STATE OF NEW MEXICO
ENERGY, MINERALS, AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION COMMISSION

COPY

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION FOR THE PURPOSE OF CONSIDERING:

APPLICATION OF LIGHTNING DOCK GEOTHERMAL HI-01, LLC, FOR APPROVAL TO INJECT INTO A GEOTHERMAL AQUIFER THROUGH THREE PROPOSED GEOTHERMAL INJECTION WELLS AT THE SITE OF THE PROPOSED LIGHTNING DOCK GEOTHERMAL POWER PROJECT, HIDALGO COUNTY, NEW MEXICO. Case No. 15357

and

APPLICATION OF LIGHTNING DOCK GEOTHERMAL HI-01, LLC, TO PLACE WELL NO. 63A-7 ON INJECTION-GEOTHERMAL RESOURCES AREA, HIDALGO COUNTY, NEW MEXICO Case No. 15365

REPORTER'S TRANSCRIPT OF PROCEEDINGS
COMMISSION HEARING
Volume III
October 7, 2015
Santa Fe, New Mexico

BEFORE: DAVID R. CATANACH, CHAIRPERSON
ROBERT S. BALCH, COMMISSIONER
PATRICK PADILLA, COMMISSIONER
BILL BRANCARD, ESQ.

This matter came on for hearing before the New Mexico Oil Conservation Commission on Thursday, October 7, 2015, at the New Mexico Energy, Minerals, and Natural Resources Department, Wendell Chino Building, 1220 South St. Francis Drive, Porter Hall, Room 102, Santa Fe, New Mexico.

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Also Present:
Meira Gault, Supervisor, Hidalgo Soil and Water Conservation District
Scott Richins

HEARING INDEX

E X H I B I T I N D E X

PROTESTANT AMERICULTURE EXHIBITS
Offered and Admitted

Lightning Dock Geothermal HI-01, LLC, Exhibits
Offered and Admitted

(Time noted 1:11 p.m.)

COMMISSIONER CATANACH: At this time, we will call case 15357 and case 15365, which is the Application of Lightning Dock Geothermal HI-01, LLC, to place certain wells on geothermal injection at the site of a Lightning Dock Geothermal Power Project, Hidalgo County, New Mexico.

Call for appearances today.

MS. HENRIE: Mr. Chairman, Michelle Henrie for Lightning Dock Geothermal, and with me is co-counsel, Pat Rogers, who has entered his appearance in this case.

MS. MARKS: Allison Marks on behalf of the Oil Conservation Division.

MR. LAKINS: Good afternoon, Mr. Chairman, Commissioners, Charles Lakins on behalf of the Protestant, AmeriCulture.

MS. GAULT: Meira Gault, Supervisor with the Hidalgo Soil and Water Conservation District, replacing the lady that was here last time.

COMMISSIONER CATANACH: And your name again is?

MS. GAULT: Meira, M-e-i-r-a, Gault.

COMMISSIONER CATANACH: I believe at the conclusion of the last hearing, I believe we finished up

with Lightning Dock as far as your direct case?

MS. MARKS: Mr. Chairman, I just have a preliminary matter before we begin.

I filed a notice of errata and a motion to correct the record. I do have copies of it. Counsel for AmeriCulture did not object. Counsel for Lightning Dock supported the motion and the errata. And I did not hear from the Soil and Water Conservation District. I do have extra copies.

COMMISSIONER CATANACH: Did we get copies of this?

MS. MARKS: They were filed with the clerk. Ms. Davidson is saying...

COMMISSIONER CATANACH: Can you just briefly explain what this is?

MS. MARKS: Sure. There was an error in the transcript. I do also have the proposed findings of fact and conclusions of law, which was in the procedural order, which all parties were supposed to bring to the hearing today. So I have those as well for the Commission.

But when I was reviewing the transcript, I noticed an error in the transcript. It is on page 201 of the second day's proceedings. It's on lines 16 through 18. And the comment there is attributed to

Ms. Henrie, and I actually made the comment.

And the comment is in reference to a letter that was submitted by the Geothermal Energy Association, the letter was I believe e-mailed to members of the commission, Mr. Brancard, and myself. And Ms. Henrie and Mr. Lakins did not receive a copy of the letter.

So if you review the transcript -- I did not make copies of the entire transcript. I do have one copy here -- it does not make sense for the comment to be attributed to Ms. Henrie. Neither party objected. Again, I don't know the position of the Soil and Water Conservation District.

So I did ask for the transcript to be corrected and for Paul Baca -- sorry, I don't know the full name -- but I would ask that the Commission take the appropriate steps to make sure that the transcript from day two's proceedings are correct -- I make that motion -- and for the errata in the transcript to be corrected.

COMMISSIONER CATANACH: Mr. Brancard, do we just vote on that motion?

MR. BRANCARD: Sure. We can direct the court reporter to check the record and make the change.

COMMISSIONER CATANACH: So do we vote on it?

COMMISSIONER BALCH: I would move to make

the amendment.

COMMISSIONER PADILLA: I would second that motion.

COMMISSIONER CATANACH: All in favor.

(In Unison "Aye.")

MR. ROGERS: And we have a couple of procedural housekeeping matters, too, if this would be the appropriate time.

We have extra copies of that same letter if there is any shortage of those. May I approach and give those to Mr. Brancard?

COMMISSIONER CATANACH: Sure.

MR. ROGERS: And on behalf of Lightning Dock, we have our proposed findings of fact and conclusions of law. I think the Commission was kind enough to address my motion, which indicated the importance of these, and, pursuant to the order, we have those here at this time.

And I will again give those to Mr. Brancard.

MR. BRANCARD: And so we are also receiving the Oil Conservation Division's Proposed Findings of Fact, and I believe AmeriCulture has already placed its proposed findings of fact with us.

MR. LAKINS: Yes, sir.

MR. ROGERS: And, again, on the housekeeping

and procedural front on behalf of Lightning Dock, we have an e-mail from Mr. Ashburn from the Deming Luna County Economic Development Corporation that we would like to make part of the record.

May I approach Mr. Brancard?

COMMISSIONER CATANACH: Yes.

MR. ROGERS: Lightning Dock -- before we rest, we have -- there is some testimony from Mr. Scott Richins, very brief, that we would like to present. He is from the community. And, additionally, we have two letters, very short, that we would like Mr. Morrison of Lightning Dock -- he is the vice president of operations -- to read into the record.

MR. LAKINS: I'll object to further witness testimony, witnesses who were not disclosed.

I think the two letters speak for themselves and they can be made a part of the public record. But I object to another witness being called to read into the record letters from private individuals who are not here to speak for themselves.

MR. BRANCARD: Mr. Chairman, I suggest that we have a period today to allow for any public comment here, nontechnical testimony.

COMMISSIONER CATANACH: Okay.

MR. BRANCARD: We normally do that every day

of the hearing, allow for nontechnical comments.

MR. ROGERS: Thank you.

One of the issues with regard to Mr. Richins, this being a long way from Deming, if you would allow him at this point because he has to get back. I've been assured that it's very short testimony, but if you wouldn't mind taking that out of order to allow Mr. Richins that accommodation, it would be appreciated.

Mr. Morrison, the vice president of operations, is only presenting letters from, again, nontechnical persons similar to what has been allowed thus far.

So my request would be that Mr. Richins be allowed just briefly at this time because of his need. He drove up, but needs to get back.

COMMISSIONER CATANACH: Okay. We will accommodate that. He can go ahead.

MR. BRANCARD: Before we do that, can we make sure we have all the preliminary matters done here.

MR. ROGERS: That's it for Lightning Dock. Thank you for your attention.

MR. LAKINS: I provided the commission with a proposed order; essentially, it's the same thing as findings of fact, just titled differently. It was

Mr. Catanach's requirement to do that at the last hearing.

I also have one change to our exhibits. Our Exhibit V, as in Victor, to the PowerPoint presentation, we just added some pages to it. And I have new sets, which Florene has. And so just to take out the old and stick in the new kind of thing would be the simplest way to do it.

MR. BRANCARD: Mr. Lakins, do the other parties have copies of --

MR. LAKINS: Yes, sir.

MR. BRANCARD: Do you have one for the court reporter?

MR. LAKINS: I gave six up here to Ms. Davidson, so that should include one for the --

MS. MARKS: I didn't re- --

MS. LAKINS: I need to give you one.

(Handing to Ms. Marks.)

MR. LAKINS: That's all from me.

COMMISSIONER CATANACH: Is that an issue, Ms. Marks?

MS. MARKS: I mean I can look at it. I just don't want any party to have an unfair advantage. And I think this time, you know, the extension of time has probably allowed one party to have an unfair advantage.

And I think probably that should probably be considered by the Commissioner.

COMMISSIONER CATANACH: You just added pages to the exhibit?

MS. MARKS: I don't know what the added pages are. I just think as a matter of fairness for the other party -- I don't know what the additional pages are. I haven't reviewed them. That's for the Commission to -- in regard to fairness.

MR. LAKINS: Those would be part of Mr. Witcher's testimony, which we may get to later this afternoon.

COMMISSIONER CATANACH: I think it will be covered on direct. And I understand your concern, but I think we should move on now.

MS. MARKS: And as another procedural matter, the map that we have been referring to, I don't know if it has been admitted as an exhibit. I'd just like to make sure that's an exhibit.

MS. HENRIE: Yes, let's move that as an exhibit. That would be --

COMMISSIONER BALCH: Do you have a small-scale version of that?

MS. HENRIE: I do not. I thought that the Commission could just take the board with them.

I can get you a small version, Bill, but it won't have the drawing on it, you know, it won't have where the wells are and things like that that have been added to it, where the power plant is.

COMMISSIONER BALCH: The record is --

THE COURT REPORTER: I'm sorry, I couldn't understand you.

MS. HENRIE: I'm sorry?

I could take a picture --

MS. MARKS: I could take a picture with my phone.

MR. BRANCARD: We'll figure that out at some point.

MS. MARKS: I would just like to make sure it's an exhibit. We've been referring to it a lot and --

COMMISSIONER CATANACH: So are we going to admit that as an exhibit?

MS. HENRIE: Let's please admit that as Lightning Dock Exhibit 15.

COMMISSIONER CATANACH: Any objection?

MR. LAKINS: No, sir.

COMMISSIONER CATANACH: Exhibit 15 will be admitted as evidence.

(Lightning Dock Geothermal HI-01, LLC,

Exhibit 15 offered and admitted.)

COMMISSIONER CATANACH: Any other procedural matters?

MR. BRANCARD: To clarify, everyone got of Lightning Dock's -- was it Exhibit 14 that you submitted?

MS. HENRIE: Lightning Dock Exhibit 14 was the confidential cross sections. This board would be Exhibit 15.

MR. BRANCARD: But after the last hearing, we requested that you submit a better version of one of the exhibits, and I don't know which one it was.

MS. HENRIE: It was Exhibit 11. It was Dr. Miller's slides. And I did provide those to Florene.

MR. BRANCARD: And everyone has received that?

MR. LAKINS: I think I left my set on your table. You gave me a set, and I think I left that on your table.

MS. HENRIE: Sure.

MR. BRANCARD: I just want to make clear that we asked that that be dealt with in between hearings and that it was dealt with.

MS. HENRIE: Yes. Thank you.

Mr. Chairman, did we come to the conclusion on AmeriCulture's new exhibit? We would like to object to that; Exhibit V, as in Victor, is that correct?

MR. LAKINS: Yes.

MR. ROGERS: Mr. Chairman, it is our understanding with the exception of just two pages that that is a completely new exhibit of 15, 16, or 17 pages.

Would that be correct, Mr. Lakins, that --

MR. LAKINS: That's probably true. We are going to go through them as a visual aid PowerPoint presentation as it is. They will be on the screen. They will be discussed by my expert. If you want to object to certain additions, certain pages, at that time...

MR. ROGERS: Just so the objection is clear, one of the concerns about Lightning Dock has been the lack of specificity with regard to objections. The deadlines for exhibits has come and gone, and to provide these on the day of the hearing is prejudicial and should not be allowed.

MS. MARKS: I would add to the objection --

MR. LAKINS: In all fairness, that's exactly what happened to us the first time around. There were exhibits that were brought and shown that we had not seen before.

And this is a PowerPoint presentation that will be utilized through Mr. Witcher. I'm providing a copy of the complete PowerPoint presentation as our proposed V. It hasn't even been moved into evidence yet. The prior V was not, we haven't even gotten to it yet.

MR. BRANCARD: We can deal with it when we get to that part of it. Is each witness going to use this PowerPoint?

MR. LAKINS: One.

MR. BRANCARD: This is just Mr. Witcher's PowerPoint?

MR. LAKINS: Yes, sir.

COMMISSIONER CATANACH: Just hold off.

MR. BRANCARD: Yes.

MR. ROGERS: May I ask at this time are there any additional new exhibits that we might look at now? Are there any other ones that are new that we might receive now?

MR. LAKINS: The only other thing I have is this diagram which is going to be discussed by Mr. Hand that he prepared. I could make it an exhibit.

MR. ROGERS: Do you have a hard copy of that that we might have?

MR. LAKINS: (Handing.)

MR. ROGERS: Thank you.

MR. LAKINS: Yes, sir.

COMMISSIONER CATANACH: Anything else at this time?

MS. HENRIE: Can we present the nontechnical testimony of Mr. Richins?

COMMISSIONER CATANACH: Yes.

STATEMENT BY MR. RICHINS

MR. RICHINS: I am Scott Richins, R-i-c-h-i-n-s.

Mr. Chairman, as stated, I am a local businessman in Hidalgo County, more specifically Animus/Cotton City Area. I am a provider on the current project as well as other places throughout the county.

With this project alone, it has been able to provide several families income, employment. It has been a good economic boon to the area. And we have families that are needing -- using this as income and to provide for other families, as well as it's one of my customers that I am contracted to work with and provides for my family and the company, which is Jhus Canyon Construction, LLC.

The area is economically deprived, and it is a boon to have this job market and potential power plant expansion and use in the area. I would urge you to

approve and thank you very much.

COMMISSIONER CATANACH: Thank you, Mr. Richins.

MR. ROGERS: That's all. Thank you.

MR. BRANCARD: Did you have other letters --

MR. ROGERS: Yes, we do. Would you like those done at this time?

MR. BRANCARD: Let's get it out of the way here.

MR. ROGERS: This is Mr. Morrison, the vice president of operations.

MR. MORRISON: Good afternoon, Commissioners --

MR. BRANCARD: Is he presenting a letter -- I mean --

COMMISSIONER CATANACH: I think we're going to let him make a statement later, right?

MR. BRANCARD: I don't know. Is he just presenting other people's letters or --

MR. ROGERS: Yes.

MR. BRANCARD: Then can't we just have the letters for the record?

MR. LAKINS: That's my point.

MR. BRANCARD: We don't need the witness really. We can just have the letters.

MR. ROGERS: Okay. Here's copies. Thank you.

MR. BRANCARD: The other party has seen the letters and no objections?

MR. LAKINS: We were given a copy.

MR. BRANCARD: Okay.

COMMISSIONER CATANACH: At this time, we will turn it over to Mr. Lakins.

MR. LAKINS: Yes, sir. I call Daniel Hand.

COMMISSIONER CATANACH: Would you stand to be sworn in, please.

