

In the Matter Of:
STATE OF MISSISSIPPI vs
STATE OF TENNESSEE, ET AL
143, Original

PROCEEDINGS
May 22, 2019



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Proceedings - May 22, 2019

1 IN THE SUPREME COURT OF THE
2 UNITED STATES

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3 STATE OF MISSISSIPPI,

4 Plaintiff,

5 v.

No. 143, Original

6 STATE OF TENNESSEE, CITY OF
7 MEMPHIS, TENNESSEE, AND
8 MEMPHIS LIGHT, GAS & WATER
9 DIVISION,

Defendants.

-----x

11 May 22, 2019

12 9:00 a.m.

14 ON BILL OF COMPLAINT

15 Before:

16 HON. EUGENE SILER,

17 Special Master.

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A P P E A R A N C E S (continued)

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Wiley - direct

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(Case called)

DAVID WILEY, resumed.

DIRECT EXAMINATION (continued)

BY MR. McMULLAN:

Q. Mr. Wiley, can you hear me okay?

A. Yes, I can.

Q. Mr. Wiley, we were talking a little bit about the work that you did in your retention for the state of Mississippi to examine the effects of MLG pumping Mississippi water, and we talked a little bit about modeling yesterday. Do you recall -- I'm sure you do -- quite a bit of discussion about modeling that you did?

A. Yes.

Q. I believe you testified yesterday concerning the use of a Brahana model that you used and updated for modeling; is that correct?

A. Yes, I did.

Q. Okay. Let me ask you a few questions about other models. Do you -- in your course of your work, did you have occasion to look at and consider and/or use the MERAS model?

A. When we started the project in 2006, the -- that model was not available, and we -- the Brahana model was the best model available at that time, so we used that model.

Q. Okay. And subsequently did you have access to the MERAS

Wiley - direct
1 model in your analysis?

2 A. Yes.

3 Q. Did you use the MERAS model?

4 A. Yes. We used it for particle tracking, and we also used it
5 as a quick check on water budget for diversion about --
6 diversion analysis.

7 Q. Okay. So let me get this straight: You did the particle
8 tracking unit using MERAS, but you also separately did an
9 examination of diversion amounts using the MERAS model?

10 A. Yes.

11 Q. And how did you go about carrying out using the MERAS model
12 to verify or cross-check against what you'd already done?

13 A. We just -- we simply looked at the water budget for DeSoto
14 County to see what -- the predevelopment, and we picked a year
15 of 2007 to see what the water budget was for that time period,
16 to see what diversion amount would be going from Shelby County
17 to -- or from DeSoto County to Shelby County.

18 Q. After you ran the MERAS model to cross-check against the
19 diversion amounts that you calculated using the Brahana model,
20 what did you find when you compared the two results?

21 A. They were -- for the year 2007, they were actually pretty
22 close. I would -- I would say, though, when we did use the
23 MERAS model, we used the MERAS model as is; that is, with the
24 pumpage that was in it. We didn't change anything.

25 Q. How would you characterize -- well, strike that.

1 Wiley - direct
2 Q. Okay. Did you prepare this document, or have it prepared
3 under your direction and control, during the course of your
4 analysis?

5 A. Yes.

6 Q. Table 1A, behind that, tell us about that document, first
7 of all. Is that a document that you prepared, or had prepared
8 at your direction or under your control, during the course of
9 your analysis?

10 A. Yes.

11 Q. What is the difference between Table 1 and Table 1A, if
12 any? Just generally.

13 A. The only thing I see is in a column that says -- starting
14 Bates numbers.

15 Q. Okay.

16 A. That's the only thing I see different.

17 Q. Do you recall whether this alteration or whether this
18 Table 1A was to add some additional source information or not?

19 A. Yes.

20 Q. Okay. Did the change from 1A -- from 1 to 1A alter any of
21 your conclusions that you reached in your analysis?

22 A. No, it did not.

23 Q. All right. Let's turn to Table -- excuse me, let's turn to
24 Plaintiff's Exhibit 158 in your notebook.

25 Are you with me?

26 A. Yes.

Wiley - direct

- 1 Q. All right. There's a Table 2, and there's also a Table 2A.
2 Do you see that?
3 A. Yes.
4 Q. Table 2, is that something you prepared in the course of
5 your analysis in this case?
6 A. Yes.
7 Q. Is 2A something you prepared in the course of your analysis
8 of this case?
9 A. Yes.
10 Q. And what is the difference, if any, between Table 2 and
11 Table 2A?
12 A. Just the labeling of -- the second column, the column in
13 the middle of Table 2 has "Shelby County"; and 2A, the second
14 column has "MLGW."
15 Q. Are the entries -- are the numbers on both of those tables
16 the same?
17 A. Yes.
18 Q. Did moving from Table 2 to 2A result in any change in your
19 conclusions in your analysis?
20 A. No.
21 Q. Let's take a look at P159. What is that?
22 A. Volume of groundwater taken from Mississippi due to MLGW
23 pumpage. It's for the years 1965 through 2016.
24 Q. Did you prepare this document in the course of your
25 analysis?

Wiley - direct

1 A. Yes.

2 Q. Let's turn to P160, please.

3 We talked a good bit about this document yesterday; do
4 you recall?

5 A. Yes, I do.

6 Q. Likewise, is this a document you prepared in the course of
7 your analysis of the issues in this case?

8 A. Yes.

9 Q. Let's go to P161.

10 Is that document one which you prepared in the course
11 of your analysis in this case?

12 A. Yes, it is.

13 Q. P162: Likewise, is that a document you prepared in the
14 course of your analysis in the case?

15 A. Yes.

16 Q. 163: Is that a document you prepared in preparation and
17 conducting of your analysis in this case?

18 A. Yes.

19 MR. HILL: Your Honor, excuse me. If the point of
20 this is just to authenticate the things in the expert report,
21 we'll stipulate that each of these --

22 MR. McMULLAN: Thank you, your Honor. I understood
23 there was an objection to authenticity on these documents, so I
24 wanted to make sure to clean that up a bit.

25 MR. HILL: Sorry, the objection is not to authenticity

1 Wiley - direct
but our other objection's pending --

2 MR. McMULLAN: Understood.

3 THE COURT: Any other objections?

4 MR. L. BEARMAN: Just -- we're reserving the
5 objections we previously made, your Honor, not to the
6 authenticity.

7 MR. McMULLAN: Thank you very much. Appreciate that
8 clarification.

9 THE COURT: Sure.

10 BY MR. McMULLAN:

11 Q. In the course of your analysis of the amounts of water that
12 were diverted by MLGW's pumping from Mississippi, did you reach
13 a conclusion about the total amount or total volume, millions
14 of gallons of water, that were diverted over the course of the
15 period that you looked at? I believe it was 1965 to 2016. Did
16 you come up with a number?

17 A. Yes.

18 Q. What was that number?

19 A. I believe it was approximately 411 billion gallons per day.

20 Q. Did you say "billion"?

21 A. Yes.

22 MR. McMULLAN: The Court's indulgence, I have one
23 slide that I would like to have the ability to put up on the
24 screen. My IT person has just arrived. And we can talk about
25 it, but I'd like to put it up in a few minutes, if I get to

Wiley - direct

1 that point.

2 Q. But Mr. Wiley, let's turn to Exhibit P189 in your book.

3 Are you there?

4 A. Yes.

5 Q. Okay. What is that exhibit, P189?

6 A. This is what I spoke of a few minutes ago regarding the
7 MERAS model. It shows -- on the left-hand side, it shows
8 predevelopment budget for model layers 5 through 10 in the
9 MERAS model, which represent Middle Claiborne; and then on the
10 right side, it's the water budget for 2007 for DeSoto County.

11 Q. Is this part of the work that you were describing you did
12 in follow-up using the MERAS model?

13 A. Yes.

14 Q. Is this a follow-up to confirm the particle tracking that
15 you did, or follow up the diversion that you did using MERAS?

16 A. No, this is not the particle tracking. This is water
17 budget, to find out how much water was flowing from DeSoto to
18 Shelby County.

19 Q. Does this reflect the testimony you gave a few minutes ago,
20 that the MERAS run of the diversion confirmed the Brahana
21 conclusions that you -- the Brahana model-based conclusions
22 which you reached?

23 A. Yes.

24 Q. Tell us a little more about that, in detail, about what
25 we're looking at here. There's two different illustrations

Wiley - direct
1 here; on the left there's one and on the right there's one.

2 What is -- what is being depicted here, if you would, please?

3 A. The one on the left, as I said, shows predevelopment
4 conditions for water moving through layers 5 through 10
5 horizontally. And it shows -- I'll just read it:

6 4.3 million gallons a day coming into DeSoto from Marshall;
7 2.3 million gallons a day coming into DeSoto from Shelby;
8 2 million gallons a day leaving DeSoto to Arkansas; 3.4 leaving
9 DeSoto to Tunica County, Mississippi; and 2.7 leaving DeSoto
10 for Tate County; again, 2.7 million gallons a day.

11 Then that's predevelopment.

12 And then on the right side we have, under 2007 pumping
13 conditions, we have 10.19 million gallons a day coming into
14 DeSoto from Marshall; 1.5 million gallons a day coming into
15 DeSoto from Tate; .8 million gallons a day coming into DeSoto
16 from Tunica County; and then 2.9 million gallons a day coming
17 into DeSoto from Arkansas. 20.3 million gallons a day leaving
18 DeSoto, from Shelby County.

19 Q. All right. So under the predevelopment conditions in
20 that -- and "predevelopment" means before pumping by MLGW,
21 right?

22 A. That -- that's before any pumping. Right.

23 Q. Okay. So does this indicate -- what does this indicate
24 with respect to amounts of water flowing from Mississippi into
25 Tennessee, predevelopment?

Wiley - direct

1 A. Well, it indicates that due to pumping that's going on in
2 2007, primarily from the Shelby County area, that there is
3 20.3 million gallons a day leaving DeSoto County for Shelby
4 County. And when you look at the net change from
5 predevelopment to 2007, you add in the 2.3 that was leaving
6 Shelby to get a total of 22.6 million gallons a day.

7 Q. The water that's moved from Mississippi to Tennessee as a
8 result of MLGW's pumping, is it going to come back?

9 A. Well, as I said before, this is everyone pumping. The
10 MERAS model had -- it did not just have MLGW pumping.

11 Q. Understood. So this doesn't attempt to depict or quantify
12 the amount from MLGW, but as I understand what you're saying,
13 this was something you used as a cross-check to confirm your
14 conclusions with -- using the Brahana and Broshears model?

15 A. That's right.

16 Q. And your conclusions were, when you compared the results of
17 this model run to Brahana, were what?

18 A. That the pumping by MLGW in Shelby County is causing water
19 from -- diversion of water from DeSoto County. And we
20 checked -- we did -- we calculated that for multiple years, but
21 it confirms that there's water being induced from DeSoto County
22 into Shelby County.

23 Q. I want to follow up on a couple of questions I asked you
24 yesterday about how the cone of depression might be affected by
25 any decisions that MLGW might make about its pumping.

1 Wiley - direct
2 Let me clarify this: If MLGW pumping were to cease,
3 would that eliminate the cone of depression that reaches into
4 Mississippi?

5 A. If MLGW -- MLGW were to cease pumping, the cone of
6 depression that they've caused extending into Mississippi would
7 cease.

8 Q. Okay. And if MLGW moved its wellfields further north about
9 20 miles, would, in your opinion, the effect of the cone of
10 depression in Mississippi be eliminated?

11 A. I haven't -- I haven't evaluated that. It would certainly
12 shift.

13 Q. Fair enough.

14 MR. McMULLAN: One moment, your Honor. Court's
15 indulgence.

16 Q. One point of clarification. I understand that a few
17 minutes ago you mentioned that there was not as much -- well,
18 maybe it was yesterday -- that you began your work initially in
19 2007; you'd had one group of data as far as pumping data is
20 concerned. Is that correct? When you did your first initial
21 work, you had one set of data to work with, and later you
22 updated it; is that correct?

23 A. Yes.

24 Q. What was the source of information for the additional
25 pumping data that you used in the follow-up work that you did
26 later? Where did you get it?

Wiley - direct

- 1 A. For ...
- 2 Q. The additional pumping --
- 3 A. For who?
- 4 Q. The additional pumping --
- 5 A. For MLGW?
- 6 Q. Correct.
- 7 A. We got data from both the MLGW and the State of Tennessee
- 8 Department of Environmental Conservation, I believe it was.
- 9 Q. Okay. It was their data?
- 10 A. Yes.
- 11 Q. And you incorporated that data into your analysis in the
- 12 follow-up work that you conducted? You used it?
- 13 A. Yes.
- 14 Q. Okay. And it's considered in your analysis and conclusions
- 15 that you've reached and the opinions you've given here today?
- 16 A. Well, we -- in 2017, for the 2017 report, we -- we received
- 17 additional pumpage data from MLGW for a period of time that we
- 18 had data from the State of Tennessee. So we updated the model
- 19 with the MLGW data instead of the State of Tennessee data.
- 20 Q. And when you updated the model with the additional data,
- 21 did it change any of your conclusions that you've given?
- 22 A. No.
- 23 Q. And opinions you've given here?
- 24 A. No, it didn't.
- 25 Q. Are all of the opinions you've given in court to a

1 Wiley - cross
reasonable degree of scientific probability?

2 A. Yes.

3 MR. McMULLAN: I pass the witness.

4 THE COURT: All right.

5 You may cross-examine.

6 MR. D. BEARMAN: Thank you, your Honor.

7 If your Honor doesn't mind, I'm going to move some
8 boxes and get set up here.

9 THE COURT: Okay.

10 CROSS EXAMINATION

11 BY MR. D. BEARMAN:

12 Q. Good morning, Mr. Wiley.

13 A. Good morning.

14 Q. Can you hear me okay?

15 A. Yes.

16 Q. My name is David Bearman, and I represent the City of
17 Memphis and MLGW. You and I have met before; I think started
18 back in 2006, when you started working on this case. Isn't
19 that about right?

20 A. That sounds right.

21 Q. Yesterday and this morning you talked about your work in
22 2007 on this case, and in 2014, and currently in 2017. Do you
23 remember that?

24 A. Yes.

25 Q. And you issued expert reports in 2007, 2014, and 2017,

Wiley - cross

- 1 right?
- 2 A. Right.
- 3 Q. And the focus of all three of those reports was the same
- 4 aquifer, right?
- 5 A. Yes.
- 6 Q. And we've heard terms this morning, and during the trial --
- 7 you've been here at least for part of Mr. Spruill's testimony,
- 8 weren't you?
- 9 A. Yes.
- 10 Q. We've heard the term the "Memphis Sand Aquifer," the
- 11 "Sparta Sand Aquifer"; do you remember that?
- 12 A. Yes.
- 13 Q. And in fact, in your 2017 report, you referred to the
- 14 aquifer at issue here as the Sparta Sand, right?
- 15 A. Which report? I'm sorry.
- 16 Q. Your 2017 report.
- 17 A. I believe so. That's right.
- 18 Q. And in your 2007 report, you referred to that same aquifer
- 19 as the Memphis Sand Aquifer, right?
- 20 A. Right.
- 21 Q. And you've heard the term "Middle Claiborne Aquifer" used
- 22 at this trial, correct?
- 23 A. Yes.
- 24 Q. And that's the same aquifer?
- 25 A. The -- the Memphis Sand and the Sparta Sand are part of the

1 Wiley - cross
Middle Claiborne Aquifer.

2 Q. So we're all talking about the same aquifer; that's what I
3 want to make sure.

4 MR. McMULLAN: Your Honor, I've got an objection.
5 This goes beyond the scope of my direct.

6 THE COURT: I'm going to let you ask the question.

7 MR. D. BEARMAN: Thank you, your Honor.

8 Q. Mr. Wiley, you remember when you gave your deposition a
9 summer ago? Do you remember that?

10 A. Yes.

11 Q. And do you remember that you were under oath when you gave
12 that deposition?

13 A. Yes.

14 Q. And you remember that I asked you that if you had any
15 questions about the questions I asked you, you didn't
16 understand something, I wanted you to clarify them, correct?
17 Right?

18 A. Yes.

19 Q. Okay. And you knew that your answers were important,
20 correct?

21 A. Yes.

22 Q. And in your deposition, when I asked you, "Mr. Wiley, in
23 your report you used the term 'Sparta Sand,' and you also used
24 the term 'Sparta Memphis Sand'; I want to make sure we're
25 talking about the same aquifer. Is that right?"

Wiley - cross

- 1 A. That sounds good.
- 2 Q. The aquifer underlies eight different states, right?
- 3 A. The Middle Claiborne Aquifer is part of the Mississippi
- 4 Embayment that underlies eight different states to some degree,
- 5 yeah.
- 6 Q. I'm talking about -- the Middle Claiborne Aquifer underlies
- 7 eight different states, right?
- 8 A. Yep, that's what I just said. Yeah.
- 9 Q. And the geographic extent -- that is, the size of the
- 10 aquifer and the fact that it underlies eight states -- is not
- 11 disputed, right?
- 12 A. That's right.
- 13 Q. It actually goes beneath the Mississippi River, right?
- 14 A. Yes.
- 15 Q. Now, you're familiar with the term "transboundary aquifer,"
- 16 right?
- 17 A. Yes.
- 18 Q. And a transboundary aquifer is one that exists on two sides
- 19 of a boundary line, right?
- 20 A. Yes.
- 21 Q. And the boundary line could be a county line, right?
- 22 A. Yes.
- 23 Q. And it could be a state line?
- 24 A. Yes.
- 25 Q. So the Middle Claiborne Aquifer is a transboundary aquifer,

Wiley - cross

1 right?

2 A. Yes, based on that definition.

3 Q. The groundwater wells that are used to pump groundwater
4 from the aquifer in Shelby County are drilled straight down,
5 right?

6 A. That's -- to my knowledge, yes.

7 Q. You have no knowledge that there are any wells that are
8 slanted?

9 A. No, I don't.

10 There are horizontal wells, though.

11 Q. But not --

12 A. Not here, that I know of.

13 Q. Okay. And the same is true of the wells in Mississippi:
14 They're -- as far as you know, they're not slanting their wells
15 beneath Tennessee?

16 A. No.

17 Q. And both Shelby County and -- Tennessee, and DeSoto County,
18 Mississippi, are pumping from the same aquifer, right?

19 A. Yes, they are pumping from the same aquifer. There may be
20 wells that are pumping from different aquifers there. You've
21 got the Fort Pillow Aquifer, but -- you know, some well -- most
22 of the wells are pumping from the Memphis Sparta Sand Aquifer.

23 Q. In both counties?

24 A. Yes.

25 Q. One in Tennessee, one in Mississippi?

Wiley - cross

1 A. Yes.

2 Q. Now, you agree that pumping in the aquifer in Tennessee can
3 impact the groundwater flow of the aquifer, the same aquifer --
4 let me try that again.

5 Pumping in the aquifer in one state can impact the
6 flow of groundwater in the aquifer in another state, right?

7 A. That's right. I've shown some figures, some information in
8 my direct, that demonstrated that.

9 Q. Right. In fact, the entire basis of your calculation of
10 those amounts allegedly diverted is based on the theory, on the
11 assumption that impact of pumping in Tennessee crosses the
12 state line into Mississippi, right?

13 A. Right.

14 Q. There are no physical barriers in the aquifer that stop the
15 water in the aquifer in Mississippi coming up into Tennessee,
16 right?

17 A. That's right.

18 Q. And there are no physical barriers in the aquifer that
19 would stop the groundwater from moving from DeSoto County,
20 Mississippi, into Arkansas, right?

21 A. That's right.

22 Q. And to be clear, my first question, when I talk about the
23 water coming up into Tennessee, I want to make sure this is
24 clear, that I'm talking about there's no physical barrier at
25 the Tennessee/Mississippi line that would stop the water in

1 Wiley - cross
2 Mississippi in the aquifer from coming up into Tennessee in the
3 aquifer, right?
4 A. Right.
5 Q. Mr. Taylor, could you pull up Slide -- Exhibit P183.
6 This is one of the figures, Mr. Wiley, in your exhibit
7 notebook that was handed out. Do you recognize that?
8 A. Yes.
9 Q. That's a figure that you created, correct?
10 A. That's right.
11 Q. Now, these flow arrows are in blue and green, right?
12 A. Yes.
13 Q. And those show the path of groundwater as it would move
14 through the aquifer in 2016, according to your calculations?
15 A. That's right.
16 Q. Now, those -- the green flow arrows are the ones that start
17 in Mississippi, right?
18 A. Yes.
19 Q. And those arrows that you drew end in Shelby County; is
20 that correct?
21 A. Yes.
22 Q. And that pink area on your map is the City of Memphis,
23 outline of the City of Memphis, right?
24 A. Yes.
25 Q. And so the very south end of Memphis would be the state
line, correct?

Wiley - cross

- 1 A. That's right.
- 2 Q. And you have labeled these green areas, these green arrows,
3 "Interstate Flow," right, down in the legend?
- 4 A. Yes.
- 5 Q. And that's because you show them going from Mississippi
6 into Tennessee, right?
- 7 A. That's right.
- 8 Q. All right. Now, every single one of your green arrows
9 shows that the groundwater that you started in Mississippi,
10 within the aquifer, passes through one of the major cities in
11 North DeSoto County, right?
- 12 A. I don't know.
- 13 Q. Well, look at the map. This is --
- 14 A. Well, I don't know the major cities.
- 15 Q. All right. Let's look at your map. Those arrows pass
16 through Olive Branch; do you see that?
- 17 A. Yes, now I see it.
- 18 Q. And it passes through Horn Lake?
- 19 A. Okay, I see it.
- 20 Q. Southaven?
- 21 A. I see it.
- 22 Q. And Hernando, right? Hernando is down to the south --
- 23 A. I see it, yes.
- 24 Q. And there are pumps within Mississippi over that entire
25 area, aren't there?

Wiley - cross

1 A. There are wells in DeSoto County scattered around, that's
2 right.

3 Q. Pumping from the aquifer?

4 A. Yes.

5 Q. And when you were asked yesterday why the amount of
6 groundwater moving from Mississippi to Tennessee had slowed
7 over the past years -- do you remember that question?

8 A. Yes.

9 Q. And it has slowed down, right?

10 A. That's right.

11 Q. You said because MLGW is pumping less. Do you remember
12 that?

13 A. I said -- I said that ML -- the cone of -- I don't recall
14 the exact question yesterday, but I thought it was related to
15 the cone of depression.

16 Q. Will you agree that MLGW was pumping less --

17 A. Yes.

18 Q. -- than it was?

19 A. That's right.

20 Q. As a matter of fact, pumping in 2016 is less than it was in
21 the 1980s, right?

22 A. Yeah.

23 Q. But another reason why the amount of water going from
24 Mississippi into Tennessee has slowed down is because DeSoto
25 County, Mississippi, is pumping more, right?

Wiley - cross

1 A. Right.

2 Q. And so in these green arrows that you've drawn on this map
3 on page P183, or Exhibit P183, some of that water is being
4 pumped by Mississippi, right?

5 A. Yes, because it's in the water budget.

6 Q. Some of that water has been pumped by Mississippi, correct?

7 A. Yes, it's in -- like I said, it's part of the water budget.

8 Q. Now, you have -- you can take that down, Mr. Taylor. Thank
9 you.

10 You previously testified about cone of depression
11 that's centered in the Memphis area, right?

12 A. Right.

13 Q. Now, every well that pumps groundwater from the aquifer
14 that we're talking about creates a cone of depression when it's
15 pumping, right?

16 A. Right.

17 Q. The cone of depression is one way of visualizing the impact
18 of pumping, correct?

19 A. Yes.

20 Q. Groundwater generally moves from higher head to lower head,
21 or higher pressure, lower pressure; is that correct?

22 A. That's right.

23 Q. So that's really how the wells work; by lowering the
24 pressure, the water kind of comes toward the well, right?

25 A. That's right.

Wiley - cross

- 1 Q. Like when you drink a milkshake with a straw, the milkshake
2 comes toward the straw, right?
- 3 A. Comes in the straw.
- 4 Q. Comes in the straw?
- 5 A. I don't know if it creates a cone of depression, though.
- 6 Q. Depends on how large and full, right? Okay?
- 7 A. I wouldn't be -- I wouldn't be ...
- 8 Q. Now, the cone of depression exists across the surface of
9 the aquifer, right?
- 10 A. The cone of depression -- in plan view, you can see it
11 across the surface, right.
- 12 Q. In the maps that you looked at the other day, yesterday,
13 plan view, that means looking from above down, right?
- 14 A. That's right.
- 15 Q. In those maps, the cones of depression can be seen across
16 the surface of the aquifer, right?
- 17 A. Well, it would be -- you can see it on the map.
- 18 Q. Right.
- 19 A. The aquifer's not -- you know, it's not in the diagram, or
20 the -- the -- superimposing the drawdown contours on it.
- 21 Q. I'm talking about on the map.
- 22 A. Yes.
- 23 Q. And if you have wells that are forming cones of depression
24 in a relatively similar area -- and you talked about this
25 yesterday -- the wells can overlap, or the cones of depression

Wiley - cross

1 can overlap, correct?

2 A. If the wells are close enough together, yes.

3 Q. All right. Mr. Taylor, can you please bring up
4 Exhibit P180.

5 Now, this is Figure 21 from your June 17 report. Do
6 you remember that?

7 A. Yes.

8 Q. And this is what you represent to be the 2016
9 potentiometric surface of the aquifer in this case, right?

10 A. That's right.

11 Q. Now --

12 A. Well, let me clarify. That's the potentiometric surface
13 for 2016, based on pumpage by -- from MLGW wells in DeSoto
14 County.

15 Q. Right. And this is -- well, let's -- let's talk about that
16 for a minute. Your model only includes pumping from MLGW in
17 Shelby County, right?

18 A. That's right.

19 Q. And DeSoto County?

20 A. Right.

21 Q. Doesn't include pumping from anywhere else?

22 A. No.

23 Q. Now, you know that there is pumping in Shelby County other
24 than MLGW, right?

25 A. Right.

Wiley - cross

1 Q. And you know that there is pumping in Crittenden County,
2 Arkansas, which is right across the river from Shelby County,
3 Tennessee, and DeSoto County, Mississippi, right?

4 A. Right.

5 Q. That's not in your model, though?

6 A. No.

7 Q. And there is also pumping from the aquifer in Marshall
8 County, Mississippi, which is to the east of DeSoto County,
9 right?

10 A. That's right.

11 Q. But there's no pumping in Marshall County represented in
12 your model?

13 A. Right.

14 Q. So when you show a cone of depression such as represented
15 on Exhibit P180, it's based on incomplete information, right?

16 A. No, it's based on complete information with respect to what
17 we were looking -- looking to accomplish. We were only looking
18 to find out what the simulated effects were from MLGW and
19 DeSoto County pumping. It would not be what you measure in the
20 real world. It's only calculations to find out what the effect
21 is from those two pumping entities.

22 Q. So this Exhibit P80 and the other potentiometric maps that
23 you have drawn, based on your model, do not show what is
24 happening in the real world?

25 A. No. The real world, it would be bigger. The cone of

1 Wiley - cross
depression would probably -- would be bigger.

2 Q. And the cone of depression in your maps show the
3 combination of pumping of MLGW and in DeSoto County,
4 Mississippi, right?

5 A. That's right.

6 Q. So part of this cone of depression in Northern
7 Mississippi -- as you say, it extends down -- is due to the
8 pumping wells that exist in DeSoto County, right?

9 A. That's right.

10 Q. And in the real world, it would also show pumping from
11 DeSoto County?

12 A. I'm not sure what -- I'm not sure what you're asking there,
13 Dave.

14 Q. The cone of depression doesn't just show the impact of MLGW
15 pumping on this exhibit, right?

16 A. Right.

17 Q. It includes the impact of DeSoto County pumping, correct?

18 A. Right.

19 Q. And the same would be true for all of the potentiometric
20 maps in your expert report, or that you've talked about, that
21 are drawn or created by your model?

22 A. Right. And -- yeah, in this 2017 report, that's correct.

23 Q. Now, the cone of depression -- you talked about this a
24 little yesterday -- the cone of depression that you have
25 used -- that you have modeled, that's centered in Memphis, has

1 Wiley - cross
actually been shrinking toward -- over the last years, correct?

2 A. It's been shrinking somewhat, yes.

3 Q. That means it's getting smaller?

4 A. Well, what I -- when I say "shrinking somewhat," I only
5 evaluated MLGW and DeSoto County pumping. So with the -- if
6 the whole world is pumping out there, I don't know what the
7 real world cone of depression looks like and if it's shrunk.
8 But the analysis that we did, looking at MLGW in DeSoto only,
9 there has been a shrinking.

10 Q. The aquifer in this case is hydrologically connected to
11 surface water, correct?

12 MR. McMULLAN: Object to the form. Ambiguous.

13 Q. Mr. Wiley, do you understand my question?

14 A. Could you ask it again, please.

15 Q. The aquifer in this case is hydrologically connected to
16 surface water, correct?

17 A. Yes, it is. It's not directly, but through LEKINS
18 (phonetic) -- through a number of units above the aquifer,
19 there is connection.

20 Q. And one of the surface water -- one of the surface water
21 rivers that it's connected to, the aquifer is connected to, is
22 the Wolf River, right?

23 A. The Wolf River -- I get -- is that the one in Memphis?

24 Q. The Wolf River starts in Mississippi, east of DeSoto
25 County, in Benton County, Mississippi; do you remember where

Wiley - cross

1 that is?

2 A. Yeah.

3 Q. That's two counties over from DeSoto County. And it flows
4 north into Tennessee, and then through Shelby County and
5 enters -- empties into the Mississippi River. Do you remember
6 the Wolf River now?

7 A. Yeah.

8 Q. And that's one of the rivers that the aquifer is connected
9 to, right?

10 A. Yeah, the -- it flows through the outcrop of the Memphis
11 Sparta Sand.

12 Q. In Mississippi and in Tennessee?

13 A. Yes.

14 Q. And the aquifer also discharges ultimately into the
15 Mississippi River, right?

16 A. It ultimately discharges into the river or the alluvial
17 aquifer.

18 Q. So the Mississippi River would be another surface river
19 that is hydrologically connected to the aquifer?

20 A. With respect to discharge, yes.

21 Q. Now, the water that we've been talking about in the
22 aquifer, the groundwater that you talked about yesterday with
23 Mr. McMullan and this morning with Mr. McMullan, that
24 groundwater is moving, right?

25 A. Yes. Very slowly, but it's moving.

Wiley - cross

1 Honor.

2 Q. Now, this map shows predevelopment conditions in the
3 aquifer at issue here, correct?

4 A. That's right.

5 Q. Now, what I want to make sure --

6 MR. D. BEARMAN: Your Honor, may I approach?

7 THE COURT: Yes, you may.

8 Q. Just want to make sure we're all on the same page.

9 This is the state line, correct?

10 A. Yes.

11 Q. And I'm pointing to the line that's on the southern edge of
12 the pink and the northern side of the yellow, correct?

13 A. Yes, that's the state line.

14 Q. Okay. I just want to make sure we're all on board with
15 that.

16 All right. So part of the aquifer is north of the
17 state line, right?

18 A. Yes.

19 Q. And part of the aquifer is south of the state line, right?

20 A. Right.

21 Q. The pink area on your map is an outline of the City of
22 Memphis, correct?

23 A. Yes.

24 Q. And we can agree that the western -- on the left side of
25 the page, the left side of that pink City of Memphis area,

Wiley - cross
1 that's the -- roughly the Mississippi River, correct?

2	A. That's right.
---	------------------

3 Q. All right. And west of the Mississippi River, of course,
4 would be Arkansas?

5	A. Yes.
---	---------

6 Q. And so part of the aquifer is also in Arkansas?

7	A. Yes.
---	---------

8 Q. Now, the black curved lines on Figure 9 are lines of equal
9 pressure, correct?

10	A. Correct.
----	-------------

11 Q. You talked about that yesterday, correct?

12	A. Yes. Yes.
----	--------------

13 Q. And so when you look at a map like this, and you draw the
14 flow lines, you're essentially -- as you go from the right side
15 of that figure to the left side of the figure, those flow lines
16 are going downhill, correct?

17 A. Yeah. It's slight -- it's based on high pressure to low
18 pressure.

19 Q. Okay. Now, there are two lines on this figure that are
20 shaded green. Do you see that?

21	A. Yes.
----	---------

22 Q. Those lines start in Mississippi, correct?

23	A. Yes.
----	---------

24 Q. And they go through Tennessee into Shelby County, right?

25	A. Yes.
----	---------

Wiley - cross

1 Q. And they ultimately go underneath the Mississippi River
2 into Arkansas, right?

3 A. Yes.

4 Q. And you have labeled those green lines in the legend
5 "Interstate Flow," right?

6 A. I see that, yeah.

7 Q. And you've done that just as you did on the previous
8 drawing we talked about, because those flow paths cross state
9 lines, correct?

