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

APPLICATION OF LIGHTNING DOCK GEOTHERMAL H1-10, 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

APPLICATION OF LIGHTNING DOCK GEOTHERMAL H1-01, LLC TO PLACE WELL NO. 63A-7 ON INJECTION-GEOTHERMAL RESOURCES AREA, HIDALGO COUNTY, NEW MEXICO

CASE NO. 15365

VOLUME 2

September 11, 2015
10:30 a.m.
1220 S. St. Francis Drive
Santa Fe, New Mexico

COMMISSION CHAIRMAN: David Catanach
COMMISSION MEMBERS: Bob Balch, Patrick Padilla
COMMISSION COUNSEL: Bill Brancard, Esq.

REPORTED BY: JAN GIBSON, CCR, RPR, CRR
Paul Baca Court Reporters
500 Fourth Street, NW - Suite 105
Albuquerque, New Mexico 87102

APPEARANCES:

For the OCD:

ALLISON MARKS, Esq.
EMNRD
1220 South St. Francis Dr.
Santa Fe, New Mexico 87505
AllisonR.Marks@state.nm.us

For Lightning Dock Geothermal H1-01, LLC:

MICHELLE HENRIE
225 E. de Vargas
Santa Fe, New Mexico 87501-2703
505-842-1800
michelle@mhenrie.com

For AmeriCulture, Inc.:

Charles N. Lakins, Esq.
P.O. Box 91357
Albuquerque, New Mexico 87199
charles@lakinslawfirm.com

INDEX

INDEX CONTINUED

EXHIBITS

(Note: In session at 10:38.)

CHAIRMAN CATANACH: We will call the hearing back to order. This is a continuation of yesterday's hearing in Cases No. 15357 and 15365. I believe Ms. Henrie was still putting on her direct case.

MS. HENRIE: I would like to call a rebuttal witness first with regard to the testimony we heard yesterday from Charles Jackson. I would like to recall Roger Bowers. I have got some materials I would like to submit to the commission in response to questions received yesterday. I would like to call Monte Morrison to clarify an issue. I think this will go very fast. And then I would like to call Mr. Miller, our final witness. With that, D.L. Sanders.

D.L. SANDERS

after having been first duly sworn under oath, was questioned and testified as follows:

MS. HENRIE: I'm going to move to qualify D.L. as an expert in water rights and qualify him as an expert.

DIRECT EXAMINATION

BY MS. HENRIE:

Q. Will you please state your name for the

record and give your qualifications on water rights?

A. Yes. My name is D.L. Sanders. I am the former Chief Counsel of the New Mexico State Engineer. I worked for the state engineer for 24 years. I held positions from a staff attorney litigating cases both in the adjudications that the State conducts as well as administrative hearings before the state engineer.

I also -- then I became a special counsel of the state engineer overseeing the state engineer's hearing unit. I was then made deputy chief counsel and then I became chief counsel. During my 24 years there.

As chief counsel I served both as the chief legal advisor to the state engineer overseeing all water rights, administration decisions. I advised the state engineer on all hearings, much as Mr. Brancard does for this commission.

I also was the chief advisor of the state engineer as far as making policy and executing on that policy.

MS. HENRIE: With that, I would tender Mr. Sanders as an expert in water rights.

CHAIRMAN CATANACH: Objections?

MR. LAKINS: No, sir. I would like to

pose an objection as this is not necessarily true rebuttal, because we disclosed early on correlative rights, impairment to water rights and the issue of our water rights. So any testimony was anticipated. There was no surprise testimony from Mr. Jackson yesterday that could be qualified as unanticipated. And all of those matters were on the table well before the hearing. This is not true rebuttal. This is bringing in a late witness.

MS HENRIE: Mr. Chairman, the day that the prehearing statements were due, September 3rd, was the first time we heard what the hearing was about, and that was the same day that Mr. Jackson was disclosed as a witness. We didn't know exactly what he was going to be testifying to nor what he would say until yesterday. So I think this is true rebuttal and I am offering you Mr. Sanders as a rebuttal witness.

MR. LAKINS: That was in our protest which was filed and a request for hearing on this.

MS HENRIE: Let's take a look at that, Charles. You want to take a look at the application for hearing?

MS. MARKS: Mr. Chairman, if I may, in support of Mr. Henrie I would like to use

Mr. Sanders as a rebuttal witness. I believe Mr. Jackson's testimony was beyond the scope of what was disclosed in the prehearing statement and his testimony was not disclosed as an expert. He was not disclosed as an expert witness before his testimony began. We did not know the scope or nature of what the testimony was until after he finished testifying.

As I said yesterday, I didn't know what he was testifying as, as an expert witness, what was an opinion and what was a fact witness. The testimony went on. He talked about policies at the State Engineer's Office, and I would like to examine Mr. Sanders as well regarding happenings at the State Engineer's Office.

CHAIRMAN CATANACH: The Commission will allow the witness to testify.

MS HENRIE: Thank you, Mr. Chairman.

Q. (By Ms. Henrie) Mr. Sanders, did you hear the testimony of Charles Jackson yesterday?

A. I did.

Q. And he testified about the AmeriCulture permit; is that correct?

A. He did.

Q. And the allocation of responsibility as

between OCD and state engineer for review of that permit; is that correct?

A. That's correct.

Q. Would you please comment on that?

A. Mr. Jackson and I served the state engineer for his entire career. I know him quite well, and he is very good, and I just think he happened to have some misrecollections about the permit to AmeriCulture.

First, I do remember that it sounded from his testimony yesterday as if he acted -- the only people involved in the application proceeding for AmeriCulture was the OCD and the District Office of the State Engineer in Deming and that's not correct. In fact, after the hearing yesterday I talked to Tink and asked him. I said, "I remember being involved in this to some degree," and he confirmed that, in fact, I was involved in making the decision with the state engineer that aquaculture is, in fact, the beneficial use of water, one. So it was acted in the state engineer office at the Santa Fe level, which is where all the upper management is.

And two, also he reminded me when I raised the issue of why he was serving as hydrologist and determining impairment, he reminded me that, in

fact, it was Mike Johnson, who is now head of the hydrology section of the state engineer, he had done the hydrology and made the determination as to effects on surrounding wells. That's what hydrology does at the state engineer. Then they referred back to the administrator to determine whether that constitutes impairment or not, and no impairment was found.

So just to be clear on that, it was not just a deferral to the opinion of OCD. The state engineer always acts on geothermal applications. In fact, I served as counsel on one application in the Jemez where the same process was followed.

Q. Did you hear the testimony about plan of replacement?

A. I did.

Q. What is the plan of replacement?

A. Well, my understanding, because to my knowledge there's never been an actual plan of replacement approved by OCD or the state engineer, and just by way of quick reference, under the act that provides OCD with jurisdiction to act on geothermal for water over 250 degrees without involvement from the State engineer -- I'm sorry, I lost my train of thought.

Q. What is the purpose of the plan of replacement?

A. Part B in 71-5-2.1 is an adaptation of existing law in the water code for deep non-potable water. So if you take water from depth and you ultimately -- if you make an impairment -- a decision of no impairment and ultimately there is an effect, there's virtually not -- the normal remedy would be to shut off the junior appropriator and allow the senior appropriator to recapture its water. But because it doesn't work that way in groundwater at that depth, it's not at a meaningful time, they chose to use a plan of replacement so that the person who is deprived of water can get water immediately. And that's the purpose of this section of the act, as I understand it.

So since none had been done, the purpose is in what fashion can you create a replacement plan, and I think that's entirely within the discretion of this body that you can allow for either a -- for instance, if LDG were to impair aquaculture's water right in some form, you could require LDG to go out and purchase a water right and transfer it in. It's more senior. But that wouldn't necessarily provide him more water if he

already can't get water under this well.

You could require his well to be deepened or replaced in order to get water, or I think it's probably entirely within the discretion of this body to allow for Lightning Dock to provide water from its geothermal wells under your jurisdiction and use part of its diversion to supply water to Mr. Damon in the event that the aquaculture water right were impaired. That's my understanding.

Q. Okay.

A. That was my understanding at the time of the act. I was one of the early drafters of this. In fact, I worked with Mr. Brancard for a while on this process.

Q. You talked about an impairment. What are the elements of a water right that can be impaired? Or stated differently, do they include the chemistry and the heat in the water?

A. Well, that's another point. And I think Tink was not entirely wrong in the way he characterized it. A judge could find impairment. I can tell you from the state engineer's perspective, and I served for every state engineer since Steve Reynolds except for the current engineer, Tom Blaine.

The only element of impairment is your right to receive water in your turn by priority in the amount that you need for beneficial use. That's the standard.

With respect to the heat element that Tink carefully tried to characterize as a judge might finding as being impairment, that's incorrect. That has been decided both by the Tenth Circuit Court of Appeals, which was then of that holding that heat is not an element of a water right. It was affirmed by the New Mexico Court of Appeals in a case involving the Burgett water rights.

Q. Who was counsel in that case?

A. Aside from me, Mr. Lakins.

Q. In that case the judge said that heat is not an element of the water right?

A. Is not an element of the water right. Also by chemical composition or by -- I believe the Court of Appeals has also -- I know the Court of Appeals has also found that water content, that the chemical makeup of the water, like dissolved solids or suspended solids, are not an element of a water right either, and that was in the Ensenada case, as I recall.

Q. Let me ask. Did you hear testimony about

the Burgett domestic water supply?

A. I did.

Q. Do you know anything about the Burgett domestic water supply?

MR. LAKINS: Objection. That's not something Mr. Jackson spoke to. That was a different witness.

MS HENRIE: Didn't he say he drank water?

MR. LAKINS: He drank water there. He didn't talk about Mr. Burgett's use of the water rights. That was Mr. Bowers.

CHAIRMAN CATANACH: I will allow it. Let's go forward.

A. Yes. I did hear, and I believe because he spoke to drinking the water there, I am aware of, from other negotiations and other discussions, that Lightning Dock acquired a well, a potable water well from the Burgetts, and that well is designated as 10. I don't have a pointer, but if you look where the green swath kind of heads to the upper northwest, following the road it's about a mile northwest from the Lightning Dock area.

So there are three wells there, I believe. One of them is the one that Lightning Dock acquired as 10. Significant to the discussions and

acquisition of that well was the insistence of the Burgetts, who owned the Rosette, that they continue to be able to access one of the other two wells and ensure that it was available for their domestic water they use for the Rosette facility.

Q. Do you know if that's a hot well or cold well?

A. It's a cold potable water well.

MS HENRIE: I have no more questions for the witness.

CROSS-EXAMINATION

BY MR. LAKINS

Q. Just to make sure, Mr. Sanders. You are retired from the State Engineer?

A. I am.

Q. After you retired, you're doing independent work?

A. That's correct.

Q. One of your clients is the applicant here?

A. That's correct.

Q. You also share an office with Ms. Henrie?

A. That's correct.

Q. In the --

A. But to be clear, I also consult with them on all water issues.

Q. You do acknowledge that AmeriCulture's permit is valid?

A. I can't speak to that. I have not reviewed it. I know it was issued in what, 2002? I also know that the state engineer has been actively pursuing eliminating certain permits that were issued but not developed. And so I don't know the status of it. I don't know if he's put water to beneficial use. I just don't have the answer to the question.

Q. But you were involved in that yourself?

A. That's right.

Q. In the application, and you found there was no impairment at that time?

A. That's correct.

Q. Right. Now, the plan of replacement that you're talking about, that's from 72-12-A9 the Mine Dewatering Act, right?

A. No.

Q. Let me make sure I understand because you said that the plan of replacement in 71-5-21B came from another section of the water code?

A. Right.

Q. What section?

A. I think it's -- I have to look at the

statute. I think it's 72-12-28, as I recall. It's towards the end of the groundwater code. It's for deep non-potable water, not the Mine Dewatering Act.

Q. 72-12 --

A. Just to be clear on that, that's what I recall where the section came from, from the discussions within the office. At that point I opted out.

Q. But you can't give me that citation for what section it is?

A. If I have the water code I can find it in two seconds. I will come over there.

Q. I will bring it to you.

A. Well, I'll be dang. It should be here. I don't understand why it's not. Do you remember the statute for deep, non-potable water?

MS HENRIE: I'm not sure. Does this matter terribly to your case?

UNIDENTIFIED SPEAKER: 12-25.

A. There it is. Thank you. I don't know how to pull it up, Charles. There we go. Here you go.

Q. Got it?

A. This was the original genesis of it. I don't know whether this came from there.

Q. 72-12-25?

A. 25, 26 -- so it's the gist of 28.
Q. Thank you. Now, the case that you talked about, you and I actually were involved in?
A. Right.
Q. It involved heat?
A. Right.
Q. That was actually the genesis of the current ongoing Animus underground valley water adjudication?
A. Right.
Q. Correct?
A. Yes.
Q. And the decision that was made in that case had to do with the aspect of heat being part of water controlled by the State as an element of water, right?
A. I think. I may not state it that way but I think I might agree.
Q. It didn't touch on water rights of an individual, it was fundamentally about the State's ability -- state engineer's ability to control heat and water?
A. No, what it says -- I can tell you what the holding is. "First we reject the holding that temperature is an element of water right that the

State must adjudicate." It said it's not an element of a water right. That's what I testified to.

Q. So it's not something that will be adjudicated?

A. That's correct.

Q. Pass the witness.

CROSS-EXAMINATION

BY MS. MARKS

Q. Mr. Sanders, I'm going to show you Exhibit AmeriCulture's Exhibit T which Mr. Jackson referred to yesterday.

A. Yes.

Q. Mr. Jackson seemed to indicate that this application somehow -- I will paraphrase his testimony but if I do so incorrectly you were in the room -- was indicative of a transfer of water rights and Mr. Seawright's water rights are senior to those who transfer water rights after his permit. Is this correct?

A. Not if the water rights transferred in, as approved by the state engineer, are senior to -- have a senior priority or earlier in time than the aquaculture priority.

Q. So this permit alone is not conclusive evidence of a priority date?

A. That's right. Well, it's conclusive evidence of a priority date. It's not conclusive of who it's prior to. You have a string of water rights with priority dates over time. Aquaculture's fits in one section and anything senior or earlier in time to that that gets in then still would have a better right if approved.

Q. I just wanted the record to be clear on that. We also discussed 71-5-2.1B, which was put into law in 2012 and prior to that the statute was different. Do you recall how the statute or that section of the Geothermal Resources Conservation Act was prior to the amendment in 2012?

A. I believe it was only Section A, and looking at the amendment comment below here, it says that the only thing changed in Section A in 2012 was rather than the number 250, it was spelled out, two hundred and fifty degrees.

Q. So in 2012 Sections E, C and D were added; is that correct?

A. That's correct.

Q. Okay. So Mr. Jackson's testimony was that the state engineer deferred to the OCD regarding impairment of water. Is that correct?

A. No. I think as I said earlier, I think

Tink would agree that his testimony wasn't fully accurate yesterday; that, in fact, it came to Santa Fe. We reviewed the application as to whether aquaculture was a beneficial use, which I consulted the state engineer on, and also I said, "I can't believe we didn't do a hydrologic analysis because we had the permit with the application," and he mentioned to me that Mike Johnson had actually done the hydrology and evaluated the effects on other wells in the area.

Mike Johnson is now the head hydrologist for the State Engineer Office. And then what happened -- at that point that's what's referred back to water rights staff to make a determination as to whether the effects on other wells constitutes impairment.

Q. Before I get to my next question, is Tink Charles Jackson?

A. I'm sorry, Charles Tink Jackson, which is ironic, I think, that we call him Tink. That suggests a small guy. Everybody in Deming is large. Big guys.

Q. So back to the statute. Would you say that the state engineer and the Oil Conservation Division prior to 2012 and now had dual regulation

of geothermal energy under 250 degrees?

A. Absolutely. What generally, typically the state engineer, if there were other permits required, before we would act on a new appropriation, we would require all other permits be obtained first, which is exactly what Tink described yesterday. Aquaculture had come to obtain the OCD permit. They brought that then to the state engineer as part of the application so we could consider that along with the application and do our own analysis, which was done.

Q. And so the only change that the 2012 -- the only statutory change made in 2012 was to make it so that the state engineer did not regulate geothermal energy over 250 degrees; is that correct? Among minor other changes?

A. That's correct.

Q. And to be clear, you're not the Oil Conservation Division's client here today testifying?

A. No, I'm not the client nor are they my client.

Q. And you did not intend to testify in these proceedings on behalf of Lightning Dock Geothermal, correct?

A. I did not. Only after the testimony yesterday.

Q. Thank you. I have no further questions.

CHAIRMAN CATANACH: Commissioners, any questions?

EXAMINATION BY THE COMMISSION

MR. BALCH: Are the Burgett fresh water wells on this map or are they off this map?

THE WITNESS: I believe they are on the map. You can see where the writing is over there. Are they off the map? I can walk over. Do you mind if I walk behind you? In fact, I was out there on a site visit just recently.

Let's see. Here is Lightning Dock right here. They are off the map. They would be -- here is LDG, here is Rosette so one mile out here. They were along Geothermal Road. They are right along the road. You can see them right here.

MR. PADILLA: Is there a potable water well on that map that you know of?

THE WITNESS: Not that I'm aware of. There could be but I don't know. I was just inspecting these wells. I'm only familiar with them through discussion with the Burgetts.

MR. PADILLA: So to your understanding,

the house which is the white structure on the bottom there?

THE WITNESS: There?

MR. PADILLA: I thought it was all the way down. That would have been supplied by one of the potable wells you just referred to outside the map?

THE WITNESS: I can only tell you what -- is it Ms. Burgett? During the negotiations when she would --

MS HENRIE: Paula Thomas.

THE WITNESS: Paula Thomas, who is one of the Burgett family. They needed to have access, continued access to to make sure that the well would continue to operate and supply the potable water supply for the area. That's what she impressed upon us as being critical to any deal that we had with her.

So I don't know. I heard others say that there may be, but it seems like, given the water quality standards, it's hard to imagine there's a potable water supply.

MR. PADILLA: Thank you.

MR. BALCH: You spoke at length about heat not being an element of the water right?

THE WITNESS: That's correct.

MR. BALCH: You also mentioned that chemical composition was impacted -- or did not water rights?

THE WITNESS: That's right.

MR. BALCH: Could you elaborate on that a little bit?

THE WITNESS: Can I see the Ensenada case? I actually -- so the way it's been defined -- the way the Court of Appeals for the State of New Mexico as affirmed by the -- not affirmed. They didn't take issue on this case.

MR. LAKINS: Could you give the cite, please?

THE WITNESS: Sure. The generic cite is 1988-NMCA-030. This was done in 1988. And so in citing these other cases what the Court of Appeals said is both these cases involve claim to diminish water quality from increased salt content in the water. Salt becomes chemically associated with water in solution while silt is physically associated with inspection. Even salt has been held not to be a part of the water in which it is dissolved. Where the proposed appropriation sought water, particularly salt content, so the salt could be extracted for sale.

So what they are saying there is they went out and they appropriated salty water. Then they evaporated, used it for salt, and they said by changing this chemical composition we diminished their ability to extract salt from the water. And the Court said that's not part of what the state engineer -- that's not what a water right is for.

This case actually involved silt, and the claim was that silt helped seal the fields, fertilize them naturally, that they were entitled to a silt content of the water. And because of the way it was being diverted and used, the silt content was going to be lessened and that would impair their water right. And that was rejected in this case as well.

MR. BALCH: But if you had a situation where somebody had potable water and then brine water was released into it making the water unusable for its purpose, that would be impairment?

THE WITNESS: It would be a tort. I don't know if it would be impairment. It's never been decided, certainly not been the policy of the state engineer.

MR. BALCH: Interesting.

THE WITNESS: Past state engineers, I

should say. I don't know. A future state engineer might see it differently.

MR. BALCH: You mentioned a couple of times greater than 250 degree water. That's Fahrenheit, I presume?

THE WITNESS: Yes.

MR. BALCH: Not regulated by the State Engineer's Office? That's not part of their water basket that they look at?

THE WITNESS: After 2012, water above 250 degrees Fahrenheit used for geothermal purposes is not within the state engineer's jurisdiction. If you take it and want to use it for beneficial use and establish a water right by applying it to other uses, then it would be under its jurisdiction for those purpose, not for the geothermal purpose.

MR. BALCH: You also mentioned, staying with water rights, that if Lightning Dock were to give geothermal water, greater than 250 not regulated by the state engineer's water, as a replacement, that would be allowed and not blocked by other water right regulations?

THE WITNESS: The way I read the changes to the current statute, 72-5-2.1, I believe, the way that reads is replacement plan is within your sole

jurisdiction, so if you want to allow water use -- geothermal water used for the non-consumptive use by Lightning Dock, you could approve its use as replacement water even though it would go to beneficial use because you're not creating new depletions, you're only providing water that would have been depleted by aquaculture, so the status quo remains unchanged.

MR. BALCH: Presumably that replacement water would have to have similar heat chemical composition to the original water?

THE WITNESS: I would imagine that would be you all's call and I would imagine you would require something like that.

MR. BALCH: Thank you.

MR. PADILLA: Just a couple questions for you. I want to go back to the heat elements we discussed earlier.

THE WITNESS: Yes.

MR. PADILLA: Yesterday when I asked Mr. Jackson to quantify what heat element, what drop in the heat element of the water would constitute impairment, I believe his answer is that would be for the judicial body to decide. Is it your impression that that is not any indicator of

impairment? Even if it were to drop from 312 degrees to 160?

THE WITNESS: The two cases I mentioned, in fact, in the case involving Rosette that Charles and I did, if heat isn't an element of a water right which is the exclusive jurisdiction of the state engineer then, then he doesn't have any jurisdiction to say the loss of heat is impairment.

