UNITED STATES DISTRICT COURT

DISTRICT OF MASSACHUSETTS

Civil Action
No. 82-1672-S

SKINNER, D. J.
and a Jury

ANNE ANDERSON, ET AL

V.

W. R. GRACE & CO., ET AL

Sixty-Ninth Day of Trial

APPEARANCES:

Schlichtmann, Conway & Crowley (by Jan Richard Schlichtmann, Esq., Kevin P. Conway, Esq., and William J. Crowley, III, Esq.) on behalf of the Plaintiffs.

Charles R. Nesson, Esquire, on behalf of the Plaintiffs.

Herlihy & O'Brien (by Thomas M. Kiley, Esq.) on behalf of the Plaintiffs.

Hale & Dorr (by Jerome P. Facher, Esq., Neil Jacobs, Esq., Donald R. Frederico, Esq., and Deborah P. Fawcett, Esq.) on behalf of Beatrice Foods.

Foley, Hoag & Eliot (by Michael B. Keating, Esq., Sandra Lynch, Esq., William Cheeseman, Esq., and Marc K. Temin, Esq.) on behalf of W. R. Grace & Co.

Courtroom No. 6
Federal Building
Boston, MA 02109
9:00 a.m., Thursday
June 26, 1986

Marie L. Cloonan
Court Reporter
1690 U.S.P.O. & Courthouse
Boston, MA 02109

A1

THE COURT: Good morning, ladies and gentlemen; good morning, counsel.

Proceed wtih the cross-examination of Dr. Guswa.

JOHN GUSWA, Sworn

CONTINUATION OF CROSS-EXAMINATION BY MR. SCHLICHTMANN

MR. SCHLICHTMANN: Your Honor, for the record, I neglected to identify for the record the exhibits that were used yesterday. I would like to do that for the record.

THE COURT: The chalks.

MR. SCHLICHTMANN: Excuse me, the chalks.

The first chalk is 901A, and that had an overlay on it, which was 901B, and that was then placed over another diagram which is 901C.

THE COURT: All right. Which one was the reproduction of Mr. Koch's diagram? Didn't you use that?

MR. SCHLICHTMANN: 901A is a xerox reproduction of Mr. Koch's diagram. And 901C is a photograph reproduction of his diagram.

In addition, for the record, we placed an overlay marked P-902 upon a previous chalk identified as G-952.

MR. KEATING: Was that D? I'm sorry.

MR. SCHLICHTMANN: The overlay was P-902 and placed over G-952.

Q And, Dr. Guswa, perhaps you could just mark on this overlay some boundary points so when we take the overlay off we can always line it up again.

A Okay.

Q For the record, 901B, the overlay, does match up with those 901A and 901C, the white dots over the top of both diagrams.

Perhaps you can line it up on the border.

THE COURT: You are the expert on overlays, Mr. Schlichtmann, perhaps you can do it.

MR. SCHLICHTMANN: All right, I will do it.

THE COURT: I don't know what happened to the graphics industry in this town, but it is going to suffer a major depression.

End A
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BS/kr

Q Dr. Guswa, during examination by Mr. Facher, you were asked the following question,"Now, I'm sure everyone, including Mr. Schlichtmann, would like to know why there are no arrows pointing directly at the heart of the Beatrice site.

I'll do some of your work for you.

Can you explain that, sir?"

Do you remember being asked that?

A Yes.

Q And your answer was "Yes. The fundamental reason for that is that the data are not sufficient to draw conclusively what the groundwater flow direction is in this location."

Do you remember answering that?

A Yes, I do.

Q Is that your testimony?

A Yes, it is.

MR. FACHER: I believe that was a part of the answer. I don't have a transcript. Was there a later answer?

MR. SCHLICHTMANN: Yes, but just that sentence.

Q Is that still your testimony?

A Yes, sir.

MR. FACHER: What page is that, sir?

MR. SCHLICHTMANN: Volume 68, Page 68.

Q Now, also, you were asked by Mr. Keating, and I guess to put it in proper context I should probably say it's Volume 68, Page 21, you were asked the question, "All right.

Is it your opinion, Dr. Guswa, that any of these five sources of contamination that you have information or you have evidence, that any of these five sources of contamination, in fact, contaminated, in your opinion, at least to the degree of certainty that you would want as a hydrgeologist, the wells in May of 1979?"

And you answered, "I'm confused by the question."

Do you remember that?

A Yes.

Q You were then asked, "Do you have an opinion" -- actually, two questions, but there was objection -- but you were then asked, "Do you have an opinion as to whether any of these mechanisms were, in fact, the source of contamination?"

Do you remember that being asked?

A Yes.

Q And you answered, "I don't know that any particular mechanism was the exact source of contamination."

Do you remember answering that?

A Yes.

Q Is that still your testimony?

A In the general sense, that is still my testimony. The problem I have in responding to that question and to your question is any one of those could have resulted in the contamination found in Wells G and H. No one has collected

any data to tell me exactly when the sewer overflowed, the exact minute, and traced the path, let's say if the sewer were the source, that got to Wells G and H. There is no data to make that determination. I cannot create facts. I can only, as a hydrogeologist, discuss probable pathways to Wells G and H. And in my opinion, any one of those is a probable pathway to Wells G and H.

My understanding of the industrial history of that area and what is going down that river valley further leads me to conclude that there is a probable pathway to Wells G and H.

Q All right.

But you haven't made that determination, have you? You said nobody else has. That means you, yourself, haven't made that determination.

THE COURT: Which determination?

MR. SCHLICHTMANN: The determination of the particular mechanism that was the exact source of the contamination of Wells G and H.

A It may have been one. It may have been all.

Q You don't know which one?

A That is correct.

Q Now, Dr. Guswa, you talked at great length about the work that you did in putting together this computer model of the aquifer. Do you remember that?

A That is correct.

Q And the steps that you followed in putting together that model, you consider that those steps should be taken by any hydrogeologist who wishes to gain an understanding of the squifer by use of a computer model, is that right?

A I am not quite sure which steps you mean. I think if anyone is trying to understand the groundwater hydrology in the area, he would approach it generally in the same manner that I have approached it.

Q You considered the way you did it was good hydrological practice?

A Yes.

Q And anybody else who was doing a computer model would have undertaken the same essential steps that you did, if they were also going to engage in good hydrological practice in putting together a model of the area, is that right?