10 A. Correct.

11 Q. And this is predevelopment, without any influence of
12 pumping?

13 A. That's right.

14 Q. All right. Now, there's a yellow triangle. Do you see
15 that?

16 A. Yes.

17 Q. And you drew that yellow triangle based on these
18 equipotential lines that you drew, because your opinion is that
19 groundwater from anywhere in that yellow triangle in
20 Mississippi would ultimately flow into Tennessee, correct?

21 A. Yes, under predevelopment conditions.

22 Q. So even though you've just drawn two green arrows, you
23 could draw an arrow from anywhere in that yellow triangle,
24 right?

25 A. That's right.

- Wiley - cross
- 1 Q. And they would go into Tennessee?
- 2 A. That's right.
- 3 Q. And you have labeled that yellow triangle "Area of Limited
- 4 Natural Flow from Mississippi to Tennessee," and then in
- 5 parentheses, "Interstate Flow," correct?
- 6 A. Yes, that's what it says.
- 7 Q. I want you to take a look at those three blue lines at the
- 8 top of the page. Do you see those?
- 9 A. Yes.
- 10 Q. Those lines start in Shelby County, Tennessee, correct?
- 11 A. Correct.
- 12 Q. And you have labeled them "Intrastate Flow," correct?
- 13 A. That's right.
- 14 Q. But those lines flow -- actually leave Tennessee and go
- 15 into Arkansas, right?
- 16 A. Yes.
- 17 Q. So those would also be interstate flow lines, right?
- 18 A. Right. I believe I labeled them "Intrastate" because
- 19 they -- I was looking at only Tennessee, where they started.
- 20 That was the logic there.
- 21 Q. All right. But they're interstate --
- 22 A. Yes.
- 23 Q. -- as you've drawn them, right?
- 24 A. Right.
- 25 Q. Correct?

Wiley - cross

1 A. Yes.

2 Q. Take a look at that yellow triangle for me. And you see at
3 the bottom left of your figure, you have a scale about -- about
4 miles. And based on what I'm looking at, it looks like roughly
5 an inch is equal to six miles. Do you see where I'm talking
6 about?

7 A. Yes.

8 Q. If you look at that yellow triangle that you drew,
9 Mr. Wiley, it appears to me that that yellow triangle goes
10 roughly two and a half miles down into Mississippi. Do you
11 agree with that?

12 A. It looks about right.

13 Q. And it stops shy of the Marshall County/DeSoto County
14 boundary by about two and a half miles, right?

15 A. Right.

16 Q. And just to be clear, the boundary between DeSoto County --
17 that would be the eastern boundary of DeSoto County -- and the
18 western boundary of Marshall County, is the light gray line
19 that passes through that little arrow pointing toward the
20 yellow triangle, correct?

21 A. Yes.

22 MR. D. BEARMAN: Judge, I'm happy to come and point
23 that out. I want to make sure everyone can see it.

24 THE COURT: I can see it.

25 MR. D. BEARMAN: Thank you.

1 A. "Addendum." There we go. Wiley - cross

3 Q. All right. Now, this is the figure you talked about
4 earlier, correct?

6 Q. And these red lines that you have on this figure are
7 particle tracks showing flow paths of groundwater in the
8 aquifer we're talking about here, right?

10 Q. All right. And I -- I don't know if you said it here, but
11 you said in your deposition that you started these flow paths
12 or these particle tracks on the DeSoto County/Marshall County
13 border, correct?

15 Q. And that's actually in the outcrop area of the aquifer,
16 right?

18 Q. And your first particle track starts about four miles south
19 of the Tennessee/Mississippi border, right?

23 Q. So, Mr. Wiley, we're looking now at an enlarged portion of
24 your particle track figure. Do you see that?

Wiley - cross

1 Q. And that very top red line is about four miles from the
2 Tennessee/Mississippi border, right?

3 A. I don't know. I don't know the scale.

4 Q. All right. Well --

5 A. I didn't measure it before you blew it up. I didn't see
6 what the scale was.

7 Q. Well, you remember in your deposition telling me that you
8 started them at about four miles south?

9 A. If -- I don't remember, but I -- that sounds -- if I said
10 that, it must have been accurate, then.

11 Q. All right. If you look at this enlarged portion, do you
12 see the Tennessee/Mississippi state line on this drawing?

13 A. Yes.

14 Q. And that is the horizontal line that goes above the word
15 "Southaven," right?

16 A. Yes.

17 MR. D. BEARMAN: Mr. Taylor, could you just highlight
18 that for a second, that state line? Just want to make sure we
19 all see what we're talking about. Right.

20 Q. Is that the state line, Mr. Wiley?

21 A. It appears to be, yeah, appears to be.

22 MR. D. BEARMAN: All right. You can take that down.
23 Thank you.

24 Q. All right. Now, the particle tracks that you started
25 roughly four, five, and six miles down into Mississippi

1 Wiley - cross
actually flowed into Tennessee, didn't it?

2 A. Yes.

3 Q. All right. Now, this is predevelopment, correct?

4 A. That's right.

5 Q. All right. So that's -- those are flow paths that are
6 actually further down in Mississippi than your yellow triangle,
7 right?

8 A. Based on -- you know, it could be a scaling thing, but it's
9 in the approximate same area. Maybe a little below.

10 Q. Now, you didn't include particle tracks north of your red
11 lines, but you would agree that if you had done the particle
12 trackings in that area between your top red line and the state
13 border, those would have also crossed into Tennessee,
14 naturally, right?

15 A. Right.

16 Q. All right. Now, let's --

17 MR. D. BEARMAN: We can take that down, Mr. Taylor.

18 Q. And I want to focus now on the area around the Mississippi
19 River. Now, these are particle tracks that you started in
20 Mississippi and didn't go into Tennessee, right, naturally; is
21 that correct?

22 A. Could you ask -- I'm not sure what you're asking there,
23 what you're stating there.

24 MR. D. BEARMAN: Let's take down the enlargement for a
25 minute.

Wiley - cross

1 there.

2 Q. All right. Well, in your deposition, on page 1260, I asked
3 you, "Would you say that most of them cross into Arkansas?"

4 And your answer was "more than half."

5 A. Okay. Well, I'm looking at this again, and it does look
6 like more than half.

7 Q. Okay.

8 MR. D. BEARMAN: Thank you, Mr. Taylor.

9 Now, would you please, Mr. Taylor, pull up
10 Exhibit P185.

11 Q. Do you recognize this figure, Mr. Wiley?

12 A. Yes.

13 Q. Now, what I want to do is just make sure we're on the same
14 page here. There's two illustrations on this figure. This is
15 from your expert report, right?

16 A. Yes.

17 Q. The figure on the left shows the area of the aquifer that
18 we're talking about in this case, right?

19 A. Yes, it does.

20 Q. And that figure is one that originally appeared in the
21 expert report of Dave Langseth, Dr. Dave Langseth, who is the
22 expert for Memphis MLGW, correct?

23 A. Yes.

24 Q. And then what Dr. Langseth did on -- and he drew those flow
25 arrows, correct, in that illustration on the left?

Wiley - cross

- 1 A. I assume he did, yeah.
- 2 Q. And then what Dr. Langseth did was enlarge a section that's
- 3 in that red square, right, and put that section on the right
- 4 side of the page?
- 5 A. Yes. I remember that.
- 6 Q. All right.
- 7 MR. D. BEARMAN: Mr. Taylor, will you enlarge that
- 8 section right there. Thank you.
- 9 Q. All right. Now, on this particular figure, the very top
- 10 arrow, that's a flow arrow, right?
- 11 A. Yes.
- 12 Q. And this is in the aquifer we're talking about, correct?
- 13 A. Yes. Yes.
- 14 Q. That top flow arrow was one that Dr. Langseth drew,
- 15 correct?
- 16 A. Right.
- 17 Q. You added the four flow arrows below that, correct?
- 18 A. That's right.
- 19 Q. All right. And what I want to do is look at the top flow
- 20 arrow that you drew, which is the second from the top. Do you
- 21 see that?
- 22 A. Yes.
- 23 Q. All right. That flow arrow -- and this is -- we're talking
- 24 about groundwater flow in the Memphis Sparta Aquifer, right?
- 25 A. Right.

Wiley - cross

1 Q. In the Tennessee/Mississippi border area, correct?

2 A. That's close, yes.

3 Q. All right. Do you see the state line, Mr. Wiley?

4 A. Yes.

5 Q. Your flow arrow starts in Marshall County, Mississippi,
6 correct?

7 A. Correct.

8 Q. Now, that's further east than your particle tracks start,
9 correct?

10 A. Right.

11 Q. And that flow arrow that you drew goes into Tennessee,
12 correct?

13 A. Yes.

14 Q. And it's kind of a sweeping motion through Tennessee,
15 counterclockwise -- it actually goes back into Arkansas,
16 right --

17 A. Yes.

18 Q. -- I mean back into Mississippi, excuse me.

19 Correct?

20 A. Oh, yes.

21 Q. All right. So your flow line starts in Marshall County,
22 Mississippi, goes into Tennessee, and goes back into
23 Arkansas -- to Mississippi, correct?

24 A. Yes.

25 Q. And then it crosses from Mississippi into Arkansas?

Wiley - cross

- 1 A. Right.
- 2 Q. And then back into Mississippi?
- 3 A. Yes.
- 4 Q. And then back into Arkansas?
- 5 A. Yes, it does.
- 6 Q. And back and forth between Mississippi and Arkansas a few
- 7 more times, right?
- 8 A. Right.
- 9 Q. Now, I want you to take a look at -- do you see where your
- 10 arrow started, that we just talked about?
- 11 A. Yes.
- 12 MR. D. BEARMAN: Mr. Taylor, I would like you to draw
- 13 a line from that point to the beginning of Dr. Langseth's
- 14 arrow. Thank you.
- 15 Q. Do you see the -- that by drawing that line, Mr. Wiley,
- 16 we've created kind of a parallelogram area?
- 17 A. I -- I see where the line's almost parallel to the state,
- 18 yeah.
- 19 Q. Right.
- 20 A. The state line.
- 21 Q. Right. If you had drawn flow arrows starting anywhere in
- 22 that area above the red line and below the state border of the
- 23 Mississippi, those flow arrows, that natural flow of the
- 24 groundwater and the aquifer, would also have gone into
- 25 Tennessee, correct?

Wiley - cross

1 A. Yeah, if you draw the lines perpendicular to all those blue
2 potentiometric surface lines, looks like -- without doing it,
3 but it looks like across most of that area, yes, they -- most
4 of the lines would likely go from Mississippi to Tennessee.
5 There may be -- there may be one or two that might not. I
6 don't know without drawing it.

7 Q. Most of them would?

8 A. Yeah.

9 Q. Okay. Thank you.

10 You had talked earlier, Mr. Wiley, about your use of
11 the computer model that was created by Brahana and Broshears,
12 correct?

13 A. Yes.

14 Q. And that model was created in the -- the '70s and maybe
15 early '80s; is that accurate?

16 A. Yeah. It was -- it was -- well, there was data calibrated
17 to 1980, so ...

18 Q. And it wasn't published until much later --

19 A. Right.

20 Q. -- but the model was based on, I guess, the technology at
21 the time of the late '70s, early '80s; is that fair?

22 A. Yes.

23 Q. The Brahana model consists of three layers, correct?

24 A. Yes.

25 Q. And when I say "layers," I'm talking about like a sandwich;

1	horizontal layers. Correct?	Wiley - cross
---	-----------------------------	---------------

3 Q. The second layer of the -- well, and each of those layers
4 go across the entire span of the modeled area, correct?

6 Q. And the modeled area in the Brahana model includes
7 Mississippi, right?

9	Q. Tennessee?
---	---------------

11	Q. Arkansas?
----	--------------

13 Q. And some other states also; maybe Missouri, Kentucky?

15 Q. Layer 2 of your model, the Brahana model, is the aquifer
16 that we're talking about here in this case, the Memphis Sparta
17 Middle Claiborne Aquifer, right?

20 Q. Right. He labeled it the Memphis Sand in the report, and
21 in your 2017 report you call it the Sparta, but it's the same
22 thing?

24 Q. The purpose of the model -- and you said this yesterday --
25 the computer model, is to simulate real world systems, right?

Wiley - cross

- 1 A. Yes.
- 2 Q. And so this computer model of groundwater would be showing
- 3 you real world system that is underground, correct?
- 4 A. Yes.
- 5 Q. So in this case, the Brahana model that you used is
- 6 designed to show what's happening in the real world, in the
- 7 aquifer that we're talking about here in this case, right?
- 8 A. Yes, with respect to MLGW and DeSoto County pumpage.
- 9 Q. And we talked about this earlier, but in the real world,
- 10 there is pumping in Arkansas?
- 11 A. Right.
- 12 Q. From this aquifer?
- 13 A. Yes.
- 14 Q. And there is pumping in Mississippi outside of DeSoto
- 15 County?
- 16 A. Yes.
- 17 Q. Out of this aquifer?
- 18 A. Yes.
- 19 Q. And there's pumping in Tennessee outside of Shelby County
- 20 in this aquifer?
- 21 A. Yes.
- 22 Q. And there's pumping in Shelby County other than pumping by
- 23 MLGW, correct?
- 24 A. Yes.
- 25 Q. But you don't represent any of that in your model?

Wiley - cross

1 A. That's right.

2 Q. So you can't say, as we're sitting here today, whether any
3 of that would make a difference in your opinions, right? You
4 don't know?

5 A. No, it wouldn't change -- my opinions wouldn't change. I
6 was evaluating what the effects of selected users was. And I
7 ran the model to see what that was.

8 Q. Without the influence of any other pumping that's been
9 omitted from your model, right?

10 A. Right.

11 MR. D. BEARMAN: Your Honor, may I have a minute to
12 consult with my partners?

13 THE COURT: Sure. We can take a short recess as well.
14 We'll recess for ten minutes.

15 MR. D. BEARMAN: Thank you.

16 (Recess)

17 THE COURT: Mr. Bearman, do you have further
18 questions?

19 MR. D. BEARMAN: I do not. I'll pass the witness.

20 THE COURT: Is the State going to ask questions?

21 MR. HILL: Yes. I haven't spoken much, so I'll just
22 reintroduce myself. I'm Dietrich Hill, and I'll be examining
23 Mr. Wiley for this case.

24 THE COURT: Sure.

25

Wiley - cross

- 1 CROSS EXAMINATION
- 2 BY MR. HILL:
- 3 Q. Good morning, Mr. Wiley.
- 4 A. Good morning.
- 5 Q. We met before, but I think only at your 2017 deposition.
- 6 A. I remember, yes.
- 7 Q. Mr. Wiley, Mr. Bearman I think asked if he could just refer
- 8 to the aquifer as "the aquifer," and you would understand what
- 9 he was referring to, correct?
- 10 A. Correct.
- 11 Q. And I'll probably do the same, but I may refer to it as the
- 12 "Middle Claiborne." Does that make sense to you?
- 13 A. Yes.
- 14 Q. You'll understand what I'm referring to?
- 15 A. Yes.
- 16 Q. Now, there was one point from your testimony that I wanted
- 17 to clarify. I believe you testified at one point, when you
- 18 were calculating the total diversion, that you had calculated
- 19 diversion of 411 billion gallons per day?
- 20 A. No. A total of 411. Not per day.
- 21 Q. Okay. It seemed like a lot.
- 22 A. It is. That is a big number.
- 23 Q. Yeah.
- 24 A. It's not per day, though. No.
- 25 Q. That's the total over the -- over 1965 to 2016?

Wiley - cross

- 1 A. Yes.
- 2 Q. That you calculated?
- 3 A. Yes.
- 4 Q. Mr. Wiley, you discussed hydrological connections with
- 5 surface waters and the aquifer. Do you recall that?
- 6 A. Yes.
- 7 Q. And I think we've heard testimony about the shallow
- 8 aquifer. Do you know what I'm referring to?
- 9 A. Do you mean the surficial aquifer?
- 10 Q. Yes. And that's the aquifer above the Middle Claiborne?
- 11 A. Yes.
- 12 Q. And separated from it by a confined layer; is that correct?
- 13 A. That's right.
- 14 Q. And the Fort Pillow is the aquifer below the Middle
- 15 Claiborne?
- 16 A. Separated by a confining layer.
- 17 Q. And separated?
- 18 A. Yes.
- 19 Q. The aquifer is connected to both the surficial aquifer and
- 20 the Fort Pillow Aquifer, hydrologically connected; is that
- 21 correct?
- 22 A. The Memphis Sparta Aquifer, is that what --
- 23 Q. Yes. Yes.
- 24 A. Yeah, it's -- there's a hydrologic connection, yes.
- 25 Q. Because water can travel through the confining layers?

Wiley - cross

- 1 A. That's right.
- 2 Q. And both of those other two aquifers, the Fort Pillow and
- 3 surficial aquifer, those also underlie multiple states,
- 4 correct?
- 5 A. Well, yeah, the surficial -- there's a surficial aquifer in
- 6 most places, but it's pretty variable. It's more -- it's more
- 7 local that -- these are confined aquifers. Surficial aquifers
- 8 are -- they're all more locally controlled than the confined
- 9 aquifers.
- 10 Q. The Fort Pillow underlies multiple states, right?
- 11 A. That's right.
- 12 Q. Now, you recall you testified about the Brahana and
- 13 Broshears model that you used, correct?
- 14 A. Correct.
- 15 Q. And when you used that -- I believe you testified that you
- 16 found there was a cone of depression centered in Shelby County
- 17 and extending into DeSoto County, Mississippi; is that right?
- 18 A. That's right.
- 19 Q. And that cone of depression also extends into Crittenden
- 20 County in Arkansas; is that right?
- 21 A. I don't -- I didn't talk to that, but there is a -- it
- 22 would extend out across the river.
- 23 Q. Right. I'm asking, does it also extend out across the
- 24 river into Crittenden County in Arkansas?
- 25 A. Yes.

Wiley - cross

1 Q. In other words, the pumping in Tennessee is having some
2 effect on the water in Arkansas?

3 A. Yes.

4 Q. And the Mississippi River does not prevent that effect from
5 crossing the river into Arkansas?

6 A. No, because the aquifer goes underneath.

7 Q. And similarly, it wouldn't affect -- it wouldn't prevent an
8 effect from going the other way, from Arkansas back into
9 Tennessee?

10 A. That's right.

11 Q. Now, I believe you testified that your model, based on the
12 Brahana model, uses one layer to represent the Middle Claiborne
13 Aquifer; is that correct?

14 A. That's right.

15 Q. And to be clear, the study area of your model is smaller
16 than the entire extent of the Middle Claiborne, correct?

17 A. Yes. It -- well, to the north, east, and west, if you look
18 at the model grid, it covers most of the Embayment, the
19 northern part of the Embayment, but not the south.

20 Q. Okay. I put up a slide here, and this is Figure 14 from
21 the 2001 paper; is that right?

22 A. That's right.

23 Q. Do you recognize this?

24 A. Yes.

25 Q. And this is also, for the record, J15 at page 35.

Wiley - cross

1 This is the representation, the extent of the layer of
2 the Middle Claiborne in your model, correct?

3 A. That's right.

4 Q. And that's -- that black line that I think we can
5 highlight, that's the representation of the boundaries in your
6 model?

7 A. Yes.

8 Q. Now, have you heard testimony -- I believe you have --
9 about the facies change that occurs in this area?

10 A. Yes.

11 Q. And that occurs south of the Mississippi/Tennessee border,
12 correct?

13 A. Yes.

14 Q. And would you agree that it's something in the range of
15 10 to 20 miles south of the border?

16 MR. McMULLAN: Objection, your Honor. I'm going to
17 renew my objection that this cross-examination is well in
18 excess of the scope of my direct. I think it's improper.

19 THE COURT: Well, I understand your objection. I'll
20 overrule that, and let's continue.

21 BY MR. HILL:

22 Q. I'm sorry, so you agree that that was a reasonable range?

23 A. Could you -- what did you ask?

24 Q. Whether the facies change is perhaps in the range of 10 to
25 20 miles south of the state border between Mississippi and

Wiley - cross

1 Tennessee.

2 A. That sounds about right.

3 Q. Now, this model's single layer extends quite a lot further
4 south than that; is that accurate?

5 A. Yes.

6 Q. In some places it might extend 50 miles south of the
7 border?

8 A. Yes.

9 Q. But your model nevertheless represents the aquifer as a
10 single layer throughout that entire grid area, correct?

11 A. That's right.

12 Q. And that goes past the facies change or transition zone
13 area, north and south, correct?

14 A. Yes.

15 I would add that the aquifer characteristics change as
16 you go south in the aquifer in the model.

17 Q. Right. But your model does not divide this layer into
18 multiple layers, correct?

19 A. No. No.

20 Q. At the facies change or at any other point?

21 A. No.

22 Q. Mr. Wiley, do you recall that at your deposition, you and I
23 discussed a calculation that you had made about the amount of
24 water within the Middle Claiborne Aquifer that, under
25 predevelopment conditions, flowed from Mississippi into other

Wiley - cross

- 1 states?
- 2 A. Yes.
- 3 Q. And I believe we had a discussion about -- you had an
- 4 84 percent number in one of your reports; do you recall that?
- 5 A. Yes.
- 6 Q. And in your deposition, you testified that the way you came
- 7 up with that number was you found the volume -- this is in the
- 8 MERAS model, correct?
- 9 A. Yes.
- 10 Q. That's the 2009 Clark & Hart model?
- 11 A. Yes.
- 12 Q. And the way you came up with that number is that you
- 13 calculated under the model the total volume of water leaving
- 14 the State of Mississippi within the aquifer, correct?
- 15 A. Yes.
- 16 Q. And then you found the total recharge within the State of
- 17 Mississippi to the aquifer?
- 18 A. Yes.
- 19 Q. And then you divided that first number by the second
- 20 number, and you came up with 16 percent; is that right?
- 21 A. Yes.
- 22 Q. Do you recall the actual total volume in gallons per day?
- 23 A. Not -- no.
- 24 Q. That the 16 percent would be?
- 25 A. No.

Wiley - cross

1 Q. I think we may be able to figure it out from the remainder
2 of your report. In the same report, you also calculated that
3 only 2.6 percent of the total recharge -- that's the same
4 number, correct, the same total recharge?

5 A. I don't recall those numbers, but that -- if that's -- if
6 that's what you have in the record, I -- I'm sure it is.
7 Without having the information, I just don't know what the
8 number is.

9 Q. Okay. Well, it might be helpful to just give you your
10 report, if that would help you recall this.

11 A. Okay.

12 Q. And I believe -- you can check this in a minute in your
13 report, but I believe --

14 A. Okay.

15 Q. -- your report said that you had calculated that
16 2.6 percent of that same total recharge within Mississippi
17 crossed the border into Tennessee under predevelopment
18 conditions. Does that sound familiar?

19 A. Yes.

20 MR. HILL: And I'll just come up, with your Honor's
21 permission?

22 THE COURT: Yes, you may.

23 MR. HILL: Does your Honor want a copy?

24 THE COURT: No, I'm okay.

25 MR. HILL: Yes. We're looking at pages 6 and 7,

Wiley - cross
1 bottom of page 6 and on to page 7.

2 BY MR. HILL:

3 Q. And do you see where you calculated that 2.6 percent of the
4 total recharge flowed from Mississippi into Tennessee? Should
5 be at the bottom --

6 A. I'm on page -- okay, I see it, yes.

7 Q. And that's the same total recharge that you calculated with
8 respect to the 16 percent, correct?

9 A. Give me a minute, please.

10 Q. And if you want to refer to those 16 percent, that's on the
11 next page, is the 84 percent on page eight.

12 A. Yes. I see that.

13 Q. And those two descriptions of the total recharge are the
14 same, correct?

15 A. Yes.

16 Q. Now, with the 2.6 percent, you also told us that that
17 2.6 percent was 6 -- well, less than 6 million gallons per day;
18 is that right?

19 A. Yes.

20 Q. And that should allow us to determine what the 16 percent
21 was, right?

22 A. Yes.

23 Q. And the way we would do that -- and I'm going to put my
24 math up on the slide here, but I'd appreciate it if you'd check
25 it; there's a reason I'm a lawyer, not a scientist -- is that

Wiley - cross
1 if you have roughly 6 million gallons per day, being
2 2.6 percent of the total recharge, that will let us divide 6
3 by .026 and tell us that the total recharge is about
4 230 million gallons per day.

5 And I've got a calculator, if you want to double-check
6 my math.

7 A. It looks -- that looks reasonable. Based on that small
8 division, you're going to get a big number.

9 Q. And -- does that look about right, 230 million gallons per
10 day?

11 A. Yes.

12 Q. And 16 percent of that would be roughly 36.9 million
13 gallons per day?

14 A. That -- about 10 percent of 230 would be 23. So 16 percent
15 would be -- yeah, that looks right.

16 Q. And as I recall, you also testified that you believe that
17 this 16 percent was a reliable estimate of flow under
18 predevelopment conditions, correct?

19 A. Correct.

20 Q. So in other words, you thought it was a reliable estimate
21 that under predevelopment conditions, almost 37 million gallons
22 of water was flowing every day from Mississippi into other
23 states?

24 A. Yes.

25 Q. And that's all within this aquifer, the Middle Claiborne

Wiley - cross

- 1 Aquifer, correct?
- 2 A. Yes.
- 3 Q. Now, just for reference, Mr. Wiley, do you recall which
- 4 layers of the MERAS model you used to do these calculations?
- 5 A. I believe it's five -- five through ten.
- 6 Q. Five through ten?
- 7 A. I believe that was.
- 8 Q. And you believe that layers five through ten accurately
- 9 described the aquifer that you were interested in, correct?
- 10 A. Well, they made up the Middle Claiborne Aquifer in the
- 11 MERAS model.
- 12 Q. Layers five through ten?
- 13 A. Yes.
- 14 Q. In Mississippi as well as in Tennessee; is that correct?
- 15 A. Yes. There were different -- some of the layers had
- 16 different characteristics. Layers five through seven, I
- 17 believe, were more similar to each other, but then they -- the
- 18 layers had different characteristics as you got down through
- 19 eight, nine and ten.
- 20 Q. But you believe that all six of those layers together
- 21 accurately represented the Middle Claiborne Aquifer in
- 22 Mississippi?
- 23 A. Yes.
- 24 Q. Mr. Wiley, just to clarify a couple of points. You are not
- 25 here today to offer any opinion about whether the groundwater

1 Wiley - cross
2 resource at issue in this case is an interstate resource; is
3 that correct?
4 A. That's correct.
5 Q. And you don't have an opinion about an -- what an
6 interstate resource would be; is that also correct?
7 A. That's correct.
8 Q. And you don't have any opinion about a test that one could
9 use to determine what an interstate resource would be?
10 A. Could you ask that again?
11 Q. You don't have an opinion about how one would go about
12 determining whether a resource is interstate; is that right?
13 A. Not here today.
14 Q. Are you aware that we're here today because the Special
15 Master ordered a hearing in an opinion in August 2016?
16 A. Yes.
17 Q. Are you aware that the Special Master described in that
18 opinion the reason why he was ordering an evidentiary hearing
19 in this case?
20 A. I don't know all the legal stuff, so I'd have to say my
21 answer would not be -- I'd have to say I don't know, because I
22 don't know all the legal stuff, so ...
23 Q. And in fact you did not read the Special Master's opinion
24 before you wrote your reports, correct?
25 A. That's right.
26 Q. Okay. Mr. Wiley, I think you testified earlier that the

Wiley - cross
1 cone of depression centered in Shelby County and extending into
2 DeSoto County, Mississippi, also extends into Crittenden County
3 in Arkansas, correct?

4 A. Yes. You asked me that -- I think that was the first
5 question you asked me.

6 Q. That may well be right. I just wanted to make sure I had
7 already asked it.

8 Now, in your June 2017 report, you said that the
9 Mississippi River creates an effective hydrologic boundary that
10 prevents the drawdown cone of depression from moving past the
11 river into Arkansas. Do you recall that?

12 A. Yes.

13 Q. But that was not correct, was it?

14 A. Well, a river, like an outcrop, can be in a boundary
15 condition in a model.

16 Q. But you just testified that the cone of depression does in
17 fact move past the river into Arkansas?

18 A. Yes.

19 Q. So that sentence in your report was inaccurate, correct?

20 A. With respect to the -- a cone of depression going into
21 Arkansas.

22 Q. With respect to this cone of depression going into
23 Arkansas?

24 A. Yes.

25 Q. One other point I'd like to clarify. Mr. Wiley, you say

1 Wiley - cross
2 several times in your June report that the Middle Claiborne
3 Aquifer is made of sandstone. Do you recall that?
4 A. Yeah, I -- yes.
5 Q. That's not correct, is it?
6 A. Well, sand is a stone.
7 Q. It's your view that sand is a stone?
8 A. Yes.
9 Q. And that sandstone is the same thing as sand?
10 A. Yes, in that context.
11 Q. Were you here on Monday when Dr. Spruill explained the
12 difference between sand and sandstone?
13 A. Yes.
14 Q. But you'd disagree with Dr. Spruill on that point?
15 A. No.
16 Q. So there is a difference --
17 A. I was just using that as a -- the term "sandstone" I was
18 using there was not in the same reference as what he was
19 describing.
20 Q. But the accurate way to describe the substance would be
21 "sand," correct?
22 A. It -- it's accurate the way I described it, which I take it
23 means the same thing to me, in that report.
24 Q. In your June report, you also described Figure 9 of your
25 report, which we've seen a number of times today, as the
predevelopment potentiometric surface under natural

Wiley - cross
1 conditions -- I'm sure you've seen this report -- as the
2 predevelopment potentiometric surface under natural conditions
3 generated by groundwater -- or generated from groundwater
4 modeling. Do you recall that?

5 A. This map is not. I may have said that, but this map is not
6 from groundwater modeling.

7 Q. But do you recall saying that in your report?

8 A. Yes. That was not -- that was not intended in the report.

9 Q. That was inaccurate?

10 A. Yes.

11 Q. Because Figure 9 is not generated by any model, right?

12 A. No.

13 Q. And in fact this potentiometric surface was created by
14 Criner & Parks in their 1976 paper, correct?

15 A. Yes.

16 Q. And I believe that is J24, for reference.

17 Do you recall that you made this same exact mistake
18 about whether or not this surface was developed from
19 groundwater modeling in your May 2007 report?

20 A. I think it was just -- in May 2007?

21 Q. Correct.

22 A. Yes.

23 Q. You made the same mistake?

24 A. I -- it was the -- that sentence was not accurate.

25 Q. Okay. But you had about ten years to fix that sentence,

Wiley - cross

- 1 correct?
- 2 A. No. Ten years later, the report was updated, but I --
- 3 there was a hiatus in the project, so ...
- 4 Q. But when you updated the report ten years later, you did
- 5 not fix the sentence?
- 6 A. No.
- 7 Q. Mr. Wiley, I think you testified about the calibration of
- 8 your model. Do you recall that?
- 9 A. I -- yes, I testified that the Brahana model was
- 10 calibrated.
- 11 Q. And it was calibrated by Brahana and Broshears, correct?
- 12 A. Right, for the period of 1980.
- 13 Q. And the point of calibration is to create an accurate
- 14 hydrologic tool to answer questions about an aquifer?
- 15 A. That's -- that's a good way to put it, yeah.
- 16 Q. And Brahana and Broshears calibrated this data in 1980.
- 17 You said that, right?
- 18 A. Yes.
- 19 Q. Now, there is more recent water level data about the
- 20 aquifer than 1980, correct?
- 21 A. Yes.
- 22 Q. There is probably a lot of data, right?
- 23 A. I would assume so, yes.
- 24 Q. Is it fair to say that calibration with more recent data
- 25 would improve the model?

Wiley - cross

1 A. Models are always being updated and improved where there's
2 data available, yes.

3 Q. So recalibration with more and more recent data would
4 improve the model?

5 A. Maybe, maybe not.

6 Q. It could improve the model?

7 A. Could.

8 Q. But you did not recalibrate your model; is that correct?

9 A. That's right.

10 Q. Even though you knew there was -- or you could have easily
11 found out whether there was more recent water level data than
12 1980?

13 A. Yeah. We wanted to -- we did not want to change what we
14 had from our original -- from the start of the project. We
15 wanted to stick with the same tool.

16 Q. But the answer is no, you did not recalibrate the model?

17 A. No.

18 Q. And earlier you testified that recalibration of the model
19 would or could improve the accuracy of the model?

20 A. It -- it could.

21 Q. Okay. Mr. Wiley, I'm going to put Figure 9 back up on the
22 screen. And again, for reference, this is both P168 and D112;
23 both of those exhibits are the same figure.

24 And you discussed this a little bit already. This map
25 depicts the predevelopment potentiometric surface of the Middle

1 Wiley - cross
Claiborne Aquifer, correct?

2 A. Correct.

3 Q. And we've discussed that the lines going from more or less
4 north to south, those are the contours that represent lines of
5 equal potentiometric levels?