MR. PADILLA: And we also discussed a heat replacement scenario in which Lightning Dock used a closed loop system to furnish aquaculture with heat by exchangers and then return its own water to the facilities. Would the Office of the State Engineer have anything to say about that?

THE WITNESS: I'm sorry, could you repeat that for me?

MR. PADILLA: If, in the case of Lightning Dock supplying, as a provision of the joint operating agreement or whatever that instrument is called wherein Lightning Dock would have to supply heat in the event of a loss on aquaculture's part due to heat projects carried out by Lightning Dock, if they were to send geothermal water in a closed loop through the exchangers to aquaculture and retrieve or to recapture all of that geothermal

water and reinject on the facility, would the Office of the State Engineer have anything to say about that?

THE WITNESS: I've never actually -- I'm not familiar with that agreement so I don't know what the genesis and the terms of it are. I don't know -- I don't have enough information to answer accurately.

MR. PADILLA: Let me rephrase. If no water was actually going outside the system and it was being used just for heating purposes, would the Office of the State Engineer have anything to say about that?

THE WITNESS: I definitely think not, not since 2012.

MR. PADILLA: Especially if it was over 250 degrees?

THE WITNESS: Yeah. If it was over 250 degrees when diverted and it stayed in a closed loop, I would say that would be under you all's jurisdiction.

MR. BALCH: Just to expand that slightly, the original water would be 312, go through Lightning Dock's cooling facility or their generator facility, cools to as little as 160 or 180. If it

then becomes lower than 250, does that change anything with regard to regulation?

THE WITNESS: Well, I don't want to testify for the state engineer, but my advice to the state engineer today if I were still his counsel, I would say that it's the point -- what governs is the temperature of the water when diverted. So if it remained -- as long as it didn't drop below 250 or hit 250 or below.

MR. BALCH: So they might have to divert some of their hot water?

THE WITNESS: That's right.

CHAIRMAN CATANACH: Just one. Mr. Sanders, if Lightning Dock actually had to replace actual water to AmeriCulture, do they have a water right to do that?

THE WITNESS: Depends on -- Mr. Chairman, I think it depends on what you guys require. If you wanted them to go out and get an alternative source -- I mean, go out and get a new source or get a new well or something as a way of replacing it and that's what you required for whatever reason, then it would be under your jurisdiction. I think the permit, the water they would be seeking to obtain, would be -- I don't know what the temperature of

aquifer -- I don't know what the temperature of aquaculture's water is to begin with, so I would probably have a difficult time answering the question.

The water provided through the geothermal resource diverted to aquaculture, as long as it was acceptable as a replacement plan, I don't think necessarily the state engineer would have to have any jurisdiction over that at all. If that was the question.

CHAIRMAN CATANACH: I mean, do they actually have a right -- would they -- I guess right now they are producing it and they are reinjecting it so they are not actually doing anything else with the closed loop system, but if they had to actually replace that water and give it to AmeriCulture would they have a right to do that? Or would they have to acquire a well or some other source?

THE WITNESS: I think if you are talking about water supply, an adequate, sufficiently hot water supply, I believe it's within the jurisdiction under the statute for OCD to let Lightning Dock use its water supply that diverts under your permit to be used as replacement water for aquaculture. Because you are not creating any new depletions in

the system, you are merely replacing the depletions that would occur but for the loss of water supply that aquaculture suffered.

CHAIRMAN CATANACH: That answers the question.

MR. BALCH: There's still mass balances.

THE WITNESS: Mass balances, right.

MR. BRANCARD: Maybe we can just walk a little bit through the 2012 legislation. I don't know if you have it.

THE WITNESS: I have it.

MR. BRANCARD: Just so it's clear to the commission exactly what the 2012 legislation decided, okay? The situation in which you do not have to get a permit from the state engineer for diversion involves diverted water over 250. We already discussed that, right?

Then it says either the use does not require any diversion, which we're not talking about here, or all diverted groundwater is reinjected as soon as practical under the same water source in which it was diverted resulting in no new net depletions to the source.

THE WITNESS: Right.

MR. BRANCARD: So it's not just 250. You

have to reinject the water back to the same source in order for there not to be a permit required by the state engineer.

THE WITNESS: Correct.

MR. BRANCARD: In any other situation, the state engineer could step in and say water law applies, you need one.

THE WITNESS: Right. And on that phrase, no new net depletions, because you are not creating any new net depletions, by using it as replacement water I think you fall within that provision of the statute.

MR. BRANCARD: Now, in this paragraph where it talks about an impairment opinion, the only agency that is directed to give an impairment opinion under the statute is the state engineer, correct?

THE WITNESS: That's correct.

MR. BRANCARD: The involvement of the OCD would be upon an opinion, an impairment opinion, being delivered by the state engineer and the OCD, the OCD would then require that party that's doing the diversion to provide a plan of replacement.

THE WITNESS: Only if it chooses to grant the permit to the applicant. OCD chooses to grant

the permit to the applicant knowing that impairment will occur, and the applicant then agrees to do that at the application level. The plan of replacement, I think, would typically occur after the fact generally, but if you anticipate impairment and that person is present and they agree to that, I think that would be fine.

MR. BRANCARD: Well, it says here, "The division, OCD, upon receipt of the opinion of the state engineer," which presumably is the impairment opinion, "shall require the owner/operator to submit to the division a plan of replacement."

THE WITNESS: That's right.

MR. BRANCARD: Then when you get down to the definition of plan of replacement it gives a whole series of options of how that party who is directed to give the plan of replacement, they can choose to figure out and then it's up to OCD to review that plan of replacement.

THE WITNESS: That's correct.

MR. BRANCARD: There's a second part to the statute. I don't know if you have it in front of you.

THE WITNESS: I do not.

MR. BRANCARD: It was codified at

71-5-21.1. It's only one sentence. 5-21.1.

THE WITNESS: I think that's the law anyway, but yes.

MR. BRANCARD: "Any water rights owner may bring a de novo action in the district court of the county in which the water rights are located for damages or injunctive relief with respect to any claimed impairment of existing water rights due to development of geothermal resources" pursuant back to what we just talked about, the section.

So in other words, if somebody is unhappy, doesn't like the opinion of the state engineer, didn't get an opinion of the state engineer, they can go to court.

THE WITNESS: If, once the permit is issued and the diversion does, in fact, cause an impairment, yes. I mean, they have to demonstrate damages, so it would be after the permit had been exercised.

MR. PADILLA: The loss of heat would not qualify as impairment according to the Office of the State Engineer?

THE WITNESS: Under the water code it would not. I don't know. This is a weird statute.

MR. PADILLA: The heat component is not

part of the water right?

THE WITNESS: Right. But actions for impairment, common law actions for tort and taking, that's -- our case law is rife with those.

CHAIRMAN CATANACH: Is there anything further of this witness? This witness may be excused.

MS HENRIE: Thank you, Mr. chairman. I would next like to recall Roger Bowers for the purpose of addressing some of the questions the commission had yesterday.

CHAIRMAN CATANACH: I would like to advise you, Ms. Henrie, we are running behind. If you can speed this up a little bit.

MS HENRIE: I think the next two witnesses will go quickly.

MR. LAKINS: I object to the recalling of any witness that already testified.

MR. BRANCARD: Well, I guess I would suggest that you finish your direct witnesses and then we can discuss whether anyone needs to be recalled at that point. Again, the other parties have not had a chance to put on any witnesses -- well, one witness.

MS HENRIE: I would like to get this

information to the commission today. With that, we will call Dr. Greg Miller.

GREG MILLER

after having been first duly sworn under oath, was questioned and testified as follows:

DIRECT EXAMINATION

BY MS HENRIE

Q. We're going to move to qualify -- not right now but we are going to move to qualify Dr. Miller as an expert witness in hydrogeochemistry, and I would like to have him state his qualifications and also tell us what hydrogeochemistry is in the course of doing that, please.

A. Thank you to the board for hearing me today. I'm Gregory Paul Miller. Greg Miller is fine for anything today. I'm a professional geochemist, practicing hydrologist. I have been a consultant geochemist for 25 years. I have three degrees from New Mexico Institute of Mining and Technology: A bachelor's of science in geology with honors, a master's in science and geology and a Ph.D. in earth and environmental science with dissertation in geochemistry.

I think it's best to kind of explain how

we get to this real specialized title of hydrogeochemistry which makes it seem like I am focused laser-like on one topic. Understand that really this is a generalist position that encompasses both the physics, hydrology, chemistry and everything else that I can possibly throw at accomplishing my tasks with my clients.

Ultimately, I am a chemical thermodynamicist. I work with the interactions between rock and water at all temperatures from freezing to the surfacing of the sun and exoplanet biology. I have been trained by experts in geothermal systems to use the same tools that geothermal folks use in evaluating ore bodies.

So ore bodies, many of them are nothing but fossil geothermal systems and we use the same tools, geothermometers, descriptions of inclusions of fluids trapped in minerals by these systems, thermodynamics, heat flow, chemical model are all the tools that we use to do this work.

Now I'm going to back up into my background and experience a little bit on this so you can see how I can apply these tools to the analysis of geothermal systems and have indeed worked on geothermal systems.

I transferred into the New Mexico Institute of Mining and Technology in 1985 with 90 semester hours of credit from Diablo Valley College in California. At Diablo Valley College I learned that in the geosciences we can explore any field we want. We can go chemistry, we can go physics, we can go structural, we can go geophysics, we can work on other planets, we can work on our own planet, we can work on the atmosphere.

This is why my Ph.D is in earth and environmental science. The Institute of New Mexico Mining and Technology has determined that I am competent to work at the research level in earth and environmental science as a generalist or a specialist.

So transfer the credit in. Come in. Dave Norman becomes my student advisor. Dave Norman is cited in numerous documents here as both conducting geothermal studies himself on the system of Lightning Dock and having additional graduate students conduct geothermal studies on the system at Lightning Dock.

Now, as many advisors at New Mexico Tech will do, Dave had me working on things that were of interest to him in addition to things that were of

interest to me. But I completed the master's degree with Dave having developed an interest in mineral equilibria, geothermal systems. I attended the first class taught on geothermometry and hydrodynamics at New Mexico Tech as far as application to geothermometry, and that was from the Society of Economic Geologists, Professional Publication No. 1, Hydrogeochemistry of Geothermal Systems.

So Dave gave me an interest level in this. But then I went off and worked on radionucleide contamination cleanup in the Oak Ridge area for about eight or nine years right up until 1996/'97 when the budget train wreck occurred and DOE cut off their environmental work.

So what was I doing in Oak Ridge? I was working with radiogenic isotopes, I was working with stable isotopes. I was calculating groundwater dates using helium 3 helium 4 dating. I was working with some of the best professionals in the world on that: Kip Solomon, University of Utah and such.

So the science that we work on there is to describe water/rock interaction, whether it be contaminants or whether it be common elements such as calcium or fluorene in the environment, but it's

considered as a totality. We have to look at the whole periodic table. We have to look at all of the physics. We have to look at thermal which controls everything.

Budget train wreck happens. What am I going to do? I worked in construction for a while, I sold water treatment door to door. Have you ever had one of those water softener guys come by your house? That was me.

I came back to New Mexico Tech and Dave said, "I want to work on gold off the Canary Islands." I said, "No, Dave, we don't want to do that. Let's work on arsenic because it's going to be front-page news in the New York Times 2000." This was 1997. So Dave Norman and I developed an arsenic research program together, had multiple graduate students working with both me underneath my Ph.D. and underneath his programs. Lots of grant money on it and Dave was really happy. He was ahead of the curve.

This doesn't mean Dave left me alone on geothermometry and geochemistry and his science, fluid inclusions and fluid inclusion gas analysis. When we picked my dissertation site to look at arsenic transport in the environment we picked Rio

Salado, Rio Caliente west of Guadalajara, Mexico, which is in the middle of the La Primavera geothermal field in the Trans-Mexican Volcanic Belt, possibly one of the largest undeveloped geothermal fields at this time.

My dissertation site was 20 kilometers of stream system which headwaters were boiling water springs with one part per million arsenic in it plus good whack of boron and everything like that. I chased the chemistry, the water/rock interaction in the partitioning of all chemicals that I could analyze in this water between the sediments of the stream and the water from 90 degrees Celsius, boiling water, to 20 degrees Celsius 20 kilometers down the stream. This is what thermodynamics does. This is what water/rock interaction geochemistry is, and this is why I call myself a hydrogeochemist, just as I did in exactly my first job that I had in Oak Ridge in 1988.

I work on the environment as it includes groundwater, surface water, geothermal, exobiology. Doesn't matter where we are, it's thermodynamics. So I feel well qualified to work in the geothermal field.

I have had a lot of consulting roles. I

have had a lot of different consulting work.

CHAIRMAN CATANACH: Can we -- I appreciate it.

THE WITNESS: I'm going to give you one more thing. The last time that I applied my geothermal tools to work on a system using stable isotope chemistry was in 2006 working on permitting for a mineral evaluation in the Monticello Box for BE Resources, a beryllium project there. There were concerns that the warm springs in that valley were going to be impacted by this work. So with New Mexico Tech and graduate students we performed geothermometry on the springs. We performed stable isotope analysis. We did all the things we do in ore deposits or geothermometry to evaluate this.

So while my academic training was indeed 14 years ago, I am still applying these tools every single day.

Finally, I run the codes that are used by the geothermal industry in my industry. I run TOUGH2, which is a Los Alamos developed code for the geothermal industry. I run HST 3D which is the USGS' geothermometry code. I also run Purple X, which is a metamorphic petrology code. So I admit to be qualified as an expert in hydrogeochemistry

including geothermometry, although I'm talking Michelle's talk right now.

MS HENRIE: Let me please tender Greg Miller as an expert in hydrogeochemistry.

CHAIRMAN CATANACH: Any objection?

MR. LAKINS: Yes. Based upon Mr. Miller's resume, I have no qualms with him being qualified as a professional geochemist because that's what he says he's done. His dissertation is in geochemistry. His master's and bachelor's were in geology. And calling one's self a hydrogeochemist does not, in my opinion, make one's self one, when his resume is all about geology and his dissertation is geochemistry and it does not go to hydrogeochemistry. So I object to that broad of an expert qualification.

MS HENRIE: I have Mr. Miller's transcript from Texas Tech here that shows his hydrology courses. I can offer that to you, Charles, if that would help satisfy your concerns. I can offer it to the commissioners or have Greg speak about it.

CHAIRMAN CATANACH: I believe in Mr. Miller's resume of employment history it does list hydrogeochemist for numerous years. In my opinion, that would qualify him as a

hydrogeochemist.

MR. BALCH: The majority of his projects have to do with hydrology to groundwater.

CHAIRMAN CATANACH: The witness is so qualified.

MS HENRIE: Thank you, Mr. chairman.

Q. (By Ms. Henrie) Briefly, Greg, do you have any licenses in New Mexico?

A. I am licensed in five states as a professional geologist. I also used to hold licensure in the state of New Mexico as a Water Systems Operator Level 3. If you're unfamiliar with the scale of the New Mexico systems operators, that entitles me to operate treatment systems for the public to remove substances that are deleterious to human health. It allows me to qualify that the system is providing water that is safe for human consumption. I let that licensure go when I was no longer working for a municipal domestic water firm as a consultant.

Q. Dr. Miller, please tell us about how you first got involved with Lightning Dock Geothermal.

A. I was asked by your office to perform evaluation of groundwater quality in the vicinity of Lightning Dock Geothermal, specifically to go and

contact landowners and sample their wells for a variety of constituents and report those results back to you.

Q. And what did the report -- what happened as a result of the report?

A. Well, I issued a report that showed that the water quality from the sample wells by comparison was very similar to what we had seen in Circular 177. The reporting was looking to see if we saw indications off-site from a tracer activity that occurred on-site. The results of that were that we found no off-site indications of the tracer work.

But one thing that surprised me on the reading of Circular 177 in comparison to my results to it and the actual sampling results themselves was that propensity of fluoride that existed at the Lightning Dock area.

So this is a graphical representation of some sampling -- I'm sorry.

MS HENRIE: Just a second. This is Exhibit 10 in your binders. It's hard to see the screen.

A. It's very hard to see the screen. We have east on the bottom axis, north on the right axis so

these samples can be located. These well sites were located by me personally with GPS coordinates. I conducted the sampling myself. The analysis was conducted by the New Mexico Bureau of Geology and Mineral Resources.

These are fluoride levels, and what we note right here is the hot wells labeled in red have hot well levels of fluoride in them, running maybe 10 to 15 PPM, kind of the range we've seen in the past. And I also noted that we still see fluoride concentrations that greatly exceed drinking water standards up and down the valley.

One of the first things to do in something like this is are my results real? So I wanted to compare against other work so I started doing literature research trying to find out what other fluoride results existed out there, and that's how I ended up with Circular 177. Table 2 in Circular 177 has some really great fluoride numbers from up and down the valley. There's Figure 6 -- I apologize for not being prepared on that. Figure 12 in the exhibit --

CHAIRMAN CATANACH: What are we looking at here?

THE WITNESS: Circular 177.

CHAIRMAN CATANACH: What exhibit?

MS HENRIE: Exhibit 6.

A. Page 27 of that. The upper right-hand corner of Page 27 depicts Figure 12 which shows this location of these P series and AN series water samples that were taken by a number of programs, Swanberg, Elston, Logsdon. They are included in the references here in the Circular 177 how and when that data was collected.

But I took the Table 2 data and I searched the document for the fluoride contours. I was looking for the fluoride contours. I really expected to find it and I did not find it. So I went ahead and hand-contoured the fluoride myself. We can move to the next slide.

Q. That's back at Exhibit 10, Page 2 of Exhibit 10.

A. This was done using completely old school stuff. Table 2 does not give the locations of the wells that they sampled so I had to make a transparency and punch holes through it and color the plots. Geologists like working with dirt and crayons. And we come up with this plot here.

What we are seeing here is this outside edge roughly contours areas greater than two parts

per million fluoride and water. Two parts fluoride in water is significant as determined by the U.S. EPA, the New Mexico Department of Health and the New Mexico Environment Department as the level of fluoride at which dental fluorisis starts. The other contour that exists out here, the inner one here, is levels approximately over four. Now, the level of four parts per million of fluoride is significant because that's the level at which U.S. EPA, New Mexico Department of Health and New Mexico Environment Department say that skeletal fluorisis begins. Damage to your skeleton.

So I was greatly surprised to see this. And I was greatly surprised to see, frankly, discussions of potable water involved with water in the lower section of the Animus Valley.

Now, this is hard to scale so I'm going to show you an overlay of this with Cotton City, the Lightning Dock leasing areas, so you can get an idea how big this fluoride plume is.

MR. LAKINS: Is this an exhibit?

MS HENRIE: It is not, Charles. And that was just because we didn't have time to put it together. I can make it an exhibit if you would like.

A. So that was georeferenced for me by Roger Bower. He took my overlay and georeferenced to that topographic map right there. But discussion of potable water inside this contoured area is really problematic. The knowledge that this water has been this contaminated has existed for 33 years and people are conversing in this meeting as if this is some pinpoint of contamination.

Note that also this extends down to the southwest here. And again, this points back to Logsdon and Deal's original analysis that this geothermal system is also trending to the southwest as you heard today, and we will present additional information on that.

So we have this fluoride anomaly here. When we get to the heart of it right here where we're talking about pumping out water that's between 10 or 15 PPM and putting it right back in the core of this plume that's 10 or 15 PPM, personally and professionally I find it ridiculous to be talking about the water quality standard.

Someone cited the water quality standard yesterday, and that sentence opens up saying, "If you cause it to exceed." Well, that presumes that it's not exceeded already, doesn't it? In my

opinion, it does.

So we can't cause water to exceed that's already exceeded. And to me, this is an enormous public health problem that nobody who has known about it, but me, has said anything about to this date. I find that entirely surprising because we have talented scientists and engineers in opposition to the project. We have the Hidalgo Soil Commission that has claimed protection of their friends, families and neighbors, and I haven't seen anybody tell anybody they are drinking poison in the Animus value.

That is my personal and my professional opinion to a reasonable degree of scientific certainty that consumption of the water in the Animus Valley inside those contours is not advisable from a human health perspective.

MR. LAKINS: I object to that opinion because he is not qualified as any sort of medical expert.

CHAIRMAN CATANACH: I will agree with that.

MS HENRIE: Can I ask Dr. Miller to respond?

CHAIRMAN CATANACH: Yes.

A. My qualifications as a Water Level Operator System 3 qualified me to determine when human health was affected and when it was not by reference to regulatory standards. And here I am making only reference to regulatory standards. It's not me that says that this water is unsafe to drink. I am merely reiterating the well-founded opinions of the U.S. EPA, the New Mexico Department of Health and the New Mexico Environment Department and speaking to that as a professional qualified to speak about the water of chemistry. That water represents a human health risk.

CHAIRMAN CATANACH: Based on the standards already established.

THE WITNESS: Based on the standards already set up.

CHAIRMAN CATANACH: I will allow that.

Q (By Ms Henrie) Dr. Miller, will you characterize, please, the geothermal water at Lightning Dock and in the Animus Valley?

A. Okay. We have seen both from the work done by other scientists and confirmatory samples -- we need to go to stiffs.

Q. The stiffs are an exhibit, Exhibit 8.

A. I will need those on the screen in order

to point out what's going on. Thank you. All right. The first diagram that we are looking at here is what's called a stiff diagram. You saw an explanation of that the other day in the stiff diagrams that were presented. I will add very little to that in that what we're doing is we're calculating concentrations in molarity, so we're counting atoms. We want to match numbers of atoms and then we weight them by charge.