A No, that is not correct. Models are the tools we use to analyze the system. The degree of complexity we incorporate in the model is a reflection of the degree of complexity of the groundwater flow situation and the precision and accuracy we want in our answer. If we don't need or tend not to include complexity or care not to be precise and accurate about our measurements, we won't use a complex model.

Q You used a complex model?

A Very complex.

Q The purpose of using it was for you to understand this aquifer and how it operates?

A Actually, it works back and forth. If you remember on that illustration conceptual understanding, model construction or revision, reality check, as you develop the conceptual understanding, you make an initial model construction. As you test the model, you get information about whether you need to add complexity to the model or not. So it's an interim process. We don't let the model drive our conceptual understanding nor do we let the conceptual understanding totally drive the model.

Q The model is an attempt to understand a reality?

A That is correct.

Q And the model makes use of mathematical equations and computations which are put together with various mathematical and algebraic formulas in attempts to make reality, recreate reality, using those mathematical formulas?

A It's an attempt to recreate the important aspects of the reality; it cannot incorporate all the aspects of the reality.

End B

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Q So oftentimes it has to average things?

A That's correct.

Q And make interpolations?

A That's correct, just as we would in any other method of analysis.

Q Now -- Well, I guess we will have to do it from here. It is a little small.

Dr. Guswa, if you wouldn't mind coming up to the jury box?

A (Witness complied.)

Q Dr. Guswa, I show you a diagram. Am I right that on this diagram is indicated a grid system such as would be used in a computer model?

A That's correct.

Q If, in fact, this is the area trying to be understood, this grid is how a hydrogeologist in trying to understand this actual real system would in essence grid the system (indicating)?

A Not exactly.

This is Dr. Pinder and John Bredehoeft who prepared this model back in the early 1960s, one of the first attempts of using a groundwater model. This is a finite definition; this is in Nova Scotia. The actual grid that they constructed is a rectangular prism that covered this area. What they have left out here

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are areas they assigned zero permeability or no water transmissive properties to the areas they were considering.

Q They put bounds on the system and then analyzed the system within those bounds?

A That is correct.

Q They are trying to understand what is going on here (indicating)?

A That is correct.

Q And here is this right here (indicating)?

A Yes.

Q That was, as you indicated, that was done by Dr. Pinder and Dr. Bredehoeft in 1968, and it is a very well-known study; is that right?

A Yes.

Q And the study they were trying to do, they were applying these principles of computer modeling to an area in which there was a well pumping near a river?

A That's correct.

Q It was the Musquoduboit River.

A I still don't know how to pronounce it.

Q In doing their model, as a matter of fact, as indicated here, they determined that the cone of depression from that well went underneath that river, is that indicated right here (indicating)?

A That's correct.

Q Now, the model that you used was the model developed at the USGS, is that right?

A One of the models was developed at the USGS, and one of the models was developed for the Nuclear Regulatory Commission.

Q The model you used you told the jury was the USGS model?

A Yes.

Q The USGS was at the forefront of using computer models to understand acquifers, is that right?

A That is correct.

Q When did you start to work for the USGS?

A 1974.

Q And you are aware of the fact that the USGS model that was used by the USGS has been used by the USGS was developed and applied by Dr. Pinder and based on Dr. Pinder's and Dr. Bredehoeft's work, that is right?

MR. KEATING: I object, your Honor. We are now referring to something in Nova Scotia. I don't see the relevance of that.

THE COURT: Well, I suppose the question is whether the theoretical applications, the theoretical structure of the model was based upon some theories of modeling developed by Dr. Pinder and the other fellow.

THE WITNESS: I would actually like to

answer the question.

THE COURT: Is that your question?

MR. SCHLICHTMANN: Yes.

THE COURT: If that is the question, that's okay.

A This was the first groundwater flow model developed at the United States Geological Survey. It is two-dimensional groundwater flow model. Our computer capability at the time this model was developed were such that we were just getting into the geological survey and was just getting into the forefront of applying these techniques. Since that time, the Survey has developed a three-dimensional model, three-dimensional flow of saturated flow and unsaturated flow, and, in addition, the chemical transport model. This is not the USGS survey model as used to -- This is the first one to develop a groundwater flow model.

Q That was work done by Dr. Pinder at the USGS?

A Dr. Pinder and John Bredehoeft.

Q At the USGS?

A At the United States Geological Survey.

THE COURT: Does the model shown on that diagram, is it not theoretically the same as the model that you were using, is that correct?

THE WITNESS: That's correct.

Excuse me, I'm sorry, your Honor. Theoretically the equations are the same. That one had the capability of only looking at one layer at a time. It did not have the capability of looking at several different layers. It was a vertical averaging process that had to be incorporated into that model, just as we study more and more problems, there was a research group that was developing modeling techniques and more complex ones.

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THE COURT: When did the three-dimensional model get developed?

THE WITNESS: The first development of the three-dimensional model was by Peter Trescott, who worked with Dr. Pinder at the Geological Survey also, and that was probably 1972 or 1973.

In 1976, there was a further revision by Steve Larson and Peter Trescott to that three-dimensional model. Since that time, there has been other revisions and modifications and updates. It doesn't mean that the earlier versions were not good, it is just that we are adding more capabilities.

Q (By Mr. Schlichtmann) Well, you will agree, the U.S. Geological Survey three-dimensional model was an outgrow of Dr. Pinder and Bredehoeft?

MR. KEATING: I object. This is the problem

we had a couple of days ago.

THE COURT: I don't know if it matters much at this point. I will sustain the objection.

Q Now, Dr. Guswa, you are familiar with the work that Dr. Pinder has done in this area of three-dimension model?

MR. KEATING: I object.

THE COURT: Overruled.

A Could you repeat the question?

Q You are familiar with the work in the area of computer simulations of aquifers?

A Yes. In general applications of modeling techniques?

Q Yes.

You know he has written in the field?

MR. KEATING: I object.

THE COURT: Unless this is going to come to some specific question, I will sustain the objection.

I'll hear where you are going.

(Conference at the bench as follows:

MR. SCHLICHTMANN: Dr. Pinder has used and developed a three-dimensional model of this aquifer.

THE COURT: So what?

MR. SCHLICHTMANN: It is not so what. The defendants have not conceded that Dr. Pinder has done that.

MR. KEATING: Where are you going?

THE COURT: I didn't get the final question.

MR. SCHLICHTMANN: That Dr. Pinder has developed a three-dimensional model and he is familiar with this aquifer system.

THE COURT: Of this aquifer system.