6 A. Correct.

7 Q. And water will flow perpendicular to those lines?

8 A. That's right.

9 Q. So in other words, if the line were exactly north to south,
10 the water would flow either exactly east to west or exactly
11 west to east?

12 A. That's right, depending on pressure differences.

13 Q. Sure.

14 Now, I think we already covered this, but I want to
15 make sure. The contours on your yellow triangle map -- do you
16 mind if I refer to this map as "the yellow triangle map"?

17 A. Everybody has been.

18 Q. The legendary yellow triangle map.

19 A. I guess I picked the right color. I don't know.

20 Q. Yeah.

21 The contours on this yellow triangle map were prepared
22 by Criner & Parks in their 1976 paper, correct?

23 A. Correct.

24 Q. And I would note that this -- this is the map that you
25 used, correct?

Wiley - cross

1 A. Yes.

2 Q. And I would just note for the record that this is also
3 Exhibit P205.

4 Now, Mr. Wiley, when you say that these contours were
5 prepared by or created by Criner & Parks in 1976, you did not
6 change any of these contours; is that correct?

7 A. No.

8 Q. And I believe you testified earlier -- if we could go back
9 to the legendary yellow triangle map -- that this yellow
10 triangle showed that only a very small amount of water was
11 flowing, under natural conditions, from Mississippi into
12 Tennessee; is that correct?

13 A. Yes.

14 Q. And you understand that this yellow triangle is important
15 to Mississippi's case, because it shows that only a very small
16 amount of water was flowing across the water under natural
17 conditions?

18 A. I don't understand your -- what you're asking.

19 Q. Well, do you understand that Mississippi's theory of this
20 case is that only a very small amount of water was flowing
21 across the border under natural conditions, and now more is
22 flowing across the border?

23 MR. McMULLAN: Object to the form.

24 THE COURT: Objection sustained.

25 Q. Mr. Wiley, you're familiar with how to create estimated

Wiley - cross
1 water level maps from observation levels, also called control
2 points, correct?

3 A. Yes.

4 Q. And the idea is that you can take known water levels at the
5 control points and estimate the water levels in between them;
6 is that fair?

7 A. Yes.

8 Q. And is it also fair to say that the more control points you
9 have, the better you can estimate the water level contours?

10 A. Yes.

11 MR. McMULLAN: Object to the form, and improper
12 hypothetical.

13 THE COURT: Overruled.

14 You may answer the question.

15 Q. I believe you answered, but the question was the more
16 control points you have, the better you can estimate water
17 level contours?

18 A. Yes.

19 Q. And do you recall Dr. Spruill telling us on Monday in a
20 confined aquifer, if you want to determine a direction of
21 groundwater flow, you need at least three walls?

22 A. When was that?

23 Q. That was on Monday. But --

24 A. I think I was -- I might have missed it, but that's --

25 Q. Is that a fair statement?

Wiley - cross

- 1 A. Yes.
- 2 Q. And the more wells you have, the more accurately you can
- 3 determine the contours?
- 4 A. Yes.
- 5 Q. Now, your June 2017 report does not include any discussion
- 6 of how Criner & Parks created their predevelopment
- 7 potentiometric map; is that accurate?
- 8 A. Yes.
- 9 Q. But would you agree that the Criner & Parks paper based its
- 10 predevelopment surface on four datapoints?
- 11 A. That's -- yes, I read that in their report.
- 12 Q. And to your knowledge, Criner & Parks do not have any other
- 13 data on which they base that map?
- 14 A. I -- I don't know if they had any other data. I would
- 15 assume they did have other data, because they're not going to
- 16 make -- they're going to -- before they make the map, they're
- 17 going to check maybe other types of data, to make sure that
- 18 what they produce fits with the hydrogeologic system.
- 19 Q. I'm really asking whether you know whether Criner & Parks
- 20 had any other data.
- 21 A. I don't -- I don't know, but I -- like I said, knowing the
- 22 USGS, I would assume that they did have other information
- 23 that -- to guide them in the -- preparing that map.
- 24 Q. But you don't know what information that would be?
- 25 A. No.

Wiley - cross

1 Q. Now, Mr. Wiley, I think you may have already testified that
2 the one thing you did do, you didn't change any of Criner &
3 Parks's contours, but you did extend some of the lines into
4 Mississippi; is that correct?

5 A. That's correct.

6 Q. And if we could look back at Criner & Parks's map -- and I
7 made the border a little easier to see on the Criner & Parks
8 figure -- it looks like their map only goes about four miles
9 south of the Mississippi/Tennessee border; is that about right?

10 A. Maybe five. It's hard to say from that scale. Between
11 four and five.

12 Q. Between four and five.

13 And Brahana and Broshears, who also reference this
14 map, they didn't draw contours any further than Criner & Parks
15 did, right?

16 A. No.

17 Q. And for reference here, it is, but you already answered.

18 Now, comparing that to your yellow triangle map, your
19 map extends those lines quite a bit further south; is that fair
20 to say?

21 A. Yes.

22 Q. Maybe at least ten miles, probably 15 miles south of the
23 border, right?

24 A. That sounds about right.

25 Q. At least ten miles, right?

Wiley - cross

1 A. Yes.

2 Q. Now, you did not have any data that you used to extend
3 these lines, is that correct?

4 A. No.

5 Q. You didn't have observation wells or contour points?

6 A. No. What I used was potential -- predevelopment
7 potentiometric mapping information from Arthur & Taylor.

8 Q. And I believe you testified at your deposition that that
9 was the 1990 Arthur & Taylor report, is that right?

10 A. Yes. Yes.

11 Q. Now, this is the 1990 Arthur & Taylor report as you
12 reproduced it in your June report; does that look correct?

13 A. Yes, it does.

14 Q. And for reference, this is P167. And the Arthur & Taylor
15 1990 report is Joint Exhibit 3.

16 And the contours that you would have used to extend
17 your yellow triangle extension lines would be the contours all
18 the way in the northwestern corner of Mississippi, correct?

19 A. It's the blue contours there, just below the state line.

20 Q. In that --

21 A. Of Tennessee and Mississippi.

22 Q. Correct.

23 MR. HILL: And so I think it would be helpful if we
24 zoom in a little bit. And I've highlighted the borders here to
25 make it a little bit easier to see.

Wiley - cross

1 Q. Will you agree that this covers about the same territory or
2 area that your yellow triangle map covers?

3 A. Pretty hard to tell from that.

4 Q. If we -- so I highlighted the borders again, your Figure 9,
5 to see if -- it really covers about the same area, correct?

6 A. Well, I think the -- well, I'm just using the river, the
7 Mississippi River, as my guide on comparing the two, and I'm
8 trying to figure out what's what on the river.

9 It looks like the -- looks like it needs to be zoomed
10 out a little further.

11 Q. On the Arthur & Taylor map?

12 A. Yes, unless I'm -- unless I'm interpreting the shape of the
13 river wrong.

14 Q. Okay. Well, so I guess then you would say that these lines
15 were some of the lines --

16 A. It's pretty close; I'll give you that.

17 Q. At least the area overlaps a fair amount, correct?

18 A. That's correct.

19 Q. And the lines, if I could just circle them for a moment,
20 and maybe tilt both of the figures so that the state borders
21 are parallel.

22 The lines that I've circled are roughly the same lines
23 that you would have used on the left side to draw your lines on
24 the right side; is that --

25 A. Our main intent was to -- based on the orientation of the

1 Wiley - cross
2 Arthur Taylor lines, to apply that orientation on the existing
3 Criner contour lines.

4 Q. Mr. Wiley, my question was just whether those are the lines
5 that you would have used to draw your extensions.

6 A. No. I -- I told you what I did. I used the orientation of
7 Arthur Taylor's map and his lines and to apply to the Criner --
8 the existing Criner lines, to extend those.

9 That's all I did. I just used the orientation.

10 Q. Okay. And you didn't have any data to back up your use of
11 this orientation?

12 A. That is my data. The orientation of his predevelopment map
13 is my data.

14 Q. I guess what I'm -- when I say "data," I'm talking about
15 actual observed water levels.

16 A. No. Just his -- the orientation of his water levels.

17 Q. If we could look back at the yellow triangle for a moment.
18 And I'll make it a little bigger, so it's easier to see.

19 Now, again, you testified that this yellow triangle is
20 the only place where groundwater is moving across the state
21 border under natural conditions; is that correct?

22 A. In our project area.

23 Q. Within the project area?

24 A. Yes.

25 Q. And the triangle ends on the west side, right where the
260-foot contour crosses the state border, correct?

Wiley - cross

- 1 A. Yes.
- 2 Q. Would you take a look at the 250-foot contour on this map,
3 which is helpfully laser-pointed.
- 4 A. I see it.
- 5 Q. Mr. Wiley, that 250-foot contour, where it crosses the
6 border, is not perpendicular to the state border, is it?
- 7 A. Not quite, no.
- 8 Q. It's not quite perpendicular?
- 9 I just want to confirm.
- 10 A. Yes.
- 11 Q. And it crosses the border at a slight angle, in other
12 words?
- 13 A. Right. That's right.
- 14 Q. And because of that angle, water at that location is
15 flowing slightly north, right?
- 16 A. That would be at that angle, yes.
- 17 Q. In other words -- and that location is on the
18 Mississippi/Tennessee border, correct?
- 19 A. That's correct.
- 20 Q. So there is natural cross-border flow where the 250-foot
21 contour crosses the state line, correct?
- 22 A. There would be in this case, yes.
- 23 Q. And this is your yellow triangle map, correct?
- 24 A. Right.
- 25 Q. Now, if you'd look at the 230- and 240-foot contours, those

1 Wiley - cross
2 lines also do not cross the border perfectly perpendicular to
3 the border, correct?
4 A. It's pretty close.
5 Q. But not perpendicular?
6 A. They're a little jagged there, but 240 looks pretty
7 perpendicular.
8 Q. Would it be --
9 A. To --
10 Q. It might be helpful if we look at the original Criner &
11 Parks map. Your contours should be identical to the Criner &
12 Parks contours, correct?
13 A. Yes.
14 MR. HILL: And we've blown up the 230- and 240-foot
15 contours on the Criner & Parks map, and could we have
16 perpendicular lines?
17 Q. So we've drawn lines that are perfectly perpendicular to
18 the border. I think you would agree, would you not, that
19 neither of those lines, 230 or 240 --
20 A. Not on this map, no.
21 Q. And your map should have identical contours, correct?
22 A. Yes.
23 Q. You did not change Criner & Parks's contours, correct?
24 A. No. No.
25 Q. So on your map as well, those two contours, 230 and 240, do
not cross perpendicular to the state border?

Wiley - cross

1 A. If -- no. If these don't, then mine don't, because I used
2 his map.

3 Q. Okay. And these don't, correct?

4 A. Correct.

5 Q. They are slightly angled?

6 A. Very slightly. So there would be a small -- small
7 component of flow there, going slightly to the northwest.

8 Q. You stole my thunder, Mr. Wiley.

9 There is northward cross-border flow at both the
10 230- and 240-foot contours, correct?

11 A. Yes.

12 Q. And so your yellow triangle -- if we can go back to the
13 full yellow triangle map -- that yellow triangle actually
14 should extend all the way to the 230-foot contour, correct?

15 A. Yes, it would be -- it would -- that -- if -- those
16 contours not being exactly perpendicular, that looks about
17 right.

18 Q. And they are not exactly perpendicular, correct?

19 A. That's what I just said.

20 Q. Well, I think you said "if," and so I just wanted to
21 confirm. They are not exactly --

22 A. That's what I -- yeah, I just said that.

23 Q. And so -- and so you think this version is about right?

24 A. Yes.

25 MR. HILL: Those are all the questions I have. Thank

Wiley - redirect

1 A. No. That was not part of my assignment.

2 Q. In your initial examination of the literature, which
3 discussed concerns about pumping in Mississippi affecting North
4 Mississippi, did you find variations in reference to the
5 Memphis Sands and the Sparta Aquifer?

6 A. Yes.

7 Q. In your reports, did you at times use, for shorthand
8 yourself, a reference to Memphis Sands and Sparta?

9 A. Yes.

10 Q. Is that because the scope of your assignment was not to
11 discern whether there was a single aquifer or more than one
12 aquifer?

13 A. That's right.

14 Q. And there was some discussion about the fact that there are
15 cones of depression in this area -- project area, if you
16 will -- that exist in Arkansas, for instance; Mr. Bearman asked
17 you about that. I think there was cones of depression in North
18 Mississippi. Do you recall that line of questions?

19 A. Yes.

20 Q. In your review of the literature, when you began your
21 assignment, did any of the literature that was looking at the
22 issues of pumping in Memphis and the effects in Mississippi
23 raise any concerns about cones of depression, other than the
24 ones emanating from MLGW -- or Memphis area, more clearly, more
25 accurately?

Wiley - redirect

1 A. Yes.

2 Q. My question is this: The literature that you looked at
3 initially, the discussions in the literature about the effects
4 of pumping in Memphis in Mississippi, did those articles
5 indicate any concerns about cones of depression elsewhere?

6 A. Yes, they did.

7 Q. Okay. What were they?

8 A. They -- well, they -- all the USGS reports that I looked
9 at, they were identified as cone of depression that were being
10 created and what -- what the effects would be then and in the
11 future.

12 Q. What cone of depression are we talking about when you
13 referred to those articles?

14 A. The cone of depression that emanated from the Memphis area.

15 Q. Thank you for that clarification.

16 There's been a good bit of discussion with you about
17 the different maps showing the predevelopment flow. Mr. Hill
18 asked you some questions about it; Mr. Bearman, too. Let's go
19 back to P184. I'm not sure which slide that is. You can pull
20 that one up. It's the MERAS slide, the particle tracking
21 slide. P184? Looks like this.

22 Just a moment. Slide 17.

23 Mr. Wiley?

24 A. Yes.

25 Q. All this discussion about predevelopment flow, all those

Wiley - redirect
1 references to flow, would the flow we're talking about be best
2 depicted in P184?

3 A. It -- it depicts -- it's a good depiction of a good bit of
4 the flow that starts at the DeSoto County line and extends
5 across the state of Mississippi.

6 Q. So all the questions you've heard that have been put to you
7 about some water flowing into Tennessee, we're talking about
8 over the course of a period of time that's depicted in P184;
9 we're talking about thousands of years. Is that correct?

10 A. That's correct.

11 Q. And is it correct that your assignment was to evaluate the
12 effects?

13 MR. D. BEARMAN: Objection, leading, your Honor.

14 MR. McMULLAN: I'll rephrase.

15 THE COURT: Objection sustained. Don't lead the
16 witness.

17 Q. Do you recall a couple of questions about whether you'd
18 examined the Court's opinion that related to the scope of this
19 hearing?

20 A. Yes.

21 Q. Did you -- were you ever asked -- strike that.

22 In the course of your work as a hydrogeologist, have
23 you ever been asked to examine a definition that's been
24 described by a judge and then try to infer your opinion from
25 that?

Wiley - redirect

1 A. No.

2 Q. Did you do that -- in this assignment, did you do that?

3 A. No.

4 Q. There were some questions about the extent to which you may
5 have relied upon information developed by others, including
6 USGS. Do you recall some questions about that?

7 A. Yes.

8 Q. In your practice as a hydrogeologist, is it standard
9 practice in your experience to rely on data information
10 collected by the USGS?

11 A. Yes.

12 Q. With respect to some of the questions you were asked about
13 some mistakes you might have made and not corrected over the
14 course of the 13 years that you've been involved in working on
15 this case, do you recall those questions?

16 A. Yes.

17 Q. Did the corrections you made alter any of the fundamental
18 opinions that you reached, conclusions you reached in the case?

19 A. No.

20 MR. McMULLAN: That's all I've got.

21 THE COURT: All right.

22 Do you have any further cross-examination?

23 MR. D. BEARMAN: Your Honor, if the Court will indulge
24 us a few minutes so we can talk with cocounsel to determine
25 that?

1 limitation, plaintiff rests. We had indicated that we may call
2 their expert, Dr. Waldron, on -- in our case. And the
3 defendant is representing that Dr. Waldron will be called in
4 their case, so we can examine him at that point in time.
5 Until --

6 MR. FREDERICK: We can't hear you here.

7 THE COURT: Speak up, everybody. They've got to hear
8 you.

9 MR. ELLINGBURG: I'll do it again, and I'll talk
10 louder.

11 Mississippi and the defendant have discussed the
12 testimony of Dr. Waldron, who is one of their witnesses.

13 THE COURT: Right.

14 MR. ELLINGBURG: We had indicated that we might call
15 him in our case, but we were assured that they would put on his
16 testimony during the hearing, and so we are not calling him
17 now. We're resting, subject to completion of his testimony.

18 THE COURT: Okay.

19 MR. BRANSON: No objection, your Honor. That is our
20 arrangement. We will be calling Dr. Waldron.

21 THE COURT: Okay. That's fine. All right.

22 So that completes the case for the plaintiff?

23 MR. ELLINGBURG: That completes the case for the
24 plaintiff, subject to the testimony of Dr. Waldron.

25 THE COURT: Okay. All right.

1 With that, where do we go from here?

2 MR. FREDERICK: Your Honor, David Frederick for the
3 State of Tennessee.

4 I would like to note for the record that we do not
5 understand Rule 50, the Rules of Civil Procedure, to apply in
6 this proceeding, and therefore we are reserving our motion for
7 judgment on the state of the evidence at this time. But to the
8 extent that you perceive there to be a need for us to make a
9 Rule 50 motion, please consider it to be made on the basis of
10 the absence of proof, at least by Mississippi in its case.

11 THE COURT: Okay. Well, that's the way I anticipate
12 that we would follow it, so we can get on with the testimony.
13 And I'm a Special Master, so it's not likely that I would grant
14 that motion, but it should be filed, and we'll consider it
15 filed. I'll let you argue at a later time that issue.

16 MR. FREDERICK: Yes. Thank you.

17 THE COURT: Yes.

18 MR. L. BEARMAN: I just want to join in on that
19 statement by Mr. Frederick.

20 THE COURT: All right. We'll have a subsequent time
21 in which we will hear argument on that. Your motion is
22 preserved.

23 MR. FREDERICK: Thank you, Judge Siler.

24 The State of Tennessee would like to call Steven
25 Larson to the stand.

1 THE COURT: All right.

2 STEVEN LARSON,

3 called as a witness by the Defendant State of Tennessee,
4 having been duly sworn, testified as follows:

5 DIRECT EXAMINATION

6 BY MR. FREDERICK:

7 Q. Good morning, Mr. Larson. Would you please state your name
8 for the record.

9 A. My name is Steven P. Larson.

10 Q. Mr. Larson, where do you work?

11 A. I work in Bethesda, Maryland.

12 Q. For what firm?

13 A. The firm of S.S. Papadopoulos & Associates, Incorporated.

14 Q. If I refer to it as SSP&A, will you understand that?

15 A. I will.

16 Q. And what is SSP&A?

17 A. We're a consulting company that provides consulting
18 services in the environmental area and also in -- with respect
19 to water resources.

20 Q. What is your position there?

21 A. I'm a vice president.

22 Q. How long have you worked there?

23 A. Thirty-nine years.

24 Q. What is your area of expertise?

25 A. I'm a hydrologist, but I've worked almost all my career

1 basically in groundwater hydrology. So groundwater hydrology
2 is the focal area of my work.

3 Q. Where did you work prior to SSP&A?

4 A. I worked for the Water Resources Division of the United
5 States Geological Survey.

6 Q. If I refer to that as "USGS," will you understand to what
7 I'm referring?

8 A. I will.

9 Q. How long did you work at USGS?

10 A. I worked at the USGS for about nine years.

11 Q. What was your position at USGS?

12 A. I was a hydrologist.

13 Q. And what did that position entail?

14 A. Initially it entailed conducting various kinds of water
15 resource investigations in Minnesota, Minnesota office of the
16 USGS. Later on in my work there, I was transferred to the
17 headquarters of the United States Geological Survey in Reston,
18 Virginia, and conducted research primarily in the development
19 of computer simulation models.

20 Q. Could you briefly describe your education, please.

21 A. I have a bachelor's degree in civil engineering from the
22 University of Minnesota I obtained in 1969. And I also have a
23 master's degree in civil engineering, also from the University
24 of Minnesota, that I obtained in 1971.

25 Q. Do you belong to any professional organizations?

1 A. Yes, I do.

2 Q. Which ones?

3 A. I belong to the American Institute of Hydrology, and also
4 to the National Groundwater Association.

5 Q. Have you written about groundwater hydrology and modeling?

6 A. Yes, I have.

7 Q. And why are you here today?

8 A. I'm here today to provide a technical answer or response to
9 the Special Master's question that he posed, that I understood
10 to be the purpose of this hearing.

11 Q. And what did you understand the purpose of the hearing to
12 be?

13 A. To answer the question of whether or not the Middle
14 Claiborne Aquifer was an interstate water resource.

15 Q. Okay. Are you being compensated for your work as an expert
16 in this case?

17 A. Yes, I am.

18 Q. What is your rate of compensation?

19 A. It's varied from about \$308 per hour to about \$316 per
20 hour.

21 Q. Does the compensation you receive depend in any way on the
22 opinions you render in this case?

23 A. It does not.

24 Q. Does the compensation you receive depend in any way on the
25 outcome of the case?

1 A. It does not.

2 Q. Have you previously given expert testimony in litigation in
3 connection with your work at SSP&A?

4 A. Yes, I have.

5 Q. How many times have you testified before a judge or a
6 Special Master or in arbitration?

7 A. Over 50 times.

8 Q. Okay. Have you previously served as a hydrological expert
9 in interstate water disputes in the Supreme Court of the United
10 States?

11 A. Yes, I have.

12 Q. In what cases?

13 A. I've been an expert in the case between Colorado and Kansas
14 on the Arkansas River. I've been an expert in the case between
15 Kansas and Nebraska that included Colorado on the Republican
16 River. I was involved in the case between Nebraska and Wyoming
17 associated with the Platte River. I've been involved in the
18 case between Montana and Wyoming on the Yellowstone River. And
19 I've also been involved in the case between North Carolina and
20 South Carolina on the Catawba River.

21 Q. Did each of those cases involve either an equitable
22 apportionment or a claim for a breach of an interstate compact?

23 A. Yes, they did.

24 Q. Did you testify about groundwater in any of those cases?

25 A. Yes, I did.

1 Q. In how many of them?

2 A. Three, and to some extent four.

3 Q. Could you briefly describe your testimony in each of those
4 cases.

5 A. In the case of Kansas vs. Colorado, or Kansas and Colorado,
6 associated with the Arkansas River, one of the issues was the
7 impact of groundwater development from the aquifer -- aquifers
8 along the Arkansas River and the impact of that development on
9 stream flows. So my work involved both the modeling of those
10 impacts and also the evaluations of stream flow conditions.

11 In the case between Kansas and Nebraska associated
12 with the Republican River, my work involved the development,
13 along with experts from the other states, of a groundwater
14 model. The purpose of the groundwater model was to provide a
15 way to estimate how the impacts of pumping from the Ogallala
16 Aquifer impacted stream flows in the Republican River, because
17 the stream flows were regulated by the compact.

18 In the case of Nebraska versus Wyoming, initially I
19 did a little bit of work on some -- on some groundwater
20 modeling issues. Ultimately the work that I reported on dealt
21 with evaluations of stream flow conditions along the river.

22 In the case of Montana versus Wyoming, I was asked to
23 develop estimates of the potential impacts of water production
24 associated with coalbed methane development on stream flows in
25 the Tongue River, which is a tributary to the Yellowstone

1 River.

2 Q. Have you previously served as a hydrological expert in any
3 nonoriginal jurisdiction cases involving the effects of
4 groundwater use?

5 A. Yes.

6 Q. Can you give us some examples?

7 A. Well, one that comes to mind is in the -- what's called the
8 Hueco Bolson -- Bolson, B-O-L-S-O-N. It's like a basin.

9 And this is a groundwater area that extended from
10 Texas into New Mexico. And I was asked as part of that matter
11 to evaluate the impacts of future groundwater development -- or
12 the availability, I should say, of water to meet certain
13 demands in the State of Texas. The City of El Paso was asking
14 for permits from the State of New Mexico to develop groundwater
15 into Mexico, and I was asked to evaluate the impacts of
16 potential development within Texas.

17 Q. Thank you. Can I ask you to turn to Exhibit D154 in your
18 binder, please.

19 Is this the most up-to-date copy of your curriculum
20 vitae?

21 A. Yes, it is.

22 MR. FREDERICK: Your Honor, we offer Mr. Larson as an
23 expert in the field of groundwater hydrology.

24 THE COURT: Is there any objection to that?

25 MR. ELLINGBURG: No, your Honor.

1 THE COURT: All right. He is so identified and may
2 testify as such.

3 MR. FREDERICK: Thank you, your Honor.

4 BY MR. FREDERICK:

5 Q. Mr. Larson, have you prepared a report in this case?

6 A. Yes, I have.

7 Q. Could you turn to Exhibit D197 in your binder.

8 Is that an accurate copy of your expert report?

9 A. Yes, it is.

10 Q. What date was it submitted?

11 A. June 30, 2017.

12 Q. What was your process in putting that report together?

13 A. Well, the first step was to make sure I understood what the
14 focus of my inquiry was, and that was to read over the report
15 of the Special Master in which he posed a question that I
16 understood to be the subject of this hearing. And
17 understanding that question, I then undertook to begin
18 reviewing various documents and reports that would bear on
19 answering the question of whether the Middle Claiborne Aquifer
20 was an interstate water resource.

21 I also evaluated -- or collected or evaluated -- and
22 evaluated certain data that was available from the US
23 Geological Survey. And then, basically relying on that
24 information and my experience and expertise, I prepared the
25 report.

1 Q. Did anyone assist you in preparing the report?

2 A. Yes.

3 Q. What will -- who was that?

4 A. Alex Spiliotopoulos.

5 Q. Okay. And what role did he perform?

6 A. He assisted me in gathering up information, reports, and
7 documents. He also assisted me in terms of reviewing my drafts
8 of the report, to help me edit and evaluate my report.

9 Q. What did you rely on in developing your expert report,
10 other than the materials you cited?

11 A. Well, I relied on my -- my training as an engineer
12 specializing in hydrology and my many years' experience working
13 in the field of hydrology.

14 Q. Are all of the sources that you relied on in developing
15 your report listed in your report?

16 A. Yes, they are.

17 Q. Is there anything in your report that you no longer believe
18 to be true?

19 A. No.

20 Q. Have you prepared any other reports in this case?

21 A. Yes, I have.

22 Q. Could you turn to Exhibit D198, please.

23 What is that?

24 A. This is a rebuttal report that I prepared.

25 Q. When was that submitted?

1 A. July 31, 2017.

2 Q. What was your process in putting that together?

3 A. Well, the first step was to review the expert reports that
4 had been prepared by experts for the State of Mississippi.

5 Having -- and after completing -- reviewing those reports, I
6 then went back to some of the documents and reports that I had
7 previously examined and looked at other documents, and also
8 looked at other data that was available to me from the
9 US Geological Survey.

10 Q. Did anyone assist you in preparing the rebuttal report?

11 A. Yes.

12 Q. Who?

13 A. Alex Spiliotopoulos, Dr. Spiliotopoulos.

14 Q. How did he assist you?

15 A. In the same fashion -- he assisted me in this report in the
16 same fashion that he did in the earlier report, helping me
17 gather and collect documents and information and gather data
18 and helping me edit and review the draft of the report.

19 Q. Are all of the sources that you listed in developing your
20 rebuttal report listed in that report?

21 A. Yes, they are.

22 Q. Is there anything in your rebuttal report that you no
23 longer believe to be true?

24 A. No.

25 Q. Now, Mr. Larson, I'd like to talk about the background on

1 aquifers. I believe that you refer to this aquifer as the
2 Middle Claiborne Aquifer; is that correct?

3 A. Yes.

4 Q. Why do you call it the Middle Claiborne Aquifer?

5 A. Well, in reviewing the various reports, one of the most
6 recent reports by the US Geological Survey in the development
7 of the Mississippi Embayment Regional Aquifer System model
8 looked to me to be the most recent characterization of the
9 hydrogeology of this area, so I followed the terminology that
10 they developed in that report.

11 Q. And remind us: What is the US Geological Survey?

12 A. US Geological Survey is the federal agency that -- among
13 their other tasks, one of their tasks is to monitor and
14 evaluate the water resources of the United States. They're a
15 very key agency in collecting water resources data and
16 conducting water resource investigations.

17 Q. What is groundwater?

18 A. Groundwater is the water that occurs beneath the land
19 surface in the zone that's fully saturated with water. So
20 below the land surface, you'll eventually encounter a zone
21 where the rock or the sediments are completely saturated.
22 That's the groundwater zone.

23 Q. Is there a name for that zone that is saturated?

24 A. Well, if it's sufficiently permeable, it can be called
25 aquifer.

1 Q. Okay. What is an aquifer?

2 A. The sort of technical definition of an aquifer is it's a
3 formation or a group of formations that are sufficiently
4 permeable that they can provide usable quantities of water to
5 wells.

6 Q. Okay. I'd like to ask you to turn to Figure 1 from your
7 opening report. This is Exhibit D197, and PDF page ten. It's
8 up on the screen.

9 What is that a figure of?

10 A. This is a diagram I obtained from the US Geological Survey
11 website.

12 Q. Could you briefly explain to Judge Siler how water flows
13 through an aquifer and how that relates to the water cycle.

14 A. Yes. The water cycle, or it's sometimes referred to as the
15 hydrologic cycle, is one which exhibits all the different
16 facets of how water circulates within the environment. That
17 is, evaporation from lakes and streams and rivers goes into the
18 atmosphere. It then falls back to earth via precipitation and
19 ice and snow. Some of that water infiltrates into the ground,
20 and some of that infiltration will reach groundwater, the
21 saturated zone. And once it reaches the groundwater, it will
22 begin to move from places to what we call recharge, where the
23 groundwater originates, toward places of discharge, where the
24 groundwater will leave the subsurface.

25 Q. When water infiltrates into the ground, does it always

1 remain in a single aquifer?

2 A. No. It will move through the subsurface, and it can go
3 from one aquifer to another, for example, or from one aquifer
4 through a confining unit into another aquifer.

5 Q. Is there a name given when there are multiple aquifers?

6 A. It's often referred to as an aquifer system.

7 Q. Are there other terms that are used?

8 A. Or hydrogeologic system.

9 Q. So if I use "hydrologic system" or "aquifer system"
10 interchangeably, do you understand them to mean the same thing?

11 A. Yes.

12 Q. Now, I show you what has been marked Exhibit J4.

13 What is that?

14 A. This is a report from the US Geological Survey, by Arthur &
15 Taylor, in 1998. It's the cover page of that report.

16 Q. Let's turn to Plate 2, which is J4 at PDF page 61 from that
17 paper. And I'm going to put it up on -- it's up on the screen.

18 Can you tell us what this is, please.

19 A. Yes. This is a subsurface profile illustrating the
20 different hydrogeologic units that comprise the Mississippi
21 Embayment Aquifer System. The profile begins in the northern
22 areas, north of Kentucky, and extends down through Tennessee
23 and into Mississippi. So basically running from a
24 northeasterly to southwesterly direction is the alignment of
25 it, and then we're kind of looking at what the subsurface looks

1 like from the side.

2 Q. Does this figure depict an aquifer system?

3 A. It does.

4 Q. So can you explain again what an aquifer system is, perhaps
5 using this figure.

6 A. Yes. An aquifer system is basically the collection of
7 hydrogeologic units that are interconnected in some fashion to
8 one another and to make -- they can be also interconnected to
9 surface streams. And so you'll have these different layers,
10 somewhat like layers of a cake, that comprise different
11 hydrogeologic units. And collectively, they are the
12 hydrogeologic system.

13 Q. What is a hydrogeological unit?

14 A. Hydrogeologic units are usually -- are principally defined
15 based on permeability characteristics. The more permeable
16 characteristics, formations or groups of formations that have
17 more permeable characteristics, are aquifers, are characterized
18 as aquifers. Those formations or groups of formations that
19 have lower permeability characteristics can be defined as
20 confinement units, to indicate their sort of less permeable
21 characteristic.

22 Q. And can you describe briefly how hydrogeologic units are
23 positioned in an aquifer, or how an aquifer is positioned in a
24 hydrogeologic unit.

25 A. The aquifers will represent -- or the aquifer --

hydrogeologic units that are aquifers will represent more extensive areas of the permeable materials. They can be overlain, and they will have a geographic extent over some region. They can be overlain by other aquifers or other hydrogeologic units that are characterized as aquifers, or they can be overlain or underlain by less permeable hydrogeologic units that have been characterized as confining units.

