimated predevelopment map by that originated from
22	Criner.
23	Q Okay. Dawn, would you put up slide Number 11, which is
24	P168.
25	Okay. Is that what we're talking about?

1	44;
Ţ	A This yean, the source of this map was from Criner.
2	We we utilized Criner's map and modified it slightly to
3	extend the potentiometric surface contours further down into
4	DeSoto County.
5	Q Okay. And any other modifications of Criner's work other
6	than what you've just described?
7	A No.
8	Q Tell us what we're looking at here in lay terms.
9	A This is our potentiometric surface map that we utilized
10	from Criner as a starting point. It we've also drawn flow
11	lines on there that are perpendicular to the potentiometric
12	surface contours. Those are the blue and green lines.
13	And then we have a yellow triangle on there. It says,
14	"Area of limited natural flow from Mississippi to Tennessee."
15	And at this time, the blue lines were labeled intrastate flow
16	because that water stayed in for example, up in the the
17	blue lines at the top were flow lines that stayed in the State
18	of Tennessee, and then the flow lines in the bottom stayed in
19	Mississippi, and then there were green lines that went from
20	Mississippi into Tennessee.
21	Q Okay. And I don't think we have any indication on here
22	when you say "flow," we don't have any indication on this
23	particular potentiometric or flow to indicate what the flow
24	rate is, but just generally, when you say "flow," what are you
25	talking about with respect to this particular

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Proceeding - May 21, 2019 444 We're just showing the direction of flow. 1 А 2 0 Okay. What -- and, again, for the benefit of the Court, 3 what's the rate of flow generally in this area predevelopment? 4 Α Inches per day. 5 All right. And I believe -- let's go back to the steps 0 6 that you were taking in your initial assessment. And when you 7 decided to do the modeling, the computer modeling, is that the next step that you did in your analysis initially? 8 9 Α Yes. Did you -- did you just pick a model randomly, or did you 10 0 select a model, or what did you do? 11 12 Well, we reviewed this -- the Brahana model from this 2001 Α report. There were several other models that were -- that were 13 14 provided to us. I forget the first names, but there was an 15 Outlaw model, a Kenley model. We reviewed those -- those three 16 models and selected the Brahana model to use as our tool for 17 evaluating the groundwater conditions in this area. 18 0 Why did you choose to utilize the Brahana and Broshears 19 model? 20 It was set up to better represent the groundwater system А that we were -- exists there. It was calibrated to 1980 21 22 conditions. It was a good calibration. 23 Let me stop you there and interrupt you, if you don't mind. Q 24 I'd like to ask you to explain what you mean by "calibration." 25 Α When you develop a groundwater flow model, you set up a

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1	model grid for the area in question. And this grid has cells
2	where you assign off for characteristics to the cells to
3	represent the hydraulic system in both aquifers and confining
4	layers.
5	Once you get the model set up, then you try to match
б	water levels that the model calculates with actual observed
7	measured water levels in the field. The process for
8	calibrating typically includes adjusting aquifer
9	characteristics in the model until you get your best match.
10	And then once the model is calibrated, you use the
11	model to simulate and evaluate hydraulic conditions,
12	groundwater conditions.
13	Q And you did all those things?
14	A No.
15	Q Not at this point?
16	A No. We we utilized Brahana's calibrated model.
17	Q Got it. And does that model have a name?
18	A Oh, the it's MODFLOW
19	Q Okay. And what's MODFLOW?
20	A if that's what you're asking. I think it's
21	Q Well, I was asking, you know, what if it had a
22	particular name or is it just Brahana.
23	What's MODFLOW?
24	A MODFLOW is a model developed by McDonald Harbaugh of the
25	USGS. It's the sort of the bible of groundwater flow models

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that's been used for decades now.
Q And with respect to calibration, was MODFLOW suitable or
not suitable?
A Suitable.
Q And you said "suitable." Why was that?
A I'm sorry?
Q Why was it suitable? Why was it well calibrated?
A The model was specific for the area we were evaluating, so
that was a big plus for us. And it had a very good calibration
to the year 1980 when that 1980 stresses on the groundwater
system were pretty high, so it had a good calibration there, so
that's why we elected to use this model to further evaluate
more recent conditions.
Q Okay. And with respect to your use of the model, what did
you do to use the model in terms of how what period of time
did you evaluate, for instance?
A Well, we were asked to look at from 1965 through
originally through 2006 and then 2016.
Q Okay. Let me ask you about that. So you did the initial
work in 2007, and there was some subsequent work; is that
right?
A Yes.
Q Okay. In 2017, I think you mentioned?
A 2014, then 2017.
Q Did you just rerun the model in 2017, or did you do