DANIEL HAND

having been first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. LAKINS:

Q. Good afternoon, Mr. Hand. Can you hear me okay?

A. I can hear you.

Q. I sometimes don't speak very loudly, so let me know.

A. I need all the help you can give me.

Q. Okay. Please introduce yourself.

A. My name is Dan Hand. I am a mechanical engineer. I am licensed here in New Mexico as a professional engineer. I'm licensed in several other states.

I have a master's degree in mechanical engineering, and my focus has been energy. And since about 2001, I have been working predominantly in the geothermal arena.

Q. Mr. Hand, let's kind of start with your education. So could you kind of give us a summary of that, please.

A. Sure. My education is very traditional in fluids, in heat transfer, and thermodynamics. I graduated from the University of Arizona. I did a master's level thesis in anisotropic conduction and laminated solids.

It's got similarities to what we are looking at today, because the flow pads that we have, you don't have isotropic conditions throughout the medium where we're trying to make flow go. And so the heat conduction problem that I presented the first closed form solution for has a lot of relevance to what we are looking at in this particular situation.

Q. What are your degrees in?

A. My degree is a master's of science in mechanical engineering. My undergraduate degree is from West Point. It is a bachelor of science.

The reason I got a master's degree was to go back and teach thermodynamics and fluid mechanics at West

Point. And I did that for three years.

Q. And I believe we have Mr. Hand's resume. Ms. Davidson has a copy of that.

MR. LAKINS: If you could pass that to the Commissioners. And I provided a copy to you as well.

Q. Mr. Hand, you mentioned some licenses. Could you give us a rundown of what license you have in what states?

A. Sure. I am licensed in eight western states as a professional engineer. My first license dates back to 1983. And I have done a lot of engineering things.

In the service, it was mainly civil kind of engineering. It's been energy since I went back to grad school predominantly, and looking at all kinds of energy systems.

Lately, it has been the geothermal. But prior to that, I looked at a lot of turbo machinery pumps, power plants. And when I say power plants, I studied energy at the University of Arizona. And it was predominantly traditional forms of energy, coal-fired power plants, gas-fired power plants, the Rankine cycle, the gas turbine cycle, the Brayton cycle it's called. And then cycles that we use in internal combustion or engines, the auto cycle.

I mean there's almost no energy system that you

could bring me that I wouldn't be familiar with or be able to model. And modeling is an important part. What you want to do is set it up so whoever you are working for, whether a state or a public entity, that you don't set them on a wrong path.

And a lot of these things we know when we know how mechanical systems behave. They all behave according to the fundamental laws of nature. And there are just a few of those to set things straight.

Q. Mr. Hand, tell us about your work experience after college. What have you done?

A. Well, after college, in the army -- I mean, I have a successful career in the army. I retired in 1994. And I did a lot of traditional things that you see the Corps of Engineers doing. And since then, I have worked in the energy market, looking at all kinds of machines and devices that consume and use power.

Starting about 2001 when I was working for Chevron, I got involved in geothermal and looking at wells and drilling and, you know, subsurface stuff. In a little town in Oregon, we built a $23,000,000 power plant, organic ranking cycle power plant.

And I actually got that project started, did the additional engineering. I mean, it has three wells. I mean, I flow tested the wells. Built the equipment to

do the flow testing. And that project is now producing power.

I worked at a school district that had an injection problem, which is not entirely dissimilar from what we have here. The water is not going where you want it to go basically.

And we solved that problem for the school district. I mean, the solution was to get the water off site. In this case the water was not contaminated. It was drinkable water. So putting it in the local river was not an issue, and that was actually the solution.

Q. Tell us about your experience, particularly concentrating on geothermal aspects of your work since 2001.

A. Sure. I have analyzed half a dozen or more resources for how much power you could make. And I've then done the initial engineering for what you could do -- I mean, the kind of power plant, the size devices you would need, the turbines, what type of turbine, how much cooling, were you going to go with a dry tower or a wet tower.

And I've worked for the DOE geothermal technology program as an expert reviewer to review proposals that, you know, come up for funding, and, especially, in the lower temperature, power kind of environment, which is

what we have at Lightning Dock.

You know, the Lightning Dock temperature is a very good temperature at 312, but it is still relatively low temperature geothermal. And the technology used there is an organic ranking cycle, which I have a lot of experience analyzing.

Q. What else?

A. Say that again?

Q. Does that kind of summarize it?

A. Yes.

Q. Talk to me about your experience in fluid dynamics.

A. I have done a lot of fluids problems. And there is almost no energy device that we have that doesn't also involve fluids. Fluids gets complicated fast when you get down to the nitty-gritty.

But if you stand back and look at the big picture, what is it we are doing, you know, those kinds of things, you can come to a good common sense thing.

And what I try to do for all my clients is to make sure that we are not proposing to violate any kind of laws of nature. I mean, even if you do that, mother nature will not allow it. So it's to try to keep projects on track and to try to provide good advice that keeps you from doing things that are outside of the

realm of being reasonable.

Q. How about your experience in analyzing geothermal resources?

A. Yes, I have analyzed geothermal resources. I have done it in the state of Oregon for about three sites. The state here in New Mexico, I have worked analyzing at least two sites. I mean, I looked at a geothermal power plant that was a solar hybrid mix for the pueblo that's actually your state flag, the Zia Pueblo. I did that under a DOE funded project.

And the low temperature resources almost always comes down to organic ranking. That's what you wind up looking at.

Q. As part of your work for the DOE, did that involve analyzing geothermal resources?

A. Yes. To add to that, I mean what you need is flow and temperature. I mean, and that's been testified to by Lightning Dock. You know, those are the two really important parameters. If you lose temperature or flow, both of them can be detrimental to the operation.

MR. LAKINS: I tender Mr. Hand as an expert witness in fluid dynamics, geothermal resource analysis, and power plant design.

COMMISSIONER CATANACH: Any objection?

MS. HENRIE: Not from us.

COMMISSIONER CATANACH: Mr. Hand is so qualified.

Q. Mr. Hand, if you could please give us an overview of what --

MR. BRANCARD: Mr. Lakins, should we accept Mr. Hand's resume as an exhibit before you go on?

MR. LAKINS: I tender Mr. Hand's resume as our Exhibit W. Thank you.

MR. BRANCARD: Any objections?

(No verbal response.)

COMMISSIONER CATANACH: Exhibit W will be admitted.

(AmeriCulture Exhibit W was offered and admitted.)

Q. Mr. Hand, could you kind of give us an overview of what you did in preparation for your testimony here today.

A. Yes. In preparation for the testimony today, I reviewed the public available documents about the Animas Valley and then specifically about the Lightning Dock Geothermal resource.

I also reviewed a DOE funded project, that was primarily done by Barber-Nichols, to design and -- to do the preliminary design of an organic Rankine cycle for AmeriCulture.

Q. You were here and listened to the testimony at the prior hearing, correct?

A. Yes. I listened to the previous testimony in this case, and I've reviewed that testimony.

Q. Mr. Hand, are you prepared to offer an opinion today?

A. I am.

Q. And could you summarize what that opinion is?

A. Yes. In my review -- and I think this study was also used by Lightning Dock or Cyrq -- but the study was by Johnson and it was for the state engineer office and it was on the Animas Valley water flow.

And Mr. Johnson came to the conclusion that the recharge in the Animas Valley was 13,000 acre feet per year.

When you review Cyrq's proposal, they propose to produce and inject 19,357 acre feet of water. So as an engineer, I look at this, and I say, Well, you know, what is the magnitude of this or what are the possibilities?

And for me, I struggle with how this could not have a large impact. I mean we are cycling 150 percent of the recharge rate of the entire Animas Valley. And if I understood the testimony by Lightning Dock, it is that there would be very minimal impact.

And I just -- that's very difficult to believe. Could you put this up?

Q. Sure.

A. This is a spacial layout. And so on the left, the red well is the production well. And everything is size relative. And so the scale matters on this.

So they're injecting -- you can see that bottom piece down there where they are producing, it starts around 1,600 feet, I believe, and then down to the bottom of the well, which is around 2,900 feet.

And then the injection currently is in this long blue well. And this one well represents both of the wells they're trying to inject into. And the injection level runs, as shown on the graph, from a little over 1,000 feet down to the bottom, which is around 4,200 feet.

And their proposal now is over -- it is further away from the injection well. And so all of these wells aren't in the same direction. But there's a clump of three of them that around are 800 feet away -- 1,800 feet away. And then the last one is in the realm of 2,200 feet away.

And so if I understand what is proposed, it is to inject into the shallow aquifer and this water is somehow going to find its way back down to the deep

geothermal system.

Q. Do you agree with that?

A. No.

Q. Why not?

A. As you go deeper, by testimony of Dr. Miller, the hydraulic conductivity decreases. And that is a general rule. So if you go deeper, you need to find some fractures.

And one of the board members asked the question, Why don't you just drill into the fractures?

I don't think this water is going to find its way back down to the deeper geothermal system unless there is some hydraulic conductivity. Dr. Miller stated, he referred to Darcy's Law, and he says that the recharge going back down deep is entirely dependent on head. And that can be calculated.

He said you can calculate on the basis of head differential what amount of flow could possibly escape.

Q. Do you agree with that?

A. No.

Q. Why not?

A. Darcy's Law has not just head in it, but it also has hydraulic conductivity. And if there's no hydraulic conductivity, it's like a plugged pipe. I don't care what the head is, you're not going to force flow to go

down there unless there's hydraulic conductivity.

I mean, just looking at this big picture, we are going to stir up 150 percent of the recharge rate. And we expect this to find fractures somewhere. We don't know where they're at, but the water is going to find them. And it is going to find its way due to the drawdown in the head.

And so Darcy's Law is K equals IA. And the K is the hydraulic conductivity. The I is the amount of head. If one of those is close to zero, it doesn't matter what the other one is. You are going to get very little flow.

So I think there is a very high probability that once the water gets out of the alluvial aquifer, that the permeability is going to change; and, in fact, in order to use Darcy's equation -- this is a very anisotropic medium for flow, in other words, the flow -- in the alluvial plane, it's easy for flow to go vertical or horizontal. But as you get beyond that, then you have different layers and those have different conductivity.

I'm not a geologist to tell you what those layers are. But once those layers are presented, then it's a matter of arithmetic to figure out what the conductivity is.

And I have seen nothing in any testimony that gives me any faith that this water is going to find its way down to the deeper system before it's swept away by the natural northwest trending of the ground flow in this region.

And so -- I mean I think the testimony was, Well, the plume might grow a little bit. Well, if you inject 150 percent of the annual recharge rate, I think it is going to grow by more than just a little bit.

And I think it is very likely that more than a few wells will be impacted by this. In fact, I don't see how the whole Animas Valley is not impacted by it.

One of the claims has been that this is a closed geothermal system.

Q. Speak to us about that. What is a closed system in your mind?

A. This bottle is a closed system. The air in that bottle is a closed system. There's no flow going in and no flow going out.

And from an engineering perspective, mass is conserved and -- I mean, it was stated that mass is -- that mass in equals mass out.

That is not a closed system. That's an open system. You get mass flowing in and the mass flowing in is going to have different properties or can have

different properties than the mass flowing out.

But it's worse than just flowing in and out. It is different on the top. It is different on the bottom, where supposedly the geothermal flow is coming in.

This could be modeled, but we haven't seen a model, and I --

Q. What would you expect or what would you utilize data-wise to compile a model that would demonstrate the concept of the water being injected and returning back down to the production? Do you understand my question? That is kind of a bad question.

A. I got it.

Q. Okay.

A. The way I would model it is I would first start from the drill logs and try to identify what layers of subsurface we have, especially below the alluvial aquifer, because that's where you're going to get into a lot of antisotrophy where the flow -- I mean, if you pull on this supply well very hard -- and let's say that the drawdown is 1,000 feet, if there is no hydraulic connectivity to that alluvial aquifer where you are injecting, the water is not going to go there.
I mean, you were told by Dr. Miller that it depended entirely on the head, and that is absolutely false.

Q. Would it be possible to assemble a model?

A. Yes.

Q. One of the things that has been testified to is that there is mounding -- is that there is an increase in the water levels surrounding the monitoring wells; do you recall that?

A. Yes.

Q. What does that tell you about the hydraulic connectivity?

A. It tells me there is not much hydraulic connectivity.

Q. Why is that?

A. Well, the theory is that when you draw down in the production well that your injectors are going to see it. But if they are mounding, I mean that means that they're not -- there's more water being injected than is being absorbed, and it's definitely not going down. It's probably spreading out. Not "probably," it is spreading out.

I mean, when you see it mound, that means the size of the injection ring is going to grow.

Q. Another aspect of Dr. Miller's testimony had to do with the percentage, 81 or --

A. True.

Q. Do you recall that testimony?

A. Yes. Early in Dr. Miller's testimony, he said

that there were 18 orders of magnitude difference in hydraulic conductivity found in nature. And he said only one hydraulic order of magnitude difference in hydraulic conductivity would cause a diversion of flow -- let's say that you had one that was the order of ten and one that was an order of 100. Well, the 100 hydraulic conductivity would get 81 percent of the flow and 19 percent of the flow would go the other way.

I mean if that's true, the hydraulic conductivity, again by what Lightning Dock has testified, they know that it's high in this alluvial aquifer. We don't know what it is in the subsurface.

And, so, you know, to me making a decision on this is like, you know, closing your eyes and hoping for the best.

This can be modeled. This is not -- I mean, it is complicated because you need data to model it. But it is not complicated to get started. And there's -- you know, Dr. Miller said that he had done a back of the envelope calculation. I mean, this is the state of New Mexico. You are about to make a decision. I mean I have doubt.

Q. Do you have an opinion as to whether or not water injected up here at 150 to 500 feet has a likelihood of making it down to the production zone based upon the

unknown hydraulic conductivity?

A. Yes.

Q. What is your opinion?

A. Yes.

Q. That it will make it or it won't make it?

A. You know my fear is it will not make it and that you are going to put this geothermal brine in your local aquifer that's used for lots of purposes.

Q. That's up here where the shallow injection would be?

A. Yes. There has been no hydraulic path identified for the water to get from that alluvial aquifer to that deep geothermal aquifer. The only way it can get there is by head, and that's only part of the picture.

Q. In your work with DOE, did you prepare models that would be similar to the task that could be accomplished here?

A. I didn't do that with DOE. I did that with the geothermal power plant in Oregon. I did that with a producer/injector/payor in Idaho.

Q. And what kind of data do you need, subsurface?

A. You need to know where the faults are. That is really what you are looking for in the subsurface. And you need to know what layers and their consistencies. You need the hydraulic conductivity.

And it is not just a simple Darcy's Law. It's a Darcy's Law that is split into at least three directions. And, you know, if I put it out here mathematically, it is complicated; but conceptually, it's pretty simple, that the water is going to take the easiest path to neutralize itself, you know, all head is going to try to neutralize itself.

And so, like Dr. Miller said, if it's an order of magnitude better permeability in this alluvial aquifer than it is deep, then 81 percent of the flow is going to be up there in that aquifer.

I mean, I think this is, you know, something that should be looked at very intently; and, you know, I mean a back of the envelope calculation?

Q. Let's switch to a different topic.

A. Sure.

Q. Are you aware of AmeriCulture's planned construction of a small scale geothermal electric power plant?

A. I am.

Q. Tell us what you know.

A. AmeriCulture hired Barber-Nichols to do the preliminary design on a power plant that they could use internally for their own power and that would serve them well for their planned growth.