Q. Now, a few minutes ago you described it as like layers. Can you describe -- explain what you mean by a "layer."

A. A layer would be the geographic extent and delineation of a particular hydrogeologic unit. Like, for example, here, the Middle Claiborne Aquifer. It would depict -- or that would be one of the layers, if you will, of the aquifer system.

If there are other hydrogeologic units that have been identified and their areal extent has been delineated, they would also be then represented, depending on where they -- where they were, let's say, physically relative to one another in the aquifer system.

Q. Are the geologic materials within a layer homogeneous?

A. No. They will vary from one place to another.

Q. Now, let's look at this figure. Is this figure to scale?

A. No, it's not.

Q. How is it not to scale?

A. The vertical scale has been greatly exaggerated, as it says on the bottom of the chart. And the reason for that is to

1 allow us to be able to see and visualize the various
2 hydrogeologic units much better.

3 Q. Okay. Is the Middle Claiborne Aquifer depicted on this
4 picture?

5 A. Yes, it is.

6 Q. Is it the area that's been highlighted in yellow?

7 A. Yes.

8 Q. Okay. Is the Middle Claiborne Aquifer a hydrogeologic unit
9 within the Mississippi Embayment?

10 A. Yes, it is.

11 Q. Do you see the pink highlighted layers labeled "Confining
12 Units"?

13 A. Yes.

14 Q. Can you explain briefly what a confining unit is.

15 A. As I mentioned earlier, in looking at hydrogeologic units,
16 those units that are less permeable, and therefore water moves
17 through them less easily than it will move through an aquifer,
18 so they represent lower permeability materials, and the extent
19 of those on permeability of materials would -- or can be
20 delineated as a confining unit from a -- in terms of the
21 hydrogeologic unit perspective.

22 Q. Are there any other names for these layers, other than
23 "confining units," which you just used?

24 A. Sometimes they're referred to as "confining beds."
25 Sometimes you may hear the term "aquitard" instead of

1 "aquifer." And that's meant to -- it's not used that much, but
2 it's meant to illustrate the less permeable characteristic of
3 the confining units.

4 Q. Are the terms synonymous?

5 A. Yes.

6 Q. Is water able to flow through these confining layers?

7 A. Yes.

8 Q. Now, can you describe how that happens.

9 A. Well, the confining units, as I said, are -- tend to be
10 areas of less permeability. When the groundwater is flowing
11 through the aquifers, in order to, say, move from one aquifer
12 to another, however -- where it may be separated by a confining
13 unit, it would have to move generally vertically and pass
14 through the confining unit. And because of the permeability,
15 it's a little more difficult for water to move through these
16 confining units.

17 Q. Now, I'd like to turn to water flow patterns in different
18 kinds of aquifers. We have a demonstrative here. Do you
19 recognize this demonstrative?

20 A. Yes, I do.

21 Q. How was it prepared?

22 A. It was prepared under my direction.

23 Q. Does this demonstrative show confining units?

24 A. It does.

25 Q. How does it show them?

1 A. It shows one confining unit at the top of what we've
2 identified as a confined aquifer, and it shows another
3 confining unit beneath the aquifer, establishing a -- the upper
4 and lower boundaries of the confined aquifer.

5 Q. So the confined aquifer is between the two confining units?

6 A. Yes.

7 Q. Now, can you explain to Judge Siler what a confined aquifer
8 is.

9 A. A confined aquifer is one in which the potentiometric
10 level -- you may hear it referred to as "potentiometric head";
11 you may hear it referred to as "groundwater level." But it's
12 basically the potentiometric level of water within the aquifer,
13 would -- that potentiometric level would rise to an elevation
14 that's above the bottom of the overlying confining layer. In
15 that respect, it's confined.

16 Q. So just so that we're clear, is there a confining unit
17 located above or on the sides of a confined aquifer?

18 A. Confining units are located above the aquifer.

19 Q. Okay. Is there a name for the level -- but not on the
20 sides?

21 A. Not on the sides.

22 Q. Okay. Is there a name for the level to which water will
23 reside -- will rise inside a properly drilled well in a
24 confined aquifer?

25 A. Yes. It's often referred to as the potentiometric level,

1 or potentiometric elevation, or it could simply be referred to
2 as the water level in the well.

3 Q. What factors contribute to the potentiometric level in a
4 well?

5 A. There are two factors. One is the elevation of the point
6 at which the pressure in the confined aquifer is being
7 measured, and the other is the pressure in the confined aquifer
8 at that position.

9 Q. Okay. Now, I see there's depicted on this figure a well
10 screen. What is a well screen?

11 A. A well screen is a -- represents opening -- the well is
12 basically a pipe that's going into the ground, and at the end
13 of that pipe there will be openings that will allow the water
14 in the aquifer to enter the pipe. A well screen is a -- is a
15 specifically designed mechanism for allowing -- for creating
16 those openings and allowing the water to come in and out of the
17 pipe.

18 Q. This figure also has words called "water table." Can you
19 describe what a water table is.

20 A. The water table is the point beneath the ground surface
21 where you first encounter fully saturated conditions. It's
22 basically -- at the top of that water table, the water is at
23 atmospheric pressure, or roughly atmospheric pressure, and
24 that's basically the level that the water surface exists in
25 the -- unconfined aquifer.

1 Q. In this figure, what is the green area below the blue line
2 labeled "Water Table"?

3 A. That tends to represent an unconfined aquifer that does not
4 have a confining unit above it, that would serve to create a
5 confined aquifer.

6 Q. What is an unconfined aquifer?

7 A. An unconfined aquifer is an aquifer that contains the water
8 table. So the water table would exist in an unconfined
9 aquifer, and that's why we call it unconfined -- well, call it
10 unconfined because there is no confining layer that would meet
11 the definition of a confined aquifer; but it has the water
12 table as the upper surface of the aquifer.

13 Q. And what happens if you drill a well into an unconfined
14 aquifer?

15 A. The water level will rise to a certain level, oftentimes or
16 most of the time near the water table.

17 Q. Now, using this figure, how does one determine the head or
18 potentiometric level of a well?

19 A. The way it's determined is you first measure the depth to
20 the water surface that would be in the well. So you -- you
21 measure from the top of the well down to the water surface that
22 is in the well. And then you take that value, and along with
23 the elevation, the topographic elevation, if you will, of the
24 top of the well, you compute the potentiometric elevation,
25 which is the potentiometric level associated with that water

1 level in the well.

2 Q. And I'd like to show you a demonstrative -- this will be
3 Slide 5.

4 Do you recognize this demonstrative?

5 A. Yes, I do.

6 Q. And what is it?

7 A. This is a -- I prepared this to illustrate how data from
8 wells, in terms of the potentiometric elevation measured in
9 those wells, is used to construct a potentiometric contour map
10 and to infer the general directions of groundwater flow from
11 that contour map.

12 Q. How is it prepared?

13 A. It was prepared under my direction.

14 Q. Okay. what does it show, generally?

15 A. It shows the steps that we undertake to -- typical steps
16 that we undertake to -- how we go about constructing the
17 potentiometric contour maps, and examining general path lines
18 of groundwater flow.

19 Q. Let's start with Step 1. What does Step 1 depict?

20 A. Step 1 depicts the locations with the little crosses on
21 them where we have a well where there's a measurement of the
22 potentiometric elevation.

23 Q. And what's the difference between the head of a well
24 labeled 2,480 feet and the head at 2,750 feet?

25 A. The numbers represent the potentiometric elevation measured

1 in that particular well, calculated in the fashion that I
2 described earlier.

3 Q. So this is --

4 A. And --

5 Q. Just so the record is clear, the 2,750 is the number of
6 feet above sea level?

7 A. Right. These are elevations relative to a datum.
8 Typically the datum is sea level.

9 Q. Okay. What does Step 2 depict.

10 A. Step 2 depicts a generalized way that we would interpolate
11 between these locations where we actually have measurements, to
12 estimate approximately where a specific value of the
13 potentiometric elevation would exist between each of the two
14 points.

15 Q. What do the red numbers represent?

16 A. The red numbers are labeling locations between two points
17 where particular elevations are estimated to occur. For
18 example, as between the center point at 2,440 and the point
19 near the right-hand -- lower right-hand area at 2,230, along
20 that line we would estimate approximately where an elevation of
21 2,400 would occur and where an elevation of 2,300 would occur.
22 And we would do that for the other lines connecting these
23 points as well.

24 Q. Okay. What does Step 3 show?

25 A. In Step 3, we would interconnect the line -- via the line,

1 locations where the potentiometric elevation has the same
2 value. So the contour line would represent a line along which
3 potentiometric elevation is the same. Much like a topographic
4 contour on a topographic map.

5 Q. Is there a name for those lines?

6 A. Well, they're referred to as "contour lines," but they
7 could be called "potentiometric contour lines" as well.

8 Q. What does Step 4 represent?

9 A. In Step 4, we're trying to illustrate how we would use the
10 information from the potentiometric contour map to infer
11 directions and pathways of groundwater movement.

12 Q. So the -- I'm sorry. I didn't mean to cut you off.

13 So what do the blue lines show?

14 A. The blue lines are constructed -- are perpendicular to the
15 red lines. The red lines are the potentiometric elevation
16 contours. And we construct lines perpendicular to those
17 contours to illustrate the average direction of groundwater
18 flow, going from higher potential to lower potential.

19 Q. And when you say "average direction," what do you mean by
20 that?

21 A. Well, if you actually look at individual molecules of water
22 as they go through the subsurface, they will wiggle back and
23 forth and go around sand grains or whatever. But there will be
24 a general tendency to migrate in a certain -- or to move in a
25 certain direction, and that's what these lines would represent.

1 Q. Now, I want to return back to the water cycle illustration.
2 This is D197, Figure 1, at PDF page 10.

3 Is this flow within the aquifer occasional, or does
4 that always happen?

5 A. This always happens. It's 24/7. The water is recharged
6 into the ground, and it begins a journey toward places of
7 discharge.

8 Q. And can you remind us where the water that's flowing
9 through the aquifer comes from?

10 A. It comes from infiltration at the land surface, either from
11 rainfall falling on the ground, or from snow melt, or from
12 seepage out of streams or other surface water bodies. That
13 infiltration goes into the ground, and some of that
14 infiltration will reach the groundwater environment.

15 Q. Can you give us some examples of infiltration, and is the
16 word "recharge" associated also with infiltration?

17 A. The portion of the infiltration that reaches the
18 groundwater we would refer to as recharge.

19 Q. Okay. So can you give us some examples of this recharge
20 effect?

21 A. Recharge is where, like I said, the infiltration and
22 precipitation and other forms of surface reach the groundwater,
23 and then they begin moving through the groundwater environment
24 toward places of discharge.

25 Q. Can you explain how discharge works from an aquifer?

1 A. Discharge is basically the emergence of the groundwater
2 into other bodies of water, say, on the land surface that could
3 be seepage into a low-lying area. It could be seepage -- or
4 seepage and flow to a spring, for example; that's the emergence
5 of groundwater on the surface. It could be seepage into a
6 water body, such as a lake or river, or it could ultimately go
7 to the ocean and discharge into the ocean.

8 Q. Okay. When do discharge and recharge occur?

9 A. They occur all the time.

10 Q. Now, what happens to the water in the aquifer if the rate
11 of recharge and discharge are roughly the same?

12 A. When the rate of recharge and the rate of discharge are
13 roughly in balance, if you look at the potentiometric levels in
14 the area where that condition exists, you will find that the
15 potentiometric levels, elevations will remain relatively
16 stable, indicating that there's a balance between recharge and
17 discharge.

18 Q. Does the particular water within an aquifer change?

19 A. Yes. The water is moving through that zone, but the
20 potentiometric levels remain relatively stable.

21 Q. And what happens if the rate of recharge and discharge are
22 different?

23 A. If there's either an increase or a decrease in either one
24 of those, the response will be that the potentiometric levels
25 would change. They will either go up or down, depending on

1 whether the recharge was higher than the discharge or vice
2 versa.

3 Q. Now, I'm showing you a figure from J40. This is at PDF
4 page 35. What does this depict?

5 A. This depicts the effects of using wells to pump water on
6 either a confined aquifer or a confined aquifer.

7 Q. Now, let's discuss the figure on the right. What does that
8 represent?

9 A. This is depicting the conditions associated with pumping
10 water out of a well where the well is completed in a confined
11 aquifer.

12 Q. What happens when pumping begins at a particular location?

13 A. When the pumping from a well begins, what happens is that
14 the water level in the well will drop, so the potentiometric
15 level will drop. That will cause water to move toward the well
16 from the area around the well to that point where the ground --
17 where the potentiometric level in the well has been lowered.

18 Q. Can you explain where the original potentiometric head can
19 be seen on this figure?

20 A. Yes. If you look at the -- toward the top of the face of
21 this block, and there's a horizontal dashed line that goes
22 across, that's to illustrate where the initial potentiometric
23 level was before the well started pumping.

24 Q. Can you explain where a decline in potentiometric head can
25 be seen on this figure?

1 A. You can see that there's a curved line beginning at each
2 side of the face of this, and it curves toward the center and
3 downward into the well. And so it -- that represents the
4 potentiometric levels associated with the area around the well
5 when the well is being pumped.

6 Q. Okay. Now, that line I think that you were referring to is
7 called "drawdown." Is that the term commonly used to describe
8 this phenomenon?

9 A. Yes. "Drawdown" is the term that we use to reflect the
10 difference between the potentiometric level that existed when
11 the well was not pumped to the potentiometric level that would
12 exist when the well is being pumped.

13 Q. Does the confined aquifer remain fully saturated when
14 drawdown occurs?

15 A. Yes.

16 Q. Now, how does that happen?

17 A. Because the water level has not been drawn down below the
18 top of the aquifer, and so the aquifer itself still contains --
19 is fully saturated with water. And the water begins to move
20 toward the well.

21 Q. Now, what do the arrows in the confined aquifer at the base
22 of the figure represent?

23 A. Those arrows are intended to depict how the water would
24 move toward the well when the well is pumped and the water
25 level in the well has been lowered by the pumping.

1 Q. Why does the water flow toward the well?

2 A. The well -- the water level in the well, it becomes the
3 lowest point in terms of potentiometric elevation in the
4 surrounding area, the area surrounding the well, and the water
5 removed from the areas of higher potential to areas of lower
6 potential, so it begins to move forward into the well, and then
7 it's withdrawn.

8 Q. And what happens to the potentiometric head as you move
9 away from the pump?

10 A. The amount of drawdown in the potentiometric level
11 decreases generally within a radial pattern around the well, so
12 as you get further and further away, the amount of drawdown
13 associated with the pumping is less and less.

14 Q. Is there a name for that drawdown pattern?

15 A. The overall extent of drawdown impacts is sometimes
16 referred to as the cone of depression.

17 Q. Can you explain what that looks like in three dimensions.

18 A. Three dimensions kind of looks like an upside-down cone, or
19 I heard one description of a funnel, which is characterizing it
20 as somewhat circular in nature. Because it's sort of radially
21 around the well, so it looks like sort of an upside-down cone.

22 Q. What affects the shape of the cone of depression?

23 A. The hydraulic properties of the aquifer. For example, its
24 permeability characteristics or its storage characteristics --
25 "storage coefficients", we call them -- as well as the pumping

1 rate from the well.

2 Q. And what about the location of the well? Does that affect
3 the cone of depression?

4 A. Yes, that will be the center part of the cone of
5 depression.

6 Q. Is there any way to avoid having a cone of depression when
7 pumping?

8 A. No. In order to utilize the resource and pump groundwater,
9 you have to pump it out of the ground, and you essentially have
10 to create a cone of depression.

11 Q. Is a cone of depression inherently bad for an aquifer?

12 A. No. I mean, that's how you get the water out of the
13 ground.

14 Q. What year did pumping begin in the Middle Claiborne
15 Aquifer?

16 A. In the Memphis area, you're referring to?

17 Q. Yes.

18 A. In about 1886.

19 Q. Okay. And how does one refer to the period before pumping?

20 A. Before pumping, it would be referred to as a period before
21 development, or predevelopment.

22 MR. FREDERICK: Your Honor, I'm just about to go into
23 his opinions. Would you like me to go into his -- in
24 introducing his opinions in the case at this time?

25 THE COURT: Okay. Well, we can break for lunch, if

1 you wanted.

2 MR. FREDERICK: I'm happy to keep going. I just
3 wanted to go to your schedule.

4 THE COURT: Okay.

5 MR. FREDERICK: How about if I just introduce what the
6 opinions are, take ten or so minutes to do that, and then we
7 have a --

8 THE COURT: I'm fine then.

9 BY MR. FREDERICK:

10 Q. Mr. Larson, would you briefly explain why you're here
11 today?

12 A. I'm here today to address the question that the Special
13 Master raised, that I understood to be the purpose of this
14 hearing, to determine whether or not the Middle Claiborne
15 Aquifer is a regional -- or is an interstate water resource.

16 Q. What do you consider an interstate aquifer or interstate
17 water resource to be?

18 A. Well, first of all, it would be a single hydrogeologic unit
19 that exists over multiple states and across state boundaries.
20 And it would also -- also -- it would also be something that
21 could -- another factor, I guess, would be one that it is
22 interconnected to other interstate resources, such as other
23 interstate aquifers or streams and other surface water bodies.

24 It would also -- it would also be one where
25 groundwater is moving through it; the groundwater is not

1 static, and it's migrating to places of recharge and discharge,
2 and it's not going to stay in one place.

3 Q. Now, you began that explanation by talking about -- I think
4 you used the words "single hydrogeologic unit." Does the
5 single unit also have to be continuous, in your opinion?

6 A. Yes. It would be a single continuous unit that would
7 extend over multiple states.

8 Q. Okay. How does your -- does your definition of an
9 interstate aquifer include both the water and the geological
10 material?

11 A. Yes, it would include both of those, because together, the
12 geologic materials and the water are what make an aquifer.

13 Q. Okay. If you took the water out, what would you have?

14 A. You would just have a geology of the geologic materials.

15 Q. Okay.

16 A. You would not have an aquifer.

17 Q. Have you used your definition of "interstate aquifer" in
18 other disputes?

19 A. Not formally. But obviously I've been involved in other
20 disputes where interstate resources were the subject of those
21 disputes.

22 Q. Applying the understanding that you just gave us of an
23 interstate aquifer, have you developed an opinion about whether
24 the Middle Claiborne Aquifer is an interstate aquifer?

25 A. Yes, I have.

1 Q. What is that opinion?

2 A. In my opinion, the Middle Claiborne Aquifer is an
3 interstate water resource.

4 Q. What are the bases of that opinion?

5 A. Well, the first one, as I said, is it is a single
6 continuous hydrogeologic unit that spans multiple states; in
7 this case, eight states.

8 Q. Okay. Does this accurately reflect the first basis for
9 your opinion?

10 A. Yes, it does.

11 Q. And what was the next basis?

12 A. That the -- this hydrogeologic unit is interconnected --
13 hydrogeologically interconnected to other resources, both
14 aquifers and to surface water bodies which are also interstate
15 in nature.

16 Q. Okay. Does this accurately reflect the second basis of
17 your opinion?

18 A. Yes, it does.

19 Q. What was the next basis of your opinion?

20 A. That the -- that the water is not static; that it's moving
21 from places of recharge to discharge. So it's not going to
22 permanently stay in one place.

23 Q. And does that opinion change whether it's predevelopment or
24 postdevelopment?

25 A. No.

1 Q. Why is that?

2 A. Because the issue is whether the -- the groundwater within
3 the aquifer is interconnected, and that interconnection will
4 allow water to move either under natural conditions or under
5 pumping conditions through the aquifer.

6 Q. And are there any other bases for your opinion that the
7 Middle Claiborne is an interstate aquifer?

8 A. Well, the other basis that I have is that when you look at
9 the work that the US Geological Survey has done collectively,
10 in my opinion, they recognize the regional nature of the Middle
11 Claiborne Aquifer and the need to understand and evaluate that
12 aquifer on a regional basis that would extend across state
13 boundaries or other political boundaries.

14 Q. And does this accurately reflect the fourth basis for your
15 opinion?

16 A. Yes, sir, it does.

17 MR. FREDERICK: Your Honor, I'm about to go into a
18 long segment about the single hydrogeological unit. May I
19 suggest that this would be a good time to break before we move
20 into that section.

21 THE COURT: Okay. Court will be in recess to 1:30.

22 (Luncheon adjournment)

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AFTERNOON SESSION

1:32 P.M.

THE COURT: All right, Mr. Frederick.

MR. ELLINGBURG: Your Honor, before we commence, if I could, I'd like to introduce Don Kilgore, who's here on behalf of the Attorney General's Office of the State of Mississippi.

THE COURT: All right. Glad to have you.
You may proceed.

MR. FREDERICK: Thank you, Judge Siler.

And welcome back from lunch, Mr. Larson.

BY MR. FREDERICK:

Q. When we left off for lunch, you had just gone through the four bases for your opinion, and you'd gotten through all four in introducing them. So what I'd like to do now is take the first one in order and go through them in more detail.

You testified that one of the bases of your opinions was that the Middle Claiborne is a continuous hydrogeological unit that extends beneath eight states. Can you explain what you mean by that.

A. Well, it has continuity over these areas in terms of its character and physical properties. It has continuity over the area in terms of the ability of groundwater to move, as illustrated by potentiometric contours; there's a continuity to those.

And that when you look at the effects of groundwater

1 development, that you can see the continuity and the effects of
2 those in terms of propagating from one area to another within
3 the aquifer.

4 Q. So before we get too far into your analysis, I'd like to
5 briefly discuss some nomenclature. Let's put Exhibit J18 --
6 this is the Clark & Hart 2009. And can you tell us what this
7 is?

8 A. This is the cover page of the report by Clark & Hart of the
9 USGS in 2009, documenting their development of the groundwater
10 flow model called MERAS.

11 Q. And did you rely on this in formulating your expert
12 opinion?

13 A. Yes. This is one of the documents that I reviewed.

14 Q. So let's turn to Table 1, which is at PDF page 15 of this
15 document. Can you tell us what this is.

16 A. Yes. This is a table that shows the correlation between
17 hydrogeologic units and model layers that have been identified
18 for use in this report and how that correlates with other names
19 that these various hydrogeologic units may be referred to.

20 Q. Okay. And what is the column second from the right
21 entitled?

22 A. That column is the hydrogeologic -- identifies the
23 hydrogeologic units.

24 Q. Can you remind us again what a hydrogeologic unit is?

25 A. Hydrogeologic units are distinguished mainly on the basis

1 of the permeability characteristics; that is, the more
2 permeable units, hydrogeologic units, would be distinguished as
3 aquifers; the less permeable hydrogeologic units would be
4 distinguished as confining units. Or -- confining units.

5 Q. And is this how the USGS classifies hydrogeological units?

6 A. Yes. Looking at groundwater flow characteristics, they
7 want to use this kind of a classification.

8 Q. Does the permeability have to be the same throughout the
9 layer?

10 A. No, it does not.

11 Q. And why would it be important for the USGS to identify
12 different hydrogeological units?

13 A. Because they're trying to understand the nature of
14 groundwater flow within the overall system and how that
15 groundwater flow might be affected or modified by the different
16 hydrogeologic units; that is, aquifers or confining units that
17 exist within the overall system.

18 Q. So this table lists the aquifers in confining units in the
19 Mississippi Embayment Regional Aquifer System; is that correct?

20 A. Yes.

21 Q. Okay. Is the Middle Claiborne Aquifer identified as a
22 hydrogeologic unit?

23 A. Yes, it is.

24 Q. Okay. I'd like to highlight that.

25 And is that the highlighted area depicted on the table

1 now?

2 A. Yes.

3 Q. Okay. Why does it say "Lower Claiborne Aquifer" in that
4 part of the Middle Claiborne Aquifer hydrogeologic unit?

5 A. Well, portions of the Middle Claiborne Aquifer in some
6 areas add characteristics that are considered to be more of a
7 confined unit character. And so they are distinguishing that
8 in areas where that might exist, they're referring to sort of a
9 subunit of the aquifer as the Lower Claiborne Aquifer.

10 Q. In your opinion, is the Lower Claiborne Aquifer part of the
11 same hydrogeological unit?

12 A. Yes, I believe it is.

13 Q. Okay. Why do you think that?

14 A. Because there's no barrier to interconnection between the
15 two units. In other words, they're all -- well, groundwater
16 can flow from one unit to the other, laterally, within the
17 system.

18 Q. Now, why does the -- do you know why the USGS sometimes
19 refers to this using different names, this section?

20 A. Well, I think they're trying to subdivide the
21 hydrogeological units into things that they can then use to
22 assemble into their overall evaluation of groundwater flow,
23 including development of the groundwater model.

24 Q. Okay. And what information is contained in the columns
25 immediately to the left of the one that we were just looking

1 at?

2 A. In the columns to the left?

3 Q. Yes.

4 A. Yeah, these are geologic names that are used at various
5 times and in various places that correlate with the
6 hydrogeologic units they've identified for purposes of this
7 report.

8 Q. What regional names are included for the Middle Claiborne
9 Aquifer?

10 A. Well, you can see that the Memphis Sand and the Sparta Sand
11 are -- are referred to, at least as regard to portions of the
12 Middle Claiborne Aquifer. There's also the Meridian Sand.

13 So you can see a number of different descriptors,
14 geologic descriptors, of those units -- those formations that
15 are part or within the Middle Claiborne hydrological unit.

16 Q. These are all names for the same hydrogeologic unit?

17 A. Yes. They're trying to show the correlation between those
18 names and the hydrogeologic unit that they've identified.

19 Q. Are there any other names used for the Middle Claiborne
20 Aquifer?

21 A. Well, it's sometimes referred to the Memphis Sand or the
22 Memphis Sparta Sand, or sometimes it's referred to as the
23 500-Foot Sand.

24 Q. Okay. So when we were hearing testimony earlier in this
25 hearing about the 500-Foot Sand, that is the same aquifer as

1 what we were calling the Middle Claiborne Aquifer?

2 A. Yes.

3 Q. Okay. Are you aware of any other aquifers where the name
4 varies in different regions?

5 A. Yeah. This is not uncommon. Often when you have layered
6 systems like this, there will be variations in names,
7 especially between the hydrogeologic unit characterization and,
8 say, the geologic formation characterization.

9 Q. I'd like to turn your attention to Figure 14G of this same
10 exhibit. This is J18 at PDF page 37.

11 What does this show?

12 A. This is a map from Clark & Hart, 2009 report, and it
13 depicts sand content within a portion of the Middle Claiborne
14 Aquifer over the area of the Mississippi Embayment Regional
15 Aquifer System.

16 Q. What is the thick brown line, labeled as "Model Area" on
17 this map, show?

18 A. That represents the boundary of the Middle Claiborne --
19 Mississippi Embayment Regional Aquifer System that they were
20 investigating -- that they are investigating.

21 Q. And what's the thinner black line immediately around the
22 shading of the map?

23 A. That represents the extent of the Middle Claiborne Aquifer
24 within what's called Layer 7 of the model.

25 Q. How does the geographic extent of the Middle Claiborne

1 Aquifer compare with the Mississippi Embayment?

2 A. It's slightly smaller than the extent for the Mississippi
3 Embayment.

4 Q. What states does the Middle Claiborne extend beneath?

5 A. You can see it extends from Kentucky and Illinois and
6 Missouri up on the north to Tennessee and Arkansas at the
7 center and Mississippi and Arkansas further down, and then at
8 the very south end, Louisiana and Alabama.

9 Q. Okay. Are there any barriers to water flow in the Middle
10 Claiborne that prevent groundwater from flowing laterally
11 across the aquifer?

12 A. No, there are no barriers there.

13 Q. And would you consider it to be an interconnected
14 hydrogeologic unit?

15 A. Yes, I would consider it to be interconnected.

16 Q. Can you describe the composition of the geological matrix
17 of the middle Claiborne?

18 A. Yes. It's predominantly a sandy environment, but it can
19 have interbedded layers of silt or less permeable materials.
20 But the bulk of it is sand or sand and gravel.

21 Q. Okay. Can you explain what the different colors of brown
22 represent.

23 A. On this map, the different colors of brown represent the
24 different amounts as a percentage of the sand content at
25 different locations throughout the area.

1 Q. Mr. Larson, how do you tell that the Middle Claiborne and
2 the water in it is hydrogeologically continuous?

3 A. By looking at maps like this that describe the character of
4 the materials over the geology -- the geographic area, and the
5 continuity of those materials.

6 Q. Are the hydrogeological properties of the aquifer important
7 in determining the continuity for your purposes?

8 A. Yes, because you need to understand the continuity of
9 the -- not only the characterization, like we see here, of the
10 amounts of sand, but also the continuity in terms of the
11 characteristics of permeability and the storage factors
12 associated with the aquifer.

13 Q. Okay. And what about potentiometric surfaces and water
14 levels? Is that factor important to determining
15 hydrogeological continuity?

16 A. Yes. The mapping of the potentiometric contours
17 illustrates continuity of the potentiometric levels within the
18 aquifer, but also is illustrative of the groundwater flow
19 patterns that exist within the aquifer.

20 Q. Are pumping effects important to determining the
21 hydrogeological continuity of the aquifer?

22 A. Yes. Pumping effects are important in terms of
23 demonstrating the degree to which pumping effects spread and
24 are continuous throughout the aquifer.

25 Q. So let's talk about each of these factors. Are the

1 hydrological and geological properties of the Middle Claiborne
2 the same throughout the aquifer?

3 A. No, they're not the same. They'll vary from place to
4 place.

5 Q. And does that -- do those differences affect your
6 conclusion about the hydrogeological continuity?

7 A. No, because they are just reflecting variations in the
8 property that don't represent barriers to safe flow, or the
9 effects of pumping, for example.

10 Q. Is that typical of aquifers?

11 A. Yes, the aquifers are more permeable units that are
12 geographically distinguishable.

13 Q. Okay. And can you explain what you mean by
14 "hydrogeological properties that extend"; what does that mean
15 in the context of a large regional aquifer like this?

16 A. That as you go from place to place, you have this area,
17 you'll be able to look at the permeability and characteristics
18 and the storage characteristics to show that it is a continuous
19 unit from the standpoint of its character.

20 Q. Do the state lines have any effect on the hydrogeological
21 properties of the Middle Claiborne Aquifer?

22 A. No, as you can see on this particular slide, state
23 boundaries do not have an influence on these patterns.

24 Q. What does this figure demonstrate to you about the
25 continuity of the geological composition of the sand?

1 A. It illustrates their continuity in the -- the occurrence of
2 the sand within -- at least within this portion of the Middle
3 Claiborne Aquifer throughout the area.

4 Q. In the Mississippi/Tennessee border region, does the
5 percentage of sand vary?

6 A. Well, the map illustrates that along that
7 Mississippi/Tennessee border area, that there's a very high
8 sand content; it's between 81 and 100 percent. And while
9 there's some variation, it extends from considerably north --
10 that level of sand percentages extends from very north of the
11 border to significantly south of the border.

12 Q. How does this figure inform your opinion about the area of
13 the aquifer that Mississippi is calling the Mississippi Sands
14 in Tennessee?

15 A. Mississippi Sands --

16 Q. Sorry, sorry, sorry. Let me start that over.

17 How does this figure inform your opinion about what
18 Mississippi has called the Memphis Sands in Tennessee?

19 A. Well, this illustrates that the Memphis Sands in Tennessee
20 has a very high sand content and is -- that sand is continuous
21 going into Mississippi.

22 Q. How does it inform your opinion about what Mississippi is
23 calling the Sparta Sand in Mississippi?

24 A. This diagram illustrates that that also has a high sand
25 content, and that sand content extends -- the high sand content

1 extends into Tennessee.

2 Q. Does the similarity in the sand content influence your
3 judgment about the identification of the Middle Claiborne
4 Aquifer as a hydrogeological unit?

5 A. Yes, that's one of the factors that is -- are used to
6 define the hydrogeological units.

7 Q. Does the sand composition affect the permeability of the
8 aquifer?

9 A. Again, the sand itself tends to be in the more permeable
10 range of things. So that permeability is what helps to
11 distinguish that hydrogeologic unit as an aquifer.

12 Q. And is the 81 to 100 percent sand composition relatively
13 permeable?

14 A. It should be relatively permeable, yes.

15 Q. Okay. And what does that say to you about the movement of
16 water in that kind of sand composition?

17 A. That the characterization of it as an aquifer that can
18 conduct water reasonably readily is an appropriate one.

19 Q. Did you consider the continuity of any other
20 hydrogeological properties of the Middle Claiborne Aquifer?

21 A. Well, I considered the -- I looked at variations in
22 hydraulic conductivity and transmissivity, as was described in
23 here, and then I also looked at the continuity of
24 potentiometric elevations and groundwater flow.

25 Q. How are those properties affected by state boundaries?

1 A. The state boundaries don't have an influence on the
2 continuity of those kinds of characteristics.

3 Q. Let's turn to your second point, that the potentiometric
4 surfaces and water levels within the Middle Claiborne continue
5 across state lines without interruption.