Ions have a charge on them, minus one, minus two, plus one, plus two, so the CAD ions on the left-hand sides of the diagram, the positively charged stuff, and the anions are on the right.

Now, what we are trying to do with a diagram like this is take a table full of numbers and force it into a visual representation so that we can pick out differences in characteristics.

The geothermal water and the data I plotted here is Well P3 from Elston, et al., 1983. And this is very typical of the geothermal water sample. We see a very low magnesium sulphate signature down near the bottom, very low calcium carbonate signature in the middle portion of these waters, but as a percentage of the amount of chemistry available, it's dominated by sodium

potassium and chloride. So this is a sodium chloride water. All of the geothermal waters, when we calculate a water type on them, generally plot right in the sodium chloride water field.

Now, waters are different in the Animus Valley. In the upper reaches of the Animus Valley we tend to have more calcium-based waters. It's more fresh infiltration taking place there. As the waters tend to move down, they become more sodic and they also tend to pick up more bicarbonate and this is picked up from the valley sediments. So I picked a very typical basin-fill well, the Valley View Church Well, which is used for references in a lot of work here and is right at the end of geothermal road and the highway. So it's a good representation of what's happening outside in the potable water zone.

And this, on the bottom right-hand corner, we still see this sodium potassium signature here but we are starting to pick up on the calcium, magnesium, a little bit of sulphate. And you can see simply from a pictorial perspective how mixed water ends up as an intermediate-shaped figure. That's really the only take-home point from this, is that we can characterize that the geothermal water

plots, all with itself in one area, various other plots you're going to see. The more pristine valley-filled aquifers look like another thing and when we come into the zone of mixing that occurs, they are mixed water. And we see the mixing in all kinds of chemistry.

Q. Let me try to summarize. The geothermal water signature looks the same. The fresh valley water cold water looks the same and there's a zone of mixing where you can see that it's actually being mixed?

A. This is a principle of end points, yes. We have a geothermal water end point that plots very tightly. You will see it on the next side. We have the Animus Valley basin fill water, which forms another nice endpoint. But lots of things happened in the Animus Valley basin fill, so there's different signatures and different mixtures. This shows up on the next slide. If we could flip to the next exhibit.

This one here which plots -- you will see a diamond at the top with two lower triangles. This plot is also plotting in charge-weighted atom counting, so we are matching one atom to another. The bottom left-hand corner of the triangle is our

CAD ions. What is plotted in red is geothermal water. What is plotted in blue are previous samples taken in the P series for Lightning Dock. Excuse me, from Elston, et al 1983, and the green samples are what I took in 2012.

So from the bottom left-hand diagram we see that the geothermal water, just as on the stiff diagrams, they plot in the bottom right-hand corner high sodium potassium, low calcium. As we move to the right the waters evolve. They evolve through mixing. That is part of the process. There's an additional process all the way down the valley where they evolve from ion exchange to calcium to sodium potassium to calcium.

We look at the right-hand diagram and we see something else here. While the geothermal waters are plotting down in the right-hand corner for chloride sulphate and bicarbonate, there's a whole bunch of the P samples and the samples I took that plot right on top of them for anions.

Now, what that tells us is that trying to differentiate these two waters based upon chloride may not be the best bet. And Elston et al. offers a theory as to why that takes place. They believe that the valley fill waters are picking up chloride

from the valley fill sediments and, in fact, did some calculations looking at gypsum and sulphate to prove out that relationship. And I tend to believe the relationship that chloride is probably not a good mixing end point.

Now, you really get an idea of what different paths things can take when you take a look at the upper diagram and you see the geothermal water that plots in this nice tight area in the right-hand corner. Then we see the valley fill waters plotting in all directions. These are different mixing processes taking place. But it starts over on this far right-hand corner in that diamond as mixing from geothermal.

The next plot we are going to see, we are going to see what some of the pristine valley fill aquifer water really looks like.

Q. Quick question.

A. Yes, please.

Q. This is a naturally mixing water?

A. Well, all processes that are occurring there other than pumping and withdrawal are all natural processes. The fluoride plume is a natural process. The hydrothermal mixing that's taking place in there is a natural process. The advection

of water down the valley where it runs into the geothermal plume is completely natural, as is the giant plume of fluoride that extends down the valley. How far, we don't know.

Q. So when we look at these samples that were pulled by Elston that are plotted on your exhibit there, those were before the power plant, right?

A. Yes, they were. Yes, those would have been prior to the power plant but they would not have been prior to geothermal use because I believe Burgett was operating in the 1980s there. Or not. I could be confused on the date.

UNIDENTIFIED SPEAKER: Shallow wells but not deep wells.

A. Shallow wells but not deep wells. But the point being really, the take-home point from the slide is mixing is observed. It's observed as a natural process in the valley. My sampling in 2012 overlays Elston's sampling. We don't see much change in the hydrogeochemistry of the system between Elston and now.

I would like to move to the next exhibit. This is called a modified duroff plot or a confusogram. There's one point I want to illustrate here and this is the right-hand side of this

diagram. What we have done is taken a piper plot, which enables us to look at mixing and we added total dissolved solids and pH to it in the right-hand and bottom boxes. Now, if we look at -- total salt solids is a conservative parameter. If you mix water with -- you know, X total dissolved solids with Y total dissolved solids it forms a proportionality in mixing. You can calculate it as X fraction of Water A, plus X fraction of Water B will give us this concentration in Water C.

When we look at the TDS, the total dissolved solids of the geothermal water, pretty much with one exception we are seeing a plot right around 500 to 1,000 PPM TDS. I want to call your attention to the dots on the left-hand side of the geothermal, the very low TDS water, the purple and green dots there. Those represent our best basin fill pristine water characteristics right there. And as that water moves into the geothermal zone it's changed. But also as that water moves through playa sediments it can be changed, too, and we see the increase in TDS, the increase in sulphate that occurs down the Animus Valley.

Basically, the system is operating about the same as it always has based upon my observations

and comparisons with Elston, Deal and Logsdon's chemistry of 1983.

Q. Let me ask a quick question. We have said that the signature of geothermal water is the same. Does that change if we are looking at shallower geothermal water or deeper geothermal water or geothermal water that's above 300 degrees, which is 100 degrees? How does the signature work?

A. One of the findings of Elston, Deal and Logsdon was that based on isotope chemistry, based on chemical geothermometers, they believe that a certain amount of mixing takes place right in the outflow zone such that only 25 percent of core confined geothermal aquifer solution is actually mixing with the basin flow waters. So it very much matters where you are in the system.

We can't describe the system as, you know, homogeneous thermally or chemically because of these dynamic processes of mixing. Now, hasn't this been about the same since the whole time the system has been operating? We would say yes because it's created this giant plume down the valley of general plume configuration. It's not blobs going down the valley, it's a relatively continuous source. So we assume that the upflow and the mixing has been

taking place.

Recognize, the mixing is really what we call a fractile process. It's taking place in little tiny fissures but it's also taking place in the unit of upflowing upwelling hot water, rising because of buoyancy, rising because its density is lower than the density of the surrounding water. When this balloon of water comes up something has to come in underneath it. It can't create a vacuum. And so we see mixing at all levels through this system.

So if you are in the very center of the best part, hottest, whatever part of the outflow plume that's coming up, you are still in mixed water. So as comparison to the end points of the valley fill water and the deep geothermal sources defined in Elston, Deal and Logsdon 1983.

Q. I'm going to ask you two questions and then I would like you to talk about them.

A. Okay.

Q. You can go ahead and answer the questions if you feel that you have a quick answer. The first question is: In your opinion will the proposed injection contaminate any underground source of drinking water?

A. My answer to that is it is my professional opinion within a reasonable degree of scientific certainty that the operations as proposed at Lightning Dock will not contaminate an underground source of drinking water.

Q. I'm going to ask you the second question and then if you want to talk a little bit more to this point you can. Will the proposed injection cause the waters of the state of New Mexico to exceed applicable water quality standards?

A. Again, this is where this problem comes in answering this question. It is my professional opinion within a reasonable degree of scientific certainty that you can't cause water quality standards to be exceeded where they are already in excess of the regulatory criteria. You may adjust the concentration situation a little bit, but you're not going to change the fact that the standards are already exceeded. This is problematic in the environmental industry and this industry.

In regulatory work, as indicated in my resume, I have great experience with contaminated sites. This is always a problem. How do we pull contaminated water out of the ground, do a treatment operation on it which may not be about 100 percent

successful, but then return it to the system so we can keep working the system for a number of years and do so without breaking the law. In the strictest sense we can't do so without breaking the law. Strictest sense right here, you are pulling water up above the ground at 10 to 15 parts per million fluoride and then magic happens. And the law says that water is no longer able to be put back into the ground it came out of.

On face value it's ridiculous but it's the environment in which we have to deal with. So in the environmental industry we recognize this. We have groundwater non-attainment zones all over Texas where it's recognized that there's no way that this naturally contaminated water will never meet drinking water standards. And if you are doing uranium mining in this naturally occurring water that's never going to meet drinking water standards, how can you ever be expected to return that to the drinking water aquifer quality? You can't.

So the regulatory environment is the problem here. It's not the fact that the water is poisonous to drink.

Q. So, Greg, do you know whether Lightning Dock has background that's been set with regard to

fluoride that has been accepted by OCD? What is that background?

A. Oh, excuse me. Yes.

Q. I'm sorry, I took your brain away.

A. In the environmental industry about 1988 during the Resource Conservation Recovery Act 1976 as amended, it was determined that the only way we could figure out what's going on in these environmental sites as to whether we have downstream contamination or not is with statistics. Part of the problem here is some of these sites have upstream problems. If XYZ company upstream of you has been contaminating the water with the same thing you have and it's flowing onto your site, how much are you responsible to clean up versus the guy behind you? Or how can you tell if you change the water that's already in kind of bad shape, how can you tell whether it's changed enough downstream?

Then we have the incident of the landfill in the Midwest. This is a great problem. It receives 100 percent of its precipitation from above. Where is up-gradient for this landfill? Where am I supposed to measure up-gradient water quality? It's the sky. But again, the regulations are forcing me to do something that science tells me

is very hard to do.

So we use statistics for a group of samples using a method approved by the U.S. EPA to calculate what's called a background threshold value. A background threshold value is a statistically generated number which we generally have, the way it's calculated, have a 95 percent confidence that -- meaning confidence that we are not seeing a false positive, that if this number is exceeded something has changed.

So there is -- and it presents an interesting problem because it says now that we have a fluoride standard of about 17 PPM and some of the highest fluoride has been seen out there a little over 15. So on face value you say, how does that work?

Well, we have noise in the data. There's always analytical sampling error. There's always changes, small changes between samples. So the EPA has tried to take the statistical approach into account and has provided us a method for calculating two numbers. One is called an alternate concentration limit and the other is called a background threshold number. The background threshold number is appropriate in this case because

we have a contaminated aquifer and we are trying to determine how bad that contamination is. We can't use the MCL as our numerical standard for what we can inject. We have to establish what the characteristics of this water are.

So David Janney, with AMEC at the time, contacted me to perform ProUCL statistics for them. This is something I have done many times since 1988. ProUCL wasn't around in 1988. It only showed up in the late 1990s but the EPA set out how we were to do this. We have done it with Excel before. It crunched the numbers for them, told them, "David, we don't have enough data yet to do these monitoring wells. We are in the landfill situation."

Your source is right here radially around this. These wells are all going to have their own individual characteristics so we need to establish what their individual backgrounds are as quickly as we can.

We can use the whole dataset for everything that's been taken out of the geothermal work, assuming they are reasonably related, to establish what the background value is for the geothermal water. So that's exactly what I have done in 2013 and most recently 2015 is take the

datasets, the same ones supplied to OCD, the same ones supplied to everybody else, use ProUCL to perform outlier tests as they indicated I should do, look at the statistical distributions to make sure I'm applying the correct statistical method, look at the background threshold value and then calculate a background threshold level. And that's what was reported here.

So the background threshold levels, at face value, yes, they are higher than what we would think would be the normal concentration in the geothermal system, but that's a reasonable approach in environmental monitoring given that we know we will see some variance in the data.

So if sampling was to start to approach that background threshold value, Lightning Dock Geothermal has a bright line that they know that indicates this water is exceeding the statistical central tendency of the data of the geothermal water. We're going to see scattered. Background threshold value tells you that no, this is the bright line, and that's what I calculated.

Q. Let's switch gears a little bit. AmeriCulture has argued that Lightning Dock is going to cause it to go out of business because Lightning

Dock is going to change either the chemistry of the water such that it is unsafe for fish or the temperature of the water. And I want to know do you think -- I'm not going to ask do you think. Have you examined that proposition?

A. I have examined that proposition. I took the testimony of Damon Seawright that he needed water to at least 85 degrees Fahrenheit for aquaculture. I took his testimony that the maximum allowable fluoride that he would like in his aquaculture is some level at or below the level in Well A44 of 5.6 milligrams per liter. And we also took into account that the temperature as reported from State Well 1 and 2 of 230, I believe -- I will have it on the chart -- 232 degrees Fahrenheit to see what his mixing opportunities are. What are the management opportunities for water blending here that could end up within those criteria over 85 degrees C but below 5.6 milligrams per liter fluoride.

Not that one. Keep going. They are backwards. That one. Go up one. There we go. We will start with this one here.

MR. LAKINS: Is this an exhibit?

MS HENRIE: No, it is not.

MR. LAKINS: We would like this an exhibit, too.

MS HENRIE: Yes, sir.

Q. Before we do that, Dr. Miller, have you visited the AmeriCulture facility?

A. I visited the AmeriCulture facility, I believe, three times. It could possibly be four. I'm a little uncertain on that.

Q. So you're familiar with how the AmeriCulture wells work in order to serve the AmeriCulture facility?

A. Yes. I actually visited the cold water well, which was used to supply the AmeriCulture facility, for my own due diligence.

Q. Where is that well?

A. That well is in Section 12 off to the west of the AmeriCulture and Lightning Dock facility. It's on the north side of the road. It's pretty much directly across the street from the three Dale Burgett cold water wells, DB 1, 2 and 3, some real high volume wells that were there. I think it's cold water wells, six-inch casing. I did trace the line back to the AmeriCulture facility.

When called to sample, I did collect samples at multiple times from a well that I've

designated AC cold, which is their cold water. I know AmeriCulture can use different wells for different operations, so at the time I sampled from his mixing tap at his mixing tank what I call AC hot, AmeriCulture hot.

So I have seen the mixes operations. He will mix the tempered water with cold water imported to the site.

Q. What's the ratios?

A. I did not -- I have never been told by Mr. Seawright what his mixing ratios were. I actually did not inquire on that point. There's certain aspects of my visits to AmeriCulture where Mr. Seawright expressed that certain information was business confidential and I respected his request on that so I can't say that I have ever been told what the mixing ratio is, but from this diagram we can see what the potential mixing ratios are based on Mr. Seawright's own criteria.

On the right-hand side of the plot here we have fluoride in milligrams per liter. On the left-hand side of the plot we have temperature and degrees Fahrenheit. This bright red line represents temperature equal to or greater than 85 degrees, and this green line right here is fluoride equal or

greater than 5.6. So we don't want to go above the green line and we don't want to go below the red line.

So this line here calculated by the simple mixing equation that I spoke to you about a while ago, for example, for temperature you would take the fraction of the hot water times the temperature of the hot water plus the fraction of the cold water times the temperature of the cold water, and that will result in the mixed temperature. So the bottom axis is fraction of water from the hot well, so we can see in order to meet minimum temperature requirements here, based on Mr. Seawright's testimony, right here a mixing ration of about .1 hot water to 90 percent cold water will achieve his minimum temperature. But over here, this intersection right here, if we put in too much hot water, about 45 percent, we will indicate -- we will exceed the fluoride concentration. Of course, this assumes that hot water that Mr. Seawright generates above the 85 C line would be allowed to cool so he wouldn't be cooking the fish.

Q. 85 C?

A. Sorry. Just slap me if I do that again. Sorry. Kelvin works. You guys want to work in

Kelvin?

Q. No.

A. Not that one. Go the other way. That one. Okay. So in science you conduct something called the sensitivity analysis. If you make an assumption you say, man, I think it's going to be like this. What if you're wrong? It's always good in science to ask what if you're wrong?

Well, what happens if we increase the fluoride concentration 50 percent in State Well 1 or 2 and mix we with it with the AC cold well? Sure, it reduces the mixing options. We are still right here. .1. We can do that one always, but right over here in this crossover area is where it starts to end up with less mixing options and you end up with about 27.5 percent hot water is going to be about the most he will be able to use if the fluoride concentration was somehow to increase 50 percent over the level which it's maintained for thousands of years now. Next slide.

MR. LAKINS: I'm going to object to this entire line of testimony at the moment. This was not disclosed to us in the prehearing statement. None of these slides which are being discussed right now were disclosed as exhibits but were obviously

prepared well ahead of time and reviewed and none of this was disclosed as anticipated testimony and none of these were provided to us ahead of time. We are highly prejudiced and even being able to respond to this testimony that's being given on a very lengthy presentation.

MS HENRIE: Mr. Chairman, once again, we had no idea what the hearing was going to be about because AmeriCulture didn't tell us until it filed a prehearing statement which was the same day our exhibits were due. So we have had to try to respond to the arguments, 13 pages of arguments that are AmeriCulture's prehearing statement. So I have a hard time knowing how we could have responded when we didn't even know what the argument was going to be.

MR. BRANCARD: Can you explain the relevance of the testimony right now?

MS HENRIE: Absolutely. As soon as I can find my pleadings. In AmeriCulture's prehearing statement it argues about certain changes that have happened to Well A444, which is the federal well, and it suggests that those changes were caused by Lightning Dock Geothermal. It also suggests that changes are going to happen to State Well 1, which

is the current production well, or State Well 2, which is in the same place or the same area as the current production well that will cause AmeriCulture to not be able to function as it currently does as a fish farm.

Those are very serious allegations, that we will be driving them out of business and as proposed injections will be driving them out of business or that the current state of the power plant, the current injections happening are, in fact, causing water quality changes or water temperature changes that will drive AmeriCulture out of business.

I am trying to show that that is not going to happen because I think those are very wavy allegations. We think there's not a way in the world that they could, in fact, be true.

MR. LAKINS: June 20th protest. June 20th included the statement "owing partially to the potential for endangerment of the original geothermal resource, underground water supplies and businesses that rely upon the original geothermal resource." They were in notice in June.

MS HENRIE: Of what?

MR. LAKINS: Of 2015. June of 2015. This

all goes to impact on business and we were not provided any of this ahead of time. The only one that can rebut this is Mr. Seawright. He hasn't even been given it and seen it until this moment to even have a chance to evaluate it to rebut it. It's highly prejudicial to us.

MR. BALCH: Can you explain better to us the progression of events? You are saying June 20th, she is saying September 3rd. When were each party aware of what the other party was going to present? That's a very general statement.

MR. LAKINS: This was prepared well ahead of time. We haven't been given this. We are just prejudiced even being able to rebut this. It was not disclosed in the anticipated testimony.

MR. BALCH: It sounds like they didn't know what was going to be presented by you until the last day.

MS HENRIE: May I go through the --

MR. LAKINS: All it says for Mr. Miller is he may testify as an expert witness hydrogeochemist. That's it. This goes way beyond that.

MR. BALCH: This is hydrogeochemistry.

MR. LAKINS: The impact on our wells and the use of our wells, how we use our wells, the

information that he had from a visit that would have been done several years ago, they had all this information long before the prehearing statement and that's all they talked about.

MS HENRIE: Mr. Chairman, if I could go through the chronology. The applications were filed in June and July. The applications for injection. AmeriCulture responded with a protest letter June 26th that included that very broad statement of harm to businesses in the area not articulating what that harm was.

On July 1st there was an order granting the application setting the hearing and there was also a procedural order after that. According to the procedural order, AmeriCulture needed to file a proper application for hearing that met the regulatory requirements. AmeriCulture did that on August 12th, but that application for hearing states absolutely no reason why to hold a hearing. The hearing had already been set so they got away with that. But as of that point in time, August 12th when the application for hearing was filed, still the only reason we knew of for their objection and for the hearing was that very broad statement of harm to businesses in the area that rely on the

resource.

It wasn't until -- the prehearing statements were filed on November 3rd, so that's the same day -- September 3rd -- that you had to disclose your witnesses and your exhibits in accordance with the procedural order and what the procedural order told us to do. That was when AmeriCulture for the first time revealed in 13 pages of argument exactly what it was worried about and that's the first time that we got to understand what the harm to the businesses in the area meant.

This is Mr. Seawright's own testimony from 2013. We feel like they should have made this analysis before making this allegation about us and so we got late notice of what they thought the problem was and we did our best to address why we think it's not a problem.

CHAIRMAN CATANACH: Mr. Lakins, this doesn't appear to be an overly complex calculation here. It seems very simple. You will have the opportunity, albeit a brief opportunity, during lunch to review this material and if you so desire you can rebut it on direct. So I think it's relevant to the proceeding and I think we need to hear it.

MR. BRANCARD: Let me just make a point here, though. I think Lightning Dock keeps referring to having to respond to their allegations. In fact, you're the applicant in this case so you have to put on a case that meets the standards of the geothermal regulations including the injection rule you presented as Exhibit 8 in your statement which says that you have to show that you're going to prevent waste, you're going to protect correlative rights, there will be no danger to any natural resource including geothermal resources, underground water supplies. That's your burden in the application, okay? You are presenting your application.

MS HENRIE: I wholly agree.