Proceeding - May 21, 2019 447 anything to change the dynamics of the run? 1 2 Α The only thing we did to the model was change pumpage as 3 time went on. What do you mean, "change pumpage"? You changed the data? 4 0 5 We put -- in 2006 we ran the model with what we had through Α 6 2006 with respect to pumpage. Then we updated it through 2014 7 with new pumpage that occurred between the two periods. And then we updated it again after 2014 through 2016, actually. We 8 9 updated it -- the report was 2014. The pumpage update was 2013 10 through 2016. 11 Okay. Q 12 А For the 2017 report. 13 Thank you. Thank you for that. 0 14 Dawn, would you put up slide Number 11. This is P168. 15 Mr. Wiley, we'd like to take a look at what's been 16 marked as P168, and it's illustrated here on Figure 11, or 17 slide 11. 18 Can you tell us what we're looking at here? That's the same slide we just went over. 19 А 20 Okay. I'll move on then. Thank you. I can move on. 0 21 Slide 12. All right. What are we looking at here, 2.2 P172? 23 This is a 1980 potentiometric surface map developed from Α 24 the groundwater model. All right. 25 Q

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1	A So it shows potentiometric surface contours based on the
2	Brahana model, 1980.
3	Q All right. And the methodology that you utilized to create
4	this slide, is it the same methodology you've already
5	described?
6	A Yes. We we've just we ran the Brahana model to make
7	sure that what we were using matched what he he had
8	produced, and it did.
9	Q Does this slide indicate or illustrate the cone of
10	depression that is that results from MLGW pumping?
11	A Yeah. This is a potentiometric surface map, but you can
12	see there's a cone of depression occurring as a result of the
13	somewhat oval contours.
14	Q And does this indicate any effect on the groundwater
15	located in Mississippi at this point in time?
16	A Yes. There's a there's definitely an effect to Northern
17	Mississippi.
18	Q And the effect that you observed in your rendition here,
19	how did it compare to the effects that had been described in
20	the existing literature that you reviewed in your initial
21	literature review?
22	A This is pretty this is similar to what every every
23	other author had been describing.
24	Q I'm going to go back to this issue of calibration. You
25	mentioned that the model was calibrated in 1980; is that

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correct?
A Yeah.
Q And what did you do with the model to use it for evaluating
groundwater conditions?
You've already covered this, though. You've already
explained everything on that.
A We updated it to more recent conditions by adding pumpage
as the years went on.
Q Okay. So you took it through 1980, and then subsequently
you did additional runs?
A Through 2006 and then through 2012 and then through 2016.
Q All right. Let me go back to the big picture on the
different four steps that you did initially in your 2007 work.
I believe you mentioned that fourth step was
developing a groundwater budget. Is that right?
A (Nods head.)
Q And remind us, to keep our place here it's not easy
what a groundwater budget is?
A It's the it's the inflows and outflows and change in
storage in the groundwater system. And the groundwater model
develops a groundwater budget when you run the model.
Q How does it do that?
A And then what we do what we do, we take the groundwater
budget. It's cell-by-cell flows from the groundwater budget,
the model. Then we plug them into another USGS program that

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1	calculates the net groundwater budget in an area, and you can
2	assign actually, this program allows to you assign numbers
3	to you can assign a whole county in one of these zone
4	budgets, and it will calculate the net budget for that
5	particular county. And that's how we determine the diversion
6	maps.
7	Q All right. Carrying out your water budget analysis again,
8	what did you conclude?
9	A We concluded that the pumping in the Memphis area,
10	primarily MLGW, was creating a large cone of depression,
11	altering the natural groundwater flow direction in Mississippi
12	and diverting groundwater from Mississippi into the Memphis
13	area.
14	Q Did you reach a conclusion as to what the disposition of
15	that water that was diverted would have been in the absence of
16	the cone of depression?
17	A The vast majority of the Mississippi water would have
18	stayed within the State of Mississippi, you know, if it wasn't
19	induced towards Memphis.
20	Q When you say stayed in the State of Mississippi, for what
21	period of time would it have stayed in the State of Mississippi
22	under natural conditions?
23	A Well, moving at an inch per day, it would be thousands of
24	years before it reached the Mississippi River.
25	Q Okay. And did you reach any conclusions in your initial