And the resource temperature that they found was 232 degrees Fahrenheit. And with that temperature, Barber-Nichols designed a power plant -- actually, similar to one that's organic Rankine cycle, a little bit different expansion device, but, basically, the same technology. And the net output would be about one megawatt.

And, you know, I was asked to look at, Well, let's imagine that through this injected water at 170 degrees -- which is about what Lightning Dock reported their injection temperature is -- if that mixed with the 232-degree water, what could the possibilities be?

So I assumed a 20-degree loss. And if you look back and use the same linear mixing model that was used by Dr. Miller, you need about 32 percent of the 172-degree water to mix with the remaining water that would be at 132, and that would drop it to 212 degrees.

Well, a 20-degree drop at those low temperatures would probably compromise your power by at least 25 percent. So having a power plant at a megawatt now, you have 750 KW.

And if you look at that power plant and you assume that the electricity is worth ten cents a kilowatt hour and you prorate that over 30 years, the

present value of that is $12.2 million. So that's a significant amount of harm.

And, again, this assumes a 32 percent mixing ratio. And I've got to think that's low because the 19,000 acre feet that they're going to pull up and put in this alluvial aquifer again is 150 percent of the recharge rate. So it is a big impulse that they're putting on this system.

And since you have a lower temperature, your power plant now needs larger heat exchangers, larger blades on your turbine, and it's going to cost probably $5 million instead of $4 million, which is another million dollars of cost.

So I would estimate the harm to AmeriCulture of a drop of 20 degrees Fahrenheit in their resource temperature to be $13.2 million.

Q. Mr. Hand --

A. There's one other item.

Q. Go ahead. Sorry.

A. Dr. Miller's testimony indicated that AmeriCulture was diluting its own well, causing harm to it by their injection routine. And the amount of injection in that particular well was ten acre feet a year.

And it seems to me to be a great, you know,

disjointedness for you to say that ten acre feet has this big impact and you are going to do 19,000 acre feet and the impact is going to be minimal. I mean, I don't see how you used the same science to reach this conclusion and you come over here and you have two -- three orders of magnitude greater injection and you're not going to have any impact.

I just -- again, a lot of what I do is big picture stuff. It just doesn't add up.

Q. I'm going to show you, Mr. Hand, what is AmeriCulture's Exhibit R. You don't have that over there. But I want you to kind of run down this slide and tell me, is this sort of the calculation that summarized the testimony --

A. Yes.

Q. -- for the potential financial loss --

A. Yes. So you start with 232-degree geothermal water when you're producing a megawatt. And you have to make some assumptions about the mixing rate of the water. And as I said, I think I'm low on this. I assume 20 degrees. But if they really injected this 19,000 acre feet a year number, I think that the ability for AmeriCulture to have a power plant is probably mute, because I think that the mixing -- I mean, Darcy's Law is not a mixing thing. The fixed law of diffusion is

something that ought to be used here in this model.

So the power plant efficiency is reduced. And the way I got at that is I took Barber-Nichols' numbers for the power plant and I used a power plant that is working on the organic Rankine cycle at the Oregon Institute of Technology. I used their numbers on what they're doing.

And when I assume a straight line, again a proration, the same sort of mixing strategy that you have seen presented before, I find that the efficiency would drop from a little over 7 percent to a little over 5 percent. And that is where you get the 25 percent reduction.

And the rest of the things here are just arithmetic. You are going to need bigger heat exchangers. And it's going to cost you more to build it initially. And you're going to get less out of it over the 30 years.

Q. I am going to turn to the second page of that document. And could you speak to the information that is on that second page that's up here.

A. That's true.

Q. No. Could you explain that, please? This kind of summarizes your testimony.

A. Yes. I mean, the quantifiable harm here is that

he will be able to produce less power and the power plant is going to cost him more; a drop of 250 KW, and over 30 years that amounts to the 12.2 million. And the power plant is going to cost approximately a million dollars more to build, because it's lower temperature and you need bigger stuff, bigger heat exchangers, bigger turbine to convert that to power.

MR. LAKINS: I move to admit Exhibit R.

COMMISSIONER CATANACH: Any objection?

(No verbal response.)

MR. BRANCARD: Mr. Lakins, could you establish who created Exhibit R?

Q. Mr. Hand, did you create these slides?

A. Yes.

MR. ROGERS: Exhibit R, no objection.

COMMISSIONER CATANACH: Exhibit R will be admitted.

(AmeriCulture Exhibit R was offered and admitted.)

Q. Mr. Hand, do you have any further thoughts on this project, further opinions?

A. The only other thing that I would add is -- I mean, it is a decision, but, I mean, I think when you look at the potential harm and the kind of back of the envelope reference and hand waving and lack of a model,

I mean, it just gives you pause.

Q. Turning back to your spacial layout, the current production in injection is almost being utilized; is that accurately portrayed --

A. Yes.

Q. -- in this spacial layout?

A. Yes.

Q. Did you create this?

A. Yes.

Q. And does it accurately portray the distances at 600 feet up there as the known distance between the production injection?

A. Yes.

Q. And the 18,000 and 25,000 feet, that's the proposed distance --

A. Yes.

Q. -- for the four proposed --

A. Yes. That's a proportional diagram. I mean, it helps me to try to visualize what we're talking about and without a lot of clutter in it. I mean, you would have to have really good connectivity -- I mean, the proposal is we are going to move further away and we are going to inject into an aquifer that has high permeability and that water is going to somehow find its way back to the geothermal reservoir.

I mean, I have no doubt they can inject in that alluvial aquifer, no doubt in my mind at all. But it getting back and not causing harm is where the doubt is at.

Q. Do you have an idea of what could be done to actually accomplish production and injection in keeping it within that lower zone; do you have any ideas?

A. Yes.

Q. What's that?

A. If you drilled wells and you found these fractures and there were some aquitard between where you're injecting and the ground water aquifer, I think that would solve the issue.

Q. Drill deeper?

A. Yes.

Q. Drill closer to the current production well?

A. You know, you are asking me a geology question -- I mean, a lot of this does reduce down to a fluids problem. I mean, where is this water going to go?

Darcy's Law, I mean, there's wrong with the law, but fluids is a lot more complicated than Darcy's Law.

Darcy's Law is a special subset that you use to describe laminar flow. What's going on around these injection wells in the immediate vicinity is probably not laminar flow. There's a lot of mixing. Laminar

connotes there's no mixing.

And then we have flowing through this in the alluvial aquifer -- and, you know, what's been described as their closed system, it's just not a closed system. You have, you know, Dr. Miller's words again, Mass in, and you have, Mass out.

And it's not just in here and in here, but it's in all over the place. I mean, he described how the -- you know, the upflow mixes. That's going to go on.

And Darcy's Law is just not appropriate to describe that kind of situation, especially not in a one-dimensional isotrophic form.

MR. LAKINS: I move to make Mr. Hand's spacial layout, visual aid, our Exhibit X.

COMMISSIONER CATANACH: Do you move to admit that?

MR. LAKINS: Yes, sir.

COMMISSIONER CATANACH: Any objection, please?

MR. BRANCARD: I guess I have an objection. Can I ask the witness some questions about his exhibit.

EXAMINATION BY MR. BRANCARD

MR. BRANCARD: On the two wells you have on the left, you have a production zone and an injection zone, a top and a bottom of the zone.

On the wells on the right, you just have the top of the zone, correct?

THE WITNESS: No. It's actually too small to show it in the scale way.

MR. BRANCARD: Did you look at the applications that indicate what their injection zones are supposed to be.

THE WITNESS: I haven't looked at their application. It is my understanding they are between 150 and 500 feet.

MR. BRANCARD: The top?

THE WITNESS: My understanding, the top is 150.

MR. BRANCARD: So you didn't know what the bottom of the injection zones were when you drew these?

THE WITNESS: I --

MR. BRANCARD: I mean, they are your exhibits, Mr. Lakins, that have the applications that my reading is the bottom of the injection zone for each one of these is 1,500 feet. And I don't see 1,500 feet being shown on this.

So the answer to Mr. Lakins' question, "Is this an accurate portrayal," is I have a real concern, Mr. Chairman, that this is not an accurate portrayal.

THE WITNESS: If the bottom injection is

1,500 feet, it's not.

MS. HENRIE: Mr. Chairman, we share that objection. Mr. Hand admitted he is not a geologist and yet we have a description of the alluvium at a certain place, of clay, limestone -- clay? Where's the clay? I don't know where this description came from.

THE WITNESS: I thought three of the injectors were 500 feet and one of them was deeper, which is what I have shown. That's not the case?

MR. BRANCARD: I was just reading your Exhibit M.

COMMISSIONER CATANACH: Which exhibit are you looking at?

MR. BRANCARD: I am looking at Exhibit M, which I believe are the form applications for the injection wells.

COMMISSIONER CATANACH: On AmeriCulture's exhibits?

MR. BRANCARD: Yes.

MS. HENRIE: Mr. Chairman, if these forms are not something that you studied before, up towards the top, it has casing and tubing data. And it says, name of string size, setting depth. And you can see the setting depth down to 1,500 feet.

COMMISSIONER CATANACH: I believe that these

show that the injection interval, the top of that zone is 150 down to 1,500 feet, is what we're showing?

MS. HENRIE: Yes, Mr. Chairman. The wells have not been drilled. We don't know what we will find.

COMMISSIONER CATANACH: So it doesn't appear that the exhibit doesn't correctly show what the injection interval is in those proposed wells.

MR. BRANCARD: Mr. Chairman, my other concern is there is this black line across here referring to the 'Allivum," Good hydraulic conductivity at 600 feet. I don't know that we've had any testimony about the 'allivum.'

COMMISSIONER BALCH: Dr. Miller did testify about the alluvium.

COMMISSIONER CATANACH: Mr. Lakin, is there going to be a witness that can clarify some of these geologic issues on this exhibit?

MR. LAKINS: Yes, sir. I will just withdraw that request for admission of that exhibit at this time.

COMMISSIONER BALCH: If you are going to readmit it later, could you add the correct depths to the wells?

MR. LAKINS: Yes, sir.

COMMISSIONER CATANACH: Okay.

MR. LAKINS: I pass the witness.

MS. HENRIE: Do you have questions?

MS. MARKS: May I just ask a few questions first?

COMMISSIONER CATANACH: Yes.

CROSS EXAMINATION

BY MS. MARKS:

Q. Dr. Hand, I just want to ask a few questions. I'll be very quick. The proposed -- the plant that you were talking about losing 20 degrees, this is AmeriCulture's future power plant; is that correct?

A. Yes.

Q. I remember -- and I'm going to be -- certainly have not memorized the exhibits very well. But I think they apply or they mention this power plant back in I think in 2002 or so.

I know -- thank you, obviously, for your service. Have you -- do they have a permit with the State Land Office? Do they have all the requisite documents to build this power plant? Do they have the contracts, all the needed documents? I don't know...

A. Are you asking me if it's permitted?

Q. Can they build this power plant. You talked about this potential harm. I don't know that they actually can build this power plant. Do you know in your analysis that they actually can build this power

plant?

A. Yes, they can build this power plant.

Q. What is your basis for them having all the state requirements -- that they met all state requirements to build this power plant? Can you talk about that?

A. They have not met all the state requirements to build the power plant. There would be construction permits that have to be pulled, they would have to have an agreement with the utility about how they are going to interconnect if they do. So they haven't done that, no.

Q. Do they need to meet certain requirements with the State Land Office as well?

A. Excuse me. Say that again.

Q. Must they meet certain requirements with the State Land Office as well?

A. Yes.

Q. And have they done that?

A. Yes.

Q. Okay. What is the basis that they can build the power plant?

MR. LAKINS: Objection, vague. I don't understand the question.

MS. MARKS: I am really confused as to all this potential loss that Dr. Hand has spoken of. I

don't really understand -- I mean there's a number of records that -- preliminary steps that must be taken.

And Dr. Hand has testified about this potential harm. And I am not really sure that AmeriCulture has taken all the necessary steps to be able to build a power plant.

MR. LAKINS: If I may, that will all come out from Mr. Seawright. We put Mr. Hand on first, kind of a little out of sequence, primarily because he has to leave and he was here before, for two days and he didn't get to testify and he needs to leave. So we put him on first.

But all those questions that you have, Ms. Marks, about the permitting, et cetera, Mr. Seawright would be the perfect one to answer all that.

MS. MARKS: Okay. I think the extent of the harm, the two are interrelated so...

MR. LAKINS: I agree.

MS. MARKS: I'll save the questions then that are related to the power plant, so...

THE WITNESS: Okay.

MS. HENRIE: Passing?

MS. MARKS: Sure.

CROSS-EXAMINATION

BY MS. HENRIE:

Q. So, Mr. Hand, you're not a reservoir engineer; is that --

A. No.

Q. And not a geologist, either?

A. No.

Q. So you talked about I believe a one-megawatt power plant. Is that one megawatt net or gross?

A. Net.

Q. And so what is the flow rate that is going to be needed to get one megawatt out of this resource?

A. The flow rate which Barber-Nichols used was around 1,000 GPM.

Q. And do you know when Barber-Nichols made this analysis or report?

A. I don't remember the date on the study. But I think it was -- it had to be after 2007. But I don't remember the date on the study.

Q. So maybe ten years ago?

A. No, it was not ten years ago.

Q. But it wasn't this year?

A. No.

Q. Do you know what's been done since 2007 or whenever the Nichols' study --

A. Do I know what?

Q. What's been done by AmeriCulture to effect this power plant since the Nichols' report?

A. My only involvement is they're trying to protect their interest that they have building this power plant from being harmed by the company you're representing.

Q. And that's it --

A. That's my involvement.

Q. -- just harassing us?

MR. LAKINS: Objection.

A. You can ask them.

MR. LAKINS: Objection to the statement "harassing." That wasn't a question. That was a characterization.

COMMISSIONER CATANACH: Let's try to refrain from that, Ms. Henrie.

MS. HENRIE: Yes, sir. Yes, sir.

Q. You talked a little bit about your experience with geothermal, including for Zia Pueblo, I believe. Did you do geothermal on that project or did Mr. Witcher do the geothermal?

A. Mr. Witcher did the geothermal; I did the power plant analysis.

Q. And have you done any analysis for AmeriCulture as whether it would be more cost effective to use solar instead of geothermal for its power generation?

A. No.
Q. And do you have any experience operating geothermal power plants?
A. No.
Q. So when you talk about the cost of power, does that include operations and maintenance of the geothermal power plant in those numbers that you gave us?
A. Yes.
Q. It does.
A. The ten cents is from the rate of Columbia Power, and it includes all their O and M and all their cost of operating.
Q. For the utility power? If they buy the power off the grid, it includes the cost of O and M?
A. Yes.
Q. But if it's geothermal power -- and I think you told us -- but I don't letter the number -- does that include O and M costs?
A. Yes.
Q. So how did you estimate those costs, not having actually operated a geothermal power plant?
A. I estimated those costs for several entities. I actually -- the ten cents is a number that is what people refer to as a lifecycle cost. And it includes

everything that you have to do to put power on the grid.

So I did not dissect it out to, this is O and M and this is cost of equipment, et cetera.

Q. Is there any relationship between the circulating rate and the recharge rate?

A. I don't know what you're trying to ask me.

Q. You talked about recharge into the Animas Valley. And I think you based that on a document by Johnson, a state engineer document by Johnson?