MR. BRANCARD: I am concerned that there are exhibits here that you're submitting that were not -- you had a burden to file the exhibits that you are not submitting. That is a problem, and I think to the extent that we allow these exhibits to be admitted, I think Mr. Lakins and his client should have some opportunity to review these and respond to these at some point. So that's my concern. But you have the burden not to respond to their allegations but to prove that this well can

meet the standards of the state regulation, and those are pretty broad standards what you have to show.

MS HENRIE: I agree, Mr. Brancard. The problem that we have had in the way this unfolded is we have to make our case first. And we're trying to defend from something that we think they are going to say based on the prehearing statement. If I don't give it all to you now, I'm not sure that I will have the opportunity.

MR. BRANCARD: Yes, but you do have the ability to have rebuttal witnesses. If something comes up in their testimony that you were not anticipating, you can request to have a rebuttal witness. This material can be presented in rebuttal. That's another way to look at this.

But you also have the burden to meet the requirements under the rule for a permit to be granted and that's pretty broad as to what you need to show here.

MS HENRIE: Okay. What would you like me to do?

MR. BRANCARD: Go forward.

CHAIRMAN CATANACH: Let's go forward.

MR. LAKINS: We just want to ensure that

prior to breaking for lunch we are provided with every exhibit that is discussed.

MR. BRANCARD: And any more that you may have.

MR. LAKINS: Thank you, yes.

MS HENRIE: It's clear we weren't planning to submit this as an exhibit. We were planning to use it to help articulate to the commissioners and explain what Greg is saying. That was the intended purpose of this.

MR. BRANCARD: But even as a demonstrative exhibit -- we were joking this morning that we wished counsel had all participated in the 9:00 o'clock hearing. It was brief and dealt with injection wells and the PowerPoint presentations were presubmitted as exhibits so the commissioners were well versed in advance about what they were going to see. I mean, I'm concerned with Mr. Lakins' clients but I'm more concerned about the commissioners not having the information in advance, too, because they have to make the decision.

MS HENRIE: Perhaps before lunch we could use the computer --

MR. BRANCARD: Whatever you want to arrange.

MR. LAKINS: That would be satisfactory.

CHAIRMAN CATANACH: Let's move forward then.

MS HENRIE: I forgot where we were. We were talking about sort of the windows of where harm might occur.

CHAIRMAN CATANACH: Do you have much further direct?

MS HENRIE: Fifteen or 20 minutes.

MR. BALCH: And more slides presumably.

MS HENRIE: Yes. Do you want to break?

CHAIRMAN CATANACH: Yes. Why don't we break for lunch and get the documents to everybody now.

(Note: The hearing stood in recess at 12:22 to 1:47.)

CHAIRMAN CATANACH: We will call the hearing back to order. At this time just a couple of announcements. It's obvious we are not going to finish the case today, so you might want to start checking your calendars to see your availability for future extra day. Also we probably -- if we can get to a good place to stop we probably don't want to go past 5:00 today, but we will see how that goes. We can probably break at 5:00, but hopefully we will be

in a place where it will be a good place to stop. With that, I turn it back over to you.

MS HENRIE: Mr. Chairman, I'm happy to try to set a schedule for today and figure out when we can meet next week if you would like to do that first.

MR. BALCH: Next week is completely out. Mr. Brancard is out and we are looking at the 21st.

MR. LAKINS: I have a federal court mandatory settlement conference on the 21st.

MR. BALCH: After that, we are looking at the 1st and 2nd of October.

MS HENRIE: I'm going to get an earful tonight.

MR. BALCH: I'm sorry, the 1st, not the 2nd.

MS HENRIE: The 1st works for me.

MR. LAKINS: I don't think I have anything. I need to call my office to verify but I think that would work for me.

CHAIRMAN CATANACH: Well, do you think one more day is going to be enough?

MR. LAKINS: Yes, sir.

CHAIRMAN CATANACH: Okay. If you can verify that, I think the 1st would probably be the

logical choice here.

MR. LAKINS: At our next break I will do that.

MS HENRIE: Mr. Chairman, with that, we have Greg Miller still on the stand and he was explaining the charts that are now in front of you. So we will let him continue.

A. Mr. Chairman of the Board, returning from where we were before, this was based upon testimony given by Mr. Seawright regarding the temperature and the fluoride range in which he can conduct operations.

One of the other wells that was mentioned in that testimony that could be used for operations was known as -- I refer to it by the state well number as A444. Sometimes I will say A4444 or only two 4s, but I'm referring to A444. This well is quite a bit cooler. As reported by Mr. Seawright, it has a temperature of 110 to 111 degrees and also has a low fluoride concentration of 5.6 milligrams per liter. The graphics of the same fluoride is on the right, temperature in degrees Fahrenheit is on the left, and the fraction of the water from the hot well is what's on the bottom axis.

The equation that I showed before still

applies here. It's a simple linear mixing equation. So we can see that the amount of A44 that can be used could be 100 percent based on its fluoride level. Based upon temperature level, you wouldn't be able to import cold water into the basin and mix with it at greater than 35 percent. Otherwise, the water would be too cold.

Next slide. On this one I also did a hypothetical, a sensitivity analysis on the basis of fluoride. And so what would happen if the fluoride level in A444 had 4.6 milligrams per liter added to it? If A444 returned to the condition that it was reported -- the waters were reported to be at in the past history.

What happens there is, of course, with the higher fluoride concentration, the mix ratio applies here and you can only put in 55 percent, .55 of the hot water, and with the temperature consideration here it's still at about 35 percent. So the window narrows, but what I've tried to present here is even given upset conditions in fluoride, even given differences in temperature between the A444 and the state wells of about 120 degrees Fahrenheit, there's still mix ratios available to AmeriCulture to produce water that Mr. Seawright testified meets

certain criteria. So on the basis of this, there are opportunities to mix given the existing situation and opportunities to mix given upset conditions which we actually don't believe will take place.

Q. Thank you, Dr. Miller. Moving to the next set of slides, the question for you would be have you reviewed Mr. Witcher's report from 2001 describing a well test of AmeriCulture State Well 1?

A. Yes, I have reviewed that document. When I came across Elston and Deal, when I was looking at fluoride concentrations, there's a theory for the occurrence of the geothermal system that is presented in Elston and Deal. Mr. Witcher in 2001 has published a competing theory regarding some aspects of the Elston and Deal hypothesis.

So what I want to do is present, just in a cartoon-like manner, my interpretation of these hypotheses so we can see what we're talking about here. We're going to run through these here.

Ground surface is in brown. This is not to scale. It is generally agreed on that there is a confined geothermal aquifer. There is some sort of a window, most probably created by intersecting tectonic features creating a large volume of

fractured rock with fractures that may well extend deep into this geohydrologic window. And we have wells that are sampling water and trying to produce and use water that are upflowing out of this geothermal window.

The giant white space represents both fractured bedrock and the alluvial fill aquifer. I just left it open and undifferentiated to try to keep it simple here. So we have some sort of flow coming towards the geohydrologic window and there's upflow out of this window.

Now, from a hydrologic perspective it's very interesting what conditions we need to actually cause this upflow. In hydrology and in nature we measure fluid flow, rock's ability to transmit fluid using a parameter called hydraulic conductivity. Hydraulic conductivity has units of velocity. In nature we find 13 orders of magnitude of variation in hydraulic conductivity between very tight clays and, say, big talus slopes out of old mountains full of boulders. So there's 13 orders of magnitude observed in nature.

To divert 81 percent of the flow out of the confined geothermal aquifer upwards in that window requires one order of magnitude hydraulic

conductivity difference, one out of ten to the 13th or an order of hydraulic conductivity difference will cause 81 percent of the flow to flow up. That is aside from any considerations of buoyancy due to heat because this water is rising because it's less dense than the water surrounding it. Heat is making it less dense.

If it was rising, if it was a bubble of fresh water in an ocean of salt water it would also rise because it was less dense.

Next slide. So as I understand it, from Witcher 2001, the hypothesis is that the confined geothermal aquifer has a reservoir temperature that is equal to the temperature of the hottest wells that we sampled in the Lightning Dock Geothermal Resource. This water moves up and convects out into the plume and there's relatively little mixing that takes place in that upflowing and outflow plume.

Next slide. We know that when water rises upward it is creating, in essence, a pressure vacuum underneath it. We know that shattered fractured rock systems are not shattered with perfectly vertical fractures. There are anaphoretic fractures all through this system.

At some point we get to the point where

the fractured rock looks like boulders and this is why it's called representative porous media. The basin fill aquifer system and the fractured bedrock next to it, not underneath it, is acting as an unconfined system. In an unconfined system, there aren't any barriers for cold water flowing in from the outside not to mix with this water rising up. In fact, it's a physical impossibility in a porous system for water not to enter from the sides as this water rises up.

But as I interpret the hypothesis from Mr. Witcher and from the diagram that I have seen in Exhibit 5, there is a complete pipe from the geohydrologic window to some point in the aquifer system, and only above that point does the plume spread and mix.

I would suggest that that doesn't take into account the same hydrologic conditions that are supposed to cause this system to be here. If we have highly fractured rock we have representative porous media. If we have representative porous media it will be mixing from the outflow zone to the surface. It's a fractile process. Little mixing happening will be happening all the way along the way.

Next side. This is a hypothesis of my interpretation that we see that Elston, Deal and Logsdon have put forward. There is a geohydrologic window caused by the intersection of tectonic features. It created a lot of shattered rock. Using geothermometry and other chemical techniques -- I have explained to you before that I have some proficiency in and that are explained very clearly in Elston, Deal and Logsdon, they have evidence that the confined geothermal aquifer actually has a much higher temperature than is observed in the Lightning Dock well field.

This makes sense from the perspective that if you consider that as soon as water is exiting the hydrogeologic window it's subject to mixing, and it's subject to mixing because otherwise it has to violate the laws of physics. You can't rise that water without pulling water in from the other sides. It's simply impossible.

So Elston, Deal and Logsdon say that confined geothermal aquifer is providing water that's 250 degrees Celsius and that only 25 percent of that water is actually reaching the currently tapped portion of the Lightning Dock Geothermal field because 75 percent of the lower basin flow

aquifer is mixing with it.

Now, part of the evidence that they have for this is chemical in nature, but one of the things that is also a major contrast between Witcher 2001 and Elston, Deal and Logsdon is the size of this geothermal system. That's a point that is extremely important in this proceedings. So what I would like to refer the board to first is Figure 9.

Q. Which exhibit?

A. Page 24 of Circular 177.

Q. That's Exhibit 4?

A. Exhibit 4. Thank you.

Q. No, it's Exhibit 6?

A. Exhibit 6. I stand corrected.

Q. Which page, please?

A. 24, please. Figure 9. Are we there? In Exhibit 5 of AmeriCulture's exhibits Mr. Witcher presents that the outflow zone for the geothermal system for consideration for heat flow and other considerations is approximately one kilometer in dimension.

First looking at Figure 24, we notice this southwestern trending anomalous temperature. Elston, Deal and Logsdon explain this southwest trending anomalous feature as being due to some sort

of structural control letting this leaky geothermal aquifer -- because that's what it is, it's a leaky confined aquifer -- well, it's leaky somewhere else, too, and they see evidence to the southwest of this.

If we refer to -- flipping to Page 31 of the same exhibit -- Figure 17 first on the right, Elston, Deal and Logsdon have used a total of nine geothermometers to calculate an estimated best bottom hole temperature, provided citations and their data for all of their calculations, what thermodynamics were used. They presented their calculations and this map. And what we're seeing here off to the southwest is these bottom hole temperatures of 55, 70, 80, 71.

It's their hypothesis that this leaky geothermal aquifer leaks in more places than just the Lightning Dock system, which means that the heat outflow signature of this is much larger than we will see portrayed in Witcher 2001 and in his testimony today.

We use stable isotopes, particularly oxygen, to look at subsurface processes. One of the things that heavy oxygen suggests is that boiling is taking place in the subsurface. So in Figure 16 Elston, Deal and Logsdon contour the Delta 18-0

values for their P series wells and we see this high negative center.

So they are saying that we are seeing additional signs of the geothermal system and the size of it from the stable isotopes. They also use that in part of their determination that the geothermal reservoir is a much higher temperature than reportedly calculated by Witcher in 2001.

Next slide. This is a slide that tabulates the stable isotope measurements that I have been able to obtain from materials that have been submitted to OCD. Elston, Deal and Logsdon didn't just make a prediction regarding the deep temperature of 250 degrees C, they also made a prediction regarding what we should expect to see in the deuterium hydrogen ratio and the 18-0/16-0 ratio, heavy oxygen in the deep aquifer of minus 97 and minus 13. They predicted we would find that if their theory worked.

Lo and behold, we drill deeper in 55-7, we sample stable isotopes and we find stable isotope numbers trending in exactly the direction as predicted by Elston, Deal and Logsdon.

In my review of Witcher 2001, it is my considered professional opinion that the level of

that document does not rise to the level of overturning the hypothesis of Elston, Deal and Logsdon. It does not present its calculations which purports to overturn the hypothesis of Elston, Deal and Logsdon. I found no evidence in Mr. Witcher's reporting that would cause me to feel that downhole temperatures of the downhole reservoir temperature predicted of 250 degrees Celsius is inaccurate.

I looked at other people publishing on this deal looking at geothermometer calculated levels, and Shandler Smith in 1978 published his own calculations of temperatures that he expected to find in geothermal reservoirs all over the Southwestern New Mexico/Arizona area, and his numbers agree with Elston, Deal and Logsdon.

So again, I can't emphasize enough that Elston, Deal and Logsdon is still the order of the day. There has not been the scientific effort published or presented by Mr. Witcher to overturn the aspects of Elston, Deal and Logsdon which lead others, such as Cyrq, to believe that this geothermal reservoir is much larger in size than represented by Mr. Witcher.

Q. So Dr. Miller, two more questions really for you. One now that Commissioner Shannon is here.

Do you believe that either the Lightning Dock project or the proposed injection wells would harm Commissioner Shannon's well, just for example? Someone else's well in the valley?

A. No, I do not believe it will. The valley aquifer in the region of the Lightning Dock project and AmeriCulture project is in the middle of a large plume of fluoride contamination, fluoride levels exceeding all New Mexico drinking water standards, all federal drinking water standards. I would not characterize the aquifer in the area of Lightning Dock as being suitable for human consumption. In my professional opinion, it is not a drinking water aquifer any more than pouring toxic chemicals in a drinking water glass makes that drinking water.

So what I would hope in the future is that there is some public communication of this to the residents so that they can act appropriately if indeed their water has problems. This represents a public health problem, in my opinion, and I was formally certified as a Water Treatment Operator Level 3 for the state of New Mexico. I operated treatment systems that protected public health. I was on the board of the Buckman Diversion Evaluation evaluating whether or not Los Alamos presents a

radiologic threat to this community's water. I speak firmly and forcefully on this that I hope you take the information that's existed for a long time and make sure it gets to the public so they can make their decisions.

Q. Dr. Miller, will you explain the slide and we definitely want to hear the questions of the commissioner.

A. What I did to produce the slide was I hand-contoured the information presented in this publication, Circular 177, Ms. Dar, from 1983. This was some efforts by scientists to characterize the water quality in and around the Lightning Dock Geothermal System.

When I contoured the information that they supplied me, what I did is the outside contour around the pink area, that represents areas that are above about 2 PPM fluoride, and at 2 PPM our national and state health agencies become concerned about dental fluorosis.

The inside contour that's plotted there that emanates right from the Lightning Dock geothermal area, that indicates an area of fluoride above 4 PPM, and 4 PPM is the level recognized by health agencies as potential for causing skeletal

fluorosis and represents the U.S. EPA maximum MCL for fluoride in the United States.

So that water, in my professional opinion, should not be used for drinking, and while we can refer to it as a drinking water aquifer, truly it's not in the area where the fluoride contamination exists.

Now, this is naturally occurring. It's been happening for thousands of years. That's why it's developed so much. But one of the things folks have thought about in the Animus Valley for so long is the geothermal influence is only up there near Lightning Dock. But if you look at the fluoride plume going down through Cotton City and the numbers associated with that, Elston, Deal and Logsdon have attributed that to leakage coming up out of this confined geothermal aquifer. They say it's much bigger.

Here we have the fluoride evidence from the geothermal aquifer and it's rendered that water undrinkable, in my professional opinion.

I am, in this circumstance, on any mechanism of questioning that the board would consider, I am completely happy with, if Ms. Dar has any questions whatsoever. I realize this is

disturbing information for her.

MS HENRIE: Mr. Chairman, let me move forward. We did want to alert the commissioner to what Dr. Miller has found and we will probably have further communications about it and questions after we rest. We will work on that.

Q. The other thing I wanted to ask Dr. Miller is about Well A444, which you have talked about previously. Can you show the commissioners on the aerial where that well is located?

A. Right about there is where I have seen it plotted as existing. Boy, my shakes are worse than anybody here. Where it's plotted by Mr. Seawright, where I see it plotted on various well applications. So it exists down in the southwestern corner of the box. Right about there.

Q. Okay. And you mentioned earlier to the commission that the well is unusual. It's right in the middle of your pink fluoride zone but it doesn't act like any other well is what I heard you say?

A. It's anomalous. Anomalous means something outside of what we expected to see. If I was looking at that fluoride map that I just showed you from Elston, Deal and Logsdon, I don't expect to find 5.6 milligrams per liter fluoride in the middle

of an upflow zone that we know runs 10 to 15 milligrams per liter fluoride. Something is changing something. Something is happening to make things different.

So we try to take a look at multiple ways on what could be making this different. Is this area blocked from upflow? When we look at its historic records, there's temperatures reported for this well in the record of 198 to 215 degrees C but now it's 110 to 111.

I look at water discharge, I look at data on importation of cold water, low fluoride water just as I did with the mixing diagrams into this valley. I look at the discharge, the pumping records for the hot wells that supply that facility that suggest 10 to 20 acre feet per month is being pumped, the cold wells that supply that facility that suggest 100 to 175 acre feet per month are being pumped.

Q. Per month or per year?

A. I have to look at the record to tell you for sure. I think those are monthly records that are seeing that. No, that's the annual total. Please put the record in front of me. Thank you. I don't want to misstate because this is the state

well records. I believe these have been submitted.

Q. I don't.

A. Okay. They contain a summary table.

MR. LAKINS: Where are we looking?

A. I misspoke. Yeah, it's on the order of 10 --

MR. LAKINS: What are we looking at? Is that an exhibit?

MS HENRIE: No, it's not. I'm refreshing his memory as to things that he's looked at before.

A. I misspoke. That is per year.

MR. LAKINS: Could I look at that?

MS HENRIE: Sure.

A. So I looked at these records and then I did kind of a seat-of-the-pants calculation. I assumed a porosity for valley fill aquifer, took an area a little bigger than the giant green area you see right there of 100 feet by 1,000 feet. It's 60 feet to the water table there. If you calculate how much saturated porosity is there, it's about 17 million gallons or about 50 acre feet.

Sure, some of it will spread laterally. It's unsaturated zone, hydrology will move that water laterally. But what it tells me is that from the operation of this well in its inception, when

Beall was running it they pumped water into the greenhouse and they pumped it on the ground. They imported cold water in the valley and they pumped it on the ground.

Q. That was prior to AmeriCulture?

A. Prior to AmeriCulture. They have imported cold water to the valley, mixed it with hot water and discharged it behind the facility. This water, by simple calculation, it's very easy to see the 50 acre feet of water can communicate directly from the ground to the water table to 60 feet. We have the prior reports of Roger Bowers indicating that he believed from a thermal perspective there was a casing problem with that well.

I have a theory. My theory is within a reasonable degree of scientific certainty that the reason that low fluoride exists at Well A444 is because it has been diluted by groundwater discharge from AmeriCulture operations. My hypothesis as to why that well has declined in temperature to 110 or 111 degrees is because AmeriCulture has quenched the geothermal resource of well A444 by discharging cold water directly to the geothermal aquifer by a Class 5 injection well, which is an aerial groundwater discharge. So next slide unless you have a

question.

Q. I do have a question. Do you know -- can you just talk about the temperatures of the water when it comes from the ground, the cold or the hot well, the blend when it goes into AmeriCulture's fish tanks and what the effluent -- the temperature of the effluent when it goes on the ground.

A. Based upon testimony and observations, they're blending water about 60 to 70 degrees Fahrenheit -- which I would have to refer to my sampling records to make sure I have the exact temperature number -- with water that's about 200, 230 degrees Fahrenheit. So this water is tempered. There's some cooling that's allowed to take place to the geothermal water before it's mixed volumetrically by two outflow pipes.

This water, according to Mr. Seawright's testimony, needs to be 85 degrees for certain processes, down to 75 degrees for other processes and at some point is discharged. So based upon that, I would assume that the discharge temperature of water from AmeriCulture is 75 degrees or less because it no longer has thermal value for him for aquaculture. And the fluoride concentration of that water will be whatever the proportional blend is, as

I demonstrated with that linear equation, between the blend between his cold water that he is introducing and the hot water that he is using.

Based upon review the records, it's just about ten to one, the cold water that is imported versus the hot water that's used based upon the pumping records that I reviewed from Office of the State Engineer. And that's been reasonably consistent over the history of those pumping records.

So again, to restate, it is my professional opinion within a reasonable degree of scientific certainty that the results that we see for fluoride, low fluoride concentrations in a sea of high fluoride and low water temperatures in a sea of hot water are related to discharge of low fluoride cold water to a groundwater infiltration area that exists west of AmeriCulture.