MR. SCHLICHTMANN: A three-dimensional model that was provided to him. He made an insinuation that Dr. Pinder does not have a three- --

THE COURT: I have not heard that.

MR. SCHLICHTMANN: That is the insinuation of the cross.

THE COURT: I have not heard it and I will sustain the objection.

MR. KEATING: Before he asks the question --

THE COURT: If Dr. Pinder did a three-dimensional model, it was either used --

MR. SCHLICHTMANN: It was used and presented to the jury.

THE COURT: Fine. Then that is all there is to it. We don't need to go over it again.

MR. SCHLICHTMANN: I want Dr. Guswa to explain that such was done. It is my cross-examination, your Honor.

THE COURT: Listen, you seem to think you can do anything you please on cross-examination.

MR. SCHLICHTMANN: No, that is not true.

THE COURT: You can't. I am going to sustain the objection. It has no bearing on what this man has been talking about.

MR. KEATING: I want to point out while we're up here, we had this discussion before. Dr. Pinder categorically said when he testified that his opinion was based on a one-dimensional model. I said at one point, I said six times, "You said at your deposition it was." Now, I know there is a back door --

THE COURT: Listen, I ruled on the question. The objection is sustained.

MR. SCHLICHTMANN: Thank you.

END OF CONFERENCE AT THE BENCH.)

Q Dr. Guswa, a computer model has certain basic principles, basic scientific principles which apply to it, is that right?

A That is correct, if it's developed properly, yes.

Q Yes.

And one of the principles of a model is that conservation of mass, that is one of the basic principles of the model?

A Yes.

Q Now, a model is an attempt to understand a particular area, in this case, your model, the East Woburn aquifer. And conservation of mass, the principle is is that for instance what comes into this area has to come out of the area or be left behind in the area?

A That is correct.

Q That is a very simple way of stating conservation of mass. And the model to understand the system has to be in balance, it has to be in equilibrium, doesn't it?

A The total accounting system has to balance. The model doesn't have to be -- Well, generally what you said is correct. It's a technical semantic, but it is not important.

Q The points is you want to understand the system?

A Yes.

Q So what you do is, you showed it very nicely on this exhibit, I think --

Would you come here to the jury.

G-966 very nicely shows the grid system you put into the system. It shows the bounds. This is the area you wanted to understand?

A Yes.

Q You put these grids over all of these areas and inside each grid goes mathematical formulas which try to understand that particular area of the aquifer?

A Yes, it provides a relationship between each of the blocks.

Q And all of these blocks have to be in equilibrium, have to be all working together for you to understand, for you to get the feeling that what came in is coming out or is left behind, but you have an understanding of what is going on in there, is that correct?

A That is correct.

Q Step to the side, please.

A Oh, I'm sorry.

Q Now, Dr. Guswa, this grid system covers the W. R. Grace site up here?

A That is correct.

Q And UniFirst over here?

A Yes.

Q And Hemingway Trucking down here?

A Yes.

Q And Olympia Avenue here?

A Yes.

Q Salem Street here?

A Yes.

Q And the railroad track going through here?

A Yes.

Q And, of course, the river, going through here?

A Yes.

Q And also the Beatrice site?

A Yes.

Q Could you outline to us for the jury on this overlay the outline of essentially the Beatrice site, roughly. Doesn't have to be that exact.

A Okay. (Witness complies.)

Can I get a different one for data location?

Q Sure. Will that help?

A Yes. There you go.

I will take it down.

That is approximately it, I think.

Q All right.

Now, the other exhibit right here, by reference to this exhibit, would you show the jury, would you outline on that exhibit, as well -- I can just hold it here -- the area that you don't have an understanding as to groundwater flow. Would you indicate that on your grid

system?

MR. KEATING: I object to the question.

A I think that is a fair --

THE COURT: I sustain the objection.

Q You said that you didn't understand groundwater flow at the Beatrice site, is that correct?

A I said on January 3rd, 1986, on the basis of that water level data, I cannot tell you exactly which direction particles of water are moving.

Q Would you please indicate on that diagram the area that you don't understand where groundwater flowed on January 3rd at the end of the pump test?

MR. KEATING: I object. That is not what he said.

MR. SCHLICHTMANN: I think that is exactly what he said.

THE COURT: No, it isn't exactly what he said. The question of the area is what we're trying to get, not a characterization of the witness's testimony.

MR. SCHLICHTMANN: I am trying to define it.

THE COURT: So if you indicate the area in which the data is, in your view, insufficient for you to be able to determine the water flow as of January 3rd, '86, I think that will satisfy the requirements of the day.

MR. SCHLICHTMANN: Satisfy me, too. Thank you.

A What I am going to draw is the area within which there is not sufficient vertical control on the measuring points for the wells nor is there sufficient precision in the water level data to go in and, as a professional, draw a groundwater flow direction as a specific direction. I understand the general flow direction, but I don't understand the specific direction.

Q All right.

Would you indicate that area?

A (Witness complies.)

Q Now, do I take it, then, Dr. Guswa, that you do understand, have an understanding, are willing to give an opinion, about the groundwater flow which is outside that blue circle? Am I right about that or am I wrong about that?

A Well, you are right in saying it that way. However, unfortunately, I was focusing on where we had drawn the red arrows yesterday.

Q What I am really interested in doing, and correct me if I am wrong, all I want to do is I'd like you to indicate to the jury, as best you can on your computer grid, the area which you, as a professional, don't feel that you can give an opinion or don't have an understanding of that area on January 3rd, at the end of the pump test.

MR. KEATING: Object to the breadth. I think

he hasn't said he doesn't have any understanding.

THE COURT: He can't give an opinion as to water flow. He's drawn the marks in response to questions on cross-examination, but he is not prepared to give his opinion that those are the correct marks, is that correct?

THE WITNESS: That is correct.

THE COURT: All right.

Q Now, you are supposed to have indicated on the chart there what the area is. Have you done that?

A Yes.

THE COURT: What is the next question?

Q My question is: Am I right -- please correct me if I am wrong -- that outside this circled area you are prepared to give an opinion about groundwater flow in this area on the morning of January 3rd, '86, or am I wrong about that?

MR. FACHER: Objection.

A I will give an opinion.

THE COURT: The objection is overruled.

A Yes.

Q Okay.

You are prepared to give such an opinion?

A Yes, I am.

Q Now, would you be able to indicate that opinion on this diagram?

MR. KEATING: Write the opinion out?

A I can indicate it on this one.

Q Do it on this one and we will do it on this one.