A. Yes.

Q. Is that your only source for that information?

A. It is the only one I reference. There were several sources that Johnson referenced that have a similar number.

Q. Did you have a chance to review Mr. Witcher's 2002 pumping test? There's a report that we included in our exhibits. Did you have a chance to look at that?

A. Yes.

Q. And have you looked at the Shomaker 2012 report?

A. Yes.

Q. And can you talk a little bit about comparing those two pumping tests, what they teach us about the resource?

A. I can't compare them. I'm not a geologist. I mean, they both make allegations -- I mean, where I can

help at is when you get down to flow and you're applying a fundamental equation, I can tell you whether you're applying appropriately, whether your expectations are reasonable; but the geology, that's not my expertise.

Q. Okay. What about transmissivity, can you define that for me?

A. In general, transmissivity is the flow of water through an aquifer. And I don't remember the units, but it is a property that's associated with the water in the medium that it's flowing through.

Q. And I think you characterized Dr. Miller's testimony as 18 orders of K. Could that have been 13?

A. It could have been. 13 orders of magnitude -- whether it is 13 or whether it is 18, you know -- it is in the testimony, so there should be no ambiguity about that.

13 orders of magnitude is a lot. One order of magnitude is a lot, too.

Q. Have you heard about or reviewed the ground water mining which took place in the Animas Valley? That came up in one of the prior testimonies, that there was ground water mining --

A. Yes.

Q. You're familiar with that?

A. Yes.

Q. What is the significance of mining with regard to recharge?

A. You are asking a question I don't know the answer to.

Q. Fair enough.

You said that this resource could be modeled and you haven't seen a model. How would you go about modeling the resource?

A. I would first try to estimate what the hydraulic conductivity is between where I am injecting and where I'm producing. I mean, your expert witness told us that the head was going to pull it down and he referenced Darcy.

And Darcy has two terms in it. One of them is head and one of them is hydraulic conductivity. This is also very anisotropic. So I wouldn't use the simple form of Darcy's Equation nor back of the envelope calculations.

Q. And you think we have done back of the envelope calculations?

A. From Dr. Miller's testimony, that's how I know.

Q. Have you ever used Darcy's Law in a geothermal calculation?

A. No.

Q. I also wanted to clarify this. I think you

characterized the effluent from the AmeriCulture facility as ten acre feet; do you recall that?

A. I didn't characterize that. I quoted that from Dr. Miller's testimony.

Q. So just to have the record clear, this is page 133 of Dr. Miller's testimony, lines 6 through 11. And he says, "I have observed that ten, 15 acre, possibly 20 acre feet for your hot water are produced, and between 100 and I think the peak number was 175 acre feet for your cold water produced."

So I think that's really different than ten acre feet. I just wanted to make that clarification.

A. Okay.

Q. All right. You talked about modeling. Have you any experience in geothermal resource modeling?

A. I do.

Q. You do. How about ground water modeling?

A. I don't.

Q. No. Just geothermal. Okay.

I thought I heard you characterize what's being reinjected as geothermal brine. Are you able to characterize that brine?

A. "Brine" is a generic term that is used to refer to geothermal fluid. I mean it doesn't bother me if you call it "fluid" or if you call it "water," but it's

geothermal and it is deep and it is different than the water in the local aquifer.

Q. So it is not necessarily briny? That term doesn't --

A. "Brine" is a term that's used in the industry.

Q. Okay. Did you say that there was no hydraulic path from valley fill aquifer to the geothermal aquifer?

A. I said there has been none identified.

Q. None identified, okay.

Do you know if the waters of the valley fill aquifer within the area of the geothermal system are hot?

A. Ask me that question again.

Q. In the area of the geothermal system where the greenhouses and the power plants are, do you know if the valley fill is hot in that area?

A. Well, to start with, I don't know what the geothermal system is because it's not been defined, and so I can't answer your question.

Q. Dr. Shomaker defined it.

A. The reference I have is that it is a closed system. It's not a closed system. And so -- I mean, this hand-waving stuff where you defined it is just not adequate.

I mean, we have a map up there, but the

geothermal system is not outlined. I have seen some maps of plumes. But still I don't see where the geothermal system is at. I don't see the mass coming in. I don't see the mass going out. And there's a lot more locations where mass is coming in and where mass is going out than has been shown in these simplistic diagrams. So I don't know what this geothermal system is.

Q. Okay. And speaking about mass coming in, when Johnson cites a certain mass coming into the Animas Valley, does that include the geothermal mass that is coming in?

A. That is recharge.

Q. That is recharge. So the geothermal mass is separate --

A. Again, that's a geology question. I mean, it is coming into the valley as recharge.

Q. Okay. So when you say that -- I think you said Lightning Dock is going to be producing and reinjecting about 19,000 acre feet. Where do you get that number from?

A. I got it from one of the applications filed with the state. But the actual number is 19,357 acre feet.

Q. So that would have been a State Engineer application that was withdrawn perhaps?

A. I don't know if it was a State Engineer application or an OCD application. But it was one filed by Lightning Dock.

Q. And it stated a rate in terms of acre feet, as opposed to gallons per minute --

A. It had 19,137 in it.

Q. Okay.

A. It calculates out to 12,000 GPM.

Q. Okay. And is that what the proposal is now, 12,000 GPM?

A. I don't know what your proposal is. I have heard testimony that it's 7-1/2 times the current rate. I have seen your documents that say you are producing around 1,600 GPM now.

It is a big number, and my whole point is you are talking about a big impulse to the system. That's not insignificant. It is something that gives me pause.

I mean, if the State Engineer called me and asked me as a mechanical engineer, I would definitely be concerned.

Q. But you are not a reservoir engineer?

A. I am not. But what you are doing up here is not in the reservoir, either. It's up here in the alluvial aquifer.

Q. And can you explain the effective pressure and

head on a production well and an injection well?

A. Can I explain what?

Q. The relationship or the effects of pressure and head as between an injection well and a production well?

A. Well, pressure and head are the same thing, so I don't understand.

Q. What I understood you to say is that despite the cone of depression, despite the injection pressures, despite all those things, you don't believe that a shallow injection will get back down to the production well or that at least -- you don't see that happening?

A. No, I don't see that happening.

Q. And so is there any effect at all on the cone of depression?

A. By "cone of depression" I take it you mean what's happening at the production level.

Q. Sure.

A. So that cone of depression is going to cause more water to flow in. Now, where that water comes from is going to be determined by the difference in head and where that's occurring and also the hydraulic conductivity.

And what was missing from testimony was the hydraulic conductivity. There's not been a path that's

been shown. It's been hand waved at. But there is no path.

And so if I have 300 feet of head, it doesn't really matter. If you have no hydraulic conductivity, then there is going to be no flow. It is like a flooded pipe. I mean that's basic fluids.

Q. And were you here for Dr. Shomaker's testimony about all the fracturing and the water is flowing in the fractures?

A. Yes.

Q. And you don't consider that as part of the hydraulic conductivity?

A. Where are the fractures at?

Q. So does a pumping test determine hydraulic conductivity?

A. Just a pumping test alone does not.

Q. So how would you determine hydraulic conductivity?

A. You would need at least two wells. I mean, the way that Darcy did it was he isolated the system and he put some head on it. And he found out that this hydraulic conductivity was a function of the material.

And, actually, the hydraulic conductivity, as Dr. Miller presented it, it actually has two constituents. One of them is a property of the medium,

like gravel or alluvium or whatever you have, and the other is a property of the fluid that's transmitting through the medium. He is using a combined term. And so you would need to know both.

You know, the rate, you need to know your drawdown and your pumping rate, and then you can compute an average hydraulic conductivity, depending on how well you've isolated the system.

Q. So are you aware of the pumping tests that have been conducted of this resource?

A. I am not.

Q. Can you do a single well test?

A. Say again.

Q. Can you do a single well test? You've described more than one well.

A. Can you do a single well test for what?

Q. A pump test to establish hydraulic conductivity.

A. If you measure the drawdown and you measure the flow rate, then you have drawdown plus you have flow rate. And then the other variable that you can back out of this is hydraulic conductivity.

Q. Okay.

(Pause.)

MS. HENRIE: Just a couple more questions.

Q. Mr. Hand, I think you said earlier that you were

familiar with both the Witcher pumping test in 2001, the report from that test, I think you --

A. I was familiar with what?

Q. The pump test report from Mr. Witcher in 2001, which is one of the exhibits in this proceeding.

A. I have read both the reports, the details, so, yes, I am familiar with it. I would recognize it.

Q. And the Shomaker test from 2012, I believe you said you were familiar with that as well?

A. Yes.

Q. And you don't feel that those say anything about hydraulic conductivity?

A. I don't -- I mean, they didn't say anything that registers with me. I don't remember.

Q. Okay. What I remember from your testimony is that you have experience with maybe a half dozen geothermal resources?

A. Yes.

Q. So five or six?

A. It is more like six to 12.

Q. Okay. And you mentioned the Zia Pueblo study. Did anything get built from that?

A. No.

Q. And I think you mentioned Paisley Power?

A. Yes.

Q. Are they generating anything right now?
A. Yes.
Q. How much?
A. Three megawatts.
Q. Okay.
MS. HENRIE: We will go ahead and pass the witness, Mr. Chairman.
MS. GAULT: Excuse me. Can I ask him some questions?
MR. BRANCARD: Just a few.
MS. GAULT: Okay.
QUESTIONING BY MS. GAULT
MS. GAULT: I read the whole testimony from the hearing in September. And I understand that they -- I want to know from you if you understand that the reason that they cannot inject deep, like they promised us, is because there is no hydraulic conductivity.
And I want to know if -- I don't recall anybody in their testimony talking about hydraulic conductivity. I do recall about pressure, head. That I recall. I do not -- but now you are giving me an answer maybe of why they cannot go to the deep reservoirs that they are supposed to go, according to my understanding.
Another thing I wanted to ask you, I also did not understand this closed route. There is

fractures there. There is fissures there. There is a possibility that the water will go laterally. So where is the closed loop?

So the hydraulic conductivity and the closed loop are connected. If there was a closed loop, we would have hydraulic conductivity? Can you -- I am just not a very smart person and I am not a hydro geochemist. Maybe if we had a hydro geochemist, he can answer this about hydraulic conductivity. It was not in the testimony.

THE WITNESS: You need both a flow path, which is hydraulic conductivity, and you need some pressure to push it along that way. And if you don't have one of them, you have no flow.

And so -- I mean if you have mediocre hydraulic conductivity and you have pressure head, you combine them and you get mediocre flow. And I think that's kind of what they have in the wells that they have drilled. I mean, you need them both.

MS. GAULT: So, basically, I think this is the answer for me as far as the conservation district, why we don't get to the deep water. There is something missing here. I don't know, maybe the model can find out where is this hydraulic conductivity, can we -- if we be closer to the production well, do you think you

will find out this hydraulic conductivity?

I don't understand if there is any reason why they cannot go close to that. Is there any reason why they cannot have the injection closer --

THE WITNESS: You are asking me a geology question. As a hydraulic connectivity problem, you'd want to be as close as possible. But then you inject, you know, cooled-off water into your production well. It's a difficult problem to solve. It's not easy.

MS. GAULT: Thank you, sir.

COMMISSIONER CATANACH: Go ahead, Dr. Balch.

EXAMINATION BY EXAMINER BALCH

COMMISSIONER BALCH: Good afternoon, Mr. Hand.

THE WITNESS: Good afternoon. I'm trying very hard to hear.

COMMISSIONER BALCH: I am also very soft-spoken.

I don't think there is much of a question that there has to be some hydraulic conductivity or conductivity between the deep geothermal aquifer and the shallow aquifer, because you have a geothermal anomaly that's deep and also a shallow. So it has to be at some level of connection.

THE WITNESS: Yes.

COMMISSIONER BALCH: Because that water is what's moving the heat from deep to shallow.

THE WITNESS: The heat is moving the water, and there has to be hydraulic connectivity for it to move. That's true.

But it is all going up so. And so you would be going against that density gradient that's already established. So I mean -- I have no doubt there's some hydraulic connectivity, but the question is is there enough?

And I never thought about orders of magnitude difference in hydraulic connectivity. But if one order of magnitude causes an 81, 19 percent split and this stuff in the subsurface, unless they get into a fracture, it's at least an order of magnitude difference -- I mean, just when you look at the tables and the published numbers, orders of magnitude.

And to me that strongly suggests that you are going to have at least 80 percent of whatever you inject that stays up in this shallow aquifer. And I think that would be detrimental.

COMMISSIONER BALCH: Well, they have four wells that they propose with an injection depth, maximum, of 1,500 feet in each of those wells. They're going to have a maximum injection pressure as well.

THE WITNESS: Sir, I need you to back up. I didn't catch what you said.

COMMISSIONER BALCH: All right. So these four wells that are proposed, each of them has a maximum injection depth of 1,500 feet and they also have -- I presume there's going to be an associated maximum injection pressure.

So if they drill the wells and they can't get the fluids to go in at the rate that they predict, they are going to have to do something else. Their hope is they are going to connect to some of those conductivity.

THE WITNESS: I think in these injection wells, they're going to start perforating at 150 feet.

COMMISSIONER BALCH: That's what the proposal is on some of them, yes.

THE WITNESS: And so if you do that -- again, it's this order of magnitude, thermal, hydraulic -- not thermal, but hydraulic conductivity, if that alluvium -- and not "if," I mean, it is permeable.

COMMISSIONER BALCH: So if the geology at the base of the alluvium, which I presume Mr. Witcher is going to show us later, is a barrier to flow, and all of your perforations are below that, that should accomplish what Mr. Lakins asked you?

THE WITNESS: Yes, I would agree with that.

COMMISSIONER BALCH: What would you do if you Lightning Dock? You'd drill them deeper.

THE WITNESS: I mean, to make these systems operate so you don't trash the local aquifer, you need some sort of aquitard between where you're injecting and that water.

COMMISSIONER BALCH: Did you find in any of your public data search kind of a flow rate of that Animas Valley aquifer to the north?

THE WITNESS: I did. But I don't remember the numbers. It is in the Johnson report.

COMMISSIONER BALCH: Do you recall approximate order of magnitude compared to the recycle volume that we are talking about here?

THE WITNESS: I don't for the flow through it. I mean, I think it is the same order of magnitude, but I don't remember the number. I would have to look it up.

COMMISSIONER BALCH: The Johnson report?

THE WITNESS: I mean, the number I keyed on was the recharge rate, because that's the rate of fresh water that essentially dilutes everything and keeps it, you know, in the state it is in right now.

COMMISSIONER BALCH: Do you know at what

depth the 232-degree water for the AmeriCulture Geothermal power wells is going to be coming from?

THE WITNESS: I don't remember the number.

COMMISSIONER BALCH: Okay. I think my other question would probably be better answered by a further witness. Thank you.

COMMISSIONER CATANACH: Go ahead, Mr. Padilla.

EXAMINATION BY EXAMINER PADILLA

COMMISSIONER PADILLA: Good afternoon, Mr. Hand.

THE WITNESS: Good afternoon.

COMMISSIONER PADILLA: Just a couple of questions for you. The 13,000 acre feet from the Johnson report, that's an OSE report -- I just want to clarify that -- from the State Engineer?

THE WITNESS: Yes.

COMMISSIONER PADILLA: And you said that that is the recharge rate listed in that report. Lightning Dock proposes to use I guess -- this never -- it may be in dispute now -- but 19,000 per year for their proposed operations?