Q. Please talk about two things. The original temperatures of A444 and the current temperatures --

A. Oh, we brought up a slide. Thank you.

Q. And also the casing of the well. I think you went through those, but let's just really get those numbers in front of people.

A. First, I can't report upon the casing of the well specifically itself. I have not evaluated that well structure completion myself. I can say that the data observed of a casing problem would only exacerbate a cold water temperature problem, because if you have a defective casing and you pond surface water around it, it runs down the casing very quickly to the aquifer. You have created a pipeline. Second question.

Q. Original temperature as we know it of A444.

A. I listed it here. In reviewing testimony and published documents, we have a reported temperatures for Well A444 back in the mid 1970s of 198 degrees Fahrenheit. There were two reports of 215 degrees Fahrenheit also in the '80s that shows those red diamonds. And I call those red diamonds out for a reason because they are a little bit different than the other trend I observed.

We get self-reporting -- I forget the exact number source of the data, but again, from document review and materials previously submitted to OCD, right around 1996/1997, that area, we start to see some indications of temperature decline. And then finally we have self-reporting from

AmeriCulture that they measured well temperatures of 110 or 111 degrees as reported in 2013. I plotted a linear plot on this, and again, that horizontal red line represents the 85 degrees Fahrenheit, the point at which that well is no longer useful to AmeriCulture, apparently, from testimony.

The yellow slope is through the green boxes. Those are the self-reported temperatures, and that indicates that AmeriCulture runs out of hot water sometime after 2018. The red slope is based upon the report of temperatures, and I forgot what the lower red diamond -- I think that might have been a state office that recorded that one. But needless to say, I plotted the slope of the alternate situation which says that we can go out there today and measure that that well is under 100 degrees.

So again, to reiterate my theory, using evidence that is presented to me by AmeriCulture itself telling me what the concentrations and temperatures are of the well, to me it's an inescapable conclusion that the probable source of this temperature decline and fluoride decrease is quenching a dilution.

Q. Dr. Miller, have you looked at isotopes to

A444, would they support the cold water discharge that you are theorizing?

A. I think all kinds of geochemical data from A444 would have been very useful to use in this work. I know that AmeriCulture has refused offers in the past from Cyrq to perform sampling on this. I think we have in Witcher 2001 requirements that we should be monitoring everything everywhere, and I believe my client has made efforts to do so and has been stymied.

MR. LAKINS: Objection, characterization.

Q. That's fine. We will stop with the characterization. Another question, Dr. Miller. Would the long-standing open discharge to the surface drainage of hot fluoride-rich geothermal waters by Rosette and more recently cold by AmeriCulture, would that have perhaps exacerbated the fluoride plume? How would that play into the situation? Do you know where the Rosette discharge is?

A. I know where the Rosette discharge is, and it's here. Based upon the data density, peripheral to the edge of the plume here, I don't think we actually have many samples out in this area for which to say what the pre-existing 1983 conditions

were in that. But however, on a mass balance basis, if you are removing water that's 10 to 15 PPM fluoride and you're allowing it to flash and evaporate, it concentrates the fluoride in the liquid phase. Additional evaporation is going to take place on land surface.

Now, there will be some attenuation of fluoride as fluoride migrates through the soil column. Fluoride's a very strong chemical. It's going to bind to the soils and pop off other elements, too, so we might be able to see evidence of that displacement of other elements off the soils by the fluoride if the fluoride itself doesn't show up. But I believe that given the volumes of discharge that have been reported and I have read about, the length of the history of operation, transferring this high fluoride concentration, I believe if we looked, we would find it.

So yes. Discharge of high fluoride waters outside of the high fluoride zone expands the high fluoride zone.

Q. Thank you. With that I'm going to just quickly ask Dr. Miller if you have anything else you want to say to the commission and then I will pass the witness.

A. It's my professional opinion that based upon review of Witcher 2001, which is a narrative of a failed pumping test and an analysis of that pumping test that has been conducted outside the science of hydrology, the review of his geochemistry, I believe that the report should not be relied upon. I believe that Elston, Deal and Logsdon is still the order of the day as amended by studies that have been completed behind it that have collected data, presented interpretations. I conclude.

Q. Thank you. With that I will pass the witness, Mr. Chairman.

MS. MARKS: The commissioner would like to ask questions at some point if that's okay, if no one has objections. She had some questions during the witness' testimony and I know her attorney is not here, so if that's okay with the commissioners?

CHAIRMAN CATANACH: That would be fine. At what point does she want to ask the questions?

MS. CARR: Whenever it's my turn.

CHAIRMAN CATANACH: We will let Mr. Lakins go first.

CROSS-EXAMINATION

BY MR. LAKINS

Q. Mr. Miller, I want to make sure I understand a few things you said. I understand your last testimony that you're stating that the surface discharge of high fluoride water in this area expanded a high fluoride zone?

A. I offered that it had the potential to. I qualified that on the basis that reactions will take place removing fluoride from that, but I do believe that the volume of discharge and the period of discharge were, again, long enough that that high fluoride water could communicate with the water table. Based upon the Elston, Deal and Logsdon sampling, that area is not 10 to 15. It's something less.

Q. Okay. Let me ask you your opinion. If you discharge high fluoride water directly into the proposed injection wells, water that is of a higher fluoride content than the existing background, will that result in an increase in the fluoride levels in those wells? In the shallow aquifer where those wells are located, I should say?

A. If you're injecting fluoride that's higher in concentration than the zone of fluoride you're injecting to, yes, it's going to increase concentration there.

Q. Now, you yourself have not prepared any sort of written report, analysis, paper subject to peer review or anything of that nature yourself concerning the Lightning Dock Geothermal area, right?

A. No, I have not.

Q. And your theory that you say about AmeriCulture's wells and the lower fluoride in one of the wells, you haven't prepared by modeling for that to present to us today, have you?

A. I did present the results of the -- really a back-of-the-envelope numerical calculation you can do involving pore space and compared it with the amount of water that's been imported and discharged there. And to me it's an inescapable conclusion that water reached the water table.

Q. Again, you don't have a piece of paper, a model or computer program that you put together or any sort of mathematical data or statistical analysis or anything for us to look at from where your data came from, your theories and your ultimate result, do you?

A. My data came from your client's testimony. The theory I'm using is called Darcy's Law. It's expressed as Q equals KIA. Where Q is discharged, K

is the hydraulic conductivity, I is the hydraulic gradient and A is the area. Using that relationship and a porosity of 30, 40 percent for valley fill sediments, the known depth of water is 60 feet, we can calculate that the water-saturated porosity that would be required to reach the water table -- and that water-saturated porosity is less than the amount of water discharged by your client. I really don't see the need for a numerical model for that analysis.

Q. Did you check with any of the local water districts, for instance the City of Cotton, regarding how bad the water quality is?

A. I looked up the public records for the City of Lordsburg which has a multi-million dollar fluoride treatment plant. Most recent notice of violation is in 2013 for failure to operate it properly. But no, I didn't bother checking with the water districts. I did look online to see if I could find any CCD, consumer confidence reports for any utility within Hidalgo County, and the only one I found was Lordsburg.

So to me, based upon initial review of information, I wasn't finding groundwater information from any other water districts so that

information would not be of utility to me.

Q. Well, you have essentially alarmed Commissioner Shannon by your statements that the water in that area is a health hazard. How long have you known that?

A. I have known that since 2013 when I presented a report of that effect to the County Commissioner Ben Kerr. I advised the Hidalgo soil and water conservation district of that when I appeared at their meeting in June of 2013. This problem and the evidence for it has been known since the '40s. It's not incumbent upon me, a latecomer, in 2013 to be providing notice on this.

Q. In your investigation did you uncover any information whatsoever about any person having consumed the water in the Animus Basin having developed any serious medical problem?

A. I did not nor was I tasked to investigate that.

Q. Let me see if I can understand what your testimony is about drinking water standards, all right? What I understand your testimony to be is that since the water in the area already exceeds drinking water standards at a fluoride level, you cannot contaminate it? Is that --

A. On the pure sense of strict to the definition of contamination, yes. You can't contaminate contaminated water. You can make it more contaminated, you can add a new contaminant, but once it's non-potable, it's non-potable.

Q. If you added -- I think you already said this. I want to make sure. If you added water with a higher fluoride content into water that -- scratch that question.

Increasing the -- is it your opinion then that just increasing the fluoride level in the water by injecting a higher content fluoride level would make no difference?

A. Functionally, it will make no difference. The effects of that will be non-detectable outside of the main geothermal area. Within the geothermal area, as I read what's proposed by Lightning Dock, they are indeed going to alter the distribution of fluoride within this geothermal area. They will be injecting water in zones that had lower fluoride concentrations. They will be injecting water of lower fluoride concentrations in some zones that have higher. Ultimately, they will create a mix. But there's a technical focus here which is kind of a redirect which I think presents a better picture

of the situation, and that's mass balance.

The operation of the geothermal system is not going to alter the mass balance of fluoride in this system. 100 percent of the fluoride in this system, within a reasonable certainty, is contributed by the geothermal source. What we're doing is taking the upper portion of the geothermal source and creating mixing lines, mixing lines that don't currently exist.

The other mixing that's taking place in the system will continue to go on. The geothermal flow out of this system will continue to go on. We will create a to hydrologic cell of mixing to extract heat.

In that zone the fluoride concentrations are going to change. Will the ultimate mass of fluoride in the Animus Valley system change ever as a result of this closed loop operation? No.

Q. Are you familiar with New Mexico's drinking water water quality standards?

A. I have reviewed the tables. I have seen them. I can't recall them from memory.

Q. Is your testimony here today, based upon your understanding of New Mexico's water quality standards?

A. With respect to fluoride, yes.
Q. How about total dissolved solids?
A. I'm not testifying with respect to total dissolved solids.
Q. Only fluoride?
A. I'm testifying with respect to fluoride today here now.
Q. Are you testifying regarding any other aspect of water quality standards whatsoever?
A. In the ProUCL statistical calculations which I performed for Lightning Dock to calculate background threshold values and that, I was tasked to calculate for different parameters other than fluoride. If that material is introduced and I'm asked to testify about it, I will be testifying about other parameters than fluoride.
Q. Let me have you turn to our Exhibit P.
A. I'm there.
Q. Were you involved in the gathering of data or the analysis of any of the data that went into this background concentration report?
A. I performed the calculations on data provided to me to calculate background threshold levels.
Q. Okay. And I would like to draw your

attention towards the back. This is not numbered, so I would say about ten pages to the back. First page that looks like this one.

A. Okay.

Q. There's a number of chart tables.

A. Yes.

Q. And this page past it.

A. Is that in the 2014? I'm not finding it.

Q. It's not Exhibit P, it's towards the back, last 10 or 15 pages.

A. In this particular copy, I am in Attachment D.

Q. Go to the back of the exhibit itself, the back of the whole P. Then go in from the back about ten pages.

A. Very good. I found it. I'm there now. I want to make sure I am on the same page as you.

Q. The first page that looks like this that follows a table that ends in this.

A. Yes. Appendix C of July 14 ProUCL results?

Q. I'm waiting for the commissioners. Top of the page, General Background Statistics for Dataset. Do you know exactly how many samples were drawn for this background value? Do you know how many samples

were drawn to evaluate and determine the background threshold value?

A. I believe I looked at the entire available dataset in 2014 that was in the possession of Cyrq at the time.

Q. Down towards the bottom -- or excuse me, one-third of the way up from the bottom, there's a sentence that starts with "Warning. The sample size of N equals 7 may not be adequate enough to compute meaningful and reliable test statistics and estimates." Do you agree with that?

A. Yes, right down to the exclamation point at the end of the sentence.

Q. Down farther it says, "Warning. There are only seven values in this data. It should be noted that even though bootstrap methods may be performed on this dataset, the resulting calculations may not be reliable enough to draw conclusions." Do you agree with that?

A. Yes, I do.

Q. Turning to the next page, at the bottom it says there are only four distinct values in that dataset and that dataset, resulting calculations may also not be reliable enough to draw conclusions. True?

A. I agree with that.
Q. And two pages following, in the middle of the page it says the same thing, that the resulting calculations may not be reliable enough to draw conclusions. Correct?
A. Correct.
Q. And the following page at the bottom, it says the same thing, doesn't it?
A. Yes, it does.
Q. So the report data that you looked at and were relying upon for background threshold values, the report indicates that that information may not be reliable enough to draw any conclusions, true?
A. True. It suggests the information should be used with caution as of July 2014.
Q. Then I ask you to turn to the front of that exhibit to Page 4. And you're familiar with ProUCL?
A. Yes, sir.
Q. Are you on Page 4?
A. Yes.
Q. The top in bold says "Background Threshold Values." Are you there?
A. Yes.
Q. Third paragraph down?

A. Yep.
Q. The second sentence says, "ProUCL guides suggest at least ten samples are needed to statistically determine the BTV."
A. Yes.
Q. "An insufficient number of samples of alluvial geothermal groundwater was collected by LDG in December 2013," correct?
A. Yes.
Q. Do you agree with that?
A. Yes.
Q. And we're talking about the alluvial area?
A. Yes.
Q. Where the proposed injection is to occur, correct?
A. I haven't evaluated that to whether or not the wells that I used here are specifically reflecting the areas of the proposed injection wells.
Q. Let's get back to the contamination aspect. Now, in your exhibit -- I believe it's 10 -- there it is. Too many binders here. Now, the first page of your Exhibit 10 is a figure, "Annotative Chloride MG 2012." Is this your data that you collected yourself?

A. Yes, it is.
Q. And that's a wide range of fluoride in that area?
A. Yes, it is.
Q. From one to 11-7?
A. Yes, that's correct.
Q. Could you sort of situate me where the heck is the 11-7 taken? And if it's from this map over this exhibit over here, the demonstrative aid here, can you tell me where that is? I'm not sure where this whole area is.
A. Well, during that sampling event -- these are the hot wells, the wells in red. So these are wells within this area.
Q. That's a big area. And on the left you've got UTM north and easterlies, but can you pinpoint where that 11-7 is anywhere on this picture?
A. I would have to refer to my report which contains a UTM location of that well, an identification number for the well and complete chemistry as I sampled and had analyzed for that well. I don't have that information with me.
Q. You don't have it with you?
A. No.
Q. Well, in this data that you have here if

fluoride were injected at a higher rate and made it into any of those wells that were below 2, would that not be a contamination?

A. You're speculating such an occurrence would actually occur.

Q. Yeah, I am, and you're speculating it won't. I'm asking if it were to occur --

A. No, you --

Q. Let me finish the question, please. If it were to occur would that not be a contamination?

A. Which well zone?

Q. Any of these.

A. Name the number. If you would, sir, please name the concentration of the well which you're asking me to inject at.

Q. I'm not asking you to inject anywhere. What I'm asking is if the injection as proposed of higher fluoride water were to make it to that well that's annotated as 1, would that be a contamination based upon your understanding of New Mexico's water quality standards?

A. If the injection caused that well to exceed New Mexico water quality standards, it would have indeed impacted its quality.

Q. How about this well right here that's at

2.1? In your understanding of New Mexico's water quality standards, if fluoride were injected into that well and it increased the fluoride in that well above that 2.1 number, would that be a contamination?

A. As explained before, and this is a difficult point, in the strictest sense that water is already contaminated. So we would not be moving it from a state of non-contamination to contamination by virtue of that injection.

From the standpoint of would that water require additional treatment over a 2.1 water for it to achieve the MCL, because that water is not drinkable right now, yes, there would be additional cost involved with that and possibly technical difficulty.

But again, turning a contaminated water more contaminated is not the same as taking a not contaminated resource and moving it past numerical standards for health and the environment.

Q. Let's flesh out what to you is contaminated.

A. Contaminated is -- contamination in a general term implies that a resource has material in it that is not natural and deleterious to health and

the environment. So strict sense and applicable sense that I always use is the numerical standards set by local regulatory or federal or state agencies for what to define as contamination.

Many years ago a lawyer told me that any time that I said something was contaminated I was practicing law, and 25 years of hydrology has not changed his opinion or mine that I am not. So I use the numerical standards as published. When the standards change, the definition of contamination changes, and many people have grief with that, too. You saw the arsenic standards changed drastically costing millions of dollars in treatment costs for utilities and that. But the number changed. So the new standard is the standard. If the standard changes for fluoride, I would revise my opinion accordingly.

Q. So let me make sure I get a good determination of what your understanding here is. This well that's 2.0 versus the well that's 2.1.

A. 2.0 is the numerical standard. Therefore, it's contaminated. 1.999 is not, and this is a very difficult thing because when you go and you know these analyses are plus or minus X percent, but in a regulatory agency if I go to them with 9.9 parts per

billion arsenic, you are below the drinking water standard. If it's 10.1 you are not. From a realistic standpoint is there a health difference? I can't say, so I use the numerical standard that's published by the government.

Q. Are you familiar with New Mexico Administrative Code, Section 20.6.2.31-03?

A. No.

Q. Would you acknowledge that New Mexico's water quality standards are what control water quality in New Mexico?

A. Yes.

Q. I ask you to draw your attention to the section right here which says, "Regardless of whether there is one contaminant or more than one contaminant present in groundwater, when an existing pH or concentration of any water contaminant exceeds the standard specified in Subsection A, B or C of this section, the resulting pH or concentration shall be the allowable limit." Were you aware that there's that particular nuance in New Mexico's administrative code?

A. This appears to be the analogous standard in the New Mexico code that allows calculation of alternate concentration limits and background

limits. This is my first reading of that in detail.

Q. So you were unfamiliar with New Mexico water quality law prior to your testimony here today?

A. I'm unfamiliar with the specifics of New Mexico water quality law. When making such comparisons of numerical standards, I do hold the numerical standards to make such comparisons.

Q. Can we pause a minute for something for Ms. Henrie needs to take care of?

(Note: A discussion was held off the record).

(Note: The hearing stood in recess at 2:57 to 3:10.)

MR. LAKINS: Move to admit our Exhibit P.

MR. BRANCARD: Any objection?

MS HENRIE: On cross?

MR. LAKINS: Sorry, right.

Q. (By Mr. Lakins) Now, Mr. Miller, do you know what the background threshold value for fluoride is outside of the boundary of geothermal? Is that the demonstration we had up there?

A. It wasn't part of my calculation. I don't think that that -- it's an interesting way to apply background threshold value outside of an area that's

out of compliance.

Q. You don't know what it is?

A. I didn't calculate one for it.

Q. Okay.

A. I did not calculate a background value for anything outside the plume area.

Q. Now, do you know if on this demonstrative aid if there's any domestic wells located on there?

A. I believe that there are wells that are characterized as domestic wells, yes.

Q. And those would be within the boundaries of the geothermal area?

A. There's one at least that I know of.

Q. Which is that?

A. I know there's been characterizations by your client that A444 is a domestic well.

Q. And that's up in this area?

A. Yeah. You almost had it. Over by the house.

Q. By the house?

A. Other way. Left, left. There. About in that area.

Q. The domestic well?

A. Yes.

Q. I'm going to turn you back to P, Page 6.

Conclusions. Second paragraph. It says, "It is unlikely the fluoride concentrations in alluvial geothermal groundwater would ever exceed the fluoride concentration of 15.46 detected in the greenhouse area." Do you know where that value -- what well that value was detected in?

A. I'm not certain. If I recall correctly, that was the value that was reported by NMED. I'm not certain on which well or where the value came from.

Q. Do you think that that 15.46 applies and is what should be the background value for wells outside the geothermal reservoir?

A. No. That would be inappropriate.

Q. Do you know what the present fluoride concentration in Well A444 is?

A. Not presently.

Q. Did you ever?

A. I know as reported by Mr. Seawright in his testimony in 2013 of a concentration of 5.6 milligrams per liter.

Q. You don't know or you just remember that that's what Mr. Seawright said?

A. That was 2013. This is -- this isn't. I don't know what the current fluoride concentration

is in that well. I know what the concentration was reported by Mr. Seawright in 2013. 5.6 milligrams per liter.

Q. Do you know of any changes in the fluoride levels in the monitoring wells located on the property since Lightning Dock's production began?

A. I have not evaluated that myself. I have heard of changes in monitoring well concentrations in Mr. Janney's testimony yesterday.

Q. And what was it you recall? Which direction were they trending?

A. Some wells went up and some wells went down. I forget.

Q. Do you yourself know about the water levels in the monitoring wells?

A. I have seen a couple of diagrams that show water levels in the monitoring wells. I'm not sure which. They were reported in Exhibit P, I believe.

Q. Do you know which way they are trending?

A. No, I haven't performed any analysis on that.

Q. From your experience and expertise, would you agree that water under pressure is going to take the path of least resistance?

A. That's a general valid statement, yes.

Q. Would you agree that the geologic conditions of the shallow alluvium, the alluvial flow, would be a path of lower resistance than water being pressured to go down to further depth?

A. You presented the key factor there. Pressure. Q equals KIA. If I is higher between the injection wells and the production well, that is the way water is going to flow. It's going to flow along that energy grading. If heads in the alluvial aquifer are not such that water wants to flow from the alluvial well laterally, if it's a bigger head difference going downward, it's going downward. I have heard there's up to 300 feet of drawdown in the production well.

Q. 300 feet?

A. 300 feet of drawdown in the production well, and under those head conditions it would be my presumption that 300 feet of drawdown in the production well is going to cause a lot of flow gradient between the injection well and the production well.

So while it is absolutely true that as far as K goes, hydraulic conductivity as a generalism, water will tend to flow, as I explained, one order of hydraulic conductivity, 81 percent difference,

water will indeed tend to flow the path of least resistance, but that resistance is also governed by the energy line. So we can't evaluate just hydraulic conductivity in isolation. You have to consider head.