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1	study as to what percentage of water the Memphis area was
2	drawing from Mississippi?
3	A Well, in our initial as I mentioned from the flownet
4	analysis, it was 33 to 43 percent. Moore had estimated
5	25 million gallons a day in 1960. We also, through research,
6	found that I forget his name, David Fetterman from the
7	University of Tennessee, had estimated in his report 20 to
8	40 million gallons a day of water being pumped in the Memphis
9	area, it was coming from Mississippi.
10	Arthur-Taylor, in their study, they estimated
11	30 percent of the water being pumped in the Memphis area was
12	coming from Mississippi. And.
13	Mr. Gentry, who used to work for the Groundwater
14	Institute, he even estimated 25 to 33 percent of the water
15	being pumped in the Memphis area was coming from Mississippi.
16	Q In that initial analysis, did that analysis about what
17	was being pumped in the Memphis area, was it an aggregate
18	including MLGW and other sources of pumping, or was it just
19	MLGW?
20	A Yeah. I believe those numbers I just gave you were all
21	relative to all pumpers, not just MLGW.
22	Q And we'll come back to this, but in subsequent analysis,
23	did you attempt to separate out what was being pumped by MLGW
24	from the other sources of pumping?
25	A Yes.

Proceeding - May 21, 2019 452 1 Did you complete that analysis? Q 2 А Yes. 3 We'll come back to that. Let me ask you a few more 0 4 questions about the cone of depression. 5 Have you seen cones of depression in your work in 6 other areas of the country? 7 А Yes. What is a cone of depression? 8 0 It's drawdown from a pumping well on or from a well field 9 Α 10 that is in the shape of a funnel where the withdrawal point is 11 in the middle. 12 Okay. Dawn, would you put up slide Number 8, please. It's 0 13 P161. 14 Okay. Mr. Wiley, can you see that slide? 15 А Yes. 16 0 All right. Did you create this slide? 17 А Yes. 18 Q Did you create this slide in the course of your analysis? 19 А Yes. 20 All right. Tell us what we're looking at. Q 21 These are just examples of what a cone of depression is. Α 22 Unfortunately, not in 3D but 2D. 23 The upper -- the upper portion of the figure shows two 24 wells. Both -- each well is pumping and each well has its own 25 unique cone of depression. And the significance of that is

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that these cones of depressions do not overlap from those two
wells.
Q Okay. And the bottom part of the slide indicates something
different, obviously?
A Well, the bottom slide part of the slide shows many more
wells close together, and their cones of depressions are
overlapping.
Q Okay. And which of these depictions, the cones not
overlapping or the overlapping cones, would be generally more
representative of well fields in the Memphis pumping area
MLGW pumping, rather?
A Well, the there's ten well fields, with approximately
170 wells, and a large cone of depression has been created that
covers all of Shelby County and down into most of DeSoto
County. So what we have there is one large cone of depression
that's created by many smaller cones of depression.
Q All right. And, Dawn, would you put up slide Number 9,
please. That's P162.
Mr. Wiley, do you see that?
A Yes.
Q What are we looking at there?
A It's a cone of depression in the Shelby County/DeSoto
County area. It shows it's vertically exaggerated to get
the point across, but it shows those those black holes,
so to speak, are approximate locations of MLGW well fields. So

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1	those are individual cones of depression within a more regional
2	cone of depression that has the outer blue shape.
3	Q Does a cone of depression exist if pumping exceeds recharge
4	rate? How does a cone of depression happen?
5	A As I mentioned, the well a well draws down the
6	potentiometric surface and is does it brings in recharge
7	from around the cone of depression, but the cone of depression
8	is created because more water is coming out of the well than
9	can be recharged at the same time.
10	Q Okay. That kind of depression that we're looking at or
11	that representation of the kind of depression, does it still
12	exist today, as far as you know?
13	A Yes.
14	Q Okay. Dawn, let's put up slide Number 7, please. That's
15	P160.
16	Mr. Wiley, do you see that on your screen?
17	A Yes.
18	Q Okay. Tell us what we're looking at in that depiction,
19	please.
20	A The yellow shaded area is the drawdown area from oh,
21	this is from a 2016 model run. The model run and it's a
22	2016 output from the model. The yellow shaded area is actually
23	the 20-foot drawdown contour from that model run, and it
24	represents the cone of depression area out to the 20-foot
25	drawdown contour.