6 Let's put up Exhibit J7. This is Schrader 2008 --
7 sorry, J71. So the record is clear, this is Exhibit J71.

8 What is this?

9 A. This is a potentiometric surface map of the Middle
10 Claiborne. It's on -- on here it's called the Sparta Memphis
11 Aquifer, over the Mississippi Embayment Regional Aquifer
12 System, and it's potentiometric levels that are contoured over
13 that region.

14 Q. Okay. And what does the map show about those
15 potentiometric surfaces in the Middle Claiborne and the
16 relationship to state boundaries?

17 A. Well, you can see that there's a continuity across the
18 state boundaries, and the state boundaries do not disrupt the
19 patterns of the contours as they -- as you cross the
20 boundaries.

21 Q. And how does that relate to your conclusion about -- that
22 the Middle Claiborne Aquifer is an interstate aquifer?

23 A. Well, it demonstrates that there is groundwater movement
24 going from areas of recharged places of discharge, and so the
25 water is moving, and that the state boundaries don't disrupt

1 that movement.

2 Q. And you can tell that by looking at these potentiometric
3 lines?

4 A. That's correct.

5 Q. Okay. Now let's turn to the point about pumping, and how
6 pumping in one area of the Middle Claiborne affects the water
7 in the other.

8 Is there pumping in the Middle Claiborne Aquifer?

9 A. Yes, there is.

10 Q. And do you know -- what do you understand the angle of the
11 wells in Tennessee to be?

12 A. My understanding is that they're vertical wells; that they
13 go vertically down into the earth.

14 Q. Okay. And what happens to the potentiometric surface in
15 the aquifer around those vertical wells?

16 A. Well, when the wells are pumped, as we've talked about
17 earlier, the potentiometric levels will be drawn down, and
18 cones of depression will develop around the wells.

19 Q. Now, looking again at this Schrader map, what do the light
20 gray areas on the map represent?

21 A. They represent the general areas of cones of depression, or
22 overlapping cones of depression, in different parts of the
23 aquifer.

24 Q. So roughly how many different cones of depression do you
25 see depicted on this map?

1 A. I think they mention about 20, if I remember correctly,
2 something like that, some small and some larger.

3 Q. So 20 cones of depression in the Middle Claiborne is -- are
4 depicted on this map?

5 A. Yes, I think so.

6 Q. Okay. Now, can you tell us a little bit more about the
7 geographic extent and the effect on the potentiometric surface
8 from a cone of depression around Memphis in the Middle
9 Claiborne?

10 Let's expand that. This is the same Schrader 2008
11 map.

12 Can you identify -- does the circle represent where
13 Memphis is, roughly?

14 A. Yes, it does.

15 Q. Okay. And then does pumping in Mississippi create a cone
16 of depression?

17 A. Yes, it does. It creates overlapping cones of depression.

18 Q. All right. And in this gray area depiction, does the cone
19 of depression cross state lines?

20 A. Yes, it does.

21 Q. Which states does it cross?

22 A. As depicted on here, it crosses into Mississippi, and it
23 also crosses to the south, and it also crosses over into
24 Arkansas to the west.

25 Q. Okay. And I believe you said that pumping in Mississippi

1 creates a cone of depression. Did I get that right?

2 A. Pumping in Mississippi?

3 Q. Yes.

4 A. Yeah, pumping around any well will create cones of
5 depression.

6 Q. And would the cones of depression by pumping in Mississippi
7 extend into Tennessee?

8 A. Yes, it can.

9 Q. Okay. And how would that happen?

10 MR. ELLINGBURG: I'm going to object to him continuing
11 to testify about what can, might be, could, would. None of
12 that's --

13 THE COURT: I understand that's not the case. You can
14 go further on that. Overruled.

15 MR. ELLINGBURG: And I have a continuing objection to
16 that.

17 THE COURT: You may.

18 MR. ELLINGBURG: Thank you.

19 A. Can you repeat the question?

20 Q. Sure. And I'll rephrase it.

21 Do the cones of depression from Mississippi pumping
22 extend into Tennessee?

23 A. Yes.

24 Q. Okay. And do the cones of depression extend across other
25 state boundaries in the Middle Claiborne Aquifer?

1 A. Yes.

2 Q. Can you show us, using this diagram on the
3 Mississippi/Louisiana border, does this depict any cones of
4 depression extending across state boundaries there?

5 A. Yes, it does.

6 Q. Can you explain that further to Judge Siler.

7 A. Yes. As you can see, there's a cone of depression that's
8 developed in Mississippi that extends over to and slightly into
9 Louisiana to the west. And water flow has been altered in that
10 area toward a cone of depression in Mississippi.

11 Q. Now, let's look at the Arkansas/Louisiana border. What is
12 shown there?

13 A. This is another overlapping -- a series of overlapping
14 cones of depression.

15 Q. And do those cones of depression affect water flow across
16 state boundaries?

17 A. Yes, they do.

18 Q. What do those cross-border cones of depression reveal about
19 the extent of the Middle Claiborne Aquifer?

20 A. Well, they demonstrate to me that there is continuity in
21 these physical properties that allows these cones of depression
22 to spread, and to spread beyond state boundaries.

23 Q. Mr. Larson, were you in the courtroom when Mississippi's
24 experts testified?

25 A. Yes, I was.

1 Q. And you heard Mississippi's experts testify about the
2 facies change in the Middle Claiborne Aquifer, correct?

3 A. Yes, I did.

4 Q. Did that feature have any effect on your conclusion that
5 the Middle Claiborne is a single continuous hydrogeological
6 unit extending beneath multiple states?

7 A. No, it does not.

8 Q. What is a facies change?

9 A. A facies change is a gradual -- typically a gradual change
10 in the character of the materials as you move from one place to
11 another. It will go from, say, a more coarse-grain type of
12 material and transition over some distance into a more fine
13 grain.

14 Q. What is your understanding of the facies change in the
15 Middle Claiborne Aquifer?

16 A. That there is an area, at least within portions of the
17 Middle Claiborne hydrogeological unit, where the character
18 transitions from a more coarse-grain type of material to a more
19 fine-grain type of material.

20 Q. Let's look at Exhibit J4 and page 61, the north/south
21 cross-section from Arthur & Taylor depicting the Mississippi
22 Embayment.

23 Is the highlighted area forming a two-pronged shape
24 the Middle Claiborne Aquifer?

25 A. Yes.

1 Q. How is the facies change we've been discussing depicted in
2 this figure?

3 A. Well, you can see in between the columns of the forks,
4 you'll see this gray area extending from the left to the right,
5 with sort of a fuzzy edge on it on the right-hand side.
6 That's -- that area, general area, is where the facies change
7 occurs.

8 Q. Now, if I highlight in pink, does that help to show exactly
9 what you're talking about?

10 A. Yes. And if you look at the right-hand side of that pink
11 area, over to the east, you'll see the jagged line indicating
12 there is a transition from a more permeable material, Middle
13 Claiborne Aquifer material, changing over into a less permeable
14 material that's then characterized as a confining unit.

15 Q. And what does the jagged line -- what does that represent?

16 A. I think that -- well, my understanding is it represents the
17 transition, and there's not a sharp boundary where it changes
18 from one to the other.

19 Q. Does the Middle Claiborne Aquifer extend both north and
20 south of the facies change?

21 A. Yes, it does.

22 Q. Is the Lower Claiborne Confining Unit in the key the
23 lateral flow of groundwater within the Middle Claiborne
24 Aquifer?

25 A. No.

1 Q. Can you explain why?

2 A. Because when you look at the aquifer materials, the more
3 permeable materials, there is continuity to those above and
4 below the Middle -- the Lower Claiborne Confining Unit, and
5 that continuity will allow water to flow one way or the other
6 above the facies change or below the facies change. And the
7 effects of pumping on one side or the other can be transmitted
8 across that area from one place to another.

9 Q. Is there any impediment to water flowing in the Middle
10 Claiborne from the top prong above the confining unit and into
11 the handle of the -- of what we've got on yellow there?

12 A. No. They are both aquifer-type materials, and so they flow
13 more readily back and forth across that area.

14 Q. Can water flow from the bottom fork of the Middle
15 Claiborne?

16 MR. ELLINGBURG: Object. Objection to form. He's
17 calling for speculation with respect to the "can."

18 THE COURT: Well, I understand that.

19 MR. FREDERICK: Your Honor, he's --

20 THE COURT: I understand.

21 Go ahead.

22 BY MR. FREDERICK:

23 Q. Does water flow, in your expert opinion, Mr. Larson, from
24 the lower prong of the Middle Claiborne Aquifer to the larger
25 portion of the Middle Claiborne Aquifer?

1 A. Yes.

2 Q. Does water flow from the upper part of the Middle Claiborne
3 past the facies change to the larger section of the Middle
4 Claiborne Aquifer?

5 A. Yes.

6 Q. Does water move in either direction, depending on
7 hydrogeological characteristics, in the manner that I just
8 described?

9 A. Yes, depending on those characteristics.

10 Q. Okay. Now, can a cone of depression -- or does a cone of
11 depression, caused by pumping north of where the confining unit
12 is, extend into the aquifer south of the confining unit?

13 A. Yes, it will promulgate through that area from one side or
14 the other.

15 Q. And what about vice versa?

16 A. And vice versa.

17 Q. Okay. Is the potentiometric level in the Middle Claiborne
18 continuous across the facies change?

19 A. Yes, it is.

20 Q. How do you know that?

21 A. By looking at maps that have been prepared that depict
22 potentiometric levels within the Middle Claiborne aquifer.

23 Q. Are there any differences in the physical characteristics
24 of the Middle Claiborne on opposite sides of that transition?

25 A. Well, there are variations throughout the aquifer, but

1 basically it tends to be predominantly sand on one side and
2 predominantly sand on the other side.

3 Q. Are the naming variations related to the areas of the
4 aquifer north and south of facies change?

5 A. Are there naming variations? Is that what you're asking?

6 Q. Yes.

7 A. Yes, there are.

8 Q. What are they?

9 A. Well, typically, to the north, it's referred to, say, as
10 the Memphis Sand, perhaps, or the Memphis Aquifer, or the
11 500-Foot Sand. Toward the south, it may be referred to as the
12 Sparta Sand; that upper portion could be referred to as the
13 Sparta Sand.

14 Q. Are the Memphis Sand and the Sparta Sand separate aquifers?

15 A. No, they're all part of the hydrogeologic unit that's been
16 defined as the Middle Claiborne Aquifer.

17 Q. Did you hear Dr. Spruill testify that the Memphis Sand and
18 the Sparta Sand are separate aquifers within the Middle
19 Claiborne?

20 A. Yes, I did.

21 Q. And do you agree with that?

22 A. No, I think they are part of the overall hydrogeologic unit
23 that is the Middle Claiborne Aquifer.

24 Q. Okay. And why do you have that conclusion?

25 A. Because there's a continuity in terms of the materials and

1 the ability of water to move within those areas from one to the
2 other, from one area to the other.

3 Q. Now, if you could assume just for the moment that there are
4 two separate aquifers called the Memphis Sand and the Sparta
5 Sand within a larger formation, would that change your
6 analysis?

7 A. No, because there's continuity.

8 Q. Okay. And when you say "continuity," explain exactly what
9 you mean by that in terms of water flow.

10 A. It means that there's not a -- a barrier between where it's
11 being called one thing and where it's being called another
12 thing that would prevent water flow from moving from one to the
13 other, or prevent the effects of pumping from being transmitted
14 across the place where the name change is being used, in either
15 direction; either from one -- say, south to north or north to
16 south.

17 Q. Now, Mr. Larson, can you consider for a moment just the
18 part of the aquifer that Mississippi has been referring to as
19 the Memphis Sand. In your opinion, is that an interstate
20 aquifer?

21 A. Yes, it is.

22 Q. Now, why do you believe that the Memphis Sand, as conceived
23 by Mississippi, is an interstate aquifer?

24 A. Because it covers multiple states, or it underlies multiple
25 states.

1 Q. What states does what Mississippi calls the Memphis Sand
2 lie beneath?

3 A. Well, it would lie between portions of Mississippi,
4 portions of Tennessee, portions of Arkansas.

5 Q. Okay. Any other states?

6 A. Probably Kentucky as well.

7 Q. Okay. Mr. Larson, can you consider for a moment just what
8 Mississippi has been calling the Sparta Sand: Is that an
9 interstate aquifer?

10 A. Yes, I believe it is.

11 Q. And why do you believe what Mississippi has called the
12 Sparta Sand an interstate aquifer?

13 A. Because in the table that we looked at earlier, you can see
14 that there are several states where that terminology is being
15 used, the Sparta Sand.

16 Q. And what states does what Mississippi calls the Sparta Sand
17 lie beneath?

18 A. My recollection was it was Mississippi, portions of
19 Arkansas, and Louisiana. I don't remember if it got down to
20 Alabama or not.

21 Q. Okay. Is the area below the Lower Claiborne Confining Unit
22 sometimes called by different names?

23 A. Yes, it is.

24 Q. What are those names?

25 A. One of them is called -- well, it's referred to as the

1 Lower Claiborne Aquifer hydrogeologic unit, or subunit, within
2 the MERAS; but it's also referred to as the Meridian Sand, at
3 least in some areas.

4 Q. Okay. Is the Lower Claiborne Aquifer separate from the
5 Middle Claiborne aquifer?

6 A. No, I don't believe so.

7 Q. What does that tell you about the nature of the Middle
8 Claiborne Aquifer?

9 A. That its extent covers -- well, that it's in hydraulic
10 communication with these other areas that have been given other
11 names.

12 Q. And when you say "hydraulic communication," what do you
13 mean by that?

14 A. I mean that there's no barrier that presents flow from
15 going from one to the other, or prevents the effects of pumping
16 from being transmitted from one to the other.

17 Q. How does this relate to your conclusion about the Middle
18 State -- or, sorry, about the Middle Claiborne Aquifer?

19 A. It relates to that in the fact that this illustrates the
20 continuity of these aquifers and the actual materials
21 throughout the Mississippi Embayment Regional Aquifer System.

22 Q. Does it support your conclusion that the Middle Claiborne
23 is an interstate aquifer?

24 A. Yes.

25 Q. Let's move to the second basis of your opinion. What is

1 that?

2 A. That the Middle Claiborne Aquifer is hydraulically and
3 hydrologically interconnected to other aquifers and other
4 hydrogeologic units and surface water within the Mississippi
5 Embayment Regional Aquifer System.

6 Q. Let's look at J19, which is at PDF page 21, the Clark &
7 Hart -- well, let's first start with the first one. Let's look
8 at J19.

9 Can you identify what that is?

10 A. This is the cover page of a report by Clark and others in
11 2011. It's another USGS report that I reviewed.

12 Q. Okay. And let's turn to Figure 6, which is J19 at PDF
13 page 21. What does this depict?

14 A. This is sort of a three-dimensional cutaway of the
15 subsurface environment and the surface environment extending to
16 the north from an area just south of the Louisiana/Arkansas
17 border. And it's cut away to illustrate the different
18 hydrogeologic units and the flow patterns under the
19 predevelopment scenario.

20 Q. What do the white arrows on this figure depict?

21 A. They illustrate how the groundwater would move under the
22 predevelopment condition; that is, prior to any pumping, how it
23 would move from areas of recharge to areas of discharge.

24 Q. Do those arrows depict movement through the confining
25 layers?

1 A. Yes, you can see the arrows pointing from either side of
2 the Embayment, east side to the right and the west side to the
3 left, migrating within the aquifers for -- or the flow within
4 the aquifers for some distance, and then curving up and
5 discharging into the central part of the Embayment through
6 other aquifers and confining units, ultimately discharging into
7 the alluvial aquifer in the Mississippi River.

8 Q. What do the black arrows show?

9 A. The black arrows are intended to depict recharge areas --
10 areas where there is recharge to the groundwater system.

11 Q. Okay. What effects can pumping in one aquifer have on
12 water in an adjoining aquifer?

13 A. Well, the pumping will reduce the potentiometric levels in
14 the aquifer that's being pumped. That will also alter the flow
15 patterns between the aquifers. And for example, if groundwater
16 prior to the pumping was flowing upward from one aquifer -- the
17 pumped aquifer to an overlying aquifer, the pumping could
18 reduce those flows into the other aquifer, or even reverse the
19 flows.

20 Q. Okay. I believe you earlier testified that there were
21 multiple aquifers in the Mississippi Embayment.

22 A. Yes.

23 Q. Are there -- other aquifers in the Mississippi Embayment,
24 are they also interstate aquifers?

25 A. Yes.

1 Q. How do you know that?

2 A. Well, for example, you can look on here. You can see that
3 the alluvial aquifer, which is the lighter-colored area at the
4 top of the diagram, you can see how it goes from Louisiana, an
5 extension of Louisiana into Mississippi and up into Arkansas
6 and portions of Tennessee and Missouri and on up. So it
7 underlies multiple states as well.

8 Q. I'm showing you Figure 2. Let's look at Exhibit J19 and
9 PDF page 16. This is Figure 2 from the same exhibit.

10 What does this depict?

11 A. This is a figure from the Clark and others 2011 USGS
12 report, and it illustrates various streams, surface water
13 features, throughout the Mississippi Embayment that are
14 hydrologically connected to the sub -- the regional aquifer
15 system.

16 Q. Can you remind us what the thick brown line is?

17 A. That's the extent of the Mississippi Embayment Regional
18 Aquifer Study.

19 Q. Okay. Are the rivers hydrologically interconnected with
20 the Middle Claiborne Aquifer?

21 A. Yes, they are.

22 Q. How do you know that?

23 A. By looking at the different layers -- or the different
24 units, and how they're positioned relative to one another and
25 how they are then related to the surface streams; that is, in

1 portions of the area, the surface streams, they go across the
2 outcrop area of the Middle Claiborne Aquifer. They will also
3 flow across portions of other aquifers, such as the alluvial
4 aquifer, and the Middle Claiborne Aquifer is hydrologically
5 connected in this system to that alluvial aquifer.

6 Q. Is it like what you were showing with the water cycle
7 demonstrative or figure?

8 A. Yes.

9 Q. What rivers in the area around Memphis are interconnected
10 with the Mississippi Embayment?

11 A. You can see the Wolf River, for example, that begins in
12 Mississippi, over to the right-hand side, and flows generally
13 westward across this into Tennessee, and then goes over and
14 eventually discharges into the Mississippi River.

15 That's -- that's one of them.

16 Q. Are there any others?

17 A. Well, there are others that go into the outcrop areas, but
18 not right near that boundary.

19 Q. Okay. But in your view, does that affect the
20 interconnection between the surface rivers and the aquifer?

21 A. No. These -- these various rivers will be interconnected
22 with various portions of the regional aquifer system, including
23 the Middle Claiborne Aquifer.

24 Q. How does the flow pattern of the Wolf River affect your
25 conclusion that the Middle Claiborne Aquifer is an interstate

1 resource?

2 A. Well, you can see that the Wolf River begins in Tennessee
3 and flows across the Mississippi/Tennessee -- or border into
4 Tennessee. So it is an interstate resource, and it is inter --
5 hydrologically interconnected with the Middle Claiborne
6 Aquifer. And that supports -- that in part, anyway, supports
7 my conclusion.

8 Q. How is the Wolf River hydrologically interconnected with
9 the aquifer?

10 A. Well, there are portions of the river where seepage from
11 the river provides recharge to the Middle Claiborne Aquifer,
12 and there are portions where groundwater discharged from the
13 Middle Claiborne Aquifer can go into the Wolf River.

14 Q. How is the Mississippi River interconnected with the
15 Embayment and the Middle Claiborne Aquifer?

16 A. Well, the Mississippi River goes down the central portion
17 of the Embayment and is connected, for the most part, to the
18 alluvial aquifer. And as we've seen in some of these diagrams
19 about how the various hydrostatic -- hydrogeologic units are
20 interconnected, there is a hydrologic connection through our
21 aquifers, or confining units, into the alluvial aquifer and
22 subsequently into the Mississippi River.

23 Q. Are any of those bodies of water directly connected with
24 the Middle Claiborne Aquifer?

25 A. Well, some, like the Wolf River, for example, are.

1 Q. But again, you described, I believe, just a moment ago, the
2 different layers; they would be connected through the layers.

3 Is that your --

4 A. Yes.

5 Q. -- understanding? Okay.

6 Are any of those rivers interstate, that interconnect
7 with the Middle Claiborne Aquifer?

8 A. Well, the Wolf River, as I've talked about, is a river that
9 goes from Mississippi into Tennessee, subsequently into the
10 Mississippi River, which then is an interstate river as well.

11 Q. Mr. Larson, have you analyzed connections between
12 groundwater and interstate bodies of surface water in other
13 original jurisdiction cases in the US Supreme Court?

14 A. Yes, I have.

15 Q. What was the nature of the relief sought in those cases?

16 A. Well, the -- I'll give you an example. In the Republican
17 River case, the relief sought was that pumping from the
18 Ogallala Aquifer was having depletive effects on the stream
19 flows of the Republican River. And the stream flows of the
20 Republican River were regulated by the Republican River Compact
21 and divided among the states. So to the extent that the
22 pumping was affecting those stream flows, that was a factor
23 that needed to be included in the accounting and the allocation
24 of the water among the states.

25 Q. When you say "compact," do you mean an agreement between

1 the states over how to allocate the water?

2 A. Yes.

3 Q. Let's look at Slide 21.

4 How do those connections to interstate bodies of water
5 relate to your conclusion about the Middle Claiborne Aquifer?

6 A. They -- I believe that the interconnection between the
7 Middle Claiborne Aquifer and these other aquifers that are also
8 interstate in nature, or surface water bodies that are
9 interstate in nature, supports my conclusion that the Middle
10 Claiborne is an interstate water resource.

11 Q. Thank you. Let's look at the third one.

12 What's the next basis of your conclusion that the
13 Middle Claiborne Aquifer, including the water in it, is
14 interstate? Third one.

15 A. I'm sorry, would you repeat the question?

16 Q. Yes. Tell us what your third -- the third basis of your
17 conclusions.

18 A. That there is groundwater movement within the Middle
19 Claiborne Aquifer. The water is not static; it's not stored
20 permanently in one place. And it's moving, and it was moving
21 in predevelopment times, and it's moving today, and that that
22 movement takes the water across state boundaries.

23 Q. Just so that we're clear, when you say water is not static,
24 what do you mean by that?

25 A. That it's not -- that it's not not moving.

1 Q. Okay. So "static" means "still"?

2 A. Still.

3 Q. Was that also true under predevelopment conditions?

4 A. Yes.

5 Q. Did you consider any predevelopment flow maps in reaching
6 that conclusion?

7 A. I've looked at a number of maps that I -- that I think
8 illustrate that continuity of flow.

9 Q. Are you aware of any map, or any model of predevelopment
10 conditions, that shows no flow between Mississippi into
11 Tennessee?

12 A. No, I'm not.

13 Q. Okay. Let's look at Exhibit J67. This is Reed, 1972.
14 Do you recognize this exhibit, Mr. Larson?

15 A. Yes, this is a USGS report by Reed in 1972. It's one of
16 the documents that I reviewed.

17 Q. Okay. Let's turn to Figure 2.

18 What is that?

19 A. This is a potentiometric surface map of the Sparta Sand and
20 Memphis Aquifer, which is equivalent to the Middle Claiborne.
21 And associated with predevelopment conditions, so it's
22 characterized as being in 1886.

23 Q. Can you remind us what those lines in the map refer to?

24 A. These lines are lines of equal potentiometric level.

25 Q. Are they also called contour lines?

1 A. They're also called contour lines, yes.

2 Q. Okay. And what do they represent?

3 A. They represent places along which the potentiometric
4 elevation is the same.

5 Q. Can you remind us how groundwater flows in relation to
6 those lines?

7 A. Yes. The groundwater will typically move at right angles
8 to those lines, and so the flow direction will be perpendicular
9 to the orientation of the contour lines.

10 Q. Does this map demonstrate water flowing out of Mississippi
11 and into other states?

12 A. Yes, it does.

13 Q. Can you show Judge Siler in what places it shows water
14 flowing out of Mississippi and into other states?

15 A. Well, you can see, along the Mississippi/Tennessee border,
16 there is groundwater flow from Mississippi into Tennessee along
17 portions of that border. And if you look to the -- off on the
18 left-hand side, you can see groundwater flow from Mississippi
19 and Tennessee into Arkansas. And if you look further down,
20 you'll see flow between Mississippi and other locations.

21 Q. So I want to focus on the 400 contour line. Can you
22 explain the direction of the water, using that 400-foot contour
23 line as an example.

24 MR. ELLINGBURG: I'm going to object -- oh, no, go
25 ahead. Go ahead and let him answer.

1 A. If you look at the sort of darker horizontal line near the
2 bottom of that circle, that's the state boundary. If you then
3 look at the potentiometric level contours, you can see how
4 they're situated relative to that. And you can see that
5 they're tilted sort of in a northeast-to-southwest direction;
6 for example, on the 400, you can see that.

7 The groundwater flow would be perpendicular to that
8 contour, which would mean that the groundwater in that area
9 would be flowing toward the northwest, or west northwest,
10 across the boundary. It would be flowing from Mississippi into
11 Tennessee.

12 Q. Okay. Is there any other water that flowed out of
13 Mississippi across state lines, according to this
14 predevelopment flow map?

15 A. Yes. You can see over on the left-hand side, you can see
16 the contours. And if you follow the contours, you'll see --
17 well, if you follow the path line that's perpendicular to those
18 contours, you will see the path line leading from, say,
19 Mississippi into Arkansas.

20 Q. And let's look down -- let's get the map larger.

21 How about between Mississippi and Louisiana?

22 A. Yes. You can also see, in areas to the south, you can see
23 potentiometric contours going from 140 to 120 to 110 in the
24 central part of that, indicating flow -- westerly flow from
25 Mississippi into Louisiana.

1 Q. Is that the area near Jackson, Mississippi?

2 A. Yeah. It's off to the west of that area.

3 Q. Okay. And what direction is the water flowing away from
4 Jackson?

5 A. Generally west, or west southwest.

6 Q. And can you show us that it's crossing the state boundary?

7 A. Well, further to the west, it's crossing the state boundary
8 as you go from the 140 contour off to the west.

9 Q. Okay. Let's look at Exhibit J24.

10 This is -- well, first, do you recognize this exhibit?

11 A. Yes. This is a USGS report by Criner & Parks from 1976.

12 Q. Did you rely on this report?

13 A. It was among the reports that I reviewed, yes.

14 Q. Okay. Let's look at Figure 4. What is Figure 4?

15 A. This is a potentiometric surface map of the Memphis Sand.
16 Again, a predevelopmental condition, in 1886.

17 Q. And what does this map show about water flowing out of
18 Mississippi?

19 A. It shows areas where the directions of flow would direct
20 the water -- or the water would be flowing from Mississippi
21 into DeSoto County, into Shelby County of Tennessee.

22 Q. And any other states that you can tell from this map?

23 A. And off to the west, it would be flowing from Tennessee and
24 Mississippi into Arkansas.

25 Q. Okay. Let's go back to J4.

1 Can you remind us what this is.

2 A. Yes. This was the USGS report by Arthur & Taylor in 1998.

3 Q. Let's look at Plate 5, which is at PDF page 64 of J4.

4 What is that?

5 A. These are a series of maps of different aquifer units,
6 and -- illustrating the predevelopment potentiometric contours
7 in the different hydrogeologic units.

8 Q. Well, let's zoom in on the Middle Claiborne Aquifer
9 specifically. What does this map show about flow direction
10 under predevelopment conditions?

11 A. Well, it shows that groundwater flow is crossing state
12 boundaries in different portions of the map.

13 Q. What does this indicate about water flowing out of
14 Mississippi?

15 A. That there's water flowing out of Mississippi into
16 Tennessee in places, into Arkansas in other places, and into
17 Louisiana in other places.

18 Q. Would all the water in Mississippi in predevelopment
19 conditions stay permanently in Mississippi?

20 A. No, it's moving. So over time it will leave Mississippi.

21 Q. Okay. Are there any other cross-border flows that are
22 noteworthy in this particular picture?

23 A. You can also see flow patterns from Arkansas into
24 Louisiana, for example.

25 Q. Okay. And what about between Mississippi and Arkansas?

1 A. Yes. You can see flow in some areas going from Mississippi
2 into Arkansas, and other areas where it's going from Arkansas
3 into Mississippi.

4 Q. What does this map say to you in forming your conclusion
5 about water flow in predevelopment conditions?

6 A. That the water is not static; it's moving. And that the
7 patterns of movement are not impacted by state boundaries.

8 Q. Okay. Let's look at Exhibit D 174.

9 Do you recognize this exhibit?

10 A. Yes. This is a paper written by Waldron & Larsen in 2015.

11 Q. And are you related to the Larsen who was a coauthor of
12 this report?

13 A. No, I'm not.

14 Q. Did you rely on this report in formulating your opinions in
15 this case?

16 A. I reviewed it as part of the -- of the documents that I
17 reviewed for this case.

18 Q. Okay. Let's look at Figure 4. This is D174, PDF page 17.

19 What is that?

20 A. This is a map of the potentiometric -- predevelopment
21 potentiometric surface in the Memphis and near-surrounding
22 area.

23 MR. FREDERICK: Can we zoom in on that a little bit?

24 Q. What does this map show about water flow in predevelopment
25 conditions?

1 A. It shows that -- first of all, that the water is moving
2 from areas of higher potential to low potential, so it's a
3 motion that -- that movement is not influenced by the state
4 boundaries, and water is moving across state boundaries.

5 Q. Can you tell from this map how significant the amount of
6 water is that would be moving across state boundaries in
7 predevelopment conditions?

8 A. I can't tell from looking at the map quantitatively what it
9 is. I can only tell qualitatively that it -- which direction
10 it's going and that sort of thing.

11 Q. Okay. Qualitatively, how would you characterize the
12 significance of the water movement between Mississippi and the
13 adjoining states?

14 A. We can see there's movement along -- according to this map,
15 movement along the Mississippi/Tennessee border, over most of
16 that border region -- in fact, all of it, looks like -- from
17 Mississippi into Tennessee. And also, at least estimated, I
18 would see the map from Tennessee and Mississippi into Arkansas.

19 Q. In your opinion, from a hydrological perspective, does
20 Judge Siler need to decide between the competing predevelopment
21 potentiometric surface maps and models to decide whether the
22 aquifer is interstate?

23 MR. ELLINGBURG: Your Honor, I'm going to object to
24 that question. I think the judge decides what the judge
25 decides.

1 THE COURT: Well, you can make these suggestions. I
2 understand that we don't have a jury, so I'll keep out things
3 that I don't need.

4 BY MR. FREDERICK:

5 Q. Well, I'm asking as a factual matter: Does the state of
6 the potentiometric map and the competing maps inform your view
7 about whether the aquifer is an interstate aquifer?

8 A. Not in terms of the details. It provides an illustration
9 of the motion of groundwater, and it's not being impacted by
10 state boundaries.

11 Q. So in your view, is it important to resolve which map is
12 the best picture of the predevelopment flow levels, flow
13 directions?

14 A. Not in my view, no.

15 Q. Okay. And why is that?

16 A. Because it's really the continuity of the flow in terms of
17 the ability of water to move from one place to another, that
18 that is not -- there's not a barrier to that along state
19 boundaries, and that that continuity is demonstrated by these
20 various maps.

21 Q. Do you have an opinion about defining an interstate
22 resource based on the predevelopment flow patterns?

23 A. No, I don't.

24 Q. Okay. And do you think that the predevelopment maps that
25 we discussed represent all groundwater flow patterns?

1 A. No.

2 Q. You talked at some point about water moving in different
3 directions. How would you model a three-dimensional
4 groundwater flow in predevelopment conditions?

5 A. How difficult is it?

6 Q. Well, how would one do it, if one could?

7 A. Well, you -- first I'd want to go back and collect all the
8 information you could about what conditions you -- had been
9 measured or estimated to exist in those kinds of time frames.
10 And you would have to try to use that information in the
11 development of a model of the conditions associated with that
12 time frame.

13 Q. Has Mississippi attempted to model a three-dimensional
14 groundwater flow model for this aquifer?

15 A. Not to my knowledge, no.

16 Q. Would a model be able to demonstrate predevelopment
17 groundwater flow patterns precisely?

18 A. I don't believe so. I think it would be very difficult.

19 Q. Why is that?

20 A. Because that time period is long gone. And we can't
21 generate new data, so we have to work only with the existing
22 data, and that would make it very difficult, I think.

23 Q. Does your definition of "interstate aquifer" depend upon
24 the specific predevelopment flow patterns?

25 A. No, it does not.

1 Q. Why?

2 A. Because in my view, the determining factors, or factors
3 that I believe support my conclusion, are the continuity of the
4 materials and the characteristics of the aquifer; the fact that
5 the aquifer is interconnected to other aquifers and streams
6 that are also interstate in nature; and that the water movement
7 from one place to another is not -- there's not a barrier along
8 state boundaries that would prevent that movement, and there's
9 not a barrier that would prevent the effects of groundwater
10 development in one state from propagating into an adjoining
11 state.