Q. Well, and in your opinion, the water that's -- the four proposed injection sites. Let's talk about that. Do you understand those are at 150 feet -- three are 150 and one is at 500?

A. I heard testimony to that effect.

Q. And are you familiar with the geologic strata that that proposed injection of 150 foot well is?

A. Based on the mapping work, most of it is alluvium. That I know for sure, and then on the testimony from yesterday -- it surfaced it's alluvium. From the yesterday the wells are projected to be in the alluvium.

Q. The alluvium fill, right?

A. Yes.

Q. And are you aware that there exists an underground water flow in that alluvial fill separate from the geologic upflow?

A. Yes, there is. The water is advecting to the north/northwest.

Q. So when water is injected, for instance, into this well here, proposed injection well here, 63.7, and the general flow, as you said, is north/northwest, don't you think that some of that water that's injected is going to follow the general alluvial flow and not necessarily make it down here to the 1500-foot production level?

A. Entirely dependent on the head differential. And that can be calculated. You can calculate on the basis of the head differential what amount of flow could possibly escape.

Q. Well, let me ask you this: Do you think that that alluvial flow would stop based upon production, proposed maximum production down in these two wells? Do you think that natural alluvial flow of groundwater would stop?

A. I haven't performed the calculation but I do believe it to be unlikely.

Q. Do you know what's the conductivity of the alluvium versus the deeper formation?

A. No, I do not.

Q. What's your understanding of an underground drinking water source?

A. It's groundwater and it meets drinking water criteria. I would also put in that it's not a

source of underground drinking water if you can't get a well to yield very well.

Q. Do you know if New Mexico's definition or federal definitions include a TDS component?

A. I know that there is a secondary drinking water standard for -- an aesthetic standard for total dissolved solids and New Mexico also has several classification systems for suggested waters for use based upon total dissolved solids.

I also know in the southwest we use water all the time that's classified as non-potable based upon its total solids content. In other states 500 is the cutoff. So we use water all the time that is 1,000 because we have no other choice.

Q. But you haven't come here to testify about water quality standards as it relates to TDS as it exists in the proposed site, correct? I think you said that earlier.

A. As introduced -- no, my primary point of testimony is fluoride. TDS is an important water quality parameter. There's no doubt about that. I note that in the notice on the meeting, that water quality rise in Well A-444 was alleged to be part of the problem. So in that context, if we wanted to look at well A44 regarding TDS, I would be

comfortable doing so.

Q. Now, you testified that AmeriCulture's surface discharge was the cause of the anomalously low fluoride level?

A. Yes.

Q. What's the flow rate being discharged from AmeriCulture's well? Or was their surface discharge?

A. There's going to be a certain loss for evaporation in their system and I have not calculated that. Based upon the amount of water that is pumped into their facility, their discharge will be some fraction less than that due to evaporation within their facility. But as a rough estimate, I believe that we can use the production amounts as roughly equivalent to their discharge amounts.

Q. You don't know what the exact discharge flow rate is; is that correct?

A. I have never measured it. I have observed flow.

Q. Well, so your calculation is based on an estimate?

A. My calculation is based on a site visit in the operation of AmeriCulture which is a geothermal

system which imports cold water to quench hot water to use in its facility, and 100 percent of the water that it produces is discharged.

Q. Well, can you give me that number? No? I asked if he can give me that number.

A. As in my review of the state pumping records for wells owned by AmeriCulture, I have observed that 10, 15 acre, possibly 20 acre feet per year of hot water are produced and between 100, and I think the peak number was 175, acre feet per year cold water produced. Roughly ten to one.

Q. But you can't give me the gallons-per-minute discharge rate?

A. I was never allowed to measure nor sample the discharge.

Q. Do you know what the present fluoride level is in the federal well?

A. No.

Q. So you don't know for sure if an introduction of higher level fluoride water would affect that well, make it exceed any standard? You just don't know?

A. Fluoride levels were reported in the AmeriCulture federal wells in the 2013 testimony and the fluoride level I used in my calculation of mix

was reported from 2013. Again, do I know the fluoride level today? No, I do not.

Q. Have you testified previously in any matter concerning geothermal?

A. Yes, I have.

Q. Tell me about it.

A. I testified -- I believe it was Catron County Commission. I forget the year. But it was involving BE Resources, a permit status to construct exploration wells on a beryllium prospect in the Monticello Gap area, which was involved with the thermal springs. There was concern that the exploration project could cause impact to the thermal springs in Monticello Gap, so we did indeed evaluate the geothermometry and the stable isotopes of those springs. That work was performed by the New Mexico Institute of Mining and Technology -- well, actually the Bureau of Geology and Mineral Resources and was integrated into a program of permitting that AMEC Earth and Environmental was doing at the time for BE Resources' application for mineral development.

Q. If I understand, you said it was before the Catron County Commission?

A. I believe so. It was Catron Sierra County

Board. I think the meeting was held in Catron. I don't recall all the specifics of where it was.

Q. Did you ever testify before any other environmental department, similar type department in any other state regarding geothermal activities or geothermal sites?

A. Not that I can recall.

Q. Have you ever testified in any court?

A. I have never testified as an expert in court.

Q. Do you know when the Well A444 was actually drilled?

A. It's old. It was drilled by the Tom McCant and I believe sold to Bealle to operate the initial Rose Greenhouse that was at that facility. So decades and decades ago.

Q. You don't know the exact year?

A. No.

Q. Would it surprise you to learn that on your chart you gave us you plotted a data point in 1980 which was three years before the well was drilled?

A. It would greatly surprise me. If there is a misinformation on that, that would have to be related to the confusion on well number that

surrounds that well and its applications. Yes, it would greatly surprise me. If you omitted the point before that well was drilled as somehow erroneous and included in my work, it wouldn't change the other content of the work one iota.

Q. So all the data that you relied upon for your testimony today is essentially before Lightning Dock's power plant began operation. Is that correct?

A. In my testimony regarding the controversy between Elston et al. and other theories of this geothermal system, yes, that data is from 1983 and before. Regarding the 2012 sampling, I don't believe the power plant started operations at the time.

Q. So none of your testimony here today is based upon any data that was obtained by Lightning Dock subsequent to the power plant beginning operations?

A. I believe that some of the data that's in the 2015 BTV value and concentration report is after operation.

Q. Can you point that out to me because I was looking at the dates and it's 2013.

A. Not unless I have my Excel spreadsheets on

which I did all those calculations right in front of me.

Q. Now, are you aware of the proposed increase in capacity of the Lightning Dock plant?

A. Not in specific numbers, sir.

Q. What are you aware of?

A. I am aware that they want to expand capacity of their power production. I am really not aware of specifics except for the testimony yesterday that I heard of Phase 1, Phase 2, 13 megawatts gross. That's what I can recall, but that's what I know of their expansion plans.

Q. Do you know how that expansion plan and the amount of the proposed injection relates to proportionally the current production?

A. Roughly double, but again, just trying to recall from yesterday.

Q. Well, if I told you that it was going to essentially increase 750 percent --

A. Seven and a half times.

Q. Seven and a half times. Do you think that a seven-and-a-half times increase in the amount of movement of water in that system would have the potential to actually result in more of the injected water moving in the alluvial flow?

A. Based upon the premises that I have already presented, that it's my understanding that these geothermal systems are operated as a closed loop by maintaining a differential pressure between injection wells and withdrawal wells such that they do maintain a closed loop, we could increase the amount of water moving. We could scale it .7 times, 7.5 times, 75 times.

If they are keeping their cell operating in such a way that they maintain those heads, there's an outer perimeter where that mixing is not taking place. So my answer would have to be no, and that answer is based upon operations and the one equation I mentioned to you, Darcy's Law.

Q. Darcy's Law doesn't account for mixing, does it?

A. No, Darcy's Law does not address mixing.

Q. Now, when you use the term closed loop, what's your understanding of closed loop geologically?

A. I know there's nomenclature used in the geothermal industry and I'm not certain of the ways they define closed loop. There's two closed loops that I'm aware of here. The first one is the closed loop heating system which indicates that the water

is not once through, it's returned to the aquifer and that closes the loop.

Q. Let me pause you on that. I don't mean to interrupt. I'm not trying to be rude.

A. Sure.

Q. But explain to me, is that a natural phenomenon that you're describing?

A. No, that's mass in, mass out. This is the geothermal production system. If they are withdrawing the same mass as they are returning, explained by Dr. Shomaker yesterday, we have a mass balance. And they are trying to achieve flow balance. So when you achieve mass and flow balance, you are not affecting the system that's advecting. Granted you are creating a big circulation cell within this system. You're mixing. But you are not altering this giant body of water that is the Animus Valley aquifer moving through the area.

Q. Given the mixing that's occurring on the edges, it's not within a solid bubble container that prevents its movement into the greater flow of underground water, true?

A. That is absolutely true, but I think what's being missed here is an essential point on mass balance and pressure balance. That while you

can create a recirculatory cell inside this outflow, if that process is closed, mass in equals mass out, then you're merely creating a circulation cell within a larger moving body. So I don't see -- so while mixing is taking place, while this circulation cell is being operated, we haven't changed one bit the amount of mass of fluoride that's coming into the system. 100 percent of that is controlled by the geothermal system. We are mixing the amount of fluoride that comes up by the geothermal system within a zone where it's beneficial for heat.

Q. The fluoride is moving around?

A. The fluoride is moving around. The fluoride has been moving around apparently for thousands of years.

Q. Let's try to figure this out from the geologic -- not a mass balance thermodynamics heat/pressure, but from a geologic perspective, okay? From your understanding of the geology of that area -- that's what I want to try to focus on -- is that geology structured in such a way that all of the water recirculates in there in what would be referred to as, in essence, a closed loop, a contained area? Yes or no?

A. No. And if you might give me the

opportunity.

Q. Go ahead.

A. Okay. The problem is that there aren't any confined aquifers out there that we know of other than the confined geothermal aquifer. And so --

Q. And if I may, I don't want to interrupt, but if you could explain what is your knowledge of a confined geothermal aquifer?

A. My knowledge of the confined geothermal aquifer has been expressed by either readings of Mr. Witcher, prior publications of his, Swanberg, other people who have published in this area or are doing basic research on that, and Elston, Deal and Logsdon.

Q. Thank you. Please continue.

A. No problem at all. Now, the current configuration that we see of the outflow is controlled by the outflow. So if the outflow -- and it is in an unconfined aquifer, which means that that outflow plume is free to expand and contract how it sees fit. Once it's put fluoride into the basin aquifer, if the conditions change in the basin aquifer, say rainfall went up incredibly and we had all kinds of recharge, that's going to spread this

naturally occurring plume out, too.

The point I'm trying to make, though, is if the geothermal system expands -- and some believe this system is growing -- if the geothermal system expands, so does that plume. That plume is going to expand. That plume is going to envelope. If the geothermal system expanded to the point we see historically from the Travertine Springs, from the calcite vein, from the fluoride veining, from the fact that there's mines on the valley walls of this valley, that fluoride plume is going to be wall to wall, and so is the hot water.

So the configuration of the outflow plume is controlled by the flow rate in and the hydraulic properties of the medium in which it's flowing in. And as I presented before, there's a great volume of shattered rock out there. It probably achieves representative porous media quality. We know it behaves in an unconfined matter and we know it's connected on the side of the alluvial fill aquifer. So the giant fractured rock system is in very direct communication with the alluvium. So that system is going to be controlled by what flows up in it and the controls there, recharge from the top. Not a small mixing zone within it. And if we might, I

really need a bio break.

MR. BRANCARD: Do you have a lot more questions? I'm really concerned because the commissioners have a whole bunch of questions for the witness.

MR. LAKINS: I pass the witness.

(Note: Witness exits and returns.)

CHAIRMAN CATANACH: Ms. Marks? Go ahead.

CROSS-EXAMINATION

BY MS. MARKS

Q. Mr. Miller, I just have a few quick questions for you. You said the aquifer is already contaminated, correct?

A. Correct.

Q. I wanted to show you what is AmeriCulture's exhibits and I just want to turn your attention to Exhibit K. This is a letter to, I believe, Cyrq's CEO, Mr. Goodman, written by Jim Griswold, the environmental bureau chief for the OCD.

A. Yes.

Q. And go to the general conditions. One of the conditions Mr. Griswold, the environmental bureau chief of the OCD, recommends for Cyrq is that the OCD must be immediately notified if the measured

concentration of any constituent in any sample exceeds the maximum levels provided in 20.6.2.3103 NMAC, with the exceptions of fluoride exceeding a concentration of 17 milligrams per liter. I won't read the rest. Do you agree with Mr. Griswold's recommendations to Cyrq?

A. I believe Mr. Griswold's recommendations are based on my calculations of background threshold values for the Lightning Dock data and are therefore appropriate.

Q. I have no further questions.

CHAIRMAN CATANACH: Okay.

CROSS-EXAMINATION

BY COMMISSIONER SHANNON

Q. Thank you very much. I will be quick. Okay, Mr. Miller. I don't have a Ph.D. so dumb it down just a hair for me, please.

A. I will help you any way I can.

Q. If you would, please. First of all, why have they changed -- if this question has been answered, go quickly. It's because I didn't understand some of the answers. Why are they no longer going to continue reinjecting into the loop system and they are going to start injecting into these shallow water wells?

A. My best understanding on this, this is risk reduction on the part of the geothermal company. As testified before, they are looking for permeability. They are looking for a place where they know that they can get the water in because once they pump it out they have to get it back in. They have had some problems at depth.

Q. But why can't it just keep going back in like originally planned? What has happened to stop that original loop?

A. Well, as far as I know, the loop is not being stopped at all. What's happening is the injection points are being moved out in a little more shallow. The withdrawal points are still down here. So instead of running a tighter loop at depth, they are planning on running a larger loop that injects here, pulls down, has the 300-foot cone of withdrawal so they're injecting out here and you've got 300 feet of head trying to pull it in.

Q. Very quickly, I am not here just about fluoride. I have been aware all my life of the heavy fluoride so I don't need you to tell me how bad the fluoride is so we will just drop that. What I am here for is the health, safety and welfare of the people in my community and in my county. Can

you guarantee me that there will be no shallow water well that will be used for private use, agricultural, cattle, that will be contaminated with the shallow water wells being injected as being presented? Can you guarantee me that will not happen?

A. I cannot guarantee you anything for the operation of Cyrq because I do not operate the company.

Q. Thank you. That's all I need to know. Thank you very much, gentlemen.

CHAIRMAN CATANACH: Commissioner?

MR. BALCH: I have a couple questions, Dr. Miller.

THE WITNESS: Yes, sir.

MR. BALCH: The fresh water well -- this is going way back to the beginning of your testimony -- that the Burgetts used is about a mile off to the west over here somewhere?

THE WITNESS: Section 12.

MR. BALCH: Do you have Exhibit 1?

THE WITNESS: Mine?

MR. BALCH: Yes. It has a little bigger map.

THE WITNESS: Thank you. Very good. Yes.

MR. BALCH: Where approximately on there is that?

THE WITNESS: We can see it. All right. If I may approach? I'll throw the x-ray specs on there.

This dot here, that clear area, if my recollection is correct this is the pad area for the Dale Burgett wells, and right across the street by the clump of bushes, if we pull it up on Google Earth we probably see the telephone pole for the cold water well for AmeriCulture.

So they are on the road in Section 12.

MR. BRANCARD: That's a long geothermal road. North half of Section 12. The witness was pointing to both sides of what's called Geothermal Road about midway across Section 12.

MR. BALCH: Looking at your data in Exhibit 10, it looks like that has a fluoride level of just over 1, 1.14?

THE WITNESS: 1.14 sounds familiar.

MR. BALCH: Looking at your approximate plume boundary, that section just inside the left edge, so it's going to be in the mixing zone, the edge of the mixing zone of the fresh water aquifer and the plume from the geothermal. All right. Just

wanted to make sure I knew where that one was.

You seem to be indicating that this is a fully connected system, surface to bottom.

THE WITNESS: I haven't seen any evidence to indicate otherwise.

MR. BALCH: But you do have changing groundwater chemistry as you get closer to the surface and as you get to the edges of the plumes, these mixing zones?

THE WITNESS: Well, yes. This plume follows all of the same solid transport laws that every other plume on the planet follows, so there is going to be chemical diffusion at its edges. There's going to be dispersion with time. The plume will continue to get larger with time regardless if the geothermal water changes its flow. The plume will get larger and expand. If the mass into it isn't the same all the time, eventually it will become diffuse and disperse. If the mass of fluoride putting into it continues the same, this is going to keep growing. There's a continual source of contamination being piped into this aquifer by the geothermal system.

MR. BALCH: And you have a bunch of other forces working upon that plume. You have the

downgradient flow to the north?

THE WITNESS: Yes.

MR. BALCH: You have mining of water in the Animus Basin, fresh water in the '80s, which is ongoing but stabilized?

THE WITNESS: I think it's stabilized. I read some of the reports. Daniel B. Stevens did a groundwater flow model of this site in 1983. The State engineer responded pretty quickly on that, and I am agreeing in the opinion that it is stabilized. The mining of groundwater that historically took place, took place to the south of the facility.

MR. BALCH: South of the facility.

THE WITNESS: So looking again at the fluoride plume, there's question as to whether there's been redistribution.

MR. BALCH: Could that give you a little bit of gradient in the back flow direction?

THE WITNESS: We are in an unconfined aquifer. If I put in a big enough well down by Cotton City, I can make the whole thing run backwards.

MR. BALCH: So you have those outside factors. You also have inside factors such as the development of Lightning Dock.

THE WITNESS: Yes.

MR. BALCH: They have a good drawdown in their production well, around 300 feet. It's stabilized for their current rate of production.

THE WITNESS: I concur with Dr. Shomaker's analysis.

MR. BALCH: The data is pretty clear. It's stabilized at that rate. However, you are mixing down deep at this point. If you start to mix up shallow, what is the potential of impacting somebody else's shallow water?

THE WITNESS: Again, because of the recirculation --

MR. BALCH: It's still bad water.

THE WITNESS: Well, in the principles of the recirculation cell, I still think that we're mixing within this hot geothermal zone. We are not changing the mass. There will be a period of stabilization, but ultimately, every bit of fluoride that comes up goes out. So us recirculating shallow versus deep, yes, if we look at the scale of that picture, we will see it. Of course. If we put in wells even tighter we would see it even more. But as far as the scale of what's happening downgradient of the geothermal lease area, it's my belief within

a reasonable degree of scientific certainty that it would be difficult for us to detect any changes one year from now, 30 years from now.

MR. BALCH: Or 1,000 years from now.

THE WITNESS: Exactly.

MR. BALCH: I don't think Mr. Seawright is worried about 1,000 from now.

THE WITNESS: Probably not.

MR. BALCH: You have the good degree of variability. I think you were saying 2.0. One of the tables indicated more like 1.6.

THE WITNESS: I think that's an advisory level. Again, when I make these determinations I go directly to the regs and have it in front of me while I'm doing it.

MR. BALCH: But you may have two interesting cases here. If you are recharging the A444 well with relatively fresh water, you could push the fluoride levels in the well below that advisory level or below a warning level.

THE WITNESS: We are not recharging well A444. The process that I alluded to and which I believe is an operable theory, yeah, they very well may push the fluoride levels down.

MR. BALCH: So you could have a well

that's not in fluoride compliance go into fluoride compliance through factors that are outside of the control of Cyrq. You also have Monitoring Well 5 here, fluoride level of 1.3. I mean, that's one that could get pushed out of compliance.

THE WITNESS: You have a 1.3 level of fluoride underneath a greenhouse that historically discharged cold water into the ground for how long?

MR. BALCH: But just like you want to look at the letter of the law when it comes to making a call when you're looking at a regulation, we have to look at the regulation as well. What is the impact of a well that could go into compliance and one that could go out of compliance as a result of a local mixing?

THE WITNESS: This is why we do this differently in other states, quite frankly.

MR. BALCH: Unfortunately, we are not -- I would say fortunately we are in New Mexico.

THE WITNESS: Well, in terms of flexibility, I love being in New Mexico, but in terms of flexibility to deal with situations like this that are complex -- we have a naturally contaminated aquifer that's been manipulated many times by other forces, some anthropogenic, some not.

MR. BALCH: There's also the chance that you could do nothing and the concentrations will change. They do change a little bit at times.

THE WITNESS: If this facility was never operated and AmeriCulture disappeared and nobody did anything to this system, your downgradient fluoride concentrations are going to change. This plume is evolving. What we are seeing right now is its condition as of today based upon an unknown determined number of years of discharge. It is going to spread laterally. That's physics and chemistry. It doesn't have any opportunity.

If hydraulic containment is maintained -- and we do this in the environmental industry. We create hydraulic containment cells within other flow cells so that we can operate on the chemistry, inject really interesting chemicals into aquifers to destroy organic compounds, and we do this safely by controlling head, Darcy's Law.

MR. BALCH: So what's the legal impact of the A444? If that well goes into compliance in fluoride, it's still probably going to be out of compliance with TDS, but say it goes in compliance for one component, Mr. Lakins pointed out one component is all it takes to change a reading on it.

What happens if it then goes out of compliance?

THE WITNESS: From a scientific perspective, I don't have a good answer.

MR. BALCH: More from the regulatory side.

THE WITNESS: I'm not a lawyer.

MR. BALCH: What's going to be the impact, though, if you are writing a report to the state engineer or to the OCD? How are we supposed to interpret that?

THE WITNESS: If I were in your position, knowing what I know from the historical recording of fluoride within this system, low fluoride waters are anomalies and they have been caused anthropogenically by discharge of water from outside the fluoride zone. So while we are creating those, I think you end up in the same situation as when you artificially create a wet one.