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1	The orange circles are the MLGW well fields, and the
2	size of the circle represents how much water, approximately, is
3	coming from that well field.
4	Q Okay. And let's take a look at a couple of a few of
5	those well fields.
6	You see the one that's marked as Davis?
7	A Yes.
8	Q Can you give me, just approximately, how far from the
9	border between Tennessee and Mississippi that appears to be
10	located?
11	A Without according to the scale here, it's less than a
12	mile.
13	Q How about Palmer, which is in the center there, close to
14	the line?
15	A I'm sorry. Davis is probably probably a mile the
16	scale is so it's hard to tell, but near a mile. Palmer is
17	definitely it looks like it's less than a mile.
18	Q And Lichterman, likewise?
19	A Lichterman, it looks like it's at least two miles, two and
20	a half miles.
21	Q Okay. And in your analysis, did you consider how many
22	wells MLGW was operating during the period of analysis?
23	A We considered the total well field pumpage from each well
24	field. The number of the wells really wasn't wasn't at
25	issue.

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1	Q All right. And so this cone of depression discussion we're
2	having about 160 and the drawdown, how did it compare to what
3	you found in your literature review of the existing sources of
4	information that we talked about earlier that you did in your
5	first step?
6	A Again, this is consistent with the the studies that had
7	been going on in Western Tennessee regarding the aquifer there
8	around the Memphis area.
9	Q And in your analysis of the literature and in your own
10	analysis of doing your own modeling, did you reach any
11	conclusions about whether the cone of depression that extends
12	into Mississippi has gotten larger, stayed the same, or gotten
13	smaller over the course of the period of study that you've
14	conducted?
15	A The cone of depression, I believe it stabilized. If
16	anything, it's stabilized, maybe even gotten a little smaller.
17	Q Do you have an opinion about why it might have gotten any
18	smaller?
19	A Yes. MLGW has been pumping less.
20	Q Okay. And correspondingly, if they pump more, would your
21	expectation be, based upon your analysis, the cone of
22	depression would increase?
23	MR. D. BEARMAN: Objection. Leading.
24	THE COURT: Objection sustained.
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BY MR. McMULLAN:
Q Do you have an opinion about whether that kind of
depression would be affected by any increase in pumping?
A Yes, it would.
Q Mr. Wiley, we've been talking a little bit about an area of
study, and I think that on this slide you talk about project
area on P160. That's Figure 7. I think you referenced project
area in some of your documents.
Why did you study this area and not all eight states
that were in the embayment?
A Because this was the area we were asked to evaluate
groundwater conditions in.
Q All right. I want to ask you to take a look Dawn, if
you would, would you put up slide 22, which is P165.
All right. What does this depict?
A It's a simple cross-section, actually a cube, that actually
shows the setup of the Brahana model by the hydrogeologic
domain and structure with a surficial system, which is
represented in the yellow upper confining bed and the gold-ish
brown. It says "Sparta Sand Aquifer" in blue and then "Flower
Island Confining Bed" below that in gold, gold-ish brown, and
then "Fort Pillow Aquifer" below that, and that's the that's
the structure of the Brahana model.
It also shows over to the east side, there's an
outcrop area of the aquifer, of the Sparta Sand Aquifer, where

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1	rainfall comes in, provides recharge, and flows into the
2	aquifer.
3	Q Okay. Just for clarification and make sure we're all clear
4	on this, when you show the arrows here in this depiction in the
5	Sparta Sand Aquifer, you're showing just a direction of
6	movement of the water naturally; is that right?
7	A Yes.
8	Q Any indication of what the flow rate is on this depiction?
9	A No.
10	Q And, again, what is that flow rate generally under natural
11	conditions?
12	A An inch or so a year. I mean per day.
13	Q An inch or so today inch or so today per day?
14	A Or per day.
15	Q I can't even say it. All right.
16	And we've been talking a bit, or I may have used the
17	phrase a couple of times, "natural conditions." And let me ask
18	you, what do you understand "natural conditions" to mean?
19	A Well, that we I've used it and others have used it as
20	predevelopment conditions before pumping.
21	Q And in your analysis, did you what did you consider to
22	be the predevelopment period of time?
23	A What was reported by the USGS as 1886.
24	Q Okay. So in your review of the literature, would it be
25	fair to say or is it accurate to say that this aquifer area,