12 Q. Okay. If we were able to model predevelopment flow
13 patterns within the Middle Claiborne Aquifer accurately, would
14 you consider Mississippi's theory to be practical?

15 A. No, I don't believe so.

16 Q. And why is that?

17 A. Because I think there's a number of issues that would have
18 to be resolved about the definition of what might constitute,
19 say, an interstate flow path.

20 For example, if the flow path leads from Mississippi
21 into Arkansas before discharging into the Mississippi River,
22 for example, does that make it interstate? Does the -- if the
23 flow path goes into Arkansas and then back into Mississippi and
24 then discharges to the river, would that make it interstate?

25 I think there's a number of questions just defining

1 what might -- what that flow path might need to be in order to
2 be characterized as interstate, and then you would have the
3 difficulty of actually trying to quantitatively assess those in
4 a three-dimensional sense.

5 Q. Is there any water that would permanently remain under
6 Mississippi, based on current flow patterns?

7 A. No, not -- not in my opinion.

8 Q. Okay. I'm showing you Exhibit J71. We've already looked
9 at this one. This is the Schrader 2008.

10 Can you remind us what that is?

11 A. This is the potentiometric surface map, prepared by
12 Schrader, of the conditions in the aquifer in 2007.

13 Q. And what do the arrows represent?

14 A. They indicate directions of groundwater movement within the
15 aquifer in various locations.

16 Q. Let's zoom in on the area in Northern Mississippi right
17 below the 35th parallel. Do you see where that is?

18 What do the arrows show in that part of the map?

19 A. That groundwater is moving, say, from -- there's an arrow
20 that indicates groundwater is moving in a northwesterly
21 direction across the Mississippi/Tennessee border into the cone
22 of depression, and also from the north into that area.

23 And off to the west, in Crittenden County in Arkansas,
24 there's migration more in an easterly direction toward the
25 center of the cone of depression.

1 Q. Okay. And how does -- how do those arrows showing the flow
2 pattern support your overall conclusion?

3 A. Well, they show that the effects of pumping can be
4 transmitted beyond state boundaries, and the state boundaries
5 look like barriers to the effects of pumping being transmitted
6 across state lines.

7 Q. Now, you mentioned a fourth factor. Can you tell us what
8 the fourth basis of your opinion is?

9 A. Yes. That the USGS, I believe, has recognized that the
10 Middle Claiborne Aquifer and the -- and other aquifers within
11 the Mississippi Embayment Regional Aquifer System are regional
12 in scope, and need to be evaluated on a regional scale that
13 would include a scale encompassing more than one state.

14 Q. Why is that important to your analysis?

15 A. Because I think it demonstrates that they're effectively
16 considering the Mississippi -- or the Middle Claiborne Aquifer
17 hydrogeologic unit to be an interstate resource.

18 Q. Okay. And can you remind us again what role the USGS
19 serves?

20 A. Well, one of their missions is basically monitoring and
21 evaluating our nation's water resources. And as you can see
22 from these reports, there are a number of studies that they've
23 undertaken to evaluate things on a regional basis.

24 Q. Can you explain what kind of regional analyses the USGS
25 does?

1 A. Yeah. Well, one in particular was in the mid-70s, when I
2 was actually still working at the USGS, they started a program
3 of regional aquifer studies called the RASA program, R-A-S-E --
4 R-A-S-A. And the purpose of that was to evaluate these aquifer
5 systems that were large-scale in nature, regional in nature,
6 fully -- rather than in sort of a piecemeal fashion, say,
7 within certain political subdivisions, like within certain
8 states or within a certain counties.

9 Q. Why do you believe that is important to the USGS?

10 A. Because I believe they wanted to provide evaluations and
11 tools that could be used to assess the regional character of
12 the system and how effects could propagate beyond state lines,
13 for example.

14 Q. Has the USGS analyzed the Mississippi Embayment as part of
15 that process?

16 A. Yes, it has.

17 Q. Do you know what publication or publications it has done
18 so?

19 A. Well, there are a number of them. One of the more recent
20 ones we've looked at is the reports on the Mississippi
21 Embayment Regional Aquifer System.

22 Q. Okay. I'm showing you slide J4 -- Exhibit J4. Can you
23 turn to page five and read the second sentence, please.

24 This is Arthur & Taylor's 1998 publication that was
25 prepared as part of the RASA; is that right?

1 A. The second sentence reads, "In general, the boundaries of
2 these studies are identified by the hydrologic extent of each
3 system, and accordingly transcend the political subdivisions to
4 which investigations have often been arbitrarily limit --
5 limited in the past."

6 Q. Okay. Did Arthur & Taylor study the Middle Claiborne
7 Aquifer on a regional basis?

8 A. Yes, they did.

9 Q. Do other USGS publications indicate a -- an interest in
10 studying the aquifer on a regional scale?

11 A. Yes, there are others.

12 Q. Okay. I'm going to show J25. This is the Cushing 1964
13 study. This is Exhibit J25.

14 What is this?

15 A. This is a report on the Mississippi Embayment by Cushing
16 and others in 1964, a USGS report.

17 Q. Could I ask you to turn to page B5, which is PDF page five.

18 Can you read the second and third sentences beneath
19 the heading "Introduction."

20 A. "Most of the water resources investigations in the
21 Embayment have been made in cooperation with state, county, and
22 municipal agencies and have been restricted to local areas
23 where the need for information was urgent -- was most urgent.
24 Reports on these studies give valuable information on parts of
25 the Embayment, but they do not treat the subject of water

1 resources on a regional basis."

2 Q. Did the Cushing study examine the aquifer on a regional
3 basis?

4 A. Yes, it did.

5 Q. What year was their study conducted?

6 A. 1964.

7 Q. I'm showing you what's been marked as J71. This is
8 Schrader's 2008 report on the Middle Claiborne Aquifer, which
9 we've already discussed.

10 Does that report indicate what USGS's goal in
11 undertaking that study was?

12 A. Yes.

13 Q. And what is -- what was the goal, as you understand it?

14 A. This was part of the regional aquifer assessment program,
15 trying to characterize and study the aquifer system on a
16 regional basis.

17 Q. Now, I want to go to the introduction. This is J71. Do we
18 have a page number?

19 This is a one-page exhibit, I'm informed. Could you
20 read the highlighted passage there, please.

21 A. "Regional assessments of water-level data from the aquifer
22 are important to document regional water-level conditions and
23 to develop a broad view of the effects of groundwater
24 development and management on the sustainability and
25 availability of the region's water supply. This information is

1 useful to identify areas of water-level declines, identify
2 cumulative areal declines that may cross state boundaries,
3 evaluate the effectiveness of groundwater management strategies
4 practiced in different states, and identify areas with
5 substantial data gaps that may preclude effective management of
6 groundwater resources."

7 Q. What do you understand, Mr. Larson, these passages to
8 indicate about the USGS's view about the interstate nature of
9 the aquifer?

10 MR. ELLINGBURG: Your Honor, I'm going to object to
11 that. There's no foundation for this. He asked him what he
12 understands.

13 THE COURT: Objection sustained.

14 (Reporter clarification)

15 THE COURT: Do you want to rephrase your question?

16 MR. FREDERICK: Sure.

17 BY MR. FREDERICK:

18 Q. In reviewing these reports, you read these passages,
19 correct?

20 A. Yes.

21 Q. And what -- how did they inform your view about the USGS's
22 recognition of the aquifer as an interstate resource?

23 MR. ELLINGBURG: Your Honor, I object again. There's
24 no foundation. I mean, you read them. I've read them.

25 THE COURT: Well, he's an expert. Once again, I'll

1 overrule your objection.

2 You may answer the question.

3 A. They indicated to me that the USGS was concerned about
4 providing information and evaluations on a regional basis that
5 wouldn't be limited to certain geographic areas, or smaller
6 geographic areas, as had happened in the past, and they wanted
7 to provide a tool and evaluation that was not limited by the
8 boundaries of some of those earlier investigations and could
9 provide a broad regional analysis, including analyses across
10 the boundaries that they felt was necessary.

11 Q. And would they have evaluated pumping in connection with
12 those analyses?

13 MR. ELLINGBURG: Your Honor, I'm going to object to
14 what they would have done.

15 THE COURT: Well --

16 MR. FREDERICK: Did they evaluate pumping?

17 THE COURT: I'll overrule the objection.

18 Go ahead and ask him the question.

19 A. Yes.

20 Q. Could you read the first two sentences on this slide,
21 please, Mr. Larson, to satisfy those of us in the courtroom who
22 are doubters.

23 A. "The most widely used aquifer for industry and public
24 supply in the Mississippi Embayment in Arkansas, Louisiana,
25 Mississippi, and Tennessee is the Sparta Memphis Aquifer.

1 Decades of pumping from the Sparta Memphis Aquifer have
2 affected groundwater levels through the Mississippi Embayment."

3 Q. Is the Sparta Memphis the same as the Middle Claiborne
4 Aquifer?

5 A. Yes.

6 Q. I'm showing you what's been marked as Exhibit J15.

7 What is this?

8 A. This is a report, a USGS report by Brahana and Broshears in
9 2001, discussing their evaluation of groundwater flow in the
10 Memphis -- in the Memphis area.

11 Q. Did you hear Mississippi's experts testify that they were
12 relying on this model?

13 A. Yes.

14 Q. Could you turn to PDF page ten. And I'd ask you to read
15 the sentence that I've highlighted, please.

16 A. "Although the study focuses on the Memphis area, the
17 aquifers and confining units are regional in occurrence and
18 extend far beyond the Memphis area boundaries."

19 Q. How long has the USGS recognized the Middle Claiborne
20 Aquifer as an interstate aquifer?

21 MR. ELLINGBURG: I'm going to object to that.

22 THE COURT: Overruled.

23 You may answer the question.

24 A. Well, they've recognized the regional nature of it, and
25 they -- implicitly, I think, the interstate nature of it for

1 50 years or more.

2 Q. Let's look at Exhibit J7. This is the Bell & Nyman 1968
3 study.

4 Can you tell us what this is?

5 A. This is a report describing the groundwater conditions in
6 the 500-Foot Sand in the Memphis area by Bell & Nyman in 1968.

7 Q. Did this paper analyze the aquifer at issue in this case?

8 A. Yes, it did.

9 Q. How do you know that?

10 A. Because reading the report, and what they're describing,
11 you come to understand that the 500-Foot Sand is synonymous
12 with Memphis Sand, or the Middle Claiborne Aquifer, in the
13 Memphis area.

14 Q. How does this report support your conclusion about the
15 USGS's recognition of the Middle Claiborne Aquifer as an
16 interstate aquifer?

17 A. Because it describes the regional nature of it and the
18 extent of it.

19 Q. Okay. Let's go back to the demonstrative. Let's just keep
20 that -- all right.

21 So that would represent your fourth basis of your
22 conclusion, Dr. Larson?

23 A. Yes.

24 Q. And why do those reports support your conclusion about the
25 nature of the Middle Claiborne Aquifer?

1 A. Because I believe collectively they recognize the regional
2 nature of the resource, and they recognize that those
3 characteristics transcend state boundaries and are interstate
4 in nature.

5 Q. Is the USGS authoritative in this area?

6 A. I believe they are, yes.

7 Q. Why?

8 A. Well, first of all, when I worked there for many years,
9 they had a very comprehensive system, a robust system for
10 review and evaluation of the reports that they prepared. And
11 it was -- it's a peer-review-type process. So they took steps
12 to ensure that their work was -- their work was appropriate and
13 up to the standards.

14 And they are really the chief agency within the United
15 States for -- with a mission to monitor and evaluate water
16 resources, both surface water and groundwater resources within
17 the United States.

18 Q. Mr. Larson, I'd like to turn to any opinions that you have
19 about testimony that you have heard in this hearing. Did you
20 hear Dr. Spruill's claim that you should consider the water as
21 an interstate resource separate from the aquifer?

22 A. Yes, I did.

23 Q. What is your opinion about that statement?

24 A. My opinion is that you can't separate the water from the
25 geologic materials that the water is in, because it's the

1 combination of the geologic materials and the water that make
2 an aquifer. And if you had geologic materials but no water,
3 you wouldn't have an aquifer.

4 Q. Okay. So an aquifer cannot exist without water?

5 A. No. The water is an integral part of the definition of an
6 aquifer.

7 Q. Were you in the courtroom earlier, when both of
8 Mississippi's experts testified repeatedly about the rate of
9 groundwater flow and residence time?

10 A. Yes.

11 Q. In your opinion, is the rate of groundwater flow within the
12 Middle Claiborne material to your conclusion that the aquifer
13 is interstate?

14 A. No, it's not.

15 Q. Why not?

16 A. Because it's a fact that the -- in my view, it's a fact
17 that the water is moving, and that recharge and discharge are
18 occurring all the time; even today, as we speak, there's water
19 discharging from the aquifer -- from Mississippi, for example.

20 And so in my view, it's that movement and continuity
21 of the aquifer that determines or supports the conclusion that
22 the resource itself is an interstate resource.

23 Q. Is water continually flowing out of the State of
24 Mississippi within the Middle Claiborne Aquifer?

25 A. Yes.

1 Q. Why did you consider that fact?

2 A. Because that fact is -- shows that there's not a permanent
3 amount of water that's -- or a permanent store of water, if you
4 will, that's just residing in Mississippi and is not moving.

5 Q. Does residence time have any effect on your opinion about
6 the interstate nature of the aquifer?

7 A. No, it does not.

8 Q. From a hydrological standpoint, does "storage" mean that
9 there is a certain amount of water that permanently resides
10 within the aquifer in Mississippi?

11 A. No, it does not.

12 Q. On a general level, what do hydrologists mean by "storage
13 characteristics"?

14 A. Well, the storage characteristics that we talk about and
15 use when we're evaluating aquifers is really a determination of
16 how the potentiometric levels will -- or it's a parameter or
17 characteristic that will determine how potentiometric levels
18 will change when the aquifer is pumped.

19 And there will be different characteristics in, say,
20 confined areas versus unconfined areas, but it doesn't reflect
21 the overall body of water or amount of water that's in the
22 aquifer itself.

23 So, for example, a confined aquifer may remain
24 saturated even though potentiometric levels have changed.

25 Q. Does the Middle Claiborne Aquifer have storage

1 characteristics?

2 A. Yes, it does.

3 Q. Has the portion of the Middle Claiborne Aquifer beneath
4 Mississippi always contained water?

5 A. Yes, it does.

6 Q. Is it the same water?

7 A. No. It's moving from place to place.

8 Q. Is it possible to isolate out the water that would have
9 remained beneath Mississippi for a very long time?

10 A. Well, it's possible to look at how -- generally how fast
11 things are moving, but it's not possible to follow individual
12 molecules of water.

13 Q. And what is your conclusion from that?

14 A. My conclusion is that the rate of movement is not -- is not
15 a determiner of whether the resource is an interstate resource.
16 It simply reflects the fact that there's continuity to the
17 groundwater system and groundwater movement.

18 Q. Mr. Larson, were you in the courtroom when Dr. Spruill
19 addressed case two, which is defense Exhibit 130 from his
20 opening expert report, where he identified what he claimed to
21 be an interstate aquifer with intrastate flow?

22 A. Yes, I was.

23 Q. Let's look at the slide. Is this that hypothetical?

24 A. Yes.

25 Q. Can you briefly describe what you take away from this

1 hypothetical picture?

2 A. Well, my understanding was that the hypothetical --
3 hypothesized that an interstate aquifer, that's an aquifer that
4 spans multiple states, but that the flow patterns within each
5 of these two states, as they're depicted on here, were
6 perfectly parallel to the boundary between the two states, and
7 that the water -- all the water would discharge into a river
8 that transcended the states from north to south.

9 Q. Now, let's assume for a moment that the flow lines in this
10 hypothetical were correct. Would you consider a formation
11 including water in it flowing from these directions to be an
12 interstate resource?

13 A. Yes, I would.

14 Q. Why?

15 A. There's a couple of reasons that come right out in my view.
16 Number one, the discharge of the water into the river; the
17 river would then carry the water, say, from State A to State B
18 and out of State B. The river would be an interstate resource,
19 and these aquifers would be interconnected to that interstate
20 resource.

21 But also, there is no barrier to the connection
22 between State A and State B, such that if you pumped water from
23 State A, you can affect the conditions in State B, and vice
24 versa.

25 Q. Okay.

1 A. I think that would make it interstate in nature.

2 Q. In this hypothetical, could either state develop resources
3 in the border area without affecting the water in the other
4 state?

5 A. No.

6 Q. Why is that?

7 A. Because the pumping effects will spread out, and if there's
8 no complete barrier to any aquifer between one state and the
9 other, those effects would propagate across the state line.

10 Q. Mr. Larson, in your view, is this hypothetical an accurate
11 representation of Middle Claiborne at issue here, according to
12 Mississippi's own experts?

13 A. No, I don't believe so.

14 Q. And why is that?

15 A. First of all, the -- when you look at the layout of the
16 states, the situation that we have in the real world is that on
17 one side of the river, we have Mississippi and Tennessee; but
18 on the other side of the river, we don't have the same states.
19 We have Arkansas.

20 The other thing is that when you look at the actual
21 flow patterns, based on some of the maps that we've looked at,
22 there's not flow, equal flow, parallel flow, to -- toward this
23 river boundary from both sides. But there's flow patterns that
24 go under the river from one side to the other, which would
25 actually take it from a state like Tennessee or Mississippi, on

1 the right side, into Arkansas, on the left side.

2 Q. Okay. Let's look at Exhibit D112.

3 What is this figure?

4 A. This is a diagram from one of the reports by Mr. Wiley.

5 Q. Is this the famous yellow triangle map?

6 A. Yes, it is.

7 Q. Okay. And what is it -- what is this figure showing?

8 A. It's illustrating estimated groundwater flow pathways from
9 various portions of the aquifer, and where those pathways would
10 lead.

11 Q. And where does it show water flowing from Mississippi?

12 A. It shows water flowing from Mississippi into Tennessee from
13 the yellow triangle area. It also shows water flowing from
14 Mississippi into Arkansas, over on the left-hand side.

15 Q. Does this diagram support your critique of Dr. Spruill's
16 hypothetical?

17 A. Yes.

18 Q. Okay. Now, Mr. Larson, did you hear the claim made earlier
19 this week that Memphis and MLGW's wellfields are not properly
20 designed, and that the resulting cone of depression in the
21 aquifer is injuring Mississippi?

22 A. Yes.

23 Q. What is your opinion of that allegation that Tennessee's
24 pumping is somehow depriving Mississippi of its ability to use
25 the Middle Claiborne Aquifer?

1 A. Well, my understanding is that -- that the claim is that
2 there is -- there is some -- water declines from the cone of
3 depression and propagated into Mississippi. As far as I'm
4 aware, water supply users in Mississippi have been able to
5 increase their water supply significantly over the last several
6 decades, and I'm not aware of any difficulties that they're
7 having in terms of obtaining their water supply.

8 Q. What does the ability to have a higher level or to increase
9 pumping say to you about the availability of water in
10 Mississippi?

11 A. That indicates to me that they're being able to increase
12 their water supply to meet increasing demand.

13 Q. Has Mississippi presented any evidence that you've seen
14 indicating that Mississippi has difficulty increasing its
15 pumping?

16 A. No, I haven't.

17 Q. Mr. Larson, have you testified in an equitable
18 apportionment action previously?

19 A. Yes, I have.

20 Q. Or should I say, have you provided expert analysis?

21 A. Yes, I have. I have provided analysis in --

22 Q. In what case?

23 A. In the South Carolina/North Carolina matter.

24 Q. And can you describe briefly what that case entailed.

25 A. It entailed looking at surface waters in the Catawba River,

1 and the regulation and use of those surface waters and how
2 the -- that regulation and use of the water impacted stream
3 flow conditions in downstream areas.

4 Q. And what was the central allegation by South Carolina, as
5 you recall?

6 A. That North Carolina was taking more than their share of the
7 water.

8 Q. In that case, did the -- did you consider the complaint of
9 South Carolina had showed a real and substantial injury?

10 A. Yes, I thought so.

11 Q. Okay. In your opinion, can Mississippi show a real and
12 substantial injury to its ability to use water in the Middle
13 Claiborne Aquifer?

14 MR. ELLINGBURG: Your Honor, I'm going to object,
15 because that's not even the issue in this case.

16 THE COURT: Well, it's not. But you're going to put
17 it in, and I'll let you put it in.

18 MR. FREDERICK: Thank you, your Honor.

19 Q. In your opinion, can Mississippi show a real and
20 substantial injury to its ability to use water in the Middle
21 Claiborne Aquifer?

22 A. Not that I'm aware of.

23 Q. And why is that?

24 A. Because it doesn't appear that -- as I said a moment ago,
25 that the ability of Mississippi to continue to develop the

1 groundwater resource within Mississippi continues to exist;
2 that they can continue to increase their water use.

3 Q. Did you hear the testimony about supposed increased costs
4 in raising the water additional feet because of a lowering of
5 the potentiometric head?

6 A. Yes, I did.

7 Q. Compared to the damages that Mississippi is seeking in this
8 case, how big would any possible damages associated with
9 increased energy costs to lift the water additional feet be?

10 MR. ELLINGBURG: Your Honor, if I could object. This
11 wasn't in the report. It wasn't the subject of discovery, and
12 it wasn't -- this was not within any parameter of the issues.

13 THE COURT: I realize this was not in your direct, but
14 I'll let you put it in, because I think that Mississippi raised
15 it to some degree by their expert witness.

16 MR. FREDERICK: Thank you.

17 Q. Would you like me to repeat the question?

18 A. Yes, please.

19 Q. Compared to the damages Mississippi is seeking in this
20 case, how big would any possible damages associated with
21 increased energy costs to lift the water additional feet be?

22 A. I think that they would be much smaller than those claimed
23 damages.

24 Q. Did you hear Mr. Wiley testify that the amount of water
25 flowing from Mississippi to Tennessee has been decreasing?

1 A. Yes, I did.

2 Q. And did he suggest an explanation for that decrease?

3 A. Yes, he did.

4 Q. What was his explanation, as you understood it?

5 A. Well, as I understood it, he concluded that some of it was
6 due to reduced pumping in the Memphis area, but also increased
7 pumping from wells in Mississippi.

8 Q. I'm showing you what plaintiffs have marked as
9 Exhibit P183. Do you recognize this figure?

10 A. Yes, I do.

11 Q. What is it?

12 A. This is one of the figures from Mr. Wiley's report.

13 Q. What does it purport to show?

14 A. It shows groundwater flow paths from areas on the
15 right-hand portion of the diagram toward pumping centers within
16 Tennessee.

17 Q. Where did you first see this figure?

18 A. When I was reviewing Mr. Wiley's reports.

19 Q. Okay. And did you review those reports in connection with
20 your rebuttal report?

21 A. I did.

22 Q. Okay. Does this map depict any water flowing to wells in
23 Northern Mississippi?

24 A. No, it does not.

25 Q. In your opinion, is that consistent with Mississippi's

1 theory that pumping in Northern Mississippi has reduced the
2 groundwater flow from Mississippi to Tennessee by more than ten
3 billion gallons per day?

4 A. No, it does not.

5 Q. Why?

6 A. Because that -- the rate of pumping -- or the increases in
7 the rate of pumping in the -- from the areas in Northern
8 Mississippi were up to almost 20 million gallons per day. One
9 would expect some of the flow paths would have to lead into
10 those wells, because that amount of water was being extracted
11 from the area north of Mississippi.

12 Q. So we've been talking just a bit about Mississippi's
13 pumping in the Middle Claiborne Aquifer. In what level of
14 detail did you study the Mississippi pumping?

15 A. Only generally. I reviewed some of the work that Mr. Wiley
16 had done in compiling that information.

17 Q. Why did you not undertake a more significant study of
18 Mississippi pumping?

19 A. Because that wasn't necessary for me to determine whether
20 or not the Middle Claiborne Aquifer was an interstate water
21 resource.

22 THE COURT: I think we'll take a short recess at this
23 time. Ten minutes.

24 MR. FREDERICK: Thank you.

25 (Recess)

1 THE COURT: All right. You may continue with your
2 questions.

3 MR. FREDERICK: Thank you, Judge Siler.

4 BY MR. FREDERICK:

5 Q. When we broke, Mr. Larson, we were talking about pumping on
6 the Mississippi side of the boundary. Does pumping in
7 Mississippi have any relevance to whether the aquifer is
8 interstate?

9 A. I don't believe the pumping itself does, no.

10 Q. Do the effects of the pumping show any relevance to whether
11 the aquifer is interstate?

12 A. Well, the ability of pumping to create effects that can
13 transcend state boundaries does have relevance, in my view, but
14 not the amount.

15 Q. Okay. So is a detailed analysis of the pumping volumes
16 relevant to whether the aquifer is interstate?

17 A. No, I don't believe so.

18 Q. Does the absolute or relative volume of the groundwater
19 flow between Mississippi and Tennessee have any bearing on
20 whether the aquifer is interstate?

21 A. Not in my opinion, no.

22 Q. Why is that?

23 A. Because in my view, it's the continuity of the materials
24 and characteristics and the ability of water to move one way or
25 the other across the boundaries that determine -- or that are a

1 factor in determining whether it's an interstate resource.

2 Q. Have you looked at the effect of pumping in these other
3 states in the Middle Claiborne Aquifer?

4 A. Yes, I've seen references to that in various documents and
5 reports.

6 Q. Okay. And in your experience, would a detailed analysis of
7 pumping volumes be performed for the Middle Claiborne in an
8 equitable apportionment case?

9 A. Yes, I believe that those kinds of issues -- or those kinds
10 of factors could be factors that would be considered in an
11 equitable apportionment.

12 Q. In your opinion, how large of an undertaking would it be to
13 perform a detailed study of Mississippi's pumping in the Middle
14 Claiborne Aquifer?

15 A. I think it would be a significant effort. USGS has done
16 some, but you'd probably have to supplement that considerably.

17 Q. And Mr. Larson, I'd like to shift gears a little bit. What
18 has happened to water levels in the Middle Claiborne Aquifer in
19 the Memphis area in recent years?

20 A. The water levels -- the potentiometric level of water
21 levels over the last, say, 20 or 30 years or so have been
22 relatively stable, and have even shown increases in more recent
23 years.

24 Q. What does that tell you, as a trained hydrologist, about
25 recharge and discharge within the aquifer?

1 A. That while there was an initial decline, say, prior to the
2 1970s, that a leveling-off would indicate that there's been
3 more of a balance between recharge and discharge, allowing the
4 potentiometric levels to become relatively stable.

5 Q. How do you know that water levels in the Middle Claiborne
6 Aquifer in the Memphis area have remained relatively stable?

7 A. By reviewing both hydrographs that were contained in some
8 of the reports, and also reviewing data that was available from
9 the USGS on their water information system.

10 Q. I'm showing you Exhibit J18. This is the Clark & Hart 2009
11 report, which we've already discussed.

12 Can you remind us what this report is?

13 A. This is the report by Clark & Hart in 2009 documenting
14 their development of the groundwater flow model of the MERAS.

15 Q. Okay. Let's turn to Figure 16, which is joint Exhibit 18
16 at PDF page 57.

17 What is this?

18 A. These are a series of hydrographs, the ones on the left
19 being hydrographs in various parts of the alluvial aquifer and
20 ones on the right in various parts of the Middle Claiborne
21 Aquifer.

22 Q. Now, remind us again, where is the alluvial aquifer in
23 relation to the Middle Claiborne Aquifer?

24 A. The alluvial aquifer extends along -- basically along the
25 axis of the Mississippi River, and it is the uppermost aquifer

1 above the Middle Claiborne and other hydrogeologic units.

2 Q. And do I understand there to be pumping out of the alluvial
3 aquifer?

4 A. Yes, there is.

5 Q. And obviously we've been talking about pumping out of the
6 Middle Claiborne Aquifer?

7 A. Yes.

8 Q. And what does this page purport to show about that
9 comparative pumping in these locations?

10 A. Well, each hydrograph shows two types of information; one
11 results from calculations using the groundwater model, and
12 that's shown in sort of the red characters or boxes on the
13 charts. And then there is the blue data that was actually
14 collected in a well, in particular wells, at the same
15 locations.

16 Q. Did you consider this figure in reaching your conclusions?

17 A. Yes.

18 Q. Do any of these charts depict a well that you analyzed in
19 Tennessee?

20 A. Yes. If you look at Well Number J, in Shelby County.

21 Q. And would this be the well -- or the pumping that's at
22 issue in this case?

23 A. This is a well in the area of pumping associated with the
24 City of Memphis.

25 Q. What does this graph demonstrate?

1 A. It illustrates that during the period, say, from about --
2 well, it starts in 1870, but if you look at the data beginning
3 in about 1930, there's a period of water decline extending into
4 1970s. But after that, the water levels have stopped declining
5 and in fact, toward the end of the period of data here, of year
6 2010, they've actually increased some.

7 Q. What does that relative stability of the groundwater levels
8 mean for aquifer equilibrium?

9 A. It indicates that there's a relative balance between
10 groundwater recharge and groundwater discharge in the area.

11 Q. So does that mean that the amount that's being discharged
12 is more or less in equilibrium with the amount that's being
13 recharged?

14 A. Yeah, they're in a rough balance between recharge and
15 discharge.

16 Q. Did you look at graph K on this same figure?

17 A. Yes, I did.

18 Q. What does that represent?

19 A. That represents information from an area down near Jackson,
20 Mississippi.

21 Q. What does it show?

22 A. Well, it shows that the groundwater-level decline is
23 beginning in the 1930s and persisted and continued to occur at
24 the end of the period of record here, in 2010.

25 And you could see from the blue, the trend in the

1 blue, it's continuing to decline out to 2010 at a little
2 steeper rate than what the model was projecting.

3 Q. Do you have an opinion about the cause of that decrease?

4 A. Well, it's in response to groundwater pumping. And it
5 hasn't reached a point where it's begun to stabilize, at least
6 at this point in time.

7 Q. And this is pumping done for the Jackson, Mississippi,
8 area; is that right?

9 A. It's pumping from that particular area, yes.

10 Q. And how does the overall decrease in the water levels
11 compare to the figure we just looked at for Shelby County,
12 Tennessee?

13 A. Well, the overall decrease goes from maybe an elevation of
14 200 down to what looks like about 50, so 150 feet as opposed to
15 maybe about 75 or 80 feet --

16 Q. Okay.

17 A. -- in the Shelby County area.

18 Q. Did you consider Figure G?

19 A. Yes, I did.

20 Q. And what is that?

21 A. This is a location in Jefferson County, Arkansas.

22 Q. Do you know approximately where Jefferson County, Arkansas,
23 is?

24 A. Yeah. Roughly, it -- it's in an area where some
25 significant water declines have occurred.

1 Q. Okay. If I represented to you that it's central
2 Arkansas --

3 A. Yes.

4 Q. Okay. And what has happened to the water levels there?

5 A. Well, you can see at or around the year -- or just beyond
6 the year 1950, that there was a sharp decline in the water
7 levels for a period of decades leading out into the 1970s or
8 1980s, and after that, again, the period where persistent
9 declines are not continuing.

10 Q. And how do the water level decreases in Jefferson County,
11 Arkansas, compare to the water levels in Shelby County,
12 Tennessee?

13 A. Well, the declines here look to be more on the order of
14 200 feet or thereabouts, or 100.

15 Q. Did you consider Figure I in your analysis?

16 A. Yes, I did.

17 Q. And where is that?

18 A. This is in Union County, Arkansas, down more near the
19 border with Louisiana.

20 Q. Okay. And what's happening to the water levels in Union
21 County, Arkansas?

22 A. You can see that there's again a fairly -- a period of
23 fairly steep decline, beginning in -- before 1950s and
24 descending out into 1970s, followed by a period of relative --
25 relatively more stable groundwater levels, so potentiometric

1 levels.

2 Q. And how does the overall decrease in the water levels in
3 Union County, Arkansas, compare to the water levels we just
4 looked at for Shelby County, Tennessee?

5 A. Well, this particular location, as well, looks like it's
6 more on the order of 200 feet.

7 Q. Okay. And all of these that we've just looked at --
8 G, I, J, K -- are all from the Middle Claiborne Aquifer; is
9 that correct?

10 A. Yes, that's correct.

11 Q. Okay. Now, I want to return to a different picture that
12 we've looked at. This is Figure 14B, Exhibit J19 and PDF
13 page 34 from the Clark & Hart study.

14 Remind us again what this shows.

15 A. This is a map depicting the amount of water level or
16 potentiometric level change between predevelopment times and
17 2007.

18 Q. Okay. And what do the different colors represent, and how
19 does this depict the relative change in water levels?

20 A. The colors represent different ranges of estimated
21 water-level decline, with the darker brown colors
22 representing -- the darkest brown colors representing the most
23 significant -- the largest declines, and the lighter colors
24 representing less declines.