MR. FACHER: I object.

THE COURT: The objection is overruled. If he can indicate the water flow on that diagram, he may do so.

A In my opinion, it's going directly into the area of greatest uncertainty, and once it gets in there, I don't know which way it is going.

Q You have no idea?

A That is correct, on the basis of these measurements.

Q Now, Dr. Guswa, please correct me if I am wrong. The purpose of doing the computer model is to get an understanding of the aquifer. Am I right about that?

A That is correct.

Q And if there is an area in the aquifer -- Every area on this map, on this grid, you, in order to understand this system, in order to have a complete model, you are forced to place into every one of these grids some value. You have to put some value in there, isn't that right?

A That is correct.

Q And whether you like it or not, a value has to go in there or there will be a big hole in your model that you just don't understand what is going on?

A That is correct.

Q And, in fact, in your computer model, you put values in

this zone of uncertainty?

A That is right.

Q You put them in there?

A That is correct.

Q And then you turned the computer on and you asked it, "Well, now, based on what I put in there, where is the groundwater"?

A That was under non-pumping conditions I made that check. Mid-November water level, water measurements, no wells pumping, I made that determination.

Q Between January 26 and today, did you ever go to your computer model and ask it, "Tell me, please, how does the groundwater flow, based on the values that I put in these grids here, how does the groundwater flow," or "how should have it flowed if I have my model all correct, if I understand reality, how did groundwater flow on the morning of January 3rd, '86, just before they clicked off the wells?"

A I was never asked that question.

Q You were never asked that question.

Is your model able to answer that question?

A The questions that I asked it relate to how much water level change was there in this general area as a result of pumping of Wells G and H and the Riley well.

Q Yes.

A I made a calculation and was satisfied the calculated

response was agreeable or accetpable to what was observed.

Now, we talk about making approximations and we talk about uncertanties. There are a lot of uncertainties about the pumping of the Riley wells when -- They were pumping, how much -- only because they were running on their normal operations. The precision of the measurements adds to the uncertainty.

We're talking, I think I said, three-tenths of a foot, but I went back and it's probably only two-tenths of a foot variation on some of the wells. To make a determination of the exact direction of movement at this scale, at the level of detail you are asking me to make it, you cannot do it on the basis of blocks that are a hundred fifty-five by a hundred fifty feet wide, which is what these are.

Q But, Dr. Guswa, am I not correct, and please correct me if I am wrong, every place that you have a grid is a place which you put a value in, is that right?

A That is correct.

Q And every place that you put a value in, every place you have a grid, your computer model can tell you for that grid where the direction of the groundwater flow on January 3rd, 1986, before they turned the wells off is? Am I correct about that?

A No, you are not correct.

You remember the last step of the box. The

flow chart interpret results. The interpretations we made are based on our understanding of the precision and the accuracy of the data that go into it. We cannot make a more precise determination on our model than we have actual precision in our measurements. It would be unrealistic to try to do it.

THE COURT: Is that expressed by the phrase, "Garbage in, garbage out?"

THE WITNESS: It is expressed by the phrase, "If you put garbage in, you will get garbage out," but it also means do not try and overextend the capabilities of the model.

Q All right.

Now, what I'd like to know is, I would like to know if I asked you, based on all the good work you have done on this aquifer, if I asked you, I was very interested, was very, very interested --

MR. KEATING: Can we leave the characterization of Mr. Schlichtmann's attitude out?

THE COURT: Oh, he needs a certain amount of latitude --

MR. KEATING: I withdraw it. I withdraw it.

THE COURT: -- in the questioning process.

MR. SCHLICHTMANN: I won't abuse the privilege, your Honor. I will try not to.

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MR. SCHLICHTMANN: I won't abuse the privilege, your Honor. I will try not to.

THE COURT: Go ahead. Add a little color to the thing.

Q (by Mr. Schlichtmann) If I was somewhat interested in understanding in this particular area here (indicating) with all of these wells, I wanted to know when Wells G and H were pumping, how did the groundwater flow from this area over to Well G, I wanted to know that, and I had constructed a computer model, much as you had done --

A Yes.

Q -- and your computer model understood reality or as best as a computer model can understand reality --

A That is correct.

Q -- could I not go to that computer model and say, if I got everything right everywhere else and I thought I got it right where you are, in this area here, would you please tell me how does the groundwater flow in that particular area in that particular grid to Well G at the end of the pump test, I would be able to have the computer give me that answer; wouldn't I?

MR. FACHER: Objection.

A I think --

THE COURT: Do you understand the question, Dr. Guswa?

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THE WITNESS: Pardon?

THE COURT: Do you understand the question?

THE WITNESS: I think I do, yes.

THE COURT: All right, you can answer it. The objection is overruled.

A I think the fundamental difference we are having here, Mr. Schlichtmann, is if that were the question that I were trying to answer --

Q Yes.

A -- this is, what is going on between the Beatrice site and Wells G and H, I would have used a different model construction and a different type of analysis using the same model than I did for the problem that I was asked to analyze, which was flow from here toward the center of the valley (indicating).

If what controls the movement of groundwater in this area is the hydraulic properties as well as the sequence of pumping at Wells G and H as well as at Riley. That would require that someone spend a lot of time making a very fine subdivision on the grid doing the same type of exhaustive checking, but also incorporate in a very detailed manner the pumping history of those wells.

We have the pumping records for Wells G

and H. We don't have any pumping records for the Riley wells, so I've made the approximation the best I can.

I cannot make a precise interpretation of the model results regarding groundwater flow directions in this area where I don't have the fine grid nor do I have the pumping information.

THE COURT: Were you asked, Dr. Guswa, to make any study of the Riley property?

THE WITNESS: No, I was not.

THE COURT: I see.

Q (by Mr. Schlichtmann) All right.

Now, you said your model was constructed -- correct me if I'm wrong -- so that you could understand groundwater flow from the Grace site to Wells G and H. Am I right about that? Is that what you said?

A That was the objective of my study. And the model was used to help me do that.

Q So, because you constructed it so you could understand how groundwater flowed from the Grace site to Wells G and H, you didn't construct it so you could understand other aspects of the aquifer which included the Beatrice site, am I right about that?

A No, you are not right.

Q Where am I wrong?

A My analysis, which is flow from here to here, I don't

need to know whether a parcel of water is going to move in a south 44 degree east direction or whether it is going to move in a south 60 degree east direction, if I can use that terminology, that level of precision on this part of the area has no relevance, really about groundwater flow from Cryovac to the center of the valley.