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1	this area of study, has been examined for decades and decades?
2	A Oh, yeah. Because we know well, one of the first
3	reports we talked about was 1960.
4	Q Right.
5	A But there's been older reports.
б	Q Let's go to slide Number 11, Dawn. This is P168.
7	Mr. Wiley, can you see that slide?
8	A Yes.
9	Q And we talked a little bit about this already, but what is
10	this?
11	A Again, it's our representation of the potentiometric
12	surface predevelopment in the Shelby-DeSoto County, and it
13	shows the flow paths in both states, and it shows some flow
14	paths that go from Mississippi into Tennessee.
15	Q Okay. Let me ask you about the yellow triangle that you've
16	got on this depiction.
17	"Area of limited natural flow from Mississippi to
18	Tennessee," what did you intend to communicate by putting that
19	on there? What is that?
20	A Well, based on the potentiometric surface contours, when
21	you draw a flow path in that area, as shown in green, that's
22	the direction the groundwater will flow. So we wanted to show
23	that there's an area where groundwater in Mississippi does flow
24	into Tennessee.
25	Q Compared to the remainder of this depiction, what strike

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1	that.
2	Let me ask you this. On the yellow area, from the
3	right side of that yellow triangle to the Mississippi border,
4	what would be the travel time for that?
5	A I'm sorry. Could you ask that again, David?
б	Q Sure. From the yellow triangle, I'm wondering if you could
7	give us your opinion about the time it would take for water
8	that's located on the right side of the triangle to cross the
9	entirety of the yellow triangle to reach the border under
10	natural conditions or predevelopment conditions.
11	A I haven't calculated that. But, I mean, if I had a
12	calculator, I could. But it's
13	Q Let me ask it this way. Would the rate of flow in the
14	predevelopment condition in that area of yellow be generally
15	the same as the rate of flow outside of the yellow triangle?
16	A It would still be inches per day.
17	Q All right. In your report and the slides we've been
18	looking at so far today, there have been a number of depictions
19	of the kind of depression that reach from Memphis into
20	Mississippi. Do any of the maps show a cone of depression that
21	cover the entire embayment, the Mississippi Embayment?
22	A Are you asking if there's one big cone of depression?
23	Q Right.
24	A Not no, I have not seen that.
25	Q We've talked a little bit about flow rates today so far.

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T	inere's also a phrase that's been used at times, perhaps in the
2	courtroom.
3	Are you familiar with the a term called "residence
4	time"?
5	A Yes.
6	Q What does that mean?
7	A How long the water resides where it's located.
8	Q All right. And in the context of this case, we've been
9	talking about flow and how that compares between the flow in
10	aquifers versus surface water. And, again, just to make sure
11	we're all very clear here, the flow we're talking about in the
12	aquifer is how does it compare to the surface water?
13	A Extremely slow moving compared to surface water. I think I
14	mentioned more than five times, inches per day in groundwater,
15	and rivers are typically feet per second.
16	Q Dawn, let's take a look at if you'll pull up slide
17	Number 17. This is P184.
18	Mr. Wiley, can you see that slide?
19	A Yes.
20	Q What are we looking at here?
21	A This is a map showing particle tracking analysis,
22	specifically across DeSoto County and beyond to the Mississippi
23	River.
24	The red the red line it's hard to see, but the
25	state line is right just below the top of the upper red line or

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1	lines, the state line between Tennessee and Mississippi. The
2	DeSoto County line is where the red lines all start. And the
3	blue lines running sort of north-south, northwest-southeast,
4	those are predevelopment potentiometric surface lines. And
5	this this base map was generated from the USGS MERAS model.
6	Q Let me stop you. Let me unpack a little bit of what you've
7	said. It's a lot.
8	First of all, what is a particle tracking model?
9	A It measures the flow in time for a particle to move a given
10	distance.
11	Q Okay. And did you perform this analysis?
12	A Yes.
13	Q When did you do this? I'll help you out. This says August
14	of 2017.
15	A So it was in 2017.
16	Q Okay.
17	A August or before.
18	Q Why did you do this analysis?
19	A We were interested in finding how long it took a particle
20	of water to move from the DeSoto County line, the east side,
21	across the remainder of the state. And we were also interested
22	in the direction of flow.
23	Q How long how long the water would move across this area
24	under what conditions?
25	A Under predevelopment conditions.