THE WITNESS: Yes.

COMMISSIONER PADILLA: Given that that is based on testimony in some sort of loop, whether closed

or not, depending on who is giving testimony, can you speak about the impact that that 19,000 would have specifically on the recharge rate of 13,000? I mean, I guess I'm trying to figure out the detriment that you are pointing out by bringing up that 19,000 number.

THE WITNESS: If there is not good hydraulic conductivity between what you're injecting and what you're producing, I think that water will stay in your local aquifer. And if you are putting the geothermal water at 150 percent the rate of your recharge, I think it is going to start -- the whole valley will start to look like the geothermal water.

COMMISSIONER PADILLA: So, essentially, based on a lack of conductivity, you think that plume that we saw on several maps would expand because of these numbers?

THE WITNESS: Yes.

COMMISSIONER PADILLA: Okay. Moving to the power plant and some of your calculations for damages, I just want to be absolutely clear, there is no power plant currently whatsoever?

THE WITNESS: True.

COMMISSIONER PADILLA: And when you did your projections or calculations, for, you know, monetary loss based on fall-off and based on water usage, did you

do a projection as to what kind of water use that plant would require?

THE WITNESS: No. The plant will be nonconsumptive in terms of water use. So I did not -- I mean, if they go to wet condensers, they could use some water. But as I understood it, that was not the plan.

COMMISSIONER PADILLA: Other than scale, how would that be different from the Lightning Dock proposal and its affect on the plume?

THE WITNESS: About an order of magnitude different. I mean, that is just based on flow rates.

And the injection well that they have eyeballed for it is actually -- I don't remember the depth, but it's a deeper injection well. They are not planning to inject in the alluvium.

COMMISSIONER PADILLA: Ballpark depth?

THE WITNESS: Say again.

COMMISSIONER PADILLA: Ballpark depth?

THE WITNESS: I would get in trouble if I ballparked.

COMMISSIONER PADILLA: I am just trying to get the clarification of one system having a negative impact, but, then, you're talking about a proposed power plant and --

THE WITNESS: Well, they are downstream of

the Cyrq power, you know, the production and injection wells. And so anything they do is not going to go up the gradient, the hydraulic gradient of the flow moving through the valley.

So this is a case where what Cyrq does, you know, has the potential to do them harm, but what they do is not going to harm Cyrq.

COMMISSIONER PADILLA: I am not so much concerned about Cyrq in this case, as, you know, the -- if we are talking about one power system, power generation system, having the potential to harm wells outside of its immediate vicinity, how is the secondary one, albeit smaller, not going to do the same thing?

THE WITNESS: I hear your question now. I mean, I think their plan to inject deeper and not in the alluvial -- it is still a closed system. I mean it just amazes me that anybody could use the term to describe a geothermal system because you have so many flows going in and out.

But the intent is to put it underneath the alluvial aquifer that is there. That is what is different as I understand it.

COMMISSIONER PADILLA: I think the rest of the questions are probably better directed --

THE WITNESS: Sure.

COMMISSIONER PADILLA: -- so, thank you.

EXAMINATION BY COMMISSIONER CATANACH

COMMISSIONER CATANACH: I have just a couple of questions. On your temperature degradation, I just want to understand some of the factors that you've used to calculate that or determine the 20-degree drop.

Was that based on the amount of fluid that Lightning Dock is going to inject?

THE WITNESS: The 20 degrees was something that I just started with as a starting number. And then I said, Well, if they inject at 170, how much of that 170 would have to mix with my 232 to bring it down 20 degrees?

And that's 32 percent. So you would need 32 percent, 170, and the rest, 232, and when you mix them, you get 212.

So there is not, you know, a detailed computation -- I mean, I don't know how much they are going to mix. But the potential for mixing, I think, when you talk about the injection rate, is clearly there.

COMMISSIONER CATANACH: If you were going to look at the whole system and what they were going to inject, could that 20 degrees be actually higher?

THE WITNESS: Yes. I mean, just -- I mean,

150 percent of the recharge rate -- I mean, if we get 50/50, it's going to be more than 20 degrees. It's probably going to be more like 35, 40 degrees.

I mean, you could actually cool it down so you are less than 200. And then, you know, the chance of making power, it really gets difficult when you get down in those low numbers.

I mean, it is not difficult to make the power from a technology point of view. It is difficult to make it pay for itself. It's just economically dead.

COMMISSIONER CATANACH: So your calculation here is not based on the actual events that are going to take place. This is just injecting 170-degree water into the 232 -- that's basically what that is -- and those two waters mixing.

THE WITNESS: Yes. I got the 170 degrees from some of their injection logs, and then I backed out what ratio that would be. And I do not know how much mixing is going to occur.

COMMISSIONER CATANACH: Okay. Without going too much into geology here, do you have an opinion as to, within the proposed injection wells, they are going to start injecting at 150 feet, which is in what you described as the alluvium --

THE WITNESS: Uh-huh.

COMMISSIONER CATANACH: And I guess they are going to have perforations down to 1,500 feet. Knowing what we do about the permeability -- and the alluvium is probably higher -- would that water tend to go into that alluvium primarily before it goes into the other, deeper zones in that injection well?

THE WITNESS: Yes. I mean, what is going to happen is the well bore is going to fill up, and then the water is going to try to get out. And, normally, the water goes out the bottom of the bucket, but if there aren't holes in the bottom of the bucket, which would be permeability down there, not much of it's going to get out. And if it is all up in the top, then that water is just going to go out in the alluvium.

COMMISSIONER CATANACH: I have nothing further.

COMMISSIONER PADILLA: Just one follow-up, if I may.

EXAMINATION BY EXAMINER PADILLA

COMMISSIONER PADILLA: On what do you base the assumption that there's no permeability at the 1,500-foot depth?

THE WITNESS: It's my understanding -- well, it's not no permeability. It's low permeability.

COMMISSIONER PADILLA: Less permeability.

THE WITNESS: It is my understanding that they first proposed they were going to drill deep, inject deep. And they are trying that. And it's not satisfactory because they come back and ask you to do something different, rearrange their model.

I mean, I think, you know, the fact that they are asking for a different injection site indicates there's something wrong with that one. And there's only two terms here that we need to worry about. One is how hard you push on it, the pressure head; and the other is the permeability, will it flow, the hydraulic conductivity.

So just by reduction, without having access to all the records, it's pretty obvious what the issue is.

COMMISSIONER BALCH: May I do follow-up?

COMMISSIONER CATANACH: Yes.

EXAMINATION BY EXAMINER BALCH

COMMISSIONER BALCH: So I did go and look at all their applications here, all of the perforated parts of the well are at the projected depth of the alluvium or below, right at in most cases.

THE WITNESS: Uh-huh.

COMMISSIONER BALCH: The injection method is gravity, so the most head you're going to have is

150 feet at the level of where the perforations might meet alluvium. Does that have an impact on how dramatic the mixing rate would be?

THE WITNESS: It would. I mean, my whole point here today is not to say I got a model. I don't. But is to say what I've seen.

COMMISSIONER BALCH: What I am having a hard time figuring out is if the formation in those four wells from 150 or 500 feet down to 1,500 feet can't take the water volume that they are trying to dispose of and they are not pumping to push that water out, the only thing you are going to have leaking to the alluvium would be part of the head down to the top or probably the base of the alluvium or where the top of your first perforation is.

THE WITNESS: Uh-huh.

COMMISSIONER BALCH: So you're not going to be having maybe as significant of a force pushing that water out into the surrounding shallow aquifer, certainly, as if you had a pump pushing it.

THE WITNESS: I think they are pumping on their existing well like 60 p.s.i. or 70, somewhere in that range. And I don't know why you would expect between the bottom of the alluvium -- the stuff that is the alluvium and, you know, what comes next, whatever it

is, I mean, why would they get away with a gravity head there. I mean, they need to find fractures --

COMMISSIONER BALCH: That is what they are proposing, is gravity heads for all four wells. So they must have some reason to think that will work, because if it doesn't work, they are going to have to drill more wells or drill deeper or something. They're going to have to find another way to get rid of their water.

THE WITNESS: Sure.

COMMISSIONER BALCH: They don't think they're going to leak enough of it out into the shallower aquifer that way, to take care of volume if there's no conductivity down deep.

THE WITNESS: And I think immediately beneath the alluvium, you probably are going to have a lot of connectivity and -- I mean, there's certainly a flow path there that would work with just gravity head.

And when you start pushing on it, then, you know, it has the potential to make it worse. I would just like to see a model about how this works.

COMMISSIONER BALCH: I agree with you 100 percent. Thank you.

MS. MARKS: I apologize but I was asking Mr. Hand questions about the power plant, and he directed me to Mr. Seawright, and then you fine experts

asked him a number of questions relating to questions that I was going to ask him, and then that seemed to be in direct contrast to certain documents in here.

So I think if we could clarify about certain depths, it may be more appropriate if Mr. Hand answers one question. I will certainly ask Mr. Seawright the other question about other documents and applications, but this one about depth, maybe Mr. Hand might be -- it might be more appropriate because of the testimony he gave you guys, in particular, Exhibit Q is AmeriCulture's proposed depth at about 490 feet.

And Mr. Hand has noted to you folks that the power plant would be -- AmeriCulture's power plant injection would be deep and, according to the application that Mr. Jackson also discussed, it would be at this depth as well.

And I was wondering if Mr. Hand had actually seen this application that Mr. Jackson also discussed, that the proposed depth was actually 490 feet, which is no different than the depths that Lightning Dock proposes. I don't really see the difference. And so that was -- with the whole power plant discussion and I would have discussed that question with Mr. Hand, but I thought Mr. Hand was directing me to Mr. Seawright. And I know Mr. Padilla asked a question about the power

plant and questions about depths. Perhaps Mr. Hand should answer that question.

THE WITNESS: I don't understand what the question is.

MS. MARKS: Well --

COMMISSIONER PADILLA: If I might condense it.

EXAMINATION BY EXAMINER PADILLA

COMMISSIONER PADILLA: I had asked what the proposed project depths were, AmeriCulture's theoretical power plant would be.

THE WITNESS: Sure.

COMMISSIONER PADILLA: And you said you wouldn't be qualified to answer it because you didn't remember, which is fair enough. But it's 490 feet.

THE WITNESS: Okay.

COMMISSIONER PADILLA: So having that piece of information, can you now give us hopefully some discussion as to the differential for harm, other than scale, that each power plant would pose to the surrounding water table?

THE WITNESS: I --

COMMISSIONER PADILLA: Basically why is Lightning Dock something that you object to --

THE WITNESS: I would say that each of them

deserve scrutiny. I mean, I am not -- the reason I am here today is to say, Look, what I have been presented, based on the way I understand fluids and heat transfer, the way this stuff works, that there ought to be a lot of questions.

And so, you know, if that proposal is to inject at 490 feet, there should be a defense of why that's reasonable. I mean, I'm not in disagreement with you.

COMMISSIONER PADILLA: I guess the issue I would have with that answer is all of your damage calculations are based on this power plant, which includes a 490-foot injection depth. I just don't --

THE WITNESS: I don't understand what else I would base damage calculations on.

COMMISSIONER PADILLA: I guess if you are giving us damage calculations for a power plant, in my mind, it is a power plant that you would theoretically approve of or a plant that you would approve, an operation that you would approve of --

THE WITNESS: I do agree with you that the power plant is not built, and it's a future power plant. But it's future harm that AmeriCulture could suffer if the water temperature is throttled.

I mean, water rights are very specific

things, and all of the farmers and ranchers that I've worked with, they zealously protect their rights.

COMMISSIONER PADILLA: So how does this future harm of AmeriCulture and its power plant and the power plant itself not impact those farmers and ranchers whereas the Cyrq one would?

THE WITNESS: Again, he would have to be injecting in some strata where he doesn't impact them. I mean he should going through the same rigor that everybody else has to go through.

I mean, I'm not -- look, I mean the main thing I looked at was the stuff that I am most familiar with, which is the turbo machinery, the power plant, you know, the energy computations, and so on. I mean, that's what I looked at.

If his temperature gets degradated, it is going to have the potential to cause him harm. But that doesn't mean that he gets to build this and harm his neighbors.

COMMISSIONER PADILLA: I think I will just leave it at that. Thank you.

THE WITNESS: Okay.

COMMISSIONER CATANACH: I don't know what the status of AmeriCulture's application is, but I just wanted to know, that application is 20 years old and I

don't know if that well was ever approved or what the status of that well is or if he still intends to do that.

And the other comment I had was on the applications for injection, there's two boxes actually, Injection to be gravity or pressure. And it is listed as gravity.

And in the next box, it's, List approximate pressure, and it says less than 100.

And I think there is some disparity there on exactly what they propose to do in terms of the injection pressure or gravity.

That's just a couple of comments.

THE WITNESS: I can't talk to the age of the application or that stuff.

COMMISSIONER CATANACH: Okay. Is there anything else of this witness? Mr. Lakins?

MR. LAKINS: Re-direct based on a few questions.

COMMISSIONER CATANACH: Okay.

RE-DIRECT EXAMINATION

BY MR. LAKINS:

Q. Mr. Hand, just a few things.

Your calculation of potential harm to AmeriCulture is based on a temperature drop in the

reservoir at AmeriCulture's well, correct?
A. It is based on temperature drop at the well head.
Q. And the proposed application on the table here today that involves injection that's shallow from withdraw of deep, right?
A. Right.
Q. And that's not what AmeriCulture's power plant operation entailed. It was injection and production at essentially the same depth; are you aware of that, do you remember that?
A. Yes.
Q. And AmeriCulture's operation is totally in the --
MR. ROGERS: Objection. It is leading and there is no foundation. The witness said he is not familiar with the application and the question is leading.
COMMISSIONER CATANACH: Can you restate it or ask a different question?
MR. LAKINS: Certainly.
By Mr. Lakins (cont'd):
Q. I will withdraw that question.
A. I don't know about the plume.
MR. LAKINS: I thought Michelle Henrie was the attorney, and Mr. Rogers' objection was out of place, because he didn't ask a single question of this

witness. Now I am being double-teamed. I ask in the future that that not happen.

MR. BRANCARD: Either one of their attorneys can object as long as they both don't object.

MR. LAKINS: I would ask if we have an attorney handling a witness, that that attorney handle that witness; otherwise, I am being double-teamed, and I don't think that's appropriate.

I pass the witness.

COMMISSIONER CATANACH: The witness may be excused. And let's take a ten-minute break.

(Brief recess.)

Back on the record. You may call your next witness.

MR. LAKINS: I call Jim Witcher.

JAMES WITCHER

having been first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. LAKINS:

Q. Mr. Witcher, please state your name.

A. My name is James Witcher.

Q. What do you do, Mr. Witcher?

A. I am a geologist. And most of my work is associated with geothermal energy. And I do some ground

water exploration type work.

Q. Have you ever been qualified as an expert witness before the Oil Conservation Commission before?

A. Yes, I have.

Q. Do you recall what you were qualified as an expert witness as to testify to?

A. As I recall, I was qualified to testify on geothermal, geology, geochemistry and geophysics.

Q. And could you give us a summary of your qualifications in those four areas, please.

A. Well, my qualifications are I have been involved with geothermal exploration and development for 37 years.

I have a bachelor's degree from New Mexico State University and a master's degree from New Mexico State University. And my master's thesis dealt with structural geology, geochemistry and geophysics.