25 Q. What are the areas of greatest drawdown?

1 A. Well, you can see the area, very dark brown, with an area
2 centered in Southern Arkansas, and another area near that in
3 Louisiana, where they have the darkest brown color. Those are
4 probably the area -- or those as depicted on here are the
5 most -- the largest -- areas of the largest decline.

6 And then north of that, also in Arkansas, is another
7 area of relatively larger declines, although not as severe as
8 the ones to the south.

9 And then there's also declines over in the area of
10 Jackson, Mississippi, and to a lesser degree, up in the area of
11 Memphis.

12 Q. And how does this map reflect the information on the graph
13 that we just looked at?

14 A. These hydrographs, at least most of them, are taken from --
15 at least the ones in the Middle Claiborne are taken from areas
16 within or near these significant areas of water-level decline.

17 Q. What does this diagram show you about pumping in adjoining
18 states?

19 A. Well, what you can see is that the effects of pumping in
20 adjoining states extends across the state boundaries, and
21 overlap across the state boundaries from one state to another.

22 Q. Can you be more specific in describing the effects of
23 cross-border pumping?

24 A. It's actually the cross-border impacts, but --

25 Q. Thank you.

1 A. If you look down at the area that spans the border between
2 Louisiana and Arkansas, you can see how the impacts have
3 coalesced across a boundary. If you look at the area to the
4 north of that, you can see areas in Arkansas that have expanded
5 or have propagated out across the Mississippi -- underneath the
6 Mississippi River into Mississippi, although there's also some
7 areas of pumping in Mississippi in that same area.

8 Similarly, down around Jackson, you can see how the
9 pumping has spread out there, reaching out to the Mississippi
10 River and slightly into Louisiana.

11 Q. And in terms of the color depicted for the water-level
12 drawdowns, how does Shelby County, Tennessee compare to those
13 other three darker areas in Central Arkansas, the
14 Arkansas/Louisiana border, and the Jackson, Mississippi area?

15 A. Well, you can see the color shading is lighter in the area
16 of Memphis, indicating that the amount of decline in the
17 Memphis area is less than those other areas that you mentioned.

18 Q. Would the pumping in these various areas typically be
19 considered in an equitable apportionment action, in your
20 professional experience?

21 A. In my experience, the amounts of pumping and the impacts of
22 those pumping would be things that would be considered in that
23 kind of an action.

24 Q. Is the volume of pumping by different states important to
25 determining whether the aquifer is interstate?

1 A. No, I don't believe so.

2 Q. Why is that?

3 A. Because it's really the ability of pumping in one state,
4 for example, to impact other states, and the continuity of the
5 aquifer and its characteristics that give it the -- in my view,
6 determine whether it's an interstate resource. The volume of
7 the pumping is not a specific factor.

8 Q. Mr. Larson, I'd like you to take a look at Figure 4 from
9 the same report.

10 What is this figure showing?

11 A. This figure shows -- or characterizes land use patterns
12 within the Mississippi Embayment Regional Aquifer Area.

13 Q. And when you say "land use," what does that mean, in lay
14 terms?

15 A. Well, it kind of characterizes what's going on at the
16 surface of the land; whether it's a populated area. For
17 example, urban -- urban characterization would indicate that
18 it's a populated area, and the degree of color would indicate
19 the density in the population.

20 Similarly, for example, the yellow area would indicate
21 areas where there are cultivated crops over -- over the area of
22 the Embayment. .

23 MR. ELLINGBURG: Your Honor, can I just have a -- can
24 Mississippi have a continuing objection to these questions that
25 are outside the scope of anything that we're talking about?

1 THE COURT: All right. That's overruled.

2 You may continue.

3 MR. FREDERICK: Thank you, your Honor.

4 BY MR. FREDERICK:

5 Q. What does the land use in the urban red tell you about the
6 areas of urban use in the Middle -- in the area affected by the
7 Middle Claiborne Aquifer?

8 A. Well, it indicates that the largest and most populous areas
9 would be around the City of Memphis, and the other areas would
10 be relatively smaller.

11 Q. Did you look at all of the different uses throughout the
12 Mississippi area?

13 A. Not in detail, but I'm aware of them.

14 Q. And why did you not look at them in detail?

15 A. Because it wasn't necessary for me to know the details in
16 order to determine whether or not the aquifer was an interstate
17 water resource.

18 Q. Thank you, Mr. Larson.

19 MR. FREDERICK: We'll pass the witness.

20 THE COURT: All right.

21 You're going next, for Mississippi?

22 MR. ELLINGBURG: Yes, your Honor.

23 THE COURT: Or Memphis first?

24 MR. ELLINGBURG: I don't know, Memphis and --

25 MR. D. BEARMAN: We have no cross.

Larson - cross

1 Now, has your experience primarily been in the area of
2 modeling?

3 A. I would characterize it more in the area of hydrology, and
4 specifically groundwater hydrology. Modeling -- I have
5 experience in modeling, and that's certainly one component of
6 my work.

7 Q. Thank you.

8 Now, you testified to this, but I'd like a little more
9 detail. You isolated out a statement in Judge Siler's
10 memorandum decision, said the threshold issue in this matter is
11 whether the aquifer is an interstate resource. Right?

12 A. Yes.

13 Q. And so you've focused everything on that one statement,
14 right?

15 A. Yes. That was my understanding of what the purpose of this
16 hearing was, so I focused on that.

17 Q. Did you read the rest of his memorandum?

18 A. I read through it, yes.

19 Q. I mean, did you read the order that actually set the
20 hearing?

21 A. I read the one from 2016, and I don't know if that's the
22 one you're talking about or not.

23 Q. No. You read the memorandum opinion, which you signed to
24 page 36 on, right?

25 A. That sounds right, yeah.

Larson - cross

1 Q. Did you read an order of that -- of the same date as the
2 memorandum opinion?

3 A. I don't recall whether I did or not.

4 Q. All right. Who provided you with the memorandum opinion?

5 A. It was provided me by the Kellogg firm.

6 Q. Did you receive any instructions as to how you would use
7 that memorandum opinion from the Kellogg firm?

8 A. No, I wouldn't say I was -- I didn't receive instructions.
9 What -- well, they sent me the memorandum, and I looked at it.

10 MR. FREDERICK: Your Honor, I'd like to just lodge an
11 objection. To the extent counsel intends to get into
12 attorney-client privilege or expert privilege, we would object,
13 and I would ask him not to venture into specific questions that
14 we asked our expert to do.

15 THE COURT: I don't see whether -- whether he read my
16 order or not. Nobody else much read it.

17 I don't see the purpose if either party sent that.
18 But you may ask him other questions, but I don't think it's
19 very relevant as to what he read they were.

20 MR. ELLINGBURG: Well, thank you.

21 BY MR. ELLINGBURG:

22 Q. My question is, how did you use the order to define this
23 particular question which you said you were providing an
24 opinion on?

25 A. Well, I used what I read to try to understand what the

Larson - cross
1 scope of this hearing was going to be about. And my
2 understanding of that was that the threshold issue, or the
3 issue of this hearing, was to determine whether or not the
4 aquifer was an interstate resource. So then I focused my work
5 on trying to address that question from a technical
6 perspective.

7 Q. Did you receive any assistance in determining that would be
8 the issue on which you would offer an opinion?

9 A. I -- I don't know what you mean by that. I mean, I read
10 the order, and I understood that to be my charge.

11 Q. I'm trying to find out whether you decided from reading the
12 order that this was the issue, or whether someone assisted you
13 in deciding it.

14 A. I decided that that was the issue as I saw it, based on
15 reading the order.

16 Q. Okay. So you interpreted the order personally?

17 A. I interpreted what I read to indicate that that would be
18 the subject of this hearing.

19 Q. Okay. What is your legal background?

20 A. I'm not a lawyer.

21 Q. Have you ever read the Court's order before and decided
22 that you would identify the specific issue that was to be
23 addressed before the Court?

24 A. Yes. As I remember, in some of the Kansas/Colorado case,
25 there were -- I don't know, orders or determinations by the

Larson - cross

1 Special Master as to what the scope of certain portions of the
2 hearings -- or, I'm sorry, certain portions of the case would
3 be about, and we used that as a focal point.

4 Q. And so did those contain specific instructions?

5 A. Well, they would -- they would outline what the scope of
6 the inquiry would be in a particular portion of the case.

7 Q. The only reason I'm getting into this is because the --
8 about two -- a sentence or two after this statement in the
9 order, it specifically refers to both the groundwater and the
10 aquifer. And then in the order, it refers to the water in
11 dispute. Have you ever focused on those two parts of either of
12 those documents?

13 A. I don't -- I couldn't hear what you said on the second
14 thing about --

15 Q. I said the water at issue or in dispute: Have you ever
16 focused on either of those two documents or those two parts of
17 the documents?

18 A. I remember reading that kind of information, yes.

19 Q. Okay. Now, do you have a specific citation you can give us
20 to a United States Geological Survey report that defines
21 specifically what constitutes an interstate aquifer?

22 A. I'm not aware of a specific definition. All I know is from
23 reading the reports about what the focal point of some of their
24 work was. And the word "interstate" does appear in some
25 reports, but I don't -- I'm not aware of a specific definition

1 Larson - cross
that says, "This is what an interstate water resource is."

2 Q. Did you ever look for one?

3 A. Pardon?

4 Q. Did you ever look for one?

5 A. I've read through these reports.

6 Q. No, I'm asking you if you've ever looked for a definition
7 recognized either by the USGS or by the Court, or by anyone
8 else, of interstate resource with regard to an aquifer? Have
9 you ever seen any of that?

10 A. I didn't look for it specifically. I just understood --
11 applied the common definition of "interstate" to water
12 resources, and that's the basis for my determination.

13 Q. Is that a scientific definition, interstate resource?

14 A. Well, I think the word "interstate" is -- in my view,
15 there's a common definition. It means it's something that
16 transcends or occupies more than one state. And I just applied
17 that adjective to water resources, and that's how I approached
18 my problem.

19 Q. That really wasn't my question. My question was, is there
20 a scientific basis for you defining "interstate aquifer"? Do
21 you have actual science that you use, other than the two things
22 you've mentioned?

23 You've testified about 90 times now -- I think that
24 may be an exaggeration; a little hyperbole -- that the basis is
25 that there is sand, which has similar qualities under multiple

Larson - cross

1 states. Right? That's -- those are the two things. They
2 underlie multiple states, and -- I forget exactly the phrase
3 you used; you used it over and over.

4 What was the phrase you used to describe the geology
5 of sand?

6 A. What was the phrase I used to describe the geology of sand?

7 Q. Yes, as you talked about --

8 A. I'm not sure what you're referring to.

9 Q. Well, didn't you say that there was continuity, right? You
10 said there was continuity in the materials within the aquifers
11 within the multiple states that crossed borders; did you say
12 that?

13 A. I said there was continuity in the aquifer itself, and in
14 the characteristics of the aquifer, and in the physical
15 properties of the aquifer.

16 Q. So how much independent study did you do to look at the
17 actual physical properties of the aquifer system throughout the
18 Mississippi Embayment?

19 A. I reviewed various USGS reports which had characterizations
20 of those properties, and that was the basis for my review of
21 those properties.

22 Q. Has the United States Geological Survey ever made the
23 statement that all of the sands or aquifer materials or
24 aquitard materials within these eight states are sufficiently
25 similar that you can just move from one state to the other

1 Larson - cross
without expecting any actual impact?

2 A. I'm not sure I understand your question.

3 Q. Okay. You used the MERAS report, right?

4 A. That was one of them, yes.

5 Q. Okay. That's your primary basis for saying that it's an
6 interstate aquifer, isn't it?

7 A. Well, that's one -- a report that illustrates the extent
8 and the nature of the aquifer, but there are others as well.

9 Q. Do you acknowledge that there are substantial local
10 variations within the aquifer units throughout the MERAS model?

11 A. I would acknowledge that there are variations in aquifer
12 units, as a general matter.

13 Q. I didn't ask that. I asked substantial variations in local
14 conditions throughout the MERAS model area. Would you
15 acknowledge that?

16 A. I -- I can't, because I don't know what you're meaning by
17 "substantial."

18 Q. Well, are there places in the MERAS model where you may
19 have the aquifer, but you may not be able to produce usable
20 quantities of water?

21 A. Where you have an aquifer but you're not able to produce
22 usable quantities of water?

23 Q. Yes.

24 A. Well, that would not meet the definition of an aquifer.

25 Q. Okay. Are there places where the quality of water is not

1 Larson - cross
as good as it is in others?

2 A. There are.

3 Q. Okay. And can you tell us where the best quality water is
4 and where the worst quality water is, within the MERAS model?

5 A. In general terms, you can, yes.

6 Q. Okay. So have you identified those areas?

7 A. I haven't tried to map them out, no.

8 Q. You didn't look at anything?

9 A. I didn't try to map them out, no.

10 Q. Okay. Well, can you give any detail on that?

11 A. Well, my understanding is throughout most of the area, the
12 water quality is quite good. When you get deeper into the --
13 some of the hydrogeologic units, you get into areas of saline
14 water.

15 Q. Is it -- do you know what transmissivity is?

16 A. Transmissivity?

17 Q. Yes, sir.

18 A. Yes, I do.

19 Q. Okay. Is the transmissivity in the Sparta Sand in
20 Mississippi the same as it is in the Memphis Sand that's
21 primarily in Tennessee?

22 A. The transmissivity will vary from one point to another.

23 Q. No --

24 A. I don't know, without you specifying exactly where you're
25 talking about, whether it is or it isn't.

Larson - cross

1 Q. Okay. Where -- where it changes to the Sparta Sand from
2 the Memphis Sand, in terms of the way those two -- those are
3 two separate aquifer units, aren't they?

4 A. There are aquifer names used in Mississippi area and there
5 are aquifer names used in the Memphis area, and there are
6 combinations of those names that are used.

7 Q. So it's your testimony under oath that there's no
8 difference in the Sparta Sand in Mississippi and the Memphis
9 Sand in Tennessee; is that correct?

10 A. I didn't testify to that, no.

11 Q. Well, it sounded like you were. My question to you was,
12 are there material differences in those two aquifer units
13 within the two states?

14 A. I think I testified that they're not homogeneous, and so
15 there are variations. And I don't know what you mean by the
16 word "material."

17 Q. Well, what about transmissivity? Is there a material
18 difference in the transmissivity of the Sparta Sand in
19 Mississippi and the Memphis Sand in Tennessee? That's a
20 straightforward question.

21 A. Repeat that?

22 Q. Are there material differences in the transmissivity of the
23 Sparta Sand in Mississippi, south of the border, and the
24 Memphis Sand in Tennessee?

25 A. Well, I don't know what you're defining as "material."

1 Larson - cross
2 There are differences in the transmissivity.
3 Q. Okay. What would you define as material?
4 A. Well, it would have to be -- have some material effect on
5 some thing that you're trying to calculate.
6 Q. Okay. Have you done any calculations of anything in this
7 case?
8 A. Yes, I have.
9 Q. And so what calculations have you done?
10 A. I have -- I've looked at groundwater levels. I've looked
11 at how they've changed over time and how they trended over
12 time.
13 Q. I haven't asked what you looked at. I'm sure you've looked
14 at a lot. But you're here as a scientist, supposedly providing
15 expert testimony. So I would like to know what calculations of
16 any kind you've actually done.
17 A. I've looked at groundwater flow rates. I've looked at --
18 as I said, calculations of trends in water levels.
19 Q. Okay. I'm sorry, we have a communication issue here. I'm
20 not asking what you looked at. I'm asking if you've done any
21 calculations at all of any characteristics of groundwater
22 applicable to this case.
23 A. And I'm trying to explain to you that I have done some
24 calculations.
25 Q. Okay. What calculations have you performed?
26 A. I've looked at how the groundwater levels have changed.

Larson - cross

1 I've looked at how those groundwater levels have trended during
2 certain periods to understand how those groundwater level
3 trends are indicated in the data that's been collected.

4 Q. I think you've said -- and I know you've told me in your
5 deposition -- that you didn't consider groundwater flow paths
6 to have any relevance -- any importance with regard to your
7 opinion; is that correct?

8 A. I don't remember exactly what I said. I don't -- well,
9 whatever. My conclusion is that the specific groundwater flow
10 paths know that the continuity of the aquifer system and
11 groundwater flow within it.

12 Q. What do you mean by "continuity"?

13 A. That the state boundaries and other political boundaries do
14 not influence, for example, potentiometric elevation contours
15 and the groundwater flow patterns.

16 Q. And you base that on regional studies, right?

17 A. Yes.

18 Q. You don't base that on any local studies?

19 A. Well, it depends on what you call "local." I mean, I --

20 Q. Well, there's an area that's been defined by the USGS for
21 decades called "the Memphis area." Okay?

22 A. Yep.

23 Q. Are there differences, even within the Memphis area, from
24 what you would find anywhere else in the Middle -- in the
25 Mississippi Embayment Regional Aquifer System?

Larson - cross

1 A. Are there differences in what, you said?

2 Q. Are there differences in the -- in the groundwater
3 availability and -- well, within the Memphis area? Are there
4 differences within the Memphis area with regard to the
5 availability of groundwater?

6 A. There are differences in the characteristics in the Memphis
7 area.

8 Q. Go ahead.

9 A. In the characteristics of the aquifer.

10 Q. And so what are those differences?

11 A. There are variations in transmissivity. There are
12 variations in permeability.

13 Q. Have you plotted or charted any of that, even for a local
14 area?

15 A. I've looked at reports that characterized that, and that's
16 how I understand that.

17 Q. Okay. So you're telling us what your version is of the
18 reports that you've reviewed, right? That's today that you're
19 doing?

20 A. I've reviewed a number of reports, and that -- and those
21 reports, along with my experience and education, are what I
22 base my conclusions on.

23 Q. Okay. But you really don't know if there's any difference
24 in the Sparta Sand within Mississippi, as a known formation,
25 and the Memphis Sand in West Tennessee? You can't tell us what

Larson - cross

1 those differences are?

2 A. Well, I can tell you that there are differences, based on
3 what I've read. There are differences in thickness. There are
4 differences in permeability. There are differences in -- or in
5 transmissivity. And I'm aware of those.

6 Q. Do any of those things make any difference with regard to
7 how much groundwater can be produced from that particular
8 formation?

9 A. They could have influences on the amount of groundwater
10 that you can produce in a particular location, yes.

11 Q. Now, could they have influences on the flow direction of a
12 particular location?

13 A. They can.

14 Q. Okay. Could they have -- make differences in the amount of
15 water within storage in any particular location?

16 A. They can.

17 Q. Did you look at any of that?

18 A. Yes, I have.

19 Q. Okay. So tell me what the difference is in storage in the
20 Sparta Sand and Memphis.

21 A. They're -- if you're talking about the water -- storage
22 coefficients, there are variations in the storage coefficients
23 characterized in the reports.

24 Q. Okay. But can you -- can you tell us what any of them are?

25 A. Not specifically, no.

Larson - cross

1 Q. No? That's not important to you?

2 A. Well, it's not important to the conclusion that I reached
3 about whether or not this is an interstate water resource.

4 Q. Let's talk about that just a little bit.

5 Now, other than you, can we look anywhere where we can
6 find the definition and the factors that you have used that has
7 been recognized either by scientists or by a court? Has your
8 definition, and your factors for your definition, to your
9 knowledge, ever been used by scientists, as you stated it --
10 not kind of generally alike, maybe inferred, maybe somewhere --
11 has it ever been used by another scientist that you know of?

12 A. I'm not aware of a specific definition, no.

13 Q. Okay. Of your definition. You're not aware of anyone else
14 using your definition. Is that correct?

15 A. I'm not aware of ever seeing a definition related to that.
16 I'm just applying the common definition of the word
17 "interstate," and that's what I'm using to draw my conclusions.

18 Q. Okay. But in terms of other scientists, because this is
19 scientific testimony, can you point me to any other scientists
20 or any other scientific literature that supports your
21 specific -- that uses your specific definition?

22 A. I know Dr. Langseth in this case. I've read his report,
23 and his approach seems to be consistent with mine.

24 Q. Okay. So one of the other experts for the defendants and
25 you have agreed, right?

Larson - cross

1 A. Yes.

2 Q. Okay. Beyond that universe of the experts for the
3 defendants, have you -- do you know of anyone that has
4 utilized, adopted, or applied your definition outside of this
5 case?

6 A. I'm not aware of a place where that specific definition has
7 been given.

8 Q. So you kind of -- you made it up from whole cloth?

9 A. No. The answer to that is no. I made that determination
10 from looking at the words.

11 Q. Okay. Do you believe that the judge in this case, and the
12 Supreme Court in this case, can't look at those same words? Do
13 you think they're somehow impaired so that they can't look at
14 those words?

15 MR. FREDERICK: Your Honor, I'd like to object to
16 this.

17 THE COURT: Well, objection sustained.

18 MR. ELLINGBURG: Okay.

19 THE COURT: We of course will make the final decision.

20 MR. ELLINGBURG: Okay.

21 BY MR. ELLINGBURG:

22 Q. Now, one of the components of your definition is that it is
23 possible to pump groundwater from one state into the next; is
24 that correct?

25 A. Well, it's possible that it's also being observed in the

1 Larson - cross
2 data and information that I've reviewed.

3 Q. Okay. Now, this issue has come up in a couple places, but
4 do you -- is it your opinion pumping is a condition found in
5 nature? Is it a natural condition?

6 A. Pumping from wells is not a natural condition.

7 Q. Okay. And what you do when you put pumps in the ground --
8 and I think you've talked about it -- is you lower -- in that
9 confined aquifer, you lower the pressure in the area of
10 influence or cone of depression of that pump; is that correct?

11 A. Well, as I've testified, you lower the water level, which
12 is the potentiometric level in the well, and that causes water
13 to flow toward the well.

14 Q. It draws it toward the well?

15 A. Yes.

16 Q. Okay. And if that pumping weren't taking place, that water
17 wouldn't be drawn toward the well in that particular cone of
18 depression in that particular way; is that correct?

19 A. It wouldn't go to that point; it would go somewhere else.

20 Q. Right. Now, within the cone of depression -- because you
21 explained the concept, or you touched on it earlier, that took
22 me a long time to understand. But within the cone of
23 depression, the pore spaces in the earth and confined aquifer
24 stay saturated, right?

25 A. Yes, in a confined aquifer.

26 Q. Okay. But there's not as much water within that cone of

1 Larson - cross
depression as there was before the pumping, is there?

2 A. The water has been -- when you pump, the water decompresses
3 involuntarily. It's a tiny bit different.

4 Q. Right. I saw something in the -- in some earth science
5 thing that said that if water were truly incompressible, all
6 the oceans would be 90 meters high, or something like that.
7 Which gave me the idea that you could compress it a little,
8 right?

9 A. It's slightly compressible.

10 Q. But it also will press those pore spaces open a little
11 further, so you can store -- at full pressure, you've got more
12 water in each pore space, right?

13 A. The aquifer skeletons are elastic, and they can expand and
14 contract slightly as well.

15 Q. Thank you.

16 And so within the cone of depression, there is in fact
17 less water; is that right?

18 A. Within the cone of depression, water has been taken out
19 of -- excuse me, the storage -- you can calculate the storage
20 depletion based on the compressibility of the water and the
21 aquifer skeleton.

22 Q. And someone who sinks a well within the confines of the
23 cone of depression can't recover as much water as they could
24 have with the cone not there, can they?

25 A. I'm not quite sure I follow your hypothetical earlier.

Larson - cross

1 Q. It was not a hypothetical. Total available drawdown, and
2 what that means is there was not as much water as there was
3 before the cone was created within the cone of depression which
4 can be recovered by pumping, is there?

5 A. I'm not quite sure what you mean by "not as much water."

6 Q. Well, we just talked about the fact that some of the water
7 has been released out of the pore spaces. Right?

8 A. There's been some decompression and some shrinkage of the
9 skeleton.

10 Q. Okay.

11 A. Inside a cone of depression and a confined aquifer.

12 Q. Right. And whether someone can still sink a well in
13 Mississippi and get groundwater doesn't mean there's still as
14 much water in Mississippi as there was before the cone of
15 depression in this case was formed, does it?

16 A. The water is changing all the time as it moves.

17 Q. You've said that. But in terms of total available
18 drawdown, it has been reduced in Mississippi, hasn't it?

19 A. Potentiometric level would have been reduced around the
20 pumping well.

21 Q. Okay. Can you recover as much water -- because you said
22 earlier -- can you recover as much water within the cone of
23 depression within Mississippi as could have been recovered by
24 wells before the formation of the cone of depression?

25 A. Well, the overall potentiometric level would be lower, so

1 Larson - cross
you would have to lift the water somewhat higher.

2 Q. But there's not as much water to produce the maximum yield,
3 is it?

4 A. Well, you can still produce water. It's only a matter
5 of -- you have to lift it somewhat higher.

6 Q. Well, unless you need more, right?

7 A. Unless you need more than what?

8 Q. What I'm saying is that if you need to use that groundwater
9 resource within the State of Mississippi, you cannot produce as
10 much water as you could if the cone of depression were not
11 there; is that true?

12 A. I don't know if it's true, in the abstract.

13 Q. Okay. I'm talking about in reality, within the confines of
14 the cone of depression. What does "total available drawdown"
15 mean?

16 A. Well, it can mean a number of things. But one of the
17 things it can mean is if you draw the water level from its
18 potentiometric level all the way down to the top of the
19 aquifer, that may be a total available drawdown, or maybe
20 considered a total available drawdown.

21 Q. Okay. And does that get reduced if you do that in one area
22 in the surrounding area within the cone? Does the total amount
23 that can be pumped out of the aquifer -- is it less?

24 You don't understand my question?

25 A. I don't understand the question.

Larson - cross

1 Q. Okay. That's fine.

2 But you do understand the concept of total available
3 drawdown?

4 A. I know there are characterizations of total available
5 drawdown.

6 Q. Okay. Now, how much have you studied geology in your area
7 of groundwater hydrogeology?

8 A. Well, most of my studies of geology are through the reading
9 of books and reports characterizing geologic conditions in
10 different areas. In a number of different areas.

11 Q. I just want to know for sure -- I'm going to ask a couple
12 of questions, then I'll move on to something else.

13 But is it your testimony that the cone of depression
14 in the Memphis area is drawing water from Kentucky -- it was
15 drawing water from Kentucky; is that your testimony?

16 A. That's not my testimony, no.

17 Q. Why not? I mean, if it's all one big aquifer, why isn't
18 your pumping in Memphis drawing water out of -- or reducing the
19 available water in Kentucky?

20 A. Because the cones of depression have limits.

21 Q. Okay. Now, an illustration was put up by Tennessee's
22 counsel which was taken from Dr. Spruill's report. And you
23 were asked the question if it was possible to move the pumping
24 further away and avoid the cone of depression overlapping,
25 right? And you said it wasn't possible.

Larson - cross

1 MR. FREDERICK: Objection, your Honor. I don't think
2 that question was asked, and I don't think Mr. Larson gave that
3 testimony.

4 MR. ELLINGBURG: Oh, okay.

5 THE COURT: I don't know what you asked, but you can
6 ask it.

7 MR. ELLINGBURG: I'll ask a different one.

8 BY MR. ELLINGBURG:

9 Q. Were you asked a question about Dr. Spruill's hypothetical
10 in his report?

11 A. I was, yes.

12 Q. And were you asked a question about what the impact would
13 be of placing wells in different areas of that hypothetical
14 aquifer on whether that water would be drawn off state lines?

15 A. I was asked, as I remember it, whether pumping near the
16 state line could affect conditions across the state boundary.

17 Q. Were you asked whether moving it away from the state line
18 would eliminate the cone of depression?

19 A. Not that I remember.

20 Q. Okay. So but again, we're talking about the hypothetical.
21 It could affect it, right? Moving the pumping location of
22 pumping could affect?

23 A. Yeah, there was no barrier to that impact being transmitted
24 across the state boundary.

25 Q. I was interested in that. Let's talk about the barrier a

Larson - cross

1 little bit.

2 Now, you completely homogenize the geology and the
3 water, right? You say it's all the same? That you can't
4 separate the water from the geology and the aquifer, as you
5 define it, which includes the entire Mississippi Embayment.
6 That's your position, right?

7 A. No. What I'm saying is that geology without water in it is
8 not an aquifer.

9 Q. Okay. But when you say the entire Mississippi Embayment is
10 one aquifer -- that's your testimony, isn't it?

11 A. No, it's not my testimony.

12 Q. Okay. What is your testimony?

13 A. That there are multiple hydrogeologic units within the
14 Mississippi Embayment. Some of those units are aquifers; some
15 of those units are characterized as confining units. And
16 they're juxtaposed against one another in certain patterns that
17 are illustrated in some of the reports.

18 Q. Okay. Is the water in that entire eight-state area all
19 available for all producers in all eight states?

20 A. I'm not sure I understand that question about -- what do
21 you mean by "available" -- available to users within those
22 areas?

23 Q. With all eight states from -- all of the water in the
24 Mississippi Embayment, is that aquifer system, is all of that
25 water available to users in every state, just -- just by

Larson - cross
1 putting the well down and pumping it?

2 A. By putting wells in, you can develop groundwater resources
3 at different places throughout the area.

4 Q. Did local variations make any difference?

5 A. Well, local variations can affect transmissivity conditions
6 and affect groundwater flow to some degree.

7 Q. Is it reasonable to take a regional model and make
8 determinations about local conditions without using the local
9 information with regard to the actual groundwater conditions in
10 the local area?

11 A. I don't know. It depends on what you're trying to do.

12 Q. Well, is it reasonable to determine the impacts of local
13 pumping by looking at a regional model?

14 A. You can make estimates with the regional model.

15 Q. All right. You've done that, haven't you?

16 A. I've made estimates with various models, yes.

17 Q. I mean, but you actually made an estimate of the amount of
18 water that was being taken from one state, under a compact, out
19 of a river, and you used a regional model to estimate it,
20 didn't you?

21 A. In the -- in a couple of different cases. But in the
22 Kansas and Nebraska case, we developed a model. It's a
23 regional groundwater model, but it's also interconnected to
24 streams, and that model is used to estimate effects on stream
25 flows.

Larson - cross

1 Q. Well, you also did that in Wyoming vs. -- in Montana vs.
2 Wyoming, didn't you?

3 A. Yes, but that was related to coalbed methane water
4 development.

5 Q. I'm not asking about the details. I'm asking you, what --
6 did you use a regional model to give opinions in the United
7 States Supreme Court case as to the impact of local pumping in
8 an area around a river? Did you do that?

9 A. No.

10 Q. You didn't? Okay.

11 Do you recall the Special Master's report that was
12 issued on December 29, 2014, in Montana vs. Wyoming?

13 A. Yes, I think I've seen that report.

14 Q. You've seen it. You testified in that case, didn't you?

15 A. Excuse me?

16 Q. You testified in that case, didn't you?

17 A. I did.

18 Q. And you gave opinions in that case, didn't you?

19 A. I did.

20 Q. Okay. And what did the Special Master conclude with regard
21 to your opinions?

22 A. He concluded that the estimated flows -- or as I understood
23 it, anyway, the estimated -- well, first of all, I was
24 assessing the impacts of coalbed methane development throughout
25 the regional area in Wyoming and the potential impacts of that

Larson - cross
1 on the stream flows in the Tongue River. And I think he
2 concluded that the estimates were relatively small, and there
3 was uncertainty about them, and therefore he did not utilize
4 those in his -- in his determination.

5 Q. Did he actually explain in his report that he found your
6 testimony to be insufficiently reliable for him to rely on?

7 A. I recall something like that. I think it related to issues
8 about potential effects of amount of aspirations along the
9 streams.

10 Q. Yes. But actually, one of the things he specifically says,
11 I believe, when he's explaining why your report -- your
12 testimony is not sufficiently reliable to be utilized in his
13 decision, was that you used a regional groundwater model to
14 project --

15 THE COURT: I think he's raising an issue.

16 MR. FREDERICK: Objection, your Honor. If he's got a
17 transcript to show us, or if he's got an opinion to show us,
18 maybe he could produce this, rather than provide a
19 characterization of what a Special Master in another original
20 action is said to have held.