What is important is the bulk or the gross characterization of flow on the western side of the river is incorporated in the model. I think it is, but I can't make the kind of precise determination you are asking me to. It is beyond the capability of the modeling technique and the grid of the model I have used (indicating).

Q So I am asking you, you are incapable of placing an arrow between this arrow and this arrow because of the limits of your understanding of the system, am I right about that?

MR. FACHER: Objection.

A No, it is not correct at all.

Q You can put an arrow between those two arrows.

MR. FACHER: Objection.

THE COURT: The objections are overruled. The witness seems to be able to take care of himself.

A I understand the groundwater flow system. I also understand that to determine which way the groundwater

is flowing, I need or anyone would need precise determinations at all of these points. There is not enough precision in there and there is a lot of confusion in here so no one can make a determination about which way exactly the groundwater is flowing unless they are not willing to recognize the uncertainties in the elevation data for the individual measurements in the wells.

Q So what I am asking you, then, because for all of those reasons, all right, I'm asking you, are you capable or are you incapable,based on all the work that you have done,to place an arrow between this arrow and this arrow to indicate general groundwater flow movement in that area on January 3rd, 1986, at the end of the pumping test?

MR. FACHER: Objection.

A That is a different question than you asked me before.

MR. KEATING: Wait, Dr. Guswa.

THE COURT: The objection is sustained. That is substantially the same question that has been asked four times, and I think now adequately answered or as well answered as it is going to be. So we will go to another question.

Q Dr. Guswa --

A Yes.

Q -- do you have an opinion as to the general groundwater flow movement that is bounded between this area, do you have a general opinion or you do not have a general opinion?

MR. FACHER: Objection.

A I have a general --

THE COURT: Waite a minute.

THE WITNESS: He didn't speak up.

MR. FACHER: Objection.

THE COURT: Sustained. The objection is sustained.

It doesn't help to repeat the question louder and louder each time.

MR. SCHLICHTMANN: I just want to know if he has an opinion or doesn't have an opinion.

THE COURT: He told you exactly what the level of his opinion is and what the restrictions are on it. I don't know how much more detail we can get. If you want to make an argument about it, the time will come at the end, at the close of the evidence. Get on with a new question.

Q A new question, Dr. Guswa.

Did you have an understanding of this area of the aquifer so you could put a groundwater flow

arrow (indicating)?

THE COURT: Which area are you pointing to?

MR. SCHLICHTMANN: Right up here to the north (indicating).

THE COURT: North of the area we were discussing previously.

MR. SCHLICHTMANN: Just north of the Beatrice site, a hundred feet, just above the property line.

Q (by Mr. Schlichtmann) Did you have an understanding to put that arrow?

A Yes.

Q How many wells did you have in that area?

A This arrow --

Q Yes.

A -- is based on this well --

Q Yes.

A -- based on these wells and based on these wells.

Q So you used these wells to put that arrow?

A Yes.

Q You used the wells in the zone of uncertainty to place your northern arrow?

A That is correct, and there is a reason for that.

Q Good. Just a minute, and we will get to the reason.

How about this arrow here, how many wells

did you use to put that arrow in there (indicating)?

A I used this well, and I used these wells, and I used this well, and I used that well, and I used these wells (indicating).

Q The wells in the zone of uncertainty?

A That's correct.

Q Now, this arrow down here, which wells did you use to put that arrow?

A I used these wells, and I used these wells.

Q The wells in the zone of uncertainty?

A That's correct.

Q Now, Dr. Guswa, because you were able to place arrows using a well up here and still able to use the wells in the zone of uncertainty, is it not also the case that you could also have placed an arrow using S79 up here of which there is no dispute, is there, about the water level at S79?

A I don't think there is any dispute on that one.

Q No dispute on that 79.

A Okay.

Q So am I not right, you could have used S79 and the wells in the zone of uncertainty to come up with an arrow for this area here or am I wrong (indicating)?

A No, you are wrong.

Q I'm wrong.

The reason I'm wrong, Doctor --

THE COURT: Would you state the reason?

THE WITNESS: I will state the reason very clearly. S78, 76, the elevation is 44.52 feet. The elevations in the zone of uncertainty fluctuate between 41 feet, 41.2 feet. Now, it's not important to now whether it is really 41 or 41.2. We have a three-foot difference, we have an elevation at 44 feet and we have something down here that could be 41 feet or 41.2 feet. Is that a difference of three feet or a difference of 2.8 feet? That difference is not important in determining general groundwater flow direction up here (indicating).

Down here, where the water levels differ by a hundredth of a foot or by a tenth of a foot, and I know there is at least a two tenths of a foot uncertainty in the measurements, I can't say that this measurement is correct and that one is not. I mean, the error in the measurement is greater than the gradient between the wells. I don't know how to answer it any other way.

Q Let me ask you this, Dr. Guswa, so I can have a complete understanding. These wells in the zone of uncertainty, the reason they are uncertain is it because you don't trust the water level measurements that were done by Woodward-Clyde and Weston Geophysical, you don't

trust their water level measurements?

A No, that is not the answer.

Q You accept their water level measurements, don't you?

MR. FACHER: Objection.

THE COURT: No, that is not a sequential question. I sustain the objection.

Q (by Mr. Schlichtmann) Do you accept the water level measurements that were provided to you by Weston Geophysical, do you accept them?

MR. FACHER: Objection.

THE COURT: Overruled.

A I accept the measurements and the associated precision of those measurements from either party.

Q Right.

Now, are you aware as to whether there are any water level discrepancies that one side says the water levels are this way and the other side says the water levels are the other way, are you aware there is any such discrepancy?

A Yes, I am.

Q Which well are you aware of this discrepancy in it?

A There are several wells.

Q Name them.

A Just a minute, please.

Just as sort of background so everyone

understands, there were at least four surveys of elevation that were done in this area. In addition to those four surveys, there were corrections to the surveys, and Woodward-Clyde hired a contractor to do land surveying in this area as well as Weston Geophysical hired a surveyor to do land surveying in that area. We received land surveying elevations from both of those companies.

End E

There is a plaintiff's exhibit, TC-5, as a matter of fact, where we made a comparison of land survey elevations, I guess these are prepared by Weston, but we have taken the time to look at the same Woodward-Clyde elevations for the wells in which they correspond, as well as the EPA elevations for corresponding measurements and, for instance, Well W-410 is one well. Well 80 is another well. And Well 78 are wells in which there are discrepancies in the land survey elevation. Consequently, discrepancies in whatever water level you calculate, depending on which land or water elevation you use.