Q. And in your 37 years of experience dealing with geothermal resources, et cetera, could you give us an overview of what you have done?

A. Well, my first work in geothermal was at the Arizona Geological Survey when it was at the University of Arizona. And I compiled the first geothermal map of the state of Arizona and was also co-author of the first comprehensive report on the state of Arizona.

And since that time, I also have done work at New Mexico State University at the Southwest Technology Development Institute. And we were heavily involved with direct use geothermal applications here in New Mexico and other areas of the West.

In the process of that, New Mexico became the largest operator of geothermal heat and greenhouses in the nation. And since that time, I've left NMSU and I do consulting work now.

And in process of that, I have done projects with the National Labs, DOE, and I have worked with every state in the western U.S., except Washington and Montana, on mostly direct use sorts of applications, but some have dealt with evaluation of geothermal leases for high temperature power generation.

Q. Talk to me about your experience in geochemistry.

A. My thesis was geochemistry. One of the things that I've done in the geochemical area is I've developed a new geothermometer for low temperature resources when I worked in Arizona. It's a carbon dioxide correction to the silica geothermometers for low temperatures.

And I have also developed a technique to explore for geothermal resources used in radon soil gas. And so those are a couple of items that I have applied.

Q. How about geophysics?

A. Geophysics, I have done a variety of geophysics, including gravity surveys, SP surveys, and dipole-dipole resistivity survey techniques.

And the dipole-dipole resistivity, probably participated in probably 20 line miles of that sort of survey work and interpretation. The SP work, I have done surveys in at least five areas in southern New Mexico looking at the geothermal resources.

MR. LAKINS: I didn't bring Mr. Witcher's resume. I can provide that to the Commission tomorrow. I tender Mr. Witcher as an expert in geophysics, geochemistry and geothermal resources, and geology.

COMMISSIONER CATANACH: Any objections?

MS. HENRIE: May I ask a question?

COMMISSIONER CATANACH: Yes.

VOIR DIRE EXAMINATION BY MS. HENRIE

MS. HENRIE: Mr. Witcher, the geothermometry work, was that published?

THE WITNESS: It was published as a technical report, and it wasn't published in a peer review journal.

MS. HENRIE: Do you remember the name of the report? That is one I haven't seen.

THE WITNESS: I would have to give a reference to you tomorrow.

MS. HENRIE: Can you go more into your qualifications for geochemistry?

THE WITNESS: I can talk about some course work I've had. I've had course work in aqueous geochemistry, isotope geochemistry. And I have also had a course that was mainly chemical thermal dynamics, which was an igneous petrology course.

MS. HENRIE: And that would have been at New Mexico State?

THE WITNESS: Yes, that would have been at New Mexico State.

MS. HENRIE: As part of your master's program or --

THE WITNESS: Yes, that was part of my master's program.

MS. HENRIE: Thank you. No objections.

COMMISSIONER CATANACH: Mr. Witcher, is most of your testimony going to be with regards to geology?

THE WITNESS: It will be with regards to geology, with some comments on using geochemistry and some geophysics in the area.

And it will certainly be very geothermally oriented. It won't be so much groundwater oriented.

COMMISSIONER BALCH: So the discussion we are having up here, I am a geophysicist. In my studies,

of course, I have learned a little bit of geochemistry and a little bit of geology. I would consider myself to be primarily a geophysicist, an expert in a variety of different fields in that area of study.

I'm not sure I would want to sit there and be qualified as an expert in geophysics when I am really trained as a geologist.

THE WITNESS: Well, I can tell you what my course was in geophysics and maybe that will help you see where I'm coming from. And with my other experience -- I've had --

COMMISSIONER BALCH: This is more of a broad question, and not specific to you. It's everybody who is going to be a hydro geodynamic, chemistry something or another -- you know, they're a geochemist or a geologist.

THE WITNESS: Sure.

COMMISSIONER BALCH: That's your real training. Why can't you just be a geologist?

THE WITNESS: I can be.

COMMISSIONER BALCH: I guess I don't understand why qualify him in geophysics and geochemistry and all that material -- and certainly he is going to have some information that would be credible in those areas, but he is really a geologist.

MR. LAKINS: The operating --

COMMISSIONER BALCH: If I have something to do with a time lapse seismic survey using a 3D VSP volume, and explain the processing to me, I don't know if he could do that. That's a geophysical thing.

MR. LAKINS: Understood.

Some of the standard operating with qualifications of experts that I have experienced before the Division and the Commission has been rather broad. And we have had this throughout this whole hearing as well. I'll tender Mr. Witcher as an expert geologist with extensive experience in geothermal, geochemistry, and geophysics.

COMMISSIONER BALCH: That sounds a lot better.

MR. LAKINS: Let's do that.

COMMISSIONER BALCH: And I am not trying to diminish your qualifications in any way.

COMMISSIONER CATANACH: Okay. Mr. Witcher is qualified as per Mr. Lakins' statement.

COMMISSIONER BALCH: I think we will make a decision whether or not he's a geophysicist or a geochemist.

BY MR. LAKINS (cont'd):

Q. All right. Mr. Witcher, could you explain to us

your experience with the Lightning Dock Geothermal resource?

A. Well, this goes back a long ways. When I was an undergraduate at New Mexico State University, one of my professors had a project, a joint project with the University of New Mexico.

And Dr. Chan Swanberg was tasked with collecting water samples. And I was one of the students that collected this data that's in circular 177. So that was my first introduction to this.

And then as a part of that also, George Jurassic, who was a professor at the University of New Mexico, they were doing geophysical surveys, mainly electrical. And so I participated a couple of afternoons out while they were collecting resistivity data. And Chan Swanberg also had a student collecting gravity data.

And so I was tasked every once in a while to go out with the gravity bunch, and we would collect gravity data.

Since that time, I did work every once in a while for Dale Burgett. I had a temperature logger at NMSU, and I would come over and take detailed temperature logs of some of his wells.

And then later on, Damon Seawright started his operation over there, and so I developed a close

relationship working with Damon and AmeriCulture.

And so that's culminated really in where I am at with my experience with Lightning Dock Geothermal, is it started as a student to where we are today.

Q. I take it you weren't a student just real recently?

A. No.

Q. What year was that?

A. The year that we were out at Lightning Dock was in the summer of 1975.

Q. So you have been doing studies in that area for the better part of 40 years?

A. I wouldn't say professional studies, but, certainly, I started looking at that area in 1975.

Q. You have been very familiar with it over the time?

A. Yes.

Q. Have you published anything about the Lightning Dock Geothermal area?

A. I have, but I can't recall it right now.

Q. Okay. Have you written any analyses about the Lightning Dock Geothermal area that have not been published?

A. There are probably analyses that haven't been published. And I couldn't give you an outline on that

right now.

Q. In preparation for this hearing, just for this hearing, could you tell us what you did in preparation for your testimony here today?

A. Well, one of the first things I did is I reviewed Circular 177 as this was presented in evidence by Lightning Dock. And I also went back and read the old report that I had done on the pump test.

And I looked at various other published articles in the literature on the Lightning Dock area. There is probably too many that I can't recall really right now to say what they were, but I looked at them.

Q. You were here for the prior testimony?

A. Yes.

Q. And you were here for the -- you testified and were at the hearing in 2013?

A. Yes.

Q. Did you have a chance to look over any of the transcripts of the testimony from the hearing last month?

A. I read portions of that. I didn't read it from cover to cover, but I read portions of that testimony, yes.

Q. And do you recall what portions those were?

A. In particular I looked at the testimony, some of

the testimony that Dr. Greg Miller had presented and Dr. John Shomaker had presented, and also some of the information that was presented by Mr. Roger Bowers.

Q. Have you formed an opinion about these four proposed injection wells?

A. I am worried that what they are proposing to do is they are going to inject a lot of geothermal fluids into a shallow aquifer and they are going to create additional outflow plumes or add to the existing outflow plume, and that the amount of water that has been suggested to go back into the primary reservoir is not going to occur because it's not permeable enough to transfer that water back into the geothermal reservoir, rather it would get short-cutted by the high permeability sediments up closer to the surface.

Q. Do you have any other opinions or concerns?

A. Well, one of the other opinions that I do have is I believe that the geologic model that was presented, which is a continuance of the model in 177, I believe the model is completely wrong.

Q. And why is that?

A. Well, I don't believe the temperatures that they say in the primary reservoir to the southwest exist. I also do not believe that there is a magnetic heat source out there. And I'm prepared to go through all of that.

I don't believe that the reservoir size is nearly as large as what is claimed to be. And I believe that there's really been no information presented to anybody in terms of cross-sections and the structural geology there by Cyrq.

But I've managed to pull together some of that, and we will talk about that. And I'll use that to make an argument that that resource is very, very small.

And I also did a calculation, which is a volumetric calculation that industry has used, the U.S. Geological Survey uses it in their evaluation of resources. A company, Geothermics, uses it. It's a volumetric method, is what it's called.

And I applied it with the numbers I came up with at Lightning Dock. And it shows that production of ten megawatts of electrical power is not sustainable.

Q. You put together a PowerPoint presentation?

A. Yes, I did. This is just really --

MR. ROGERS: And I believe this was the one that we objected to because of the new documents that were not provided pursuant to the schedule. So before he goes through that, I'd request that we hear objection upon that and have a ruling, before he talks about evidence in his exhibits that I do not believe should be in the record.

MR. LAKINS: I think there is a difference between exhibits being put into the record for evidence and Mr. Witcher's own testimony from visual aids and PowerPoint presentations.

And it would seem -- so I haven't moved this for admission yet nor have I moved the prior one for admission. And in fairness we had lengthy PowerPoint presentations before that we should allow Mr. Witcher the opportunity to give his testimony and then deal with an inadmissibility objection, rather than having to pick out and not permit him to talk to the substance of his opinions.

MR. ROGERS: May I?

COMMISSIONER CATANACH: Yes.

MR. ROGERS: The objection is that the exhibits should not be addressed or shown until it is properly admitted. You don't go through the exhibit, give you all the information, and then move the exhibit there, because the prejudice is done.

Our concern is that this contains -- 16 of the 19 pages are new. 16 of the 19 pages are new things that could have been done timely, could have been supplied at the time and were not.

And the difference between an exhibit and an demonstrative exhibit is not we get to ambush you with a

demonstrative exhibit. It is a demonstrative exhibit has to depict and illustrate the existing testimony. You can't come in -- you shouldn't come at an adjourned session here with a whole new set of these matters.

We have objected from the very beginning about the failure to provide the proper objections. This is a piece and akin to that same matter. It should not be allowed. It should not be allowed up there for you to review before it is admitted and it should not be admitted.

MR. LAKINS: In all fairness, the prior hearing, we were ambushed with PowerPoint presentations aplenty. We also have had information withheld that we requested in HIPPA requests and even motions before this council, that there's a ton of missing data that Cyrq has that isn't on the table and hasn't been provided despite request.

This presentation of Mr. Witcher's is no different than what we saw before where we were not provided any sort of information from Cyrq's witnesses or exhibits beforehand, and they gave PowerPoint presentations, and that was supporting their testimony. That was allowed. This is no different.

MS. MARKS: Just so the record is clear, OCD

did not receive this exhibit until the start of the hearing or when the hearing had already commenced. We didn't get a chance to review this, discuss this with any internal personnel within the OCD.

And we view it as prejudicial to the OCD. All exhibits were submitted with the prehearing statements and changing the exhibits now we do feel is prejudicial.

MR. BRANCARD: I think this is very important, but I think the Commission has, in general, been fairly liberal at letting parties provide PowerPoint presentations to sort of let them walk through their testimony.

I think there is some fairly detailed documents in here that kind of go beyond the normal discussion overview type slide here that the Commission may want to discuss whether to admit as exhibits or not.

But I would disagree with Mr. Rogers here. The Commission's practice has been to have people walk through exhibits and then decide later whether to admit them. That is sort of the way it's done. Obviously, if it is not admitted as an exhibit it can't be used as part of the record and part of the evidence in support.

So I guess I would say that you allow the witness to walk through it and then decide whether you want all or part of this to be admitted as an exhibit or if you think it is in any way prejudicial to the parties.

I think there's a lot of detail in some of the stuff here that you may not want to have unless the parties are given much more time to respond to and to extend this hearing to respond to these.

MR. ROGERS: May I respond?

COMMISSIONER CATANACH: (Nodding head in the affirmative.)

MR. ROGERS: The specifics here, this is not illustrating existing testimony or for something. This is new, particularly technical sort of material that should have been promptly provided at the time.

And I understand at some level the history and the practice of the Commission. But let me point out to you the prejudice of that. If this exhibit is not properly before you, I would recommend that you consider that before the time is spent going through the matter. I would recommend that you consider the prejudice of this new, very technical information, and ask yourself the question as to why this couldn't have been provided timely.

And I would suggest there is only one answer to that, and that is to avoid effective cross-examination and avoid the opportunity to effectively address this witness's new points presented here.

And so recognizing the OCC has procedures and, perhaps, a history, I recommend to you now it's time to reconsider that history, because he has 16 new technical slides here that are not illustrating existing testimony. They are new.

And so for those reasons, I'd recommend that you not accept exhibits or not go through exhibits and then consider admission, but, rather, that they be established as reliable and appropriate before you spend that time going through them.

Thank you for indulging me.

COMMISSIONER CATANACH: We are going to just take a couple of minutes to discuss this.

MS. MARKS: Mr. Chairman, I think if the original exhibit differs significantly that perhaps those differences could be explained by the expert as well, between the two exhibits. Maybe the theory has changed. I don't know why the exhibits changed so much between the initially filed exhibit and this.

COMMISSIONER CATANACH: I move that we go

into executive session.

COMMISSIONER PADILLA: I second that motion.

COMMISSIONER CATANACH: All in favor say "aye."

COMMISSIONER BALCH: Aye.

COMMISSIONER PADILLA: Aye.

(Brief recess.)

COMMISSIONER CATANACH: We are back on the record. And at this time, we will turn it over to Mr. Brancard.

MR. BRANCARD: We need a motion to go back into open session.

COMMISSIONER CATANACH: I'm sorry. Can I have a motion to go back into open session?

COMMISSIONER PADILLA: So moved.

COMMISSIONER BALCH: I'll add to the motion, the one thing we discussed was the issue of Exhibit V. And now we're set.

COMMISSIONER CATANACH: All in favor.

COMMISSIONER PADILLA: Aye.

COMMISSIONER BALCH: Aye.

MR. BRANCARD: The Commission considered, went through the original proposed Exhibit V that came in the prehearing statement and the new Exhibit V that has been proposed today by AmeriCulture. It has been

determined that the differences between the two exhibits are fairly significant and that many of those differences relate to highly technical drawings and matters presented in the new Exhibit V. Therefore, the Commission determines that it will only accept the original Exhibit V at this time as an exhibit due to the prejudice to the parties.

So if you want to go ahead with the original Exhibit V -- I don't know if you have that on your computer. We all have it in front of us.

MR. LAKINS: Here is what I would like to do, because we are talking about an exhibit but we are also talking about testimony, and a large part of what those new exhibits are are essentially directly addressing evidence that was presented by Cyrq at the prior hearing, including the Piper diagram.

What I would like to have the opportunity to do is to give Mr. Witcher a hard copy of the new so that he can talk about the slides that are in the new and use them and at least give him the opportunity to discuss those, because they are realistic comparisons of data that was provided and presented previously. And that's what the majority of those new slides are.