The mitigation of that is generally determined through legal processes because we don't have a good way to draw a bright line on Dale Burgett water or water imported here. You might say the corollary was if cold water importation continued and was just allowed and somebody decided to grow corn on the top of that, and then they stopped, has the corn farmer diluted the water and

allowed it to contain to a condition of contamination? So it's difficult.

MR. BALCH: Let's try to get more specific. You have Monitoring Well 5 here at 1.3. You also have a proposed injection Well 76.6.

THE WITNESS: If monitoring 5 goes over 1.3 it will be exceeding water quality criteria.

MR. BALCH: What happens to Cyrq in that case?

THE WITNESS: I can't predict that.

MR. BALCH: They are going to make that report that they pushed the well out of compliance.

THE WITNESS: If I were in your position --

MR. BALCH: Would you drill the well, I guess is the question.

THE WITNESS: Well, in a regulatory position, I would have to consider the totality of the evidence that this is an anomalous water within a high fluoride zone. Eventually, if mounding heats up Well A44 and moves geothermal water over there, have we ruined it or restored it to its original condition?

MR. BALCH: Or something closer to it.

THE WITNESS: I can't answer that

question.

MR. BALCH: What about 13.7? I know it's a star on the map. Is it here?

THE WITNESS: I don't know. I didn't draw the star and I haven't plotted the well permits. I'm sorry.

MR. BALCH: We have maybe another 3,000 feet to the edge of the plume there and the edge of the flesh water.

THE WITNESS: Again, if we were injecting there and you were pulling real hard, what are the headlines going to look like around the well? The headlines will be big Us because there will be water being pulled in from behind that well in addition to the water that's being injected. If they are operating the system for capture, they're capturing water from the outside edges of the plume and pulling it inward.

So part of their water that they are pulling down deep is water that was once lower fluoride and will be higher fluoride. That's the purpose of the mixing zone.

MR. BALCH: You know in the '80s and 2012 it didn't look like there was a difference in the rate of mixing. It seemed to be roughly happening

at the same level. I think that means you didn't see higher fluorides in 2012 than you saw in the 1980s.

THE WITNESS: I'm uncertain what you're referring to. Are you referring to A44 mixing?

MR. BALCH: No, this was earlier in the discussion. We were talking about the entire mixing zone.

THE WITNESS: Entire mixing zone. The stable isotope work from 2012. What it does is, in my opinion, validates the predictions of Elston, Deal and Logsdon. They said we should find water close to that Delta D and Delta 18-0. And indeed, when we drilled deeper we did find water that matched their conclusions. I have not performed any calculations whatsoever to evaluate the current state of mixing, geothermometry, whatever. I'm comparing the theories of Elston Deal, et al. to the theories of Witcher 2001.

MR. BALCH: Would you agree with Witcher that we need to be doing much more monitoring?

THE WITNESS: For the purposes of permit and assuagement of public concern, I would think that more monitoring around the proposed alluvial injection wells would be appropriate. But the

mission of Cyrq in geothermal development is not creating papers, it's operating the system sustainably.

MR. BALCH: It's also to be compliant with regulations.

THE WITNESS: To be compliant with regulations. If this commission felt that continuing validation of the Elston, Deal and Logsdon hypothesis for operation of the system was necessary, that work could indeed be performed by additional chemical analysis, most probably from our existing monitoring centers. The work may have already been performed and I don't know it, because I am not privy to the confidential information of hydrogeologists, geophysicists.

MR. BALCH: Welcome to the club.

THE WITNESS: Thank you, sir.

MR. BALCH: We are also not privy to a lot of that stuff. I wanted to clarify. You were referring to AC hot and AC cold?

THE WITNESS: Yes, those were names that I assigned to a cold water tap and hot water tap that was inside the AmeriCulture facility.

MR. BALCH: Okay, so it's not directly tied to a particular well?

THE WITNESS: I did trace some information that Damon provided me. It is my belief that AC cold is indeed the well that they've identified in Section 12 that they used to bring cold water into their facility.

MR. BALCH: That's the well that I had you identify on the map?

THE WITNESS: Yes. That was not sampleable at the wellhead.

MR. BALCH: You think that's AC cold?

THE WITNESS: Yes.

MR. BALCH: And AC hot?

THE WITNESS: I would have to go back to my records to see which well he was operating at the time, but I believe it's one of the wells off to the east of the facility. I am not certain which well it was, but it was more of a 200-degree well than a --

MR. BALCH: So AC 2 or 1?

THE WITNESS: I believe so. I'm not sure which was being operated.

MR. BALCH: I believe I will get a chance to ask Mr. Seawright later. Thank you for that. I assume there's commercial defluoridation technology?

THE WITNESS: Yeah. Gamma activated

alumina works real well, even on high temperature water. So it's the original fluoride removal of granular material. So if somebody wanted to treat fluoride they could set up a whole-house filter with changeable filter cartridges relatively inexpensively, under $100 probably.

MR. BALCH: What about for fish farms?

THE WITNESS: For fish farm use defluoridation -- that would be a lot of water and so still the preferred treatment that I know of is indeed flow-through media or granular media such as activated alumina. It would take a water treatment plant to go precipitate out fluoride and then readjust chemistries and all this other stuff.

MR. BALCH: Probably a good-sized plant?

THE WITNESS: Probably a good-sized plant.

MR. BALCH: Probably capital intensive?

THE WITNESS: Probably capital intensive.

MR. BALCH: I appreciated you providing the diagrams for the plume. Kind of back-of-the-envelope thinking, what percentage of that plume is going to recycle through this apparently fully connected system? Half, quarter, third, two-thirds?

THE WITNESS: I can't even ballpark that.

To do that I would have to look at the true material in place in the alluvial valley. I would have to look at real Ks. We would have to have a water level monitoring program that gave us good gradients around the facility, and that means everybody's well.

MR. BALCH: Dr. Shomaker testified essentially that it's going to be a closed loop. Most of the water or all of the water is going to recycle.

THE WITNESS: Here is what's happening. We are entraining water and then we're advecting it away. So new water comes in and entrains and it gets advected away. So describing closed loop and open loop is a matter of scale.

MR. BALCH: Let me ask it a different way. You have this natural upwelling. There's nobody doing anything there at the surface. There's going to be an influx of fluoride-rich water that is then going to be diluted by the basin aquifer flow. If you start to cycle this water at a shallow level, is it going to change that overall amount of fluoride per year that's going into that shallow mixing?

THE WITNESS: Absolutely not. The mass of fluoride is controlled by the geothermal system, not

by whether we are doing mixing here, here, here.

Now, there is a time lag when all that fluoride comes out and up. So things, you know -- we talk about the plume as if it has an edge boundary to it and we talk about a closed system. I can guarantee you some of the water in the system went through the digestion of a dinosaur. I can guarantee that you some of the fluoride molecules in the system are going to end up in Antarctica someday. Everything connects to everything in hydrology. We can't get away from that.

So where is the boundary? Is the boundary diffusion of one femtomole of fluoride across a centimeter? Is the boundary -- we're moving towards an MCL out here and we should start to think about that or provide treatment. Or provide treatment. Or -- the plume is collapsing over years. Oh, my gosh. The geothermal source is decreasing in size or less fluoride. So I can't predict all the what-ifs on that. But what we can do is we can use the natural analogue that we observe, and if the contours that we see for Elston, Deal and Logsdon are about the same contours we see 30 years later, we can say on the scale of 30 years we are not changing the system. And I believe on the scale of

30 years we are not changing the system.

MR. BALCH: Thank you. I just want to be a little clear. My hydrology courses are well in my past and I don't practice hydrology right now. Confined aquifer. Could you give me a bit of a definition of that?

THE WITNESS: A confined aquifer is sealed by confining strata. There isn't a fundamental this-many-orders-of-magnitude-difference of hydraulic conductivity --

MR. BALCH: You're talking about vertically confined?

THE WITNESS: Vertically confined. And so confined aquifers are discovered more operationally than they are by stratigraphic definition in that we pump on a confined aquifer and we will see very rapid propagation of a cone of depression, although it will be very shallow. It's like water in a pipe, and other than the time lag offered by hydraulic conductivity, pressure propagation is instantaneous.

This is why there is a mound when we're injecting. Pressure propagation is instantaneous except slowed down by the time lag of hydraulic conductivity. So to come back to your question --

MR. BALCH: I'm just looking for the

definition of confined aquifer.

THE WITNESS: So confined aquifer is not receiving recharge from the surface, does not have a potentiometric surface that is equal to atmospheric pressure.

MR. BALCH: So the fluid recharge, presuming there is a fluid recharge, to the deep geothermal reservoir is coming from the south.

THE WITNESS: It has to come from somewhere. Elston, Deal and Logsdon suggest the geothermal system trends to the southwest or at least the leakiness of it trends to the southwest. Could the water be coming in from due north? Sure. It's a confined aquifer. We don't have any monitoring points in it. I don't think that --

MR. BALCH: Could be coming down the basin sides?

THE WITNESS: What we know is it doesn't have a mantle signature in it and we know that from the stable isotopes. So we know there isn't a deep leakage of some mantle-related water coming up.

MR. BALCH: No --

THE WITNESS: Not right under it. I think Mr. Witcher would agree with me on that.

MR. BALCH: So the A44 well currently is

low in fluoride. That wasn't always so in the past.

THE WITNESS: That's presumptive. I don't have analytical results for it. I wasn't able to pair it exactly with the Elston, Deal and Logsdon sampling because of disparate publications on that. But based upon the contouring, it's right in the middle of the hot well high-fluoride area, and this is right out where they discovered boiling water at the water table when it was first drilled.

So my expectation is -- again, why is this anomalous? What are the potential ways this could be anomalous? The geothermal system can't create this; something else had to. Upwelling geothermal water doesn't create a cold zone.

MR. BALCH: There's a pretty good variability of what could happen. There's probably going to be some changes to the chemistry, fluoride in particular. I think you gave charts to indicate that those could probably be worked around in most circumstances.

THE WITNESS: Well, this is with respect to AmeriCulture's operations.

MR. BALCH: Right.

THE WITNESS: And based upon Dr. Seawright's testimony regarding what he needs

for temperature and what he needs for fluoride, I believe that he has management opportunities to deal with this. There may be some tankage required. There could be capital requirement for cooling when the water is too hot for him, but he has knobs to turn. It's not a pure fixed.

MR. BALCH: So there does appear to be some language referring to a replacement plan, water replacement plan.

THE WITNESS: I have seen the Joint Facility Operations Agreement. In my layman's reading of it, it says that heat gets replaced.

MR. BALCH: I think the water replacement came up somewhere else.

THE WITNESS: There's been discussion of that, yeah. But my understanding is that from a geothermal perspective, if the operations of Lightning Dock impact AmeriCulture with respect to heat, Lightning Dock will replace heat for AmeriCulture. That's, again, just my recall of it.

MR. BALCH: That's what the Paragraph 3 Section B(A)6 of their agreement says.

THE WITNESS: Okay. I guess I recalled it correctly then.

MR. BALCH: I think the water replacement

plan came up in a different context.

THE WITNESS: Water replacement is different.

MR. BALCH: So if there are these broad ranges where they can turn the knobs and adjust things, what do you think the potential is for this system to go out of that range during the lifetime of AmeriCulture's operation? To get out of that little box?

THE WITNESS: To mean there wouldn't be hot enough water available for 85 degree water?

MR. BALCH: They wouldn't be able to adjust the temperature and the fluoride at the same time using the resources they had available to them.

THE WITNESS: I think having the resources available right now their ranges of adjustment are near infinite because they have that cold water resource they can bring in, as they have for dilution. So they can dilute down any fluoride that they need to. They have water up to 230 degrees. I think they have a large range in the knobs to turn, but there's much more to AmeriCulture management than I know. I'm looking at fluoride and temperature, and in fluoride and temperature I don't see a constraint.

MR. BALCH: I'm wrestling still a little bit with the levels of contamination greater than 2 being non-drinking water, and then the edges on top of the mixing zone. You could be having that happen dynamically caused by nature continuously.

THE WITNESS: Welcome to my world.

MR. BALCH: And likely you do. But if you were to monitor every inch of the entire plume you would see short-term variability. The thing is, we live in a world -- the commission -- where we have to look at point data that occurs at a specific time and then we say oh, you are greater than that number or you're less than that number.

THE WITNESS: My world isn't any different than that. But what there has to be in this is an understanding of how the system operates. And if the actual physics of the system are outside the way you can accommodate in law, then the science should win, in my humble opinion.

MR. BALCH: At least an appeal, right?

THE WITNESS: So one of the ways I have tried to look at this is, again, on scale. When we pull back from this and this entire problem in itself, we have two neighbors separated by a fence that both are using a contaminated water resource

for their own uses, and in that process they are kind of arguing who is peeing in the cattle yard. Because there is a large body of contamination and it's been present for many, many years and it's moving naturally.

So various levels of mixing and introduction of waters from outside the basin and so on and so forth are changing things at the level of that picture, but they are not changing things at the level of the Animus Valley, and that's where I think the concern for the -- most of the concern for the commission should be is are we changing overall the general nature of this system? No, it's hot and full of fluoride and people will be able to continue to use it for years to come.

MR. BALCH: Our concern is the resource is not wasted.

THE WITNESS: I think that's a valid concern.

MR. BALCH: And our concern is that all parties have their correlative rights reserved. Really, that's the number one priority. We also have to look after human health and safety, protection of groundwater, et cetera, but those are subsidiary concerns.

The reason you are here in this room is because it's an energy resource and we are a commission that deals with energy.

THE WITNESS: On that basis, and again, I will state it, it is my professional opinion within a reasonable degree of scientific certainty that the proposed shallow well injection program is not going to markedly alter the water quality in the Animus Valley.

MR. BALCH: How about for AmeriCulture?

THE WITNESS: If the current pathway continues, if the trough between the AmeriCulture mounded water and the mounded water that's over here at Lightning Dock that Mr. Seawright testified, if this mound is lost, this water will encroach. That water at the surface is the natural upwelled water from the geothermal system. Yes, it will move over and change A44 back to the way I say it was 20 years ago. Is that a damage or is that a restoration?

MR. BALCH: That's a good question.

THE WITNESS: I haven't found the answer to that one either.

MR. BALCH: So this is my last question. If the system really is fully connected from depth to surface and you have near alluvium -- not near --

if it behaves like porous rock because of the fractures all the way from 1500 feet to the surface, is there any reason why you couldn't put the injection wells at an intermediate depth to minimize the impacts on the near surface water table and mixing of chemistries?

THE WITNESS: I think, again, the factor is risk. What we found in the situation, and we would like to assume it is a very homogeneous body of fractured rock. That's very simple. They are finding as they drill that in some bodies where their open hole section is, they are not finding the permeability they need. As a general rule, permeability decreases with depth, so an intermediate well approach might be appropriate.

From what I understand, their perspective is minimize risk to the degree that we possibly can. Let's put it in the stuff that we know is most permeable so we can get it in and then let's control where it goes via drawdown.

MR. BALCH: I believe Mr. Bowers yesterday said you can drill your well and be an inch or two away from a large fracture network and have no permeability.

THE WITNESS: I disagree with Mr. Bowers,

because I believe that in all these fracture systems we see antithetic fractures an inch or two away, and I believe it's a matter of scale. Because for me, interconnection is water will flow and flow at a rate that makes sense to the time period of question we are asking. For him it's 1000 GPM, and so I have been real close. We almost had it. The well will only pump 100. Well, for me that's a lot as a hydrologist.

It's been my experience in mapping in the basin, it's been my experience in the field of geology, I have sat hundreds of wells drilled in the Rio Grande, that we see lots of fractures in the fractured rock. And fracture zones, yes, they can disappear very quickly.

MR. BALCH: On the oil side of things we often deal with pre-existing fabrics of natural fractures on a variety of scales. You can try to intersect as many as you can using hydraulic fracturing.

THE WITNESS: Yes.

MR. BALCH: Is there some reason that's not used in a case like this?

THE WITNESS: Mr. Chairman, what --

MR. BALCH: I'm not the chairman.

THE WITNESS: Well, the body in the chair. What do you believe the response would be if I was to propose well acidification and fracking as a methodology for getting greater hydraulic control out here? While it's completely acceptable from the technical standpoint and it's done many, many places without -- again, we are dealing with people that are very concerned about the effects on their drinking water aquifer. I would suggest to my client that well stimulation activity here is to be avoided. This system has to be drilled and operated naturally or we are going to lose our social license to operate here.

MR. BALCH: So in the absence of being able to use hydraulic fracturing, as effective as it would probably be, your next alternative is to deviate the wells or go horizontally?

THE WITNESS: And I believe they have done that. I believe they've done some well deviations in the past and drilled some outlegs. Again, we are talking dollars squared per foot, though.

MR. BALCH: Right now is a good time to be drilling a well.

THE WITNESS: Running rigs have been dropping a little bit.

MR. BALCH: It's cheap.

THE WITNESS: So to come back to the original question, as far as my understanding, it's a multi-variable program of risk reduction. You are trying to go where you get the most permeability. They have to have some level of certainty going through these permitting processes that extend months that they are going to be able to get the water in.

So in a situation where they might be able to rapidly respond with a permitting process, I could see where they might propose all kinds of different phased activities. But in this situation where every permit has been incredibly drawn-out for them, I completely concur with going for maximum risk reduction to operate the facility right here right now. Let's put wells in the highest permeability that we know is there and let's control it by hydraulics because then the company can operate.

MR. BALCH: Thank you.

MR. PADILLA: Dr. Miller, I have a start-off question for you that I think may be better suited for Mr. Bowers, but since it came up during your testimony I'll throw it out there. We

heard that the proposal is for a 750 percent increase in capacity and output. I believe yesterday there was not a corresponding increase in the flow rate of water necessary for the reservoir to reach that. But can you talk about that at all?

THE WITNESS: Only vaguely and by recollection. Yesterday, if I recall the testimony correctly, they are going to put in the capacity and increase the flow rate. So the design in capacity for the anticipated eventual flow rate.

MR. PADILLA: But there's not necessarily a corresponding increase in flow rate or is that outside your expertise?

THE WITNESS: I think we are reaching outside. I think we're into operations there.

MR. PADILLA: You also mentioned early on some tracer testing that was done.

THE WITNESS: Yes.

MR. PADILLA: Can you speak about that and the results?

THE WITNESS: I did not conduct the tracer test. I was asked to respond to community concerns that the tracer had gotten out into the alluvial aquifer. So I went and sampled anybody's well who wanted sampling, both for the general water quality

parameters that I mentioned but also a fluorescent dye. We did not find the fluorescent dye out of the central geothermal site. We did not find it in any other wells in the alluvial aquifer. But I was called in second-hand on that. That was my initial involvement with the project was that water quality sampling.

MR. PADILLA: Okay. You seem to have a really good knowledge of the wells in the area and I'm wondering if the well previously identified by Dr. Balch in Section 12 is, to your knowledge, the closest potable well to the project area.

THE WITNESS: I can't say that with certainty, and I think you overestimate my knowledge of recall of the wells out there. I have seen various U.S. geographic topos that show various windmills that have been in the area and that.

I cannot answer the question with certainty. I have been to the Section 12 wells, both Dale Burgett's and Dr. Seawright's and have sampled both of those wells in 2012 -- or four of the wells in 2012.

MR. PADILLA: Your upset condition scenario from earlier in the presentation used an additional measurement of 4.6 milligrams per liter?

Was it milligrams per liter or PPMs?

THE WITNESS: I am using milligrams per liter as equivalent to PPM. I am assuming a density of one.

MR. PADILLA: Why did you use that factor of 4.6?

THE WITNESS: To bring it to 10. It must have been -- it's either 4.6 or his well is 5.4 and I'm confused now. But it was to bring it to 10.

MR. PADILLA: Okay. Lastly, another question that came up during your testimony but may be better suited elsewhere. The letter from Mr. Griswold to Mr. Goodman seems to imply, just in the quick reading on my part, that as you and Dr. Balch were discussing measuring Well 5, I believe, which is the one down here, the closed site, the very low fluoride level of 1.2, 1.3 was thrown out. But according to this --

THE WITNESS: Thank you for that. Because, you see, really so many things -- I get a little boggled. We have created an alternate concentration level, have we not? We have established the new MCL for this site, this 17 milligrams per liter.

MR. PADILLA: That was my question.

THE WITNESS: So to answer the previous question in context, that would be the number that I got to look to.

MR. PADILLA: So unless anything in the project area exceeds 17, you are still within the parameters outlined by Jim Griswold?

THE WITNESS: Yes, based upon my understanding of the letter.

MR. PADILLA: What's the definition of the project area based on your understanding?

THE WITNESS: I believe Dr. Shomaker previously testified in permit hearings on this that they believe the maximum area of effect from this injection and withdrawal would be a half mile to a mile. So that would be my idea of the project area. It would be -- the project area should be equivalent to the central core plus some, a little bit of the upflow plume. What that little bit is, is dependent upon how steeply concentrations dive off.

So I think that's a pretty good depiction of the project area. There's some leasing to the southwest and the Rosette lease is to the north so it's hard to define. I think it's been defined in previous permit processes, what they believe the project area to be. One easy definition is the

leased area.

MR. PADILLA: As far as relating to that 17, that number threshold.

THE WITNESS: Again, we are getting to Greg talking about regulations and I'm uncomfortable there interpreting what the regulatory interpretation is.

MR. PADILLA: I will go back to one that's probably more in your bailiwick. When I brought up the increase in plant capacity vis-a-vis an increase in water production and reinjection, is it safe to say, as a very rough summary of your testimony today, that functionally the rate of water through that plant is pretty much irrelevant, in your opinion, due to mass balance?