Q How many are there?

A S-92, --

Q That is an EPA well?

A S-92 may be an EPA well, but it's right here.

Q It's on the street?

A It's in the zone of uncertainty, Mr. Schlichtmann.

Q S-92 is in the zone of uncertainty?

A It contributes to the zone of uncertainty.

Q So you are not sure of the water levels at S-92?

MR. KEATING: Object.

MR. FACHER: Object. That is not the question.

THE COURT: I don't think you have answered the question. Is that a well in which the discrepancies have been measured?

THE WITNESS: There are discrepancies in the reported elevations for the measurements.

THE COURT: You can't be sure about the water level within this?

THE WITNESS: Within the level or precision of the measurement.

THE COURT: Within the two-tenths of an inch?

THE WITNESS: In this case, it's 800 and 1/10th of a foot.

THE COURT: One-tenth of a foot is 1.2 inches.

Q All right.

Now, the different in gradients between S-92 and the other wells is what?

A S-92, the elevation we have reported for this well is 40.9. I am trying to find the highest elevation in here. In Well W-12 it's 41.49. So that is --

THE COURT: Fot and a half.

THE WITNESS: Six-tenths of a foot. Six inches.

In between or within this zone of uncertainty is a groundwater divide which separates the direction of groundwater flow. To locate that divide, the location of that divide is beyond the precision of the measurement.

THE COURT: Have you seen Mr. Koch's diagram of where the divide is?

A No.

MR. SCHLICHTMANN: I have a picture of it. We don't have the exhibit here.

THE COURT: Did you find any ridge or mound of water under the river at the 42-foot level?

THE WITNESS: No.

THE COURT: No.

Q I want to show you a picture of Mr. Koch's exhibit. I don't think we have the exhibit here. Mr. Koch's end of pump test.

MR. FACHER: I don't have it. We can get it if you like.

Q All right.

Here is a picture of it. Just so the jury, then can remember it.

THE COURT: It's a contour line. A pair of 42-foot contour lines running up either side of the river.

MR. FACHER: Your Honor is talking about deep wells. These are deep and the others were shallow. This is a different exhibit.

THE COURT: Well, I am asking --

MR. FACHER: It won't be on that exhibit.

THE COURT: I am not suggesting it's on the same exhibit. I am asking him if he found this mound of water. He was talking about a divide.

MR. FACHER: I see.

THE COURT: Mr. Koch was talking about a divide. Let's see if it's the same or different divide or if they both exist or there is uncertainty about the whole shebang.

MR. FACHER: I object to that question.

Q Have you had an opportunity to study the picture?

A Yes.

Q In your opinion, sir, does that fairly and accurately represent how you believe groundwater flowed in that area on January 3rd, '86 at the end of the pump tests?

MR. FACHER: I don't think that is a fair question, based on a Polaroid picture.

THE COURT: Can you understand the picture?

THE WITNESS: I understand the picture. I understand it and now that I have overheard Mr. Facher talking about these being the shallow wells, I have not contoured shallow wells in the same manner that we have contoured the deep wells that are opposite the pumping area. So I can't say that this is wrong, but it is not where I would have put a divide, based on what we have observed in the deeper zone of the aquifer.

THE COURT: Do the shallow wells, in your view, have any significance in terms of water flow to Wells G and H?

THE WITNESS: As I was showing on the cross-section yesterday or the day before, one of the ways we could

substantiate water coming out of the river was the vertical gradients measured in the shallow wells, middle wells and the deeper wells. So they do indicate there is downward flow of water from the shallow wells to the deep wells.

THE COURT: Do they have any significance in terms of lateral flow?

MR. FACHER: I was going to object but you're going to overrule it. The reason is I don't understand the question.

THE COURT: You don't understand lateral flow?

MR. FACHER: I understand it means sideways.

THE COURT: Sideways.

THE WITNESS: They don't preclude lateral flow.

THE COURT: Do they contribute to an understanding of lateral flow to groundwater?

THE WITNESS: Yes, they would.

THE COURT: In what respect?

THE WITNESS: We have three wells, or wells at different density, three-dimensional representation and you look at all of it together.

THE COURT: Did you consider the shallow wells?

THE WITNESS: Yes, in our vertical cross-section.

THE COURT: Did you consider them in connection

with lateral flow?

THE WITNESS: Yes.

THE COURT: What significance do you attribute to the data from the shallow wells with respect to lateral flow?

THE WITNESS: That they support on the east side of the river lateral flow directly to Wells G and H. It's unclear what is exactly happening at Well S-92. But I think, for my purposes in understanding the aquifer, there is lateral flow from across the river, from the Beatrice side of the river, if you will, the western side of the river. So there is no barrier or wall of water under the river, completely through the aquifer. At the top there may be, but not at the bottom.

THE COURT: No barrier?

THE WITNESS: No.

THE COURT: So water could flow from the Beatrice site under the river to the area of the well, as far as you are concerned? That is one of the possibilities?

THE WITNESS: It's one of the possibilities, yes, sir.

THE COURT: But you are not prepared to give an opinion one way or the other?

THE WITNESS: The opinion that I have given is that there is the surface where I would say the possibility

for lateral flow exists and the precision of the measurements are such that I can't draw the divide. I can't indicate for each point whether it's flowing south toward the Riley pumping or east toward the G and H pumping.

THE COURT: All right. So you say any lateral flow from the Riley area towards G and H would be at the deep level of the aquifer rather than towards the surface?

THE WITNESS: That was where you would see the greatest response. That is where we saw the greatest response, and that is why we were interested in that information.

THE COURT: All right.

Q Well, now, Doctor, you said there is a dispute about water level measurements at W-14, is that right?

A It's not a dispute about the measurements as much as two land surveyors surveyed it, as far as I know, two land surveyors surveyed the same well and came up with different numbers.

Q Well, whether or not they came up with different numbers, let's say they came up with different numbers.

Did you put the values in for W-14 and see if the gradient went from W-14 over to 92 to Wells G and H? Did you do that?

MR. FACHER: Objection.

A No.

THE COURT: The objection is overruled. He said no, he doesn't.

MR. FACHER: All right.

Q Do you happen to have the values for W-14? All right.

MR. FACHER: White W-14?

THE COURT: There are three W-14.

MR. SCHLICHTMANN: All three of them.