And I am trying to get on the Internet right now so I can provide that to Ms. Marks. And that is

what I request to be able to do, is let him at least discuss his slides, because that's his testimony and that's presentation, but those slides would not be admitted into evidence, but he should be given the opportunity at least to talk to them.

MR. BRANCARD: Mr. Rogers.

MR. ROGERS: Commissioners, Mr. Brancard, I think we will have to handle it on a bit by bit analysis, because whether the new material is on a slide or whether it's new proposed oral testimony, if it wasn't reasonably noticed, the prejudice is the same. But I am afraid we are going to have to do it almost topic by topic.

And so I do object to the cheat sheet beside him with all of the information that was just ruled as impermissible. I do object to that.

MR. LAKINS: I think there is a difference between impermissible slides and his ability to testify. He hasn't been given to a chance to testify at all yet.

And his ability to testify, particularly in comparing the testimony and rebutting the testimony that was given previously, is part of his analysis of that and his comparison of that. It isn't even on the table yet. And the slides that he has are comparative visuals of what was given and what his testimony will be. That

should not be prevented. He should be allowed to give his testimony.

MR. BRANCARD: Yes, yes. Mr. Witcher should go ahead with his testimony. I believe some of Lightning Dock's witnesses had pieces of paper they relied on while they testified also, so...

MR. LAKINS: What I need to be able to do then is to get a copy of the exhibit --

COMMISSIONER BALCH: Have one of ours.

MR. BRANCARD: We are not using them.

MR. LAKINS: Thank you. This is the prior. I think we can take note that this document that I have projected up here is 16 pages, which is the original Exhibit V. And what I also will be using will be pages from the new as well for Mr. Witcher to be able to speak from.

I think that's the directions that I have been given. If I've misunderstood, please tell me.

MR. BRANCARD: The Commission should just be seeing the original. You can look at them on your screen and he can look at them, but the Commission should just see the original Exhibit V.

MR. LAKINS: So the Commission -- I can't show the Commission slides, as part of his testimony, that aren't in this presentation, even though we had

that same exact scenario last time where there were a number of slides shown that had not been presented and given to us ahead of time.

What I am hearing is I am restricted from my witness being able to give his presentation thoroughly using any sort of visuals when that exact thing happened prior? I just want to make sure I understand that.

MR. BRANCARD: Mr. Rogers.

MR. ROGERS: Yes, that was the ruling. The new exhibits are technical, they are complex. They are supplied to us for the first time today and there is no explanation, no reason and no justifiable purpose in allowing that sort of ambush.

And, yes, so, for instance, the new exhibits which you have up there are improper and they should not be up there. That was the ruling.

And if I understood, I said that certainly some latitude is allowed on his examination. I understand that. I understand that is the nature.

It may get into something that is unfair, that -- but I think we address it question by question. There's no blanket now that he can read from the exhibit that's ruled out, because it's recognized that that was prejudicial.

And so it is not a perfect line here. It's

a bit of a fault in conductivity here, but the issue is should he be allowed to testify to something that should have and could have been provided timely to allow our experts the opportunity to look at it, instead of hitting them on the fly.

So my understanding of the proper way to proceed is to proceed, to ask him the questions, and to the extent that we believe they are unfair or out of bounds or something that should have been done, we'll object. But to allow him to put it up there and to allow him to read from the exhibit that was determined to be prejudicial wouldn't be correct.

COMMISSIONER BALCH: That is more or less the way we interpreted it. I mean, you can ask him any questions you want.

MR. LAKINS: One of my slides is their exhibit.

MR. ROGERS: And we accept that one.

MR. LAKINS: It is in evidence, that they presented.

MR. ROGERS: No objection.

MR. LAKINS: And next to it is Mr. Witcher's comparison; it's a Piper diagram, which is straightforward data. And it's a side-by-side comparison of the applicant's exhibit that Mr. Miller

spoke from --

COMMISSIONER BALCH: I think when you ask Mr. Witcher a question about that slide, then you would then ask to introduce that data if you could. We would address that presumed objection at that time.

MR. LAKINS: Very good.

DIRECT EXAMINATION BY MR. LAKINS (cont'd):

Q. Mr. Witcher, you had put together two different PowerPoint presentations in preparation for today. I'm going to talk to the first one, the one that has been presented initially. Are you with me?

A. I am with you.

Q. And then you hear what we got to do, so we are going to go through this first.

A. We'll figure it out.

Q. All right. Now, Mr. Witcher, if you would, please, give us an overview of what your testimony is going to be and what this PowerPoint presentation includes.

A. Okay. I think the first thing that I'm going to say is we are going to talk about the geothermal matter that's being used at Lightning Dock. And this model comes out of Circular 177, which is the paper that is published by the New Mexico Bureau of Geology. The author is Elston, Beale, and Logsdon.

And near the end of their report, they have a large figure. It is a page-sized figure. It shows their model that they developed.

And in this model they show a basaltic magma in the subsurface. It is heating fluids to 250 degrees centigrade.

And then this water is boiling and it is creating a steam cap that then condenses. And then this condensed water then flows laterally to the northeast to Lightning Dock, where it upwells as a 150-degree C resource.

And this is the framework that was provided by Mr. Roger Bowers and Dr. Miller. And what I would like to do is --

COMMISSIONER BALCH: This figure in Exhibit 6 of Lightning Dock?

THE WITNESS: Yes.

COMMISSIONER BALCH: Page 40, Exhibit 6.

Q. Please continue.

A. Okay. And what I am going to show and discuss and argue is that there is no magma chamber in the Animas Valley. And if there was a magma chamber in the Animas Valley, it would be clearly evident that it's there.

There is a magma chamber in New Mexico in the

subsurface at roughly 18 kilometers depth beneath Socorro and Belen. And this magma chamber has micro-earthquake forms on a regular basis. It is a highly active area.

And you can go to another area in New Mexico that has magma in the subsurface. It is a small amount. It has been identified seismically. And this particular area, it's also seismically very active. And it also has very young rhyolitic extrusions to the surface.

Battleship Rock and San Diego Canyon in the Jemez Mountains is, in particular, what I am speaking of. And that is the only high temperature resource that's been identified in New Mexico. And it has a high temperature resource.

At Lightning Dock, there's no rhyolite bodies near the surface. There's no micro-seismicity. And there's no indication of fumeroles or anything like this. And this is the sort of thing you'd see with a magma-generated body or geothermal resource.

The other thing that is told there is that a basaltic magma can be a heat source for a hydrothermal geothermal system, and that is not possible, only if you are in an area like Iceland or if you are in an area like Hawaii, where you have tremendous volumes of basalt being erupted into the shallow crust.

What happens with these small basalt volcanic fields that we have in the Southwest, you have cinder cones and lava flows that are fed by dikes. And these dikes are probably less than 100 across or thick. The volume of magma that is extruded into the shallow crust has a huge surface area compared to the volume.

And there is a classic book that was printed in 1959 by a couple of mathematicians, Carslaw and Jaeger. And they developed several really interesting little mathematical solutions for that problem.

And you can go through that and calculate that 100-feet-thick, 30-meter-thick magma body will cool to ambient temperature in a matter of years or tens of years. And that's not going to support a hydrothermal system that's circulating water past it.

So we can throw out the magma model for Lightning Dock creating a 250 degrees C resource out to the west.

And this is important to understand, because one of the arguments that Cyrq and Lightning Dock is trying to make is if the resource they are tapping into near where their power plant is is it's huge and vastly expansive and extends back to the southwest.

And they plainly stated that they were using the model of Circular 177. And so the magma argument, I would say, that that doesn't apply. There's no evidence

for a magmatic heat source out there, even a magma body, because if it was there, we would see a lot of evidence for it. These things, they don't hide themselves very easily.

The other issue that comes up is the 250-degree C resource. And in 177, Logsdon, the person that did the geochemistry on this used an empathy silica diagram. And he misapplied that silica empathy diagram. A silica empathy diagram was developed by Fournier and Truesdale. They're the fathers of a lot of geochemistry.

And they put several stipulations on the use. And one of the stipulations is is that after mixing takes place, there can't be any loss of silica. And any temperature change that occurs with mixing has to result just from mixing; you can't have conductive heat loss off that flow of water.

And I don't think that those sorts of things apply at Lightning Dock because they are using wells to do this evaluation.

The original intent of that technique was developed for large flow thermal springs in volcanic areas, in particular, Long Valley Caldera in California in Yellowstone. And this is what they developed it for.

The other thing that the diagram fails to -- fails is when you have boiling in the subsurface. And

if you have boiling in the subsurface, that causes the silica content to increase, because water leaves and is steam and you increase the concentration of silica. It is like increasing the concentration of a salt. And so that causes it to deviate.

However, you can make a correction to that if it is just a one-stage boiling. You did use the steam curve, use that to correct -- to get a proper temperature.

And I went through that process. And the temperature that you come up with is 165 degrees C, which is exactly in the framework of what the resource that's currently being tapped, which is in the order of 155 or a little more degrees Centigrade.

Q. Okay. Jim, let me bring you back to the slide, to the summary of what you are going to talk about --

A. Okay.

Q. Don't get into all the detail yet. All right.

Give me a summary of the known subsurface geology. And I am going to refer you to your --

A. That's not the slide we want to use for that.

Q. This one?

A. The one just prior to that. This is a -- it's not a cartoon, but it's almost. But what I wanted to show here was the main structural elements that you see

in the vicinity of the Lightning Dock Geothermal system.

And the circular 177, they did an extensive mapping campaign in the Pyramid Mountains to the west, and they identified a silicic caldera of the Oligocene Age. And that's what's called Muir Caldron there. These caldrons or caldera, basically -- it has a ring fracture around the outside of the crater that fills in.

And what I show in a dashed line there is my estimation of where that outer ring fracture zone is coming through there. And that is based upon core information out of that well number -- that yellow dot that you see, number two there.

The other important feature that we see there that goes back to fracture permeability or to reopening of older fractures, and that's the Pleistocene Animas Valley Fault.

And I ended about where you see, Hot Wells Horst. I mapped that fault. That fault does not continue to the south. But it ends right there.

And that's a good place for good fractures to form, is on the horsetails or the end of these faults. So that works.

These gray bars that you see with another little bar with a ball on the end of it, I call those geophysical faults. And they are identified by using

gravity data.

It's not a calculation or anything like that. It is basically eyeballing the map and seeing where the gravity gradients increase. So those areas, you are looking at where the gravity contours are very close together from a gravity survey.

Gravity survey's map, mass are density differences in the subsurface. So where you have a large contrast between higher density and lower density materials, you'll get a steep gradient. And a lot of times that ends up being a fault zone. So that is what those gray areas represent.

And what you outline there is a gravity high that is shown by the Hot Wells Horst. It is separated by steep gravity gradients, which are the faults.

And then you have out to the west and east areas of lower gravity. And that is what I called the Lower Animas Graben. And there is another little graben between the Pyramid Mountains and the Hot Wells Horst.

It's important to note the Pleistocene Valley Fault is not a large fault. It's just a young fault. It is what I would call an incipient fault.

It has no gravity signature. In fact, it cuts across the Hot Wells Horst high there or Horst Block, which is an uplift in geological terms, bound by normal

faults.

Then there is an older feature, which I call a west, northwest landlocked tectonic inversion. And that is geo jargon for a feature that first formed during the Jurassic, is a large normal fault.

And then -- and where the hanging wall side of that fault dropped downward and forged a basin, a riff basin, kind of like the Albuquerque Basin. And then the upthrown side which would have been to the north, formed a Horst block.

And then this was eroded. And then you had a -- you changed the regional stress field and everything reoriented itself. And that normal fault then became a reverse fault. And the motion on that fault reversed itself.

And the reason that's important is these zones with repeated deformation over time created a lot of fractures. And so all these things kind of coincide with one another to create fracture permeability.

Now, what I should point out is that west, northwest Larmide tectonic inversion zone that I show there, that's -- I am basing that on core hole -- or well data between Well No. 1 to the north and Well No. 2 and Well No. 3.

These are very deep holes, that the 1 and 3

wells, they went into basements. So I could see the full picture there.

And I have a published paper on that. And it goes into the detail. We don't need to do that.

I just wanted to show that there's repetitive deformation with west, northwest deformation on it. We see that in southeast Arizona and southwest New Mexico. And they are the first order of structures in the whole region. And they go back to the Precambrian.

And that latter phase of faulting, the reverse faulting that took place there, it had associated thrust faults with it that are sometimes mistaken as the overthrust belt. There is no such thing as an overthrust belt in southeastern Arizona and southwest New Mexico.

But what you may have is some structures like that that are embedded in the bedrock beneath the territory volcanics and Hot Wells Horst. And I made cross sections, and I am not even going to attempt to show that, because the only way you would be able to see that would be with some very good seismic reflection data, even if they could see that.

Q. Does that kind of wrap up your summary?

A. That wraps it up.

Q. The next topic that you are going to talk about

is the isotopic composition?

A. Yes. The isotopic composition that I was originally going to talk about, I've added some other things, because in the testimony before, Greg Miller introduced an analysis of oxygen, 018 to 016, ratio. It's not a percent ratio. It's a permil ratio based upon a standard mean ocean water that they use as a standard.

And what he argued was that this minus 13 value that they had was evidence that there was boiling from a 250-degree C resource and then it was condensing and flowing back over from the southwest to the northeast.

And what I was going to show here is I was going to show a plot of oxygen isotopes versus hydrogen isotopes. And when you do that, almost all data in a continental setting plots up on a linear line, which we call a mean water line. And it represents meteoric water.

And on that meteoric water line, everything that we see out in Lightning Dock plots within one mil of that line. But it also tends to show how the mixing takes place.

Oxygen and deuterium isotope information is one of the most valuable geochemical tools you can use in geothermal evaluation, and also in reservoir studies

after you are in development, because one of the things you can see is see mixing.

And the other thing you see is if there is a lot water/rock interaction, the oxygen isotopes will shift permil off the mean water line to the right by five to ten mil. And we don't see that at Lightning Dock.

And if there'd been a 250-degree sea resource, that data that was reported by Cyrq in the last session that we had here would have shown a shift to the right, a significant shift to the right.

This data does not shift to the right. It is on the mean water line. It is meteoric water.

Q. Is this one of the slides that you prepared?

A. Yes, it is one of the slides that I prepared for this particular presentation.

Q. And is the testimony that you just gave summarized in that chart --

A. I --

Q. -- for lack of a better term?

A. I'm not finished with that.

Q. Keep going.

A. Okay. One of the things it does show is it shows mixing. And we can see from the mixing that there is mixing going on between the fresh water and the outflow plume water, which was measured -- that we have isotope

information for.

The only deep upflow zone water that we have information for is the stuff that Cyrq presented last time in minus 13. Everything else plots up into the minus ten to minus eight region in terms of the oxygen isotopes.

What we do see there, after mixing has taken place, we see one-stage boiling. And I took a chart that shows the depth head of water over a particular depth and at what depth water would boil at a particular temperature given a particular salinity.

And what pops out here, when you look at that chart, is that if you had 250 degrees C water, it would boil at a depth of about 150 feet, which would be a little less or a little over 450 meters.

If you subtract the mean annual air temperature from 250 degrees and divide that by that boiling depth, you come up with a temperature gradient, a minimum temperature gradient that -- what you see in that area.