THE WITNESS: To a certain level of scale. At some point if we get to ridiculous levels of pumping we are affecting head farther and farther out. That head field becomes bigger, the drawdown becomes bigger. Within the proposed capacity of one to ten times their current work, I just don't see that there's going to be major changes in water chemistry outside the project area as a result of this. Inside the project area things change because it's a project.

MR. PADILLA: Can you qualify ridiculous?
THE WITNESS: Did I say ridiculous?
MR. PADILLA: Ridiculous increase.
THE WITNESS: Above 17. To cause areas outside the project area to come up to this ACL level, that would be ridiculous. We're not going to see that. I apologize for the use of the term. I was a little bit -- that's unprofessional of me.
MR. PADILLA: Quite all right. We got a definition. Thank you, Dr. Miller.
CHAIRMAN CATANACH: I'm sorry, where did the 17 come from?
THE WITNESS: Oh, okay. When we take the fluoride concentrations that have been measured in geothermal waters and I go through the processes of establishing a background threshold value, that 17 is the background threshold value.
What it is, is you have a bell-shaped curve of probability and tails out on the end. What the 17 does is it says here is the distribution of all the fluorides we have observed, but if we were to go out here on the tail, if we go to 17, at that point we have only a 5 percent probability that that number is a false positive, that that is a false increase over the background concentration.

So when we hit 17, we say we can't discount that number as being false. Therefore, we have a problem. So that's what it is, is determining out of the statistical distribution what numbers on a one-tailed test up here towards the high part give us a problem and where it is is the 5 percent confidence level.

CHAIRMAN CATANACH: On your plume exhibit, I'm a little confused on the scale. Is that plume approximately three miles north/south.

THE WITNESS: More like -- from here to here? More like --

CHAIRMAN CATANACH: No, I'm sorry. There's a scale there.

THE WITNESS: More like 12 top to bottom and open-ended on both sides.

CHAIRMAN CATANACH: And you're not suggesting that plume stops. You just don't have data to extend that plume?

THE WITNESS: This is the contour of the Elston, Deal and Logsdon A N & P data. There is some LD data that runs farther down, but it was a linear run of well points so I didn't include it.

Recalling from what's happened historically, when you start looking for something

you will find more. If we start looking for fluoride out there, we will find more. This happened with the arsenic standard long ago. We had the data reported from USGS to go by as to how many communities would be impacted by the new arsenic standards, but their detection limit was 50 PPB so we really didn't have knowledge.

And as soon as we looked we found more and the problem became bigger. If we have more wells put in by homeowners, ranchers or anybody else around the periphery of the plume, if they sample we will be able to recontour because we will know more. But we're not going to put more wells out there and find no fluoride. If we put more wells out there we will find more fluoride, some of it below the MCL and some above.

CHAIRMAN CATANACH: The area that you contoured that's above four parts per million of fluoride, is the southern end of the plume the area that you determined to be the geothermal uplift area?

THE WITNESS: Yes, it is. In this map figure it's overlaid by the leasing area. But the previous figure that shows the contour plume, that bulbous area with 11s and 12s in it, again, those

are the hot wells so that's sourced right on the geothermal project area.

CHAIRMAN CATANACH: So the lighter colors on the map, the two above two parts per million, that's just as a result of the main plume diffusing into that?

THE WITNESS: Well, to the southwest -- the hypothesis is to the southwest of Cotton City and to the southwest of the project, that's the geothermal leaky confined aquifer leaking in those areas. That's an extension of the source. The normal groundwater flow here is predominantly to the north.

Now, did mining cause some of the migration to the south? I can't say one way or the other. Was there redistribution in the south in the area around Cotton City due to agricultural? I can't say one way or the other.

The other indicators of Elston, Deal and Logsdon, the downhill temperatures, the element ratios of sulphate to boron, so on and on forth, I think they are more indicative of the geothermal area to the south, but the plume to the south, I would be hard-pressed to believe that that was pulled backwards from the geothermal area by the

overdraft, although looking at the headlines of the overdraft that was achieved, it might be possible. I don't know whether the timing or the hydraulic conductivity would have allowed it.

So the simplest explanation, I believe, for the southern projection of the fluoride is leakage from the confined geothermal aquifer.

CHAIRMAN CATANACH: You testified that injection into the shallow aquifer will not markedly affect AmeriCulture's wells. What is markedly? How do you confine markedly? Is it going to affect it? Is it going to increase the fluoride in their wells?

THE WITNESS: Well, State Well 1 and 2, no, I don't believe that. I don't believe their hot thermal wells, their deeper wells, are going to be affected by this at all.

As I testified, A444, yes. Years in the future I do believe if the shallow ejection goes, they are going to form a mixing zone and the water that is on the surface is going to be homogeneous. It will achieve a temperature that will be higher in some areas, lower in others. This is explained by other experts here.

If that groundwater divide that currently exists between AmeriCulture's mounding and the

Lightning Dock mounding is breached, then we have got mounded water that will move over into A444. If that water is higher fluoride, A444 is going to come back up. It's going to come back up in temperature, too.

So again, I come right back to the same place I was. Is this a bug or a feature? Are we restoring this well or damaging this well? Based upon the preproduction geothermal system, we are restoring this well. Based upon anthropogenic importation of cold water into the basin and discharging it for decades, we are hurting this well.

CHAIRMAN CATANACH: Would that change in the well be as a result of the injection or would it be as a result of the normal flow to the northwest?

THE WITNESS: Some of it is going to result from the flow to the northwest. Now, here is a balancing factor and this would require calculation. Is the normal flow of thermal water to the northwest sufficient to overcome the discharge of cold water? Historically, no. Otherwise, we wouldn't see what we see. So no, the advection is not going to do that. If the mound increases to the point that the amount pushes over, we will see that.

Now, again, I'm talking about effects as related on the surface, potentiometric surface. And there may be some things that happen different. Well A44 is anomalous, to start with. And the zone proposed may well cause that well to rebound to more original fluoride concentrations and more original temperatures.

MR. BALCH: If they were to drill deeper at the same location as A444, they would find at some point more original heat and --

THE WITNESS: That would be my theory, yes. They would also find how deep the area of quenched water is and we could track that chemically.

MR. BRANCARD: So along that, just to follow that theory for a second, if your assumption is there's a discharge here from AmeriCulture causing this wonderful green swath in the desert and that discharge is also what's quenching --

THE WITNESS: I have observed the discharge.

MR. BRANCARD: So if the discharge stops --

THE WITNESS: Over some period of time the system would re-equilibrate. Discharge would not be

forming a water table mound that is opposing the advection of the normal Animus Valley water geothermal flow through it. So yes, if you stop that discharge, there wasn't a groundwater mound associated with A44, and advection took place, that water is going to return back to the normal geothermal condition. The condition it has right now is maintained by discharge.

MR. BRANCARD: Let me totally shift gears. I want to talk about the data, your analysis that was used in the report of April 20, 2015 that is Exhibit P. Some questions were asked of you about this data and about the reliability. Let me just go to Page 4, the third paragraph. Mr. Lakins asked you about the statements in here about that at least ten samples are needed to statistically determine --

THE WITNESS: We are in the 2014 or the 2015?

MR. BRANCARD: 2015, Page 4.

THE WITNESS: Very good.

MR. BRANCARD: Okay. And you agreed with him that an insufficient number of samples were collected, the seven samples in December of 2013, and you agreed that at least ten samples are needed.

THE WITNESS: Yes.

MR. BRANCARD: Okay. So if we look down at Table 6 under the third column, F, which I assume means fluoride, there are ten samples there, correct?

THE WITNESS: In 2015, yes, we have ten samples.

MR. BRANCARD: If you go to Table 8, next page, fourth row, all fluoride number of observations is ten.

THE WITNESS: Correct.

MR. BRANCARD: If we then flip to Attachment B to this report a few pages later, Table 3.

THE WITNESS: Yes.

MR. BRANCARD: These are your samples, correct? This is where you got your data from?

THE WITNESS: No, because this only lists three hot wells. Let me make sure I am referencing the right thing here. I haven't read the report since I wrote it.

MR. BRANCARD: Attachment B, Table 3.

THE WITNESS: Attachment B, Table 3 does not reflect all of the hot water analyses that were used in this analysis.

MR. BRANCARD: I'm confused because there

are ten samples. There are actually eleven; one is a duplicate. And the numbers that are listed here under the fluoride, Row 6, are the exact numbers in Table 6 and they are all fluoride.

THE WITNESS: I understand now.

MR. BRANCARD: So you had seven samples from the monitor wells collected prior to the startup of the project in November/December 2013. I think Mr. Lakins pointed that out. These were prior to the startup of the project?

THE WITNESS: Yes.

MR. BRANCARD: So the additional three you added to get to the statistically relevant ten were the old samples, is that right?

THE WITNESS: Correct.

MR. BRANCARD: Burgett 1986, Burgett '93, LCD hot 2008.

THE WITNESS: Correct.

MR. BRANCARD: This has become significant because those numbers, the monitor wells, if you flip back two pages, the locations of the monitor wells are on this map?

THE WITNESS: Yes.

MR. BRANCARD: So, for instance, Monitor Well 2 and Monitor Well 3, which appear to be the

closest ones to the AmeriCulture property, they both measured -- I saw an 11 and a 12 fluoride.

THE WITNESS: I am seeing the same numbers.

MR. BRANCARD: If we go to the beginning of the report, Table 1, it gives us the depth of all these monitor wells, 55 to 85 foot depth.

THE WITNESS: Correct.

MR. BRANCARD: So these are all shallow measurements of fluoride?

THE WITNESS: Yes, they are.

MR. BRANCARD: And the one that Commissioner Balch pointed out, Monitor Well 5, all the way furthest south is the only one that is at this point within the standard.

THE WITNESS: Correct.

MR. BRANCARD: Which I will have to correct you. I read the regulations, 3103 which Mr. Lakins pointed out. The fluoride standard is 1.6.

THE WITNESS: Thank you, sir.

CHAIRMAN CATANACH: Any other questions?

MS HENRIE: Mr. Chairman, we would like to move Exhibits 7, 8, 9 and 10. We also would like to move the handout as an Exhibit 11. That's the

slides that we should have tendered it earlier. Let me stop there for a second.

MR. LAKINS: I'm not going to object, but the handout, as it is, is a bit confusing because it's front to back and not numbered pages. If that could be reproduced single pages and numbered.

MS HENRIE: Absolutely.

CHAIRMAN CATANACH: So no objection?

MR. LAKINS: No, sir.

MR. BRANCARD: We will make that -- the next number is 11? So the entire thing will be 11.

CHAIRMAN CATANACH: Exhibits 7 through 11 will be admitted.

(Note: Exhibits 7 through 11 admitted.)

MS. MARKS: The OCD would like AmeriCulture's Exhibit K that's been referenced moved into evidence as well.

CHAIRMAN CATANACH: Any objection?

MS. MARKS: In case it's not later moved and admitted into evidence.

MR. LAKINS: I'm just a little stymied because they objected to my admitting an exhibit on cross but I'm not going to object to that. I will eventually get all of mine in. But K?

MS HENRIE: Yes.

MR. BRANCARD: We can admit P also because everybody has been talking about it. How about that?

MS HENRIE: Yes.

MR. LAKINS: Thank you.

CHAIRMAN CATANACH: Exhibits K and P will be admitted.

(Note: Exhibits K and P admitted.)

MS HENRIE: Mr. Chairman, I realize it's almost 5:00 o'clock. I would like to, if the commission allows, recall Roger Bowers and he can identify the materials that he brought with us at the commission's request yesterday. Mr. Bowers, if you are interested, can also stand for questions of the commission and clarify that Lightning Dock intends to rely on the deep injection wells once they open up.

MR. LAKINS: I thought the decision was made that all recalls would be after we're done.

CHAIRMAN CATANACH: Yeah, and I think in the interest -- I don't think we're going to be able to finish with Mr. Bowers in a reasonable amount of time, so I think it would be better to save room for the next hearing.

MS HENRIE: Would the commission like to

take administrative notice of the things that I brought?

MR. BALCH: Would you like to admit them as exhibits?

MS HENRIE: No, I actually don't want them in the record but I would like you all to have a chance to see it. I noticed this morning you took administrative notice of some items.

MR. BALCH: You don't want us to take them home and study them for two weeks?

MS HENRIE: You can. Absolutely.

MR. BALCH: Do you have copies for us to take?

CHAIRMAN CATANACH: What are the documents?

THE WITNESS: May I be excused?

CHAIRMAN CATANACH: Yes.

MS HENRIE: We believe this is confidential but we would share with the commission the well log you saw. We would not like to share that with the AmeriCulture. This is a report that Roger Bowers referenced. It's available on the internet so AmeriCulture probably has it. It's the 2005 REDW report that summarizes the earlier studies to 2005.

The final thing is something again we are happy to share with AmeriCulture. Mr. Bowers plotted all of the data that he could get his hands on down to 100 feet, and again, this is based on a wider field of data over time. This is the outline that you will be seeing AmeriCulture present when it makes its case. We have a comparison of what will be presented and what we think the size of that hot spot is based on Roger's knowledge.

MR. BALCH: How do we treat proprietary data?

MR. BRANCARD: I mean, the point has been made, and I think it's a valid point, that if all the parties can't have access to this, I don't know if you want to have that be evidence that we look at. Because I think it's important evidence. We would certainly --

MR. BALCH: But it removes their chance for rebuttal.

MR. BRANCARD: I don't know if there's anything in there to question.

MS HENRIE: We would share these with everybody.

MR. BALCH: Except for the cross-sections? You can get the logs of the state from the New

Mexico Bureau of Geology and make your own cross-sections.

MS HENRIE: That is true. We just did the work ourselves. You're right, another person could. We can share all of this, which doesn't mean that we are --

MR. BALCH: You don't want it in the public record?

MS HENRIE: We don't. So I would suggest you take administrative notice of it, share it with all the parties but don't add it as an exhibit.

MR. BRANCARD: I mean, I think we would have to have some sort of simple confidentiality agreement.

MR. LAKINS: I think we need to have it. I believe, as was pointed out in my reply, I believe, in my motion, that the commission can hold information confidential even to the point of closing a meeting, but I think the point is made that the underlying data is public data. And this is just a compilation of publicly obtainable data which would, therefore, tell me it's not trade secret. The physical compilation of public data.

But aside from all that, I think the way to approach it that we would prefer, we would be

happy with a confidentiality agreement. We did one before two years ago and that would seem to work for us. We just would like to have the benefit of being able to analyze the same data that the commission is going to be given and not for us to have to operate in the blind.

MS HENRIE: This is also an interpretation of the data. It's a compilation and interpretation.

MR. BALCH: That's probably one of the most common things we would get is a cross-section and interpretations.

MS HENRIE: Right. So what I'm trying to say not very well is that we are not conceding on our trade secrets.

MR. BRANCARD: Can we all agree that the parties will work on a simple confidentiality?

MR. LAKINS: I think the one we had before can be cut and pasted.

MR. BRANCARD: If you can find it.

MR. LAKINS: It's probably in here.

MS HENRIE: I believe it says all confidential materials are returned at the end of the hearing, too.

MR. LAKINS: We did that.

MS HENRIE: I agree.

MR. BRANCARD: We can resurrect that.
MR. LAKINS: Yes, sir.
MR. BRANCARD: Then the second document is a publicly available report.
MR. LAKINS: We have that.
MR. BRANCARD: Do you object to it being offered as an exhibit?
MR. LAKINS: No. For a moment I thought it was that thick.
MS HENRIE: It is 96 pages.
MR. LAKINS: 1,000 pages is too much.
MS HENRIE: Okay. So --
MR. BALCH: You have a map that you are also willing to make an exhibit?
MS HENRIE: Yes.
MR. LAKINS: That's not an issue. We like maps.
MR. BRANCARD: Again, I guess I have the same -- I'm going to have a little bit of problem with what you submitted as exhibits earlier today. There's a lot of information -- not a lot -- but information on pieces of paper, you know, without alleging or a scale or a source. So you have a map. It has dots on it, lines on it. Is there an explanation as to what those dots, lines, things

mean?

MS HENRIE: It has a key. There is a scale in feet. The black dots are TG holes. The sections are numbered and the contours have the degrees -- you will see from this that this is 175 degrees Fahrenheit. What it doesn't say -- oh, no, it does. Temperature at 100-foot depth.

MR. LAKINS: If we could look at it. As long as my expert can read it and understand it, I'm okay.

MR. BRANCARD: Let's admit this report as Exhibit 12.

MS HENRIE: Okay.

MR. LAKINS: You will give us one of those?

MS HENRIE: I prefer to give you one now if the commission is okay.

MR. BRANCARD: Make that Exhibit 13. And then we will figure out what to call the cross-sections. Did we have a separate numbering system for the confidential documents in the previous hearing? Do you recall?

MR. BALCH: I guess you have to refer to it in the testimony.

MR. LAKINS: I don't recall that we did.

I would -- I could be wrong. I would just suggest we call it Confidential Exhibit 14.

MR. BRANCARD: We will call it Exhibit 14C.

MS HENRIE: I will get your copies to you as soon as I can.

MR. LAKINS: Redo the ones that were printed so they are in numbered sequence?

MS HENRIE: I did. Mr. Chairman, before we close, and with apologies, I have heard from my client who objects to moving the hearing to October 8th. We filed our applications on June 1st. We were assured by the agency they would be processed, and here it is months later, again, before we get through this process. Is there any way we could try to resume tomorrow? Is there any -- I mean, we now don't have any more witnesses. We are ready to rest and so it's just a question of hearing AmeriCulture and any division witness.

MR. LAKINS: I thought you had one more.

MS HENRIE: We were going to bring back Roger and Monte.

MR. BALCH: Your prehearing statement said seven hours of testimony. We can't help it if it takes two days to do that.

MR. BRANCARD: I think the commission is trying its best to get this done as soon as possible. We have other hearings we had to put off to hear this. So our process is what it is. So I think one thing I would suggest is that the parties sort of come prepared for the next hearing. Start thinking already about proposed orders, proposed findings and conclusions, because that's going to be the next step after the commission makes the decision is rendering a decision to try to deal with your concerns about time. That usually adds several months or weeks to the process.

MS HENRIE: Could the commission order the parties to do that? We are ready. We have got ours drafted.

MR. BRANCARD: Bring it with you then. This morning at the hearing the party came with an order. Obviously, that was a lot quicker.

MS HENRIE: I really want to cut down in post-hearing briefing or delays or arguments. We have had a lot of time together and we are going to have more.

MR. BRANCARD: Mr. Lakins, how many witnesses do you have?

MR. LAKINS: Three.

MR. BRANCARD: Do you recall how much time you have?

MR. LAKINS: We are going to say four. We are going to start at 1:00 o'clock. On that day we will get through, in my opinion, two for sure that one day. Mr. Seawright will be last. I don't see us taking our presentation part as being four hours. Cross-examination and the commission's questions obviously.

MR. BALCH: And rebuttal.

MR. LAKINS: Yeah. But from my presentation of my three witnesses, I will do my best to get through all of them as fast as possible. I anticipate the first two on that afternoon for certain.

MS MARKS: Just so I don't forget, there was a letter that came in as a public comment yesterday.

MR. BRANCARD: Revised version came in today.

MS. MARKS: I don't know what you want to do about that but it came in when the hearing was scheduled.

MR. BRANCARD: It's non-technical non-party comments.

MS. MARKS: I just don't want something not be made part of the record.

MR. BRANCARD: Did you have a chance to read it?

MR. LAKINS: I have not seen it.

MS. MARKS: It did not go to either counsel.

MR. BRANCARD: We will forward it. Thumbs up or thumbs down on the comments. Non-technical, non-sworn, non-party comments.

CHAIRMAN CATANACH: Mr. Lakins, at the next hearing can you be prepared with a draft order?

MR. LAKINS: Yes, sir.

MS HENRIE: Thank you.

CHAIRMAN CATANACH: Do we have enough copies to distribute those now?

MS HENRIE: Yes, we do.

CHAIRMAN CATANACH: So that's 12 and 13, right?

MS HENRIE: 12, 13 and 14C.

CHAIRMAN CATANACH: So at this time we will admit Exhibits 12, 13 and 14C.

(Note: Exhibits 12, 13 and 14C admitted.)

MS HENRIE: Thank you, Mr. Chairman.

MR. BRANCARD: You will get us a better

version of Exhibit 11?

MS HENRIE: Yes, I will. And shall I e-mail you copies? Would that suffice or shall I bring hard copies or both?

MR. LAKINS: If you would e-mail me as soon as possible. Also e-mail me the maps. Yes, please.

MR. BRANCARD: If you could, Ms. Henrie, try to send these to Mr. Dominici.

MS HENRIE: Yes. I'm just writing exhibit numbers on them. I don't have anything more to present today. I would like to save resting my case and closing argument until next time.

CHAIRMAN CATANACH: We will save it. So there being nothing further, we will adjourn the hearing for now and reconvene on October 7th at 1:00 p.m.

(Note: The hearing was concluded at 5:10).

REPORTER'S CERTIFICATE

I, JAN GIBSON, Certified Court Reporter for the State of New Mexico, do hereby certify that I reported the foregoing proceedings in stenographic shorthand and that the foregoing pages are a true and correct transcript of those proceedings and was reduced to printed form under my direct supervision.

I FURTHER CERTIFY that I am neither employed by nor related to any of the parties or attorneys in this case and that I have no interest in the final disposition of this case.

JAN GIBSON, CCR-RPR-CRR
New Mexico CCR No. 194
License Expires: 12/31/15