THE COURT: All three. That is shallow, middle and deep, is that what you mean?

MR. SCHLICHTMANN: That is what I mean.

THE COURT: All right.

MR. SCHLICHTMANN: I'd like to have the picture marked as an exhibit.

THE COURT: No, no, no. We have the original marked.

MR. SCHLICHTMANN: It's not here. He did look at the picture. Could I have it marked as a chalk?

THE COURT: Mark it as a chalk. It's a duplication of the same stuff.

(Picture marked as chalk.)

THE COURT: I don't know how we will put all this stuff into the jury room.

MR. SCHLICHTMANN: The question is whether they want it.

A I will have to do some calculations. Do you want it written on anything or do you want me to do it on a piece of paper?

MR. SCHLICHTMANN: Probably do it on a board.

MR. FACHER: Do you have all the material?

THE COURT: Wait a minute. Wait a minute.

MR. FACHER: I'm sorry. The measurements, he is asking for all the measurements.

THE COURT: The witness seems to be able to understand the question. I don't think he needs any help.

THE WITNESS: Pardon my back for a minute.

MR. FACHER: Could I have him identify what material he is using so I could know what to ask about or add to when I examine him again?

MR. KEATING: Could you also let me know what the question is to Dr. Guswa?

You are asking for well measurements at 14 by whom?

THE COURT: All the alternate well measurements and what effect they have if you choose the various alternates. I gather that is the subject of the investigation.

MR. SCHLICHTMANN: Yes.

MR. KEATING: Thank you.

THE WITNESS: Is it all right if I move this slightly?

F10

THE COURT: Sure. Move it. Throw it out.

THE WITNESS: It will take me a little bit to figure this out.

Q Let me ask, do you have the values all calculated?

A No, I don't.

Q Well, the ones we did yesterday, the ones we did on here, these here, you calculated those?

A That is correct.

Q All right.

Now, the material you used, you know what you used. That was from your folder, right?

A Yes.

Q These weren't values given to you by me. You gave me these values, is that correct?

A Yes.

Q You accepted those yesterday?

A Mr. Schlichtmann, I accepted them as I have accepted for the whole time I have been doing this investigation, with the very clear understanding on my part that there is a measurement point discrepancy between those water levels and, therefore, I will not try to be more precise than my interpretation than the data permits. If you want me to do the calculations, I will do them.

MR. SCHLICHTMANN: Please. Excuse me.

End F

Gl
MC:ls

A (Witness placing calculations on the diagram.)

There are four wells in the cluster. This column represents measured point elevations determined by the contractors, these two companies hired.

I'm sorry, these are the ground elevations that were surveyed. (Writing on the diagram.)

In addition to the ground, there was a determination made of the top of the steel casing. (Writing on the diagram.)

In addition to the top of the steel casing, there was the top of the PVC casing. (Writing on the diagram.)

Q Are you done with W14?

A I am just checking to make sure. I think I am, but just wait one minute.

(Pause.)

Okay, I guess we are ready to try.

Q All right, Dr. Guswa, if you would over here -- now, over here on this chalk, which we will mark as P-903.

A 4.

Q 904. You put down the measuring points done by the surveyors for Weston and surveyors for Woodward-Clyde?

A That is right.

Q Now, to be able to determine what water level

elevation was on January 3rd, 1976, you would have to subtract from these measuring points?

A That is right.

Q You have to know which measure, the top of the PVC, the plastic pipe, or whether the person out in the field was measuring from the top of the steel, a mark on the steel pipe itself?

A That's right.

Q And you have to subtract it from these measuring points?

A That's right.

Q And you determined that there are different measuring points that were given for the 14 cluster?

A Yes.

Q Now, would you put here -- would you put a little thing here for Weston and a thing here for Woodward-Clyde (indicating)?

A Okay. (Witness marking on the board.)

Q Now, why don't you put the well over here (indicating)?

A You mean like a schematic of the well?

Q OW14 and CW14, and SW14.

A All right. (Marking the board.)

Q Leave some room for some calculations, a little arithmetic.

A All right.

THE COURT: OW is the shallow one?

MR. SCHLICHTMANN: It is called observation well.

THE WITNESS: The observation well is shallower than the shallow well.

THE COURT: OW means a very shallow well? CW means?

MR. SCHLICHTMANN: You've got me. Just as lettered.

THE WITNESS: There was a cobblestone, so the C was in for the cobblestone, that is why it had the CW.

THE COURT: That is deep.

MR. SCHLICHTMANN: And W is the deeper.

THE WITNESS: B is the bedrock well.

THE COURT: So C is the medium one?

THE WITNESS: C is the one that is about 80 feet below -- opposite the screened interval of the pumping well, about 80 feet below the surface. And W is deeper than that. W is in the bedrock, deeper than that.

THE COURT: How deep is that?

THE WITNESS: I have depth to -- bottom of the well is 85 feet for W14, CW14 is 63 feet, SW14 is 30 feet or 29 feet, and OW14 is 14 feet.

THE COURT: Okay.

Q (by Mr. Schlichtmann) Now, to find out what the water level measurements or how these measuring points will affect the water level measurements, you first have to have the actual water level measurements that were taken on that day. For OW14, there is no dispute about that sheet, one person took it and it is on the sheet, is that right, there are not two different sheets here?

A Now, you tricked me yesterday.

Q I tricked you yesterday?

A Yes. There was an update on the measuring points for the geological surveyor data loggers, that hundredth of a foot I was right.

End G
CM:ls

BS/kr

Q How much would the W-14, OW-14, would that be this sheet here?

A Okay.

Q I don't want to trick you.

A Right. I don't want you to, either.

Q Look in your file and see if it doesn't comport with my sheet.

A Staring me right in the face.

Q All right.

Isn't that it there?

A But there are three different days.

Q All right.

A Here we go.

Q Are they the same?

A Yes.

Q We agree?

A Yes, sir.

Q Only one sheet. Okay. Water level measurement at 10:30 was 6.19?

A 6.19, that is correct.

Q Okay.

What we do is take the measuring points. The other most important thing is to make sure what was the measuring level, the pbc or top of the steel. No dispute top of the casing is circled. TOC, top of casing, do you agree?

A Yes.

Q OW-14. Put the measuring point for Weston at top of the steel, which is 47.52.

A Okay. 47.52.

Q And when you subtract 6.19 from 47.52, you come to 41.33, am I right?

A That is right.

Q Put the answer down. 41.33.

Now, if you use --

A I will circle this so we don't get confused. That is the measuring point.