And if you do a simple heat flow calculation, you get a heat flow anomaly that would form over something like that that is larger than what we see at Lightning Dock today.

So that is more evidence that that higher temperature stuff out to the southwest does not exist.

And so this business of using that for correlative rights purposes or to show that they've got this huge resource, that just does not apply.

To go back to the mixing, if you look at the isotope, hydrogen and oxygen isotopes and do the mixing, it's probably less than 20 percent mixing. It's not the 24 percent that's being thrown out. So it is a lot less.

Q. Is that testimony that you just gave summarized in a visual that you prepared?

A. Yes, it is.

Q. Can you tell me what page in that new --

A. That would be page five in the new PowerPoint.

Q. Is that --

A. That would be the water isotopes, water stable isotopes.

Q. Is this what you are talking about?

A. That is exactly what I'm talking about.

Q. All right. Give me an overview, real quickly, kind of summarize what your charts are showing in the context of the testimony that you just gave, Mr. Witcher.

MR. ROGERS: May I be heard?

COMMISSIONER CATANACH: Do you have an objection?

MR. ROGERS: I do.

COMMISSIONER CATANACH: Go ahead.

MR. ROGERS: I object on the basis that Mr. Witcher's underlying basis for his opinion is not being produced with this. It is, again, technical, complex, and undisclosed.

So what you have here, what you have here is a diagram using a collection of materials not before the Commission, not available to Lightning Dock to address, but, again, an unfair presentation because of that.

And I don't object to testimony reflecting Dr. Miller's testimony. That is fine. These calculations here go much, much further than that and they are prejudicial.

Q. (By Mr. Lakins:) Did that data come from Applicant's Exhibit 9?

A. The two analyses on Well 55-7 came from that particular exhibit.

Q. So a large part of the data that's in the slide is --

A. Just two data points.

Q. Two data points. And the other data points you said were from?

A. The other data points that are in are data that was plotted up from data that was presented in Circular

177, which was their exhibit that they presented at the last meeting. I just plotted it up.

Q. And that's Exhibit 6, Circular 177?

A. That's it.

Q. So all of the information that you derived for this slide came from the exhibits in evidence already?

A. That's correct.

COMMISSIONER CATANACH: I'll allow it.

MR. LAKINS: I move to admit this slide, Water Soluble Isotopes --

THE WITNESS: That would only apply to the box on the left.

Q. What about the two boxes on the right?

A. I just drew those down from the literature to illustrate what I was arguing.

Q. The scientific literature?

A. Yes.

MR. ROGERS: And my objection is that it could have been done prior and it should have been done prior.

And if I may, if I could clarify the record here. So there is absolutely nothing else that you used in coming to these conclusions other than 177 and these two exhibits; is that correct?

THE WITNESS: And my expertise in this

particular field.

MR. ROGERS: And no other reference, anything else --

THE WITNESS: I'm not sure --

MR. ROGERS: No other document that is not listed?

THE WITNESS: No.

MR. ROGERS: Okay. I'm going to object to the one on the left. The ones on the right could have been and should have been produced timely.

And I have another concern, too.

Mr. Witcher is listed for 45 minutes. I certainly understand that some of my objections have slowed this down and stretched this out, but he has 16 new exhibits. If you give them about three minutes each, my math -- and it is a lawyer's math -- comes out to about 48 minutes.

And his summary was more than twenty minutes. And so my concern about this is the length of this and giving counsel fair notice of some end point in this matter.

We are concerned that a significant portion of this is not relevant and it is not for the purpose of addressing application, but, rather, for some other purpose. So my other objection has to do with the time

that this is going to take with 16 new exhibits, to go through this.

COMMISSIONER CATANACH: Do you have an estimate on the time it's going to take?

MR. LAKINS: It would have gone a lot faster using this, because I am going to have to go through and do this pretty much on several exhibits.

I think in all fairness, all the times -- and this goes for every witness -- were way under. We spent two days for AmeriCulture's four hours of anticipated testimony.

I intend to get through Mr. Witcher and Mr. Seawright by the end of the day tomorrow, including cross and questions from the Commission.

I hear Mr. Rogers' point, and I'm going to do my absolute best to make it as snappy as possible, sir.

MR. ROGERS: Thank you.

MR. LAKINS: I think that the testimony that's here right now that is relevant goes to the fundamental question here of the chemistry of the water, the deep geothermal water and the difference in that deep geothermal water and the water in the shallow alluvial. That's, in essence, what this document and Mr. Witcher's testimony on this point is really

fundamentally about. It's important for us to have that in there.

COMMISSIONER CATANACH: I think we are going to allow this exhibit. But I would urge you guys to try and speed it up as best you can, because, you know, you are talking about finishing up by the end of the day tomorrow, and I am not sure that's going to be possible. I mean, it's going pretty slow and if we have continual objections to every exhibit and the testimony, it's going to be a lot longer.

MR. LAKINS: Understood.

MS. MARKS: Mr. Chairman, is this witness going to be here tomorrow? I will have questions --

MR. LAKINS: Oh, yes.

COMMISSIONER CATANACH: I'm sure he's going to be here tomorrow.

MR. LAKINS: And depending on how late we want to go tonight --

COMMISSIONER BALCH: Five o'clock is Florene's bedtime. And I think some attorneys have to pick up their children.

MR. ROGERS: Attorneys don't have children.

COMMISSIONER BALCH: Spawn.

MS. MARKS: Bill, get rid of him.

MR. LAKINS: So this will be Exhibit Y, move

this slide for Exhibit Y.

COMMISSIONER CATANACH: Exhibit Y will be admitted.

(AmeriCulture Exhibit Y was offered and admitted.)

BY MR. LAKINS (cont'd):

Q. Mr. Witcher, in summary of this slide, give us a real quick recap, highlight point what does this say?

A. It says that there is no magma body, there is no 250 degrees C resource, there is no transport of water from the southwest to some structure that's trending northeast.

The water that is flowing upward in the upflow zone of this geothermal system is meteoric water that has been heated. It is under advective transport, which means it's recharged at high elevation.

And it is the water table differences that are driving it deep and back to the surface up vertical fractures.

It comes into contact with shallow ground water in the outflow plume, and it mixes. And then you have a minor amount of boiling that takes place there, at about 250 degrees Fahrenheit, 230 degrees Fahrenheit. And we see a shift in the isotopes that show that. And then it continues and flows on out the outflow plume to the

north.

Q. And what I want to take you to is this slide here, which is from the original, and could you tell me why you included this slide in the information, why it is pertinent?

A. Well, it would be good to give a framework on the slide earlier before we get to that, but I will just cover it right now. And we'll just refer back to that and I will point what I was pointing out.

The oxygen 18 and oxygen 16 ratio information that was plotted in that diagram, so that's the other step. And that's already been there.

But the important thing that I wanted to look at here was the carbon isotopes, stable isotopes, carbon 13 versus carbon 12, and the carbon 34, sulfur -- or the sulfur 34, sulfur 32 and the strontium 87/86 ratio isotopes.

The carbon isotopes are too low for water to have flowed through a Paleozoic carbonate rock. And let me tell you what the importance of that little concept is, is the bulk of the rock in the upper crust out there, once you get beyond the volcanics, is Paleozoic limestone. You are in a feature called the Pedrogosa Basin. And it's very thin in that region.

The sulfur isotopes show that that water has

never been in contact with Paleozoic rocks either. They have completely different ratios. In fact, the oil industry uses some of these sorts of things to tie down where this water's been moving also.

Q. Why is that important here?

A. Well, it is important here because the sulfur isotopes indicate that this water has never flowed through a limestone, it's never been in a reservoir or in contact at high temperature with a limestone. Otherwise, it would have picked up evaporite, oceanic evaporite type sulfur isotopes.

The sulfur isotopes here, there's very little variation and the sulfur isotopes, they plot in a magmatic field, which tells me that the sulfur came from an igneous intrusive type situation. And it probably came from trace amounts or small amounts of accessory pyrite that precipitated as the -- or crystalized out as the magma cooled. And then it was later oxidized and then it went into solution. And that's what we're seeing.

The strontium isotopes say that this water had to circulate in Precambrian granite to great depth or it had to circulate through really high potassium, high silica rhyolite to great depth.

And so the Precambrian rocks, that forms the bulk

of everything beneath the limestone. The intrusive rocks, like the Muir Cauldron over there, that would be the rhyolitic rocks.

Don't have enough information with what I have done here to tell you which is which, but that pretty much tells you what the flow path is and what the residence history of where this water has been.

This tells us something about what's permeable out there and what's not permeable.

The Paleozoic limestones out there are not carrying or storing hot geothermal water. The isotope information tells you that that's exactly the case for the Lightning Dock Geothermal system.

So we can eliminate an area of high permeability in the Paleozoic limestones.

Q. And that is important why?

A. That is important because there is no input of water out of the Paleozoic limestones and that's why they have not been -- or Cyrq has not been successful with their deep wells in getting the proper permeability to go over to their upflow zone resource that they have they're tapping and injecting into right now.

Q. What does that tell you about the current proposed --

A. What that tells me is they have to inject shallow

to make it work, and that's the bottom line there.

Q. What do you mean?

A. Well, they are not going to be able to get the fluid to go into the ground without putting enormous amounts of pressure and creating new fractures unless they inject shallow.

Q. Do you have an opinion about whether the current proposed injection zones, 150 to 1,500 feet and their well locations, that the injected fluid would reach the production well?

A. Run that question by again.

Q. Do you have an opinion, based upon the proposed applications of their locations, which are shown up here, and their depths, the proposed injection depths 150 to 1,500, and what you know about the subsurface geology, what's your opinion about whether or not the fluids being injected at those proposed sites, would that fluid make it to the production zone; what's your opinion?

A. I don't believe it would.

Q. Why not?

A. There is not enough permeability for it to get over there.

Q. Give me a brief explanation of this slide.

A. This is just a cartoon to illustrate a concept.

And that concept is, is that we have an aquitard, which is the purple, and you could think of that purple as being some of the Andesitic volcanics that are in the area. And you could think of that as being the Paleozoic limestone.

And you could think the hydrologic window is a fault zone that has a sufficient fracture damage zone around it or it could be a silicic intrusive of some kind that is highly fractured that allows the hot water to flow towards the surface.

Q. Is that to scale?

A. No, it is not. It's a cartoon. It's a concept. And then that hot water flows to the surface and it then mixes with shallow ground water and then forms an outflow plume that is in concert with the regional ground water flow direction.

Q. And from your knowledge, this boundary between the shallow and the aquitard, approximately what is the depth of that shallow aquifer?

A. That varies. It depends upon whether you are in the Horst Block or whether you are in the basin.

Q. Do you know what it is at the proposed locations?

A. I do not.

Q. Can you give us an average --

A. The reason I can't give you an average and I

can't give you a location on that is because I don't have their data that they have collected to be able to make that estimate. I just know it is there. And the reason I know it is there is the core hole that we drilled right here.

Q. Is that this one?

A. That is hole, yes.

Q. That is AmeriCulture's well?

A. The Americulture No. 2 Well. And a lot of that well was drilled with core, so I know exactly what the rock units are and what their permeable characteristics are, because it preserves the fractures and what's in the fractures.

The Paleozoic limestone that's out in this area has a lot of fractures in it, but the fractures are filled with mineralization. They are typed. And we weren't able to move any water around in there.

The best permeability was up in the fractured silicified basin fill or Gila conglomerate unit, which is second or third unit you see down from the top. It's dark.

And then the units below that, the ash flow tuffs, they were fairly permeable also.

Q. Is there a fair amount of the geology known to you out there that the layers are impermeable?

A. We just covered the Paleozoic units. They're probably fairly impermeable.

Q. Talk to this slide real quick.

A. This is a geologic cross section based upon what well data I could gather. And it is somewhat sketchy. But I was able to get enough to see the major rock units and see where the major structures were.

The Animas Valley fault, that's been mapped at the surface. The fault on the far east, that's the eastern side of that hot wells Horst Block. And that's more of a gravity interpretation.

And between AMC-2 and 52-7, that's where that fault is derived from, is basically cutting the distance between, and looking at the gravity data that is available for the area.

Q. Go ahead.

A. And then out to the west, 12-7, and 52-7, there was sufficient information there to infer a fault there. So what you have is a stepped block rising into the main Horst Block.

Q. Now, this next slide here, this location of reserves, talk to that.

A. Okay. What we are looking at here, all these wells that are drilled out around 55-7 and 45-7, they are less than 300 degrees Fahrenheit, as best I can

tell, with the information that I can tell. And all the other wells around there, they either don't take very much fluid or they have just been abandoned.

So I interpret that as this geothermal system covers a very small area. It's probably less than a kilometer square at the surface. And that's what I am mapping here. And it is centered on that west side fault zone right there.

And this would be a cross section looking in the subsurface. The blue is the Paleozoic limestone. The JKVG, that's the Bisbee group of sediments, which is basically rift fill from that earlier rift zone.

And then the tertiary volcanics would be the rhyolite units and the andesite units not broken out.

The QTGC, that's the orange color. That's silicified basin fill. That's where the outflow plume is for this system. And that is what caused that silicification to take place. It silicified with quartz.

Then there's 55-7. That's the injection well. And I don't show the intervals where they are injecting, but it's roughly outlined where that black circle is.

45-7, I have very little information on that. I just know they got into tertiary volcanics. And they are producing out of that.

And that's basically where the production is taking place and the injection is taking place. And that may be the size of the productive reservoir with everything that I can pull together. So it's a very small geothermal system.

Q. So this Q2GC, that's the alluvium?

A. Yes, that's the alluvium. I call it Gila conglomerate.

Q. That is where the outflow plume is?

A. The outflow plume, as best I could tell, is mainly in the Horst Block. Because as far as I know from anything that I've seen on available well information, that's the only area that has silicified through the conglomerate.

I am not aware of 45-7 encountering anything like -- or 36-7. That information is all kept top secret. But I don't think that's what the case is there.

MR. LAKINS: I am kind of just wondering how much longer the Commission wants to go here.

COMMISSIONER CATANACH: How much longer do you have on direct?

MR. LAKINS: It's going to be a lot, at least an hour.

COMMISSIONER CATANACH: I guess we should go

ahead and break then. Let's reconvene at 8:30.

MR. LAKINS: Very well, sir.

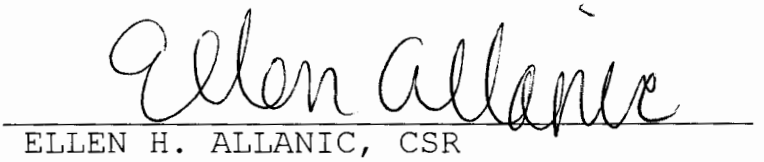
(Time noted 5:05 p.m.)

STATE OF NEW MEXICO)
) ss.
COUNTY OF BERNALILLO)

REPORTER'S CERTIFICATE

I, ELLEN H. ALLANIC, New Mexico Reporter CCR No. 100, DO HEREBY CERTIFY that on Thursday, October 7, 2015, the proceedings in the above-captioned matter were taken before me, that I did report in stenographic shorthand the proceedings set forth herein, and the foregoing pages are a true and correct transcription to the best of my ability and control.

I FURTHER CERTIFY that I am neither employed by nor related to nor contracted with (unless excepted by the rules) any of the parties or attorneys in this case, and that I have no interest whatsoever in the final disposition of this case in any court.



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