21 THE COURT: Okay. If you want him to see that, share
22 it.

23 MR. ELLINGBURG: I think that's reasonable.

24 Here you go.

25 THE COURT: Do you need time to look this over?

Larson - cross

1 MR. ELLINGBURG: I'm going to point to specific pages
2 and specific language from the Special Master's report.

3 THE COURT: If you need time to look it over ...

4 MR. FREDERICK: Did the witness get a copy?

5 MR. ELLINGBURG: I'll give him a copy.

6 THE COURT: We'll take a short recess, and then come
7 back in ten minutes.

8 (Recess)

9 THE COURT: You may proceed, if your witness has had a
10 chance to look at whatever you're talking about.

11 BY MR. ELLINGBURG:

12 Q. Have you had a chance to look at it?

13 A. I've looked at it some, yes.

14 Q. Do you recall this testimony and this ruling by the Special
15 Master?

16 A. I recall the ruling and what he said about it, yes.

17 Q. Okay. I mean, and he found some specific faults with your
18 use of the regional model in that case, didn't he?

19 A. We used a model developed by the BLM, and I think what he
20 found was the -- well, the impacts were -- that we were
21 estimating with the model, which was developed to look at
22 coalbed methane, the impacts on the stream were relatively
23 small, and they were probably within the uncertainty of the
24 model. And that's what he found.

25 Q. They were relatively small compared to what you testified

Larson - cross

1 to, right?

2 I said they were relatively small impacts compared to
3 the impacts that you testified to, based on the model; is that
4 correct?

5 A. No, that's not correct.

6 Q. That's not correct? Okay.

7 Did he criticize your use of that model?

8 A. He indicated that he didn't believe the model was
9 sufficiently reliable to estimate those impacts.

10 Q. Okay. And why did he reach that conclusion? I think one
11 of the things was it covered 8,000 square miles, right?

12 A. That wasn't my understanding.

13 Q. Would you please look at page 212.

14 A. 212?

15 Q. Yes. 212.

16 Do you see, about the middle of the page, where it
17 says "Mr. Larson chose"? Do you see that? On 212.

18 A. Yes.

19 Q. Okay. It says, Mr. Larson chose the BLM model because
20 quote, "a lot of effort went into the development of that
21 model" (including detailed mapping and elevations), and BLM was
22 a disinterested party giving the model some -- quote, "some
23 credibility."

24 Is that -- is that what the judge reported in his
25 recommendation?

Larson - cross

1 A. I think that's what I said.

2 Q. Okay. So he was quoting you, and it was one of the reasons
3 he didn't accept the model, wasn't it? Why would he say this
4 if he weren't finding fault with that element -- that level of
5 an --

6 MR. FREDERICK: Objection. Calls for speculation from
7 a Special Master.

8 THE COURT: Objection sustained. We can't decide why
9 the Special Master decided.

10 BY MR. ELLINGBURG:

11 Q. "He also believed" -- he's now talking about you, the
12 Special Master, right?

13 He says, He also believed that the model had the quote
14 "appropriate structural features," closed quote, needed to make
15 reasonable calculations. Right?

16 A. He's talking about me.

17 Q. Yes. Did you give that testimony?

18 A. Yeah.

19 Q. Okay. And the Special Master also then started talking
20 about the model, and he said that it covered 8,000 square
21 miles. Right?

22 A. Yes.

23 Q. And that the model itself recorded that it had limitations
24 that -- in the available data. Is that correct?

25 It's at the bottom of the page.

Larson - cross

- 1 A. Yes.
- 2 Q. Okay. Did you look at the limitations on the MERAS model?
- 3 A. I've reviewed some of the calibration information.
- 4 Q. No. Did you read, in the MERAS report that you have
- 5 testified to extensively, the limitations the USGS reported for
- 6 that model?
- 7 A. I've read the report, so ...
- 8 Q. Do you recall any of the limitations?
- 9 A. Well, my recollection was that they characterize it as a
- 10 regional model, and therefore it may not be appropriate to look
- 11 at very localized conditions.
- 12 Q. Okay. The regional model; that was the one in the Montana
- 13 case the judge said covered I think -- what do we say -- what
- 14 did I say, 8,000 miles, square miles?
- 15 A. Yes.
- 16 Q. Okay. How many square miles does the MERAS model cover?
- 17 A. Some -- somehow the number 70,000 sticks in my mind, but I
- 18 don't remember exactly.
- 19 Q. 70,000 square miles. Right. And it uses a model grid of
- 20 one mile squares for that entire 70,000 miles, right?
- 21 A. Yes, the grid spacing is one mile.
- 22 Q. And there -- I don't want to misstate this. If you
- 23 would -- I'll need to let you see this -- this is Joint
- 24 Exhibit 18, and you've testified to it a great deal on direct.
- 25 It's in your notebook, I believe.

Larson - cross

1 Yes, I can see you've got a couple right there. Thank
2 you. Could you look at page 56 of Joint Exhibit 18.

3 A. Okay.

4 Q. At the top, do you see where it says "Limitation of
5 analysis"?

6 A. Yes, I see that.

7 Q. And beginning with the second sentence -- I'm going to read
8 it, and you tell me if I've misrepresented it. It says: "The
9 accuracy of groundwater model is limited by simplification of
10 complexities within the flow system, conceptual model, space
11 and time, discretization." What does "discretization" mean?
12 What does that word mean?

13 A. Time discretization?

14 Q. No. It says time "discretization." What does that mean?

15 A. Time discretization. That's what you're asking me?

16 Q. Yes. What does it mean?

17 A. It means that the model solves differential equations
18 numerically, and in numerical schemes, the time is divided into
19 segments. And the size of those segments are time
20 discretizations; that's how they calculate -- they calculate
21 from one time to the next in discrete segments.

22 Q. Thank you.

23 So it's -- "The model is limited by simplification of
24 complexities within the flow system, space and time
25 discretization effects, and assumptions made in the formulation

1 Larson - cross
of the governing flow equation."

2 Did I read that correctly?

3 A. Yes. You did.

4 Q. And then further down -- and I'm just picking out some
5 highlights, but further down on that same column, to I'd say
6 the bottom fifth or so -- this is a long paragraph -- it starts
7 with "Areas of sparse geophysical information."

8 Did you see that?

9 A. Are you in the next paragraph, or the same?

10 Q. I'm in the next paragraph, almost all the way at the bottom
11 of the page. "Areas of sparse geophysical" --

12 A. Yes, I've got it.

13 Q. Okay.

14 "Sparse geophysical information may affect model
15 results through assumptions in the altitude and thickness of
16 these geohydrological units and the lack of definition of
17 structural controls that may affect groundwater movement."

18 Now, this is talking about throughout the entire MERAS
19 model, right?

20 A. They're talking about areas of sparse geophysical
21 information.

22 Q. Right. But I'm saying this is -- this is relating to this
23 particular regional model, right?

24 A. It's talking about the MERAS model, yes.

25 Q. Right. And so this is a warning of limitations. And I

1 Larson - cross
2 think in the next -- the top of the next paragraph, the column
3 is probably the part that's most important -- it says, "The
4 goal of the MERAS model is to develop a model capable of
5 suitable accuracy at regional scales.

6 "The intent was not to reproduce individual local
7 scale details, which are typically not possible, given the
8 uniform scale size of a mile -- one mile squared. Although the
9 MERAS model may not represent each location detail, it is
10 relevant for a better understanding of the regional flow
11 systems."

12 So you've given a lot of opinions about the flow paths
13 shown by the MERAS model, right?

14 A. The flow paths shown by the MERAS model?

15 Q. The arrows on the maps shown from one state to another are
16 generated by that model?

17 A. The general patterns, yeah, the regional patterns, right.

18 Q. Now, this -- this is a warning that you're to be careful
19 about that; is that right?

20 A. Yes, that's something that you would consider with any
21 model.

22 Q. Okay. And in this case, we have a local or -- model, which
23 had been worked on for years by the USGS, do we not, the
24 Brahana Broshears model?

25 A. You have a different model applied that -- back in the
1980s, and its resolution is a lot different than the models we

Larson - cross

1 have now.

2 Q. Okay. But you're saying that the Brahana model was never
3 changed from the time of the 1980s; there were no changes to
4 that. Is that your testimony?

5 A. I'm not aware that there was any changes in the model.

6 Q. Okay. It was published, I think, in -- what, '98 or '99,
7 or 2001?

8 A. That's when the report was published, but I think the work
9 was done in the 1980s.

10 Q. Right. But you don't know if there was anything that was
11 changed between the time of the initial work and then?

12 A. In 2001?

13 Q. Do you know if there was any changes?

14 A. Not that I'm aware of, no.

15 Q. Okay. You say not that you're aware of, but does that mean
16 you don't know if there were or were not?

17 A. I don't -- I don't know whether there were or were not.
18 I'm not aware of any changes, and what I've looked at, the
19 model structure that people have used, it appears to me to be
20 the model that was constructed in the 1980s.

21 Q. Okay. But that was a -- that's a local model for the
22 Memphis area, based on Memphis data; is that correct?

23 A. I --

24 Q. The Brahana and Broshears model?

25 A. I wouldn't characterize that. That model extends from

1 Larson - cross
2 south of the Mississippi border up almost to the extent of the
3 Embayment.

4 Q. The MERAS model does?

5 A. No, the --

6 Q. The Brahana model?

7 A. Yes.

8 Q. All the way to the top of the Mississippi Embayment?

9 A. Almost, yes.

10 Q. Okay. Now, do you now recall that the Special Master in
11 the Montana case found your testimony unreliable because you
12 used a regional model, where the local model should have been
13 used; at least, that was one of his bases?

14 MR. FREDERICK: Your Honor, could I just ask for a
15 page reference to this 200-and-some-page Special Master report?

16 THE COURT: You may cite the page.

17 MR. ELLINGBURG: I thought I'd given it to you.

18 If you begin reading -- because on page 211, there is
19 an analysis of the evidence and expert testimony. And to
20 your -- in your defense, it points out that groundwater is
21 really difficult to completely analyze, because it's underneath
22 the ground, and you can't see it, right?

23 And he starts off, he says, This case demonstrates --
24 As this case demonstrates, determining whether groundwater
25 pumping interferes with the continued enjoyment of surface
rights is often difficult."

Larson - cross

1 And so he talks about that, and then he starts talking
2 about -- he says, "Montana's" --

3 A. Could I ask you where you're reading from?

4 Q. I'm reading from page 211.

5 Do you see where it says, "Analysis of the evidence
6 and expert testimony"?

7 A. Yes, I do.

8 Q. Okay. And it says, "Montana's principal groundwater
9 expert, Mr. Steven Larson" -- that's you, right?

10 A. Yes, it's me.

11 Q. All right.

12 "Used the MODFLOW groundwater model developed for a
13 BLM study of the CBM groundwater production in the Powder River
14 Basin to estimate the impact." Right?

15 A. Yes.

16 Q. Okay. And then I read you already what he starts off with
17 in terms of your description of the model and your basis for
18 relying on it. And one of them is appropriate structural
19 features.

20 Now, you've used this phrase "continuity" to support
21 your position that the groundwater at issue in this case is all
22 the water in the Mississippi Embayment; is that correct?

23 A. No. I'm trying to answer the question of whether or not
24 the aquifer is an interstate water resource.

25 Q. Okay. Are you separating the water in the aquifer from the

Larson - cross
1 aquifer, or are you just saying that because the geology
2 underlies multiple states, the water is necessarily interstate?

3 A. No, I'm looking at the extent of this aquifer, which, by
4 definition, is the geology and the water.

5 Q. Okay. Now, you were shown some of the USGS maps, toward
6 the end of your testimony, that showed cones of depression,
7 right?

8 A. Yes.

9 Q. Now, is it your testimony that the cone of depression in
10 South Central Mississippi or Southwest Mississippi is actually
11 capturing groundwater from the Memphis area?

12 A. No, it's not my testimony.

13 Q. Okay. It can't, can it?

14 A. Well, as scientists, we often don't say "can't," but it's
15 not likely.

16 Q. Okay. Nothing that you know about groundwater hydrology
17 would suggest that that pumping that was emphasized in that
18 lower part of Mississippi is -- would have an impact on the
19 local condition in this case?

20 A. Not on the condition on the aquifer. The only thing I can
21 think of is if there was some connection through the surface
22 water system.

23 Q. Now, before I go to that, the -- what about the pumping in
24 Louisiana and Arkansas that is near the border of Louisiana and
25 Arkansas? Is that large cone of depression, in your opinion,

Larson - cross
1 withdrawing groundwater from Northwest Mississippi?

2 A. My opinion is that those cones of depression have spread
3 across state lines from both directions and have coalesced.

4 Q. But in Arkansas and Louisiana?

5 A. Yes.

6 Q. But you're not giving the testimony that those cones of
7 depression are withdrawing groundwater out of Northwest
8 Mississippi, next to Memphis, are you?

9 A. No, I'm not giving that opinion.

10 Q. Okay. Because it isn't, is it?

11 A. Not that I'm aware of.

12 Q. Okay. Now, the surface water and groundwater connection, I
13 believe you've testified that there is a hydrologic connection
14 between the Mississippi River and the Sparta Sand and Memphis
15 Sand; is that correct?

16 A. Yes. To the regional aquifer system and the intervening
17 layers.

18 Q. So did you ever perform any calculations with regard to the
19 travel time of that groundwater from the outcrop until the
20 point that it was discharged into the Mississippi River?

21 A. The travel time from the outcrop to the river? No, I did
22 not.

23 Q. Okay. Do you have any estimate of how long that would be?

24 A. No, I don't.

25 Q. Okay. You didn't look at it at all, did you?

Larson - cross

1 A. I didn't try to estimate travel times, no.

2 Q. Okay. Did you attempt to determine the residence time,
3 which I believe is somewhat related, of a groundwater molecule,
4 as it's been described, entering the outcrop of the Sparta Sand
5 or Memphis Sand in Mississippi, within the state of
6 Mississippi?

7 A. I am not sure how that's different from the question you
8 just asked me, in terms of the travel time.

9 Q. Me either. But so -- so residence time would be the
10 equivalent of travel time?

11 A. Well, it certainly can be, yes.

12 Q. Right. Now you do --

13 A. But you're talking about a specific time, residence time,
14 from where it went in the outcrop area into the river?

15 Q. Yes. Yes.

16 You do environmental work, right?

17 A. Yes, I do.

18 Q. And in the case of environmental work, do you calculate
19 travel times in terms of pollutants, in the point that they
20 were, I guess, spilled on the ground or -- you know, poured on
21 the ground, to a -- another water resource?

22 A. At times, yes.

23 Q. I mean, is that part of trying to remediate it and control
24 it?

25 A. It can be part of that.

Larson - cross

1 Q. Okay. So it's not -- you know how to calculate travel time
2 and residence time, right?

3 A. Well, I'm going to put it this way: I know how to make
4 estimates of travel time.

5 Q. Okay. That's good. But you didn't do it in this case
6 because you didn't think it was important?

7 A. I didn't think it was necessary for me to draw the
8 conclusions that I drew about the interstate water resource.

9 Q. Did you make any effort to determine the relative storage
10 capabilities of the aquifer within Mississippi and Tennessee
11 across the board, stored -- in the storage capacity? How much
12 groundwater could the aquifer hold?

13 A. No, I haven't tried to figure that out.

14 Q. Okay. Because you didn't consider it important?

15 A. No, I did not. At least to the question that I was
16 addressing. It may be important in other situations, but ...

17 Q. Now, the question you were addressing was the question that
18 you took out of the order and interpreted as you interpreted
19 it; is that correct?

20 A. Yeah, it was a question, as I understood it, as to whether
21 or not this was an inter -- the Middle Claiborne Aquifer was an
22 interstate water resource.

23 Q. Okay. Now, do you -- a lot of your opinions are stated in
24 either absolute or very broad terms. So when you say as an
25 expert that the groundwater that came in at the outcrop in

1 Larson - cross
2 Mississippi and was moving across Mississippi would not be
3 there permanently, did you put any kind of range on what you
4 meant by "permanently"? You just meant it would never leave,
5 right?

6 A. My conclusion was that it would leave.

7 Q. Right. So that it would not be there permanently?

8 A. Correct.

9 Q. But you made no effort to determine how long it might
10 reside there?

11 A. No, I did not.

12 Q. Okay. And based on what you know from --

13 A. Well, maybe I should rephrase that.

14 I didn't try to make a travel time calculation from
15 the outcrop to the point of discharge. I mean, I recognize
16 that even as we sit here today there's water discharging --

17 Q. Right.

18 A. -- from the Mississippi into other areas.

19 Q. Right. The groundwater is pumped out of the cone of
20 depression that's been taken out of storage, right?

21 A. Well, not -- if you look at the recent water level trends
22 in the area of Memphis, they've been relatively stable. So
23 within those areas, where the water level has been relatively
24 stable, the storage hasn't changed.

25 Q. Do you know where the recharge is coming from? Can you
state an expert opinion as to where the recharge coming into

Larson - cross
1 the Memphis Sand and Sparta Sand is coming from? Is it all
2 coming from the outcrop?

3 A. Coming from the outcrop. It can also come from other
4 underlying and overlying aquifers.

5 Q. Do you know where it's coming from, within that larger
6 universe?

7 A. I haven't tried to see a detail where it's coming from.
8 I've only observed that the water level declines in that --
9 those areas have been relatively stable over the last number of
10 years.

11 Q. Now, you also gave a lot of testimony in terms of --
12 certain things could take place. Right?

13 A. To some degree, yes.

14 Q. Okay. But you -- those statements aren't intended to be
15 opinions, are they, when you say something could take place?

16 MR. FREDERICK: Objection, your Honor. I think his
17 testimony speaks for itself. And if I was asked to redo his
18 questions, which I did upon his first objection, I was quite
19 happy to rephrase them to satisfy Mr. Ellingburg.

20 THE COURT: I'll overrule the objection if the witness
21 can understand the question.

22 MR. ELLINGBURG: I need to try to do better with the
23 questions, based on that, your Honor.

24 Q. Have you designed any wellfields?

25 A. At times, yes.

Larson - cross

1 Q. Okay. Is that an area that you claim expertise in?

2 A. I've designed wells and pumping systems in my time.

3 Q. Have you done any real study of the wellfields in this
4 particular case with the kind of detail you would need to make
5 any recommendations as to those wellfields?

6 A. No, I haven't studied at that level of detail.

7 Q. So when you made comments about the wellfields, they aren't
8 based on the study -- they aren't based on any studies that
9 you've made, any study you've made in this particular case; is
10 that correct?

11 A. They're not based on a particular study that I might have
12 done, no.

13 Q. Okay. Now, does the USGS actually play any role in
14 groundwater management within specific states?

15 A. I'm not aware of -- that they are involved in groundwater
16 management. They may be, but I'm not aware.

17 Q. They provide scientific data to the various cities and
18 states that are using groundwater; is that correct?

19 A. They -- that's generally what their mission is, certainly.
20 The only caveat was I was involved in some -- or I'm aware that
21 the USGS was involved in some projects while I was at the USGS
22 where they were somewhat acting as a consultant to a municipal
23 entity.

24 Q. But ultimately they don't have the authority to make a
25 groundwater management decision within the states, do they?

Larson - cross

1 A. Well, I'm not aware that they do groundwater management.

2 Q. Is that something typically handled by each separate state,
3 based on your experience?

4 A. It could be states, it could be municipalities, it could be
5 water purveyors.

6 Q. To the extent that Tennessee is -- the City of Memphis and
7 Shelby County are pumping water that is, at the time the
8 pumping takes place, is known to be coming from the State of
9 Mississippi, how can Mississippi regulate that pumping, that
10 you know of?

11 A. Could you repeat the first part of that?

12 Q. How can Mississippi regulate pumping that is taking place
13 in the State of Tennessee, in Shelby County or by the City of
14 Memphis, if that pumping is withdrawing groundwater from within
15 the State of Mississippi?

16 MR. FREDERICK: Your Honor, I have an objection,
17 because he used the word "regulates," which is a legal term of
18 art. Mr. Larson is a trained hydrologist. He's not a lawyer.

19 THE COURT: I'll sustain the objection on that.

20 MR. ELLINGBURG: Thank you.

21 Q. Is the word "interstate" a scientific term of art?

22 A. I wouldn't call it a scientific term of art. I would call
23 it just a -- it's a word that has a meaning.

24 Q. It's an observation anybody can make?

25 A. Excuse me?

Larson - cross

1 Q. It's an observation anyone could make; is that correct?

2 A. Well, "interstate" has a common meaning.

3 Q. Right. And you're applying the common meaning, and anyone
4 could do that, right?

5 A. I'm applying the common meaning of "interstate" to the term
6 "water resources."

7 Q. Right. And that's ...

8 Have you done any calculations of groundwater velocity
9 within either the State of Mississippi or the Southwest area or
10 West Tennessee, to give your opinion?

11 A. Not for purposes of this particular case, no.

12 Q. Have you evaluated the amount of groundwater that can be
13 withdrawn from the available aquifer system within -- within
14 West Tennessee? Have you done an evaluation of that?

15 A. No, I have not.

16 Q. Because it's not important to you?

17 A. Excuse me?

18 Q. It's not relevant to your opinion, right?

19 A. How much water can be developed?

20 Q. Right.

21 A. Yeah, no, I don't think that's relevant to the conclusion
22 as to whether this is an interstate water resource.

23 Q. And what do you base that on?

24 A. Because I believe that the determination of whether this is
25 an interstate water resource is determined by the continuity of

Larson - cross
1 the aquifer and its characteristics, the connection between
2 that aquifer and other aquifers and surface waters that might
3 be interstate in and of themselves, and also on the ability of
4 pumping in one area to affect another area that could go across
5 state boundaries.

6 Q. Can you provide us with any metric of any kind, other than
7 sand, as to what you mean by "continuity"?

8 A. Well, "continuity" just means that within an area, the
9 entity -- which in this case is the Middle Claiborne Aquifer --
10 exists, and that it has physical properties that allow
11 communication hydraulically throughout that area.

12 Q. What are those specific physical properties within DeSoto
13 County, Mississippi, that you have identified?

14 A. Properties of permeability, properties of transmissivity,
15 storage characteristics.

16 Q. Are those properties, based in -- what you have studied,
17 uniform throughout DeSoto County, Mississippi?

18 A. No, they're not uniform.

19 Q. And I believe that this whole system would be -- DeSoto
20 County, Mississippi, and Shelby County, Tennessee, is complex;
21 is that fair?

22 A. There are complexities.

23 Q. Okay. And what kind of complexities?

24 A. Well, there are variations in the amounts of sand, for
25 example, that you might find in one area versus another. There

1 Larson - cross
2 are areas where the materials become finer grain and become
3 confining units.

4 Q. Thank you.

5 Those things affect all of the properties that
6 determine groundwater flow and direction and storativity, don't
7 they, those variations?

8 A. They can have impacts.

9 Q. They can have impact -- they determine impact?

10 A. Well, that's not the only thing that determines those.

11 Q. There's more, right? There are other factors?

12 A. Well, there are places where the water is recharged and
13 places where the water is discharged. Those also play a role
14 in that.

15 Q. And those are all local conditions?

16 A. Not necessarily. I mean, the Mississippi River is a large
17 river.

18 Q. Thank you.

19 MR. ELLINGBURG: Would you put the slide up, the first
20 slide.

21 Q. Okay. Now, you used this chart during your direct
22 examination; is that correct?

23 A. I don't remember if we used this one or another one.

24 MR. FREDERICK: Your Honor, I don't think we used this
25 one.

 MR. ELLINGBURG: Okay. So you used Arthur & Taylor in

Larson - cross
1 1990; I used another Arthur & Taylor.

2 MR. FREDERICK: We didn't use this one.

3 MR. ELLINGBURG: Okay.

4 BY MR. ELLINGBURG:

5 Q. Well, is this similar? Is there some continuity between
6 this chart and the chart you looked at earlier?

7 A. The one that we used was showing generalized flow patterns,
8 as I remember, in the predevelopment condition.

9 Q. Okay. Is this a very, very high-level generalization?

10 A. A very, very high-level what?

11 Q. Generalization.

12 A. Yes, this is a generalization of a profile through the
13 Mississippi Embayment.

14 Q. Because it doesn't show any -- any separate aquifers within
15 the Middle Claiborne Aquifer group, does it?

16 A. It shows the Middle Claiborne Aquifer, and it shows the
17 Upper Claiborne Aquifer.

18 Q. Does it show a Lower --

19 A. And a Lower Claiborne Aquifer. I'm sorry.

20 Q. I thought you said there wasn't a separate Lower Claiborne
21 Aquifer.

22 A. I didn't say that. There's a Lower Claiborne hydrogeologic
23 unit that was defined as part of MERAS.

24 Q. But this says "Lower Claiborne Aquifer." Right?

25 A. That's what it says, yes.

Larson - cross

1 Q. Is that a separate aquifer from the Middle Claiborne
2 Aquifer?

3 A. It's been identified as a -- at least a subhydrogeologic
4 unit within the Middle Claiborne hydrogeologic unit.

5 Q. Do you know if a Lower Claiborne Aquifer exists in the
6 State of Tennessee?

7 A. Not to my understanding. In terms of where it was
8 characterized, it was further south.

9 Q. Thank you.

10 MR. ELLINGBURG: Well, I'd like to pull up another
11 chart. MERAS, the next slide, if you would.

12 Q. Now, this -- was this the slide you looked at on direct?

13 A. No.

14 Q. It was not?

15 A. Not this particular one, no.

16 Q. Okay. Does it contain the same hydrogeologic units as the
17 one you discussed?

18 A. Yes, it does.

19 Q. Now, over in the "Hydrogeologic Unit" column, there seems
20 to be some separation between the Lower Claiborne Aquifer or --
21 exactly where it exists. Is that what that indicates, the
22 little area where it's all hatched off? What does that show?

23 A. That indicates to me that there is a transition from what
24 they're calling the Middle Claiborne Aquifer to what they're
25 calling the Lower Claiborne Aquifer within that overall

Larson - cross

1 hydrogeologic unit.

2 Q. I believe counsel highlighted everything that's -- Sparta,
3 Lisbon, and then over, and then came back and came under where
4 it says Meridian Sand member here. Does this indicate that all
5 of that is continuous as the Middle Claiborne? From looking at
6 this particular chart, as a hydrogeological unit?

7 A. My understanding is that there's a continuity to those
8 connections between the Middle Claiborne Aquifer and the Lower
9 Claiborne Aquifer.

10 Q. "Continuity" means that they have somewhat similar sands;
11 is that right?

12 A. Well, there's not a barrier that separates one from the
13 other.

14 Q. Okay. It's the barrier thing. Because from your
15 description, "barrier" has to be a geological feature or
16 something that's been installed that just cuts off any
17 potential flow; is that correct?

18 A. Well, in order for them to be somehow separated, there
19 would have to be a barrier between them.

20 Q. Does groundwater flow from the area of higher pressure to
21 lower pressure?

22 A. A higher potentiometric level to lower potentiometric
23 level.

24 Q. Thank you very much. I always appreciate that.

25 So does the pressure drive the direction and the flow

1 Larson - cross
of the water within the confined aquifer unit?

2 A. The potentiometric level will determine the flow of the
3 water, which is a combination of pressure and elevation.

4 Q. Okay. So if the natural pressure pushes that water in a
5 specific direction, then until somebody introduces the well,
6 that water will follow that path, will it not?

7 A. Well, the water will move from higher potentiometric levels
8 to lower potentiometric levels.

9 Q. So that will determine direction, will it not?

10 A. Well, it isn't just two points. It has to be more than two
11 points to figure out which direction it's going.

12 Q. Right. But if you've got more than two points, and you've
13 got the potentiometric pressures, you can determine the
14 direction of the natural flow; is that correct?

15 A. If you have more than two potentiometric levels -- more
16 than two potentiometric levels, you can estimate the directions
17 of groundwater movement.

18 Q. And groundwater hydrologists do that all the time, don't
19 they?

20 A. Yes, that's part of the work that we do.

21 Q. Now, you've given some testimony which is a little, seems
22 to me -- I can't completely -- excuse me. I strike that
23 question.

24 I can't completely synthesize some testimony about the
25 USGS work. I mean, do you believe the USGS does high-quality

Larson - cross

1 work?

2 A. Yes, I do.

3 Q. And do they have very rigorous guidelines in place that are
4 required to be met before they will publish material?

5 A. They did when I worked there.

6 Q. Okay. Good enough. Do you think they've lowered those
7 standards?

8 A. I do not.

9 Q. Thank you.

10 Do you believe that the work that was -- has been
11 performed in the Memphis area, in that local area, by the USGS,
12 has been high-quality work?

13 A. I -- I believe that the reports that they've issued would
14 meet their standards for release, and obviously the work over
15 time improves as more and more information becomes available.

16 Q. That was another thing I wanted to touch on. I mean, the
17 USGS has been collecting groundwater data in the Memphis area
18 for a very, very long time, isn't that right?

19 A. They have, yes.

20 Q. I think going back at least to the early 1900s?

21 A. Yeah, I don't remember what the first data points are.

22 Q. And is their process to build on their prior studies?

23 A. Generally speaking, I think that's true.

24 Q. Unless they find some error, and they'll correct it, right?

25 A. That would be my understanding.

Larson - cross

1 Q. Have you identified any -- any errors in the Brahana and
2 Broshears model that were correct on the MERAS, or is the MERAS
3 model just an expanded version of the regional, and covers more
4 layers?

5 A. No, I think it's a little more nuanced than that. I think
6 the Brahana model, back at the time that was done, modeling in
7 general was limited by computer capacity, and so certain
8 assumptions and simplifications are made in order to
9 accommodate that.

10 More recently, in the MERAS model, now we're in a
11 different era of computing power, and some of those assumptions
12 are -- some of the issues don't have to be made.

13 Q. Have you identified specific assumptions and
14 simplifications that have been removed from the MERAS model?

15 A. Yes.

16 Q. Okay. And what are they?

17 A. Well, the one that sticks in my mind is that the
18 communication between the layers in the model, there were three
19 layers. The way they defined the interconnection between those
20 layers was to a parameter called LEKINS. And LEKINS is sort of
21 an idealization that tries to represent the ability of water
22 removed vertically, but it doesn't represent the actual layer
23 that the water is moving through.

24 Similarly, there are assumptions about the surficial
25 aquifer and the shallow aquifer; they imposed what we call a

Larson - cross
1 constant head condition throughout that area and did not

2 actually simulate movement of groundwater within those

3 aquifers. Those have now been improved in the MERAS model.

4 Q. Could you tell me what the constant head boundary was in
5 the Brahana model?

6 A. The outermost layer in the model was set at a constant
7 head.

8 Q. Can you tell me what it was?

9 A. Well, it varied from place to place. It wasn't just one
10 number.

11 Q. Okay.

12 THE COURT: I think we'll stop for the evening at this
13 time, and we'll resume tomorrow at 9:00 a.m.

14 How are we doing on our schedule to get through with
15 the defense case? Can you all give me an idea?

16 MR. FREDERICK: Well, your Honor, we've got two more
17 witnesses to present, and then we will rest. Once Mr. Larson
18 is done, we have two more witnesses.

19 MR. ELLINGBURG: And I will attempt to be brief.

20 THE COURT: Is there a chance we'll get through by
21 Friday --

22 MR. ELLINGBURG: It depends on how long they're on
23 direct.

24 MR. FREDERICK: Well --

25 MR. ELLINGBURG: And how long I cross.

Larson - cross

1 MR. FREDERICK: How much more cross do you have for
2 Mr. Larson?

3 MR. ELLINGBURG: I believe, once I've conferred with
4 cocounsel, there won't be a great deal.

5 MR. FREDERICK: So, your Honor, our expectation is
6 that very early tomorrow, as soon as the cross is finished, we
7 would present Dr. Brian Waldron, and that our expectation is
8 that Dr. Waldron could be completed tomorrow; and that we would
9 then have David Langseth, that MLGW would be presenting, and
10 his presentation would either start at some point tomorrow or
11 first thing Friday morning.

12 THE COURT: Okay. Does that make you think you might
13 get through Friday, or does that make you think you might not
14 get through?

15 MR. ELLINGBURG: It's certainly a possibility.

16 THE COURT: All right.

17 MR. ELLINGBURG: I've been learning how to answer
18 questions.

19 THE COURT: Okay. Very good. Just trying to see
20 how -- where we are on our schedule. If we have things next
21 week we have to postpone, we'd have to do so, and so forth.

22 MR. FREDERICK: Thank you, your Honor.

23 THE COURT: We'll recess until 9:00 tomorrow morning.

24 (Adjourned to Thursday, May 23, 2019, at 9:00 a.m.)
25

STATE OF TENNESSEE:

COURT REPORTER'S CERTIFICATE

I, PATRICIA A. NILSEN, Licensed
Reporter for the State of Tennessee, CERTIFY:

1. The foregoing deposition was
taken before me at the time and place stated in the foregoing
styled cause with the appearances as noted;

2. Being a Court Reporter, I then
reported the deposition in Stenotype to the best of my skill
and ability, and the foregoing pages contain a full, true and
correct transcript of my said Stenotype notes then and there
taken;

3. I am not in the employ of and am
not related to any of the parties or their counsel, and I have
no interest in the matter involved.

WITNESS MY SIGNATURE, this,
the _____ day of _____, 2019.



PATRICIA A. NILSEN, RMR, CRR, CRC

TN Licensed Court Reporter

LCR Number: 717

Expiration: 6/30/2020

Proceedings - May 22, 2019

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