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1	463 O Okay. Excuse me. Let's take a look at your particle
2	tracking analysis insert on the left-hand side
- 2	Do you see that?
۵	A Veg
5	0 Tell us what you reached as far as conclusions that are
5	reported there
0	Number and the second states are second states and the second states are second states and the second states are second stat
/	A well, these particles, they all they travel differently,
8	so they reach their final destination at different times. So
9	we had the minimum travel time to get from the DeSoto County
10	line across the state was 3,877 years, the maximum was 22,189
11	years, and the average was 7,542 years.
12	Q Would that be the same thing as residence time?
13	A Residence time in Mississippi, yes, for those water
14	particles.
15	Q Is particle tracking analysis standard methodology or
16	something that you invented?
17	A No, I didn't invent it.
18	Q Is it a standard analysis?
19	A It's a standard standard analysis, yes. It's used quite
20	a bit in the contamination assessment industry.
21	Q Why is that?
22	A To to try to track how long it takes some some
23	chemical in the water to move from point A to point B to make
24	sure it's not causing a problem.
25	Q And you mentioned that this was a MERAS model.

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1	A Yes. The Mississippi Embayment Regional Aquifer Simulation
2	model.
3	Q And how did you choose the MERAS model?
4	A Actually, we got it from MLGW.
5	Q Something they use?
6	A Yes. I don't know if we got it from MLGW, but you got it
7	for us from somebody on that side.
8	Q All right. Let's go back. I think we may have already
9	seen slide Number 7, but it's P160. Let's make sure we're
10	clear about this.
11	Does this depict the area of diversion that you're
12	talking about with respect to water removed from Mississippi by
13	pumping by MLGW?
14	A Well, it it doesn't depict the area of diversion. It
15	depicts the drawdown area or part of the cone of depression.
16	Q Okay. And can you explain to the court the drawdown area
17	and whether that's the same thing as the cone of depression or
18	what the difference may be?
19	A This drawdown area is a planar view of where the cone of
20	depression occurs.
21	Q So essentially, they're one and the same or not?
22	A I would say yes, this is this is a planar view of the
23	cone of depression.
24	Q What are you saying? What view?
25	A Map view, planar view.

		465
1	Q	And in your experience as a hydrogeologist planning well
2	fie	lds, is drawdown good, bad, neutral?
3	A	Cone of depression, good typically it always occurs when
4	you	pump a well because you're drawing down faster than
5	rec	harge occurs. So it's depending on how big it is and
б	wha	t it's impacting as to whether it's good, bad, or otherwise.
7	Q	Are cones of depression avoidable?
8	A	No.
9	Q	Can they be mitigated?
10	A	Yes.
11	Q	What are the means by which they can be mitigated?
12	А	Well, let me let me back up on that. The cone of
13	dep	ression in itself can't can only be mitigated if you put
14	wat	er back in it. So
15	Q	How do you do that?
16	A	You'd have to put water back in it, and that's not a normal
17	thi	ng to do.
18	Q	Would the cone of depression we've been talking about today
19	con	tinue to exist if MLGW stopped pumping their pumping
20	sta	tion?
21	А	Yes.
22	Q	Why would it continue?
23	А	Oh, did you say would it continue or stop?
24	Q	Yes.
25	А	If they stopped pumping?

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1	Q Yes, sir.
2	A No, it wouldn't. The cone of depression would shrink and
3	maybe even go away. If there's no pumping at all, it would go
4	away.
5	Q I want to talk to you a little bit about your analysis and
6	whether you reached any conclusions, and I think you mentioned
7	you had, but tell me if I'm right.
8	Did you reach any conclusions about the amounts
9	total amount of groundwater that was diverted or captured by
10	MLGW through its pumping in Northeast Mississippi, as depicted
11	in the cone of depression?
12	A Yes.
13	Q Let's look at slide 26. That's P171. That's not the right
14	one. Let's look at 172, slide 12. No, that's not right
15	either. Hang on a second. The Court's indulgence.
16	All right. Let's start with this. P157, which is
17	is that Figure Number 2, I believe.
18	Mr. Wiley, there's a lot of information on this, this
19	slide. Tell me what we're looking at here.
20	A This is a table with historical Memphis Light, Gas & Water
21	pumpage from 1965 through 2016.
22	Q How was this information obtained?
23	A Most of it was from MLGW records, and I believe some was
24	from the State of Tennessee.
25	Q All right. And let's take a look and see, over the course

6

	467
1	of a period of time I think you've testified earlier that
2	there had been some changes in the total amount of pumping over
3	the course of a period of time from 1965 through 2016. Is that
4	correct or is that
5	A Yeah. The pumpage is it increased, and then it
6	decreased in later years.
7	Q Okay. Let's take a look at a couple of the columns that
8	let's focus on the well fields that we've been discussing that
9	are closest to Mississippi.
10	Do you recall those, the Palmer and Davis and
11	Lichterman? Take a look with me on this depiction.
12	Let's talk about Lichterman first. Can you tell us
13	the trend with regard to pumping in Lichterman, let's say from
14	2000 well, all the way through? Has the trend increased
15	over time, stabilized? What do you see there?
16	A Well, it started out at 4,240,000 gallons a day. And then
17	it increased 13 million, 14 million, 16. Stayed around that
18	for a while. And then in '78, it got into the low 20s. It
19	looks like mid-'80s, mid- to late '80s, it went up and then
20	went down into the low 20s again, staying in the low 20s. Then
21	in 2001 it dropped below the low 20s.
22	Q Okay. Well, I follow all that. Let me ask you about
23	totals. At the very bottom, let's look at the 2016 figures.
24	Out of the various well fields that are on this graph,
25	that are on this list, Lichterman, how does it compare to the

468 others in that bottom column, that bottom number? 1 А 2 Lichterman, for example, in 2016, pumps more than any --3 pumped more than any of the other of the well field except for 4 Shaw. 5 Let's see. What was the number for Davis in 2016? Q А 6 Davis was 14,980,000. 7 Okay. Let's go back to talk a little bit more about what Q you did in the groundwater budget analysis. 8 9 Did you come up with a total amount of water that was diverted from Mississippi into Memphis due to the MLGW pumping? 10 11 А Yes. 12 And how did you go about doing that? Let's remind the 0 Court about the methodology involved in the groundwater budget 13 14 analysis. 15 We ran the model, took the cell-by-cell flows, put them А 16 into zone budget analysis, and calculated net budget out of 17 DeSoto County into Shelby County. 18 And I think -- and I think in 2016 the average was about -- in the 2017 report, the historical average we 19 20 calculated in '65 through 2016 was about 21.7 MGD, if I 21 remember right. 2.2 Okay. Did you do a groundwater budget analysis in your 0 23 initial work in 2007? 24 А Yes. Did you do a groundwater budget analysis in your subsequent 25 Q

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update in 2017?
A Yes.
Q And let's take a look at slide Number 33, Dawn. This is
P181.
All right. Mr. Wiley, what are we looking at here?
A Just as it says, "Volume of Groundwater Contributed to
Shelby County, Tennessee, from DeSoto County, 1965 through
2016."
Q Okay. Let's start on the left-hand side in from that first
data point. About how much are we talking about there for a
starting point?
A It looks like about 13 million gallons a day.
Q And then I guess it climbs up, and it peaks out, it looks
like, in about 1988. Is that correct?
A That looks about right.
Q And presently for 2016, what did we end up with on your
graph?
A We're back down, it looks like, about maybe
14 million gallons a day.
Q So this would be the amounts that you calculated as being
contributed to Shelby County from Mississippi due to MLGW
pumpage from that period?
A That's right. That's right.
THE COURT: I think we'll stop now for the evening and
recess. So we'll resume tomorrow at 9:00 o'clock. We'll

1	recess now.	470
2	(Proceeding concluded at 5:00 p.m.)	
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1	REPORTER CERTIFICATE
2	STATE OF TENNESSEE
3	COUNTY OF DAVIDSON
4	I, JULIE K. LYLE, RPR, RMR, CRR, Licensed Court Reporter, in and for the State of Tennessee, hereby certify that I
5 6	reported the foregoing transcript by machine shorthand to the best of my skills and abilities, and thereafter the same was reduced to typewritten form by me.
7	I further certify that I am not related to any of the
8	parties named herein and have no interest, financial or otherwise, in the outcome of the proceedings.
9	I further certify that this transcript is the work product
10	reproduction and/or transfer of it, in whole or in part, will
11	Theft of Services.
12	IN WITNESS WHEREOF, I have hereunto set my hand this 22nd
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