Q All right.

If you use Woodward-Clyde's report of 47.57 and you make a subtraction of the water level at 86.1, what do you come to?

A 41.38.

Q And, as a matter of fact, that was reported by Mr. Koch, the water level he used, 41.38. Are you aware of that?

A I wasn't aware of it.

Q We agree those are the differences (Indicating)?

A Yes.

Q Now, SW-14, if you use copper steel measurement by Weston, 47.30 and as you subtract on January 3rd, the number is 6.11, am I right? We agree on the sheet? No dispute here?

A Yes, that is all right.

Q Okay.

That was a measurement taken by Weston Geophysical?

A That is correct.

Q 6.11. So 47.30 and subtract 6.11. What is SW-14?

A 47.30. I will put the number. There are too many numbers in the column. I will put this here. 6.11, right.

Q Yes.

A That becomes 41.19.

Q In fact, that was the figure we used yesterday?

A Yes.

Q If we use Woodward-Clyde's measuring points of 47.40 and subtract 6.11?

A 47.29.

Q 47.29 -- 41.29?

A I knew I was going to break sooner or later.

Q CW-14. Use Weston Geophysical 47.07 and on that day, January 3rd, my sheet from Weston Geophysical is 5.86, taken at 10:25. Do you agree on that?

A Yes.

Q Same sheet?

A Yes.

Q All right.

Now, 47.07, subtract 5.86.

A Wait a minute. 46.07.

Q Subtract.

A 5.86. 41.21.

Q Exactly.

Now, if we use Woodward-Clyde's measuring points 47.17?

A Minus.

Q 5.86?

A 41.831

Q 41.31?

A Yes.

Q All right.

And the deep well is in bedrock. But we might as well do that, too. OW -- Excuse me, W. And the measuring point for W is 46.75, Weston's surveyor.

A Excuse me?

Q This sheet right here, January 3rd, 10:30.

A Yes.

Q Taken by Weston, 5.53.

A Okay. Top of casing. 46.75. I'm sorry. Top of steel, top of steel. 46.77 for the top of the steel. Yes.

Q Right. 46.77. Subtract 5.53, which is the measurement.

A 41.24.

Q Yes.

And if we use Woodward-Clyde's survey, it's 46.85, and we subtract 5.53?

A 41.32.

Q Those are the values. Those are the differences in the values, is that right?

A Yes.

Q All right.

Now, look at the cross-section. We plug in the numbers. Using the survey done by Weston, we get 41.33 shallow, 41.19 medium and 41.21 deep?

A Yes.

Q No question that the head is higher here than it is here, is that true?

A That is correct.

Q And the flow, as you have drawn it, is in this direction?

A That is correct.

Q Now, let's put Woodward-Clyde's values there.

A Yes.

Q 41.38. And then 41.29. Let's get rid of this here.

A Yes.

Q And 41.31?

A Yes.

Q Now, when you compare the head here, using Woodward-Clyde figures, the arrows still go in this direction, is that

right?

A No.

MR. FACHER: Objection.

Q They don't. The head is not higher than it is here?

A The head is higher than either direction.

Q But is the head higher here than here?

MR. FACHER: Objection, your Honor.

THE COURT: Overruled.

A Except for this well?

Q Yes.

A Yes.

Q It's higher?

A Yes.

MR. FACHER: Objection.

THE COURT: Except for what well? Comparing two different wells?

Q S-92, but that is the same, whether you use Weston or Woodward. S-92, which is measuring the recharge into the river from the aquifer, is always higher than these other numbers, isn't that right?

A Yes.

Q So no matter which figures you use, the head at 14 is still higher than 92, is that right?

MR. FACHER: Objection.

Q Am I right about it?

THE COURT: The objection is overruled.

Supposing you used Woodward-Clyde's for one well and Weston's for the other.

THE WITNESS: Your Honor, I think this highlights the problem here. If we use the wells, if you use the water levels based on the Weston measurements, we sort of get a general indication of a gradient, component of gradient toward S-92.

If you use the Woodward-Clyde, it looks like -- and this is only a two-dimensional representation -- it looks like 14 splits the difference and half is going toward 13 and half 92. And that is the whole problem I have been trying to talk about, is you can't make that designation because of this uncertainty and the lack of gradient within the area.

THE COURT: Let's get in the alternatives.

You compared Weston and Weston and Clyde with Woodward-Clyde, but, given the fact you don't know who is right, you ought to compare Weston and Woodward-Clyde and then the other way around, Woodward-Clyde and Weston, and you will have all the possible alternatives and know exactly the degree of uncertainty that we are facing.

Can you do that?

MR. FACHER: I would object, unless you use all the wells, because S-92 shallow is not on there and

that is a different figure. That is still a different figure.

THE COURT: Where is S-92?

MR. SCHLICHTMANN: It is --

MR. FACHER: Not the shallow figure.

MR. SCHLICHTMANN: 42.48.

THE COURT: I thought we just used it.

MR. FACHER: I'm sorry. I misread it.

THE COURT: Let's not stop there. We have gone this far. Let's figure first A is right and B is wrong and then B is right and A is wrong and see where we come out. Let's get the full permutation here. Can you do that, Dr. Guswa?

THE WITNESS: I will do whatever you ask me to do.

THE COURT: Can you do what I have just asked you to do? Is it possible?

THE WITNESS: I think we have done --

THE COURT: You have compared the same set of figures. You have compared Weston with Weston and Woodward and Clyde with Woodward and Clyde?

THE WITNESS: No. I'm sorry.

THE COURT: Now I ask you to split it.

THE WITNESS: Which ones are they that we did yesterday?

MR. SCHLICHTMANN: Weston Geophysical.

THE WITNESS: So I will put all the Woodward-Clyde's onto the others. That is what you are asking, right?

THE COURT: As I understand what you have now done is draw conclusions assuming Weston's figures are right on both -- on all the wells -- another set of conclusions, assuming that Woodward and Clyde's figures are the correct ones on all the wells.

Now, I want you to make another set of assumptions, based upon the fact that Woodward and Clyde is right some of the time and Weston is right some of the time, which is equally, it seems to me, an equally open assumption.

THE WITNESS: Yes.

THE COURT: Because we don't know who is right, do we?

THE WITNESS: No. And the fundamental discrepancy is in the reported land survey elevation.

THE COURT: That is what I understand. Let's see what happens when you mix them up.

Q He wants to know the other wells to do it. Let's get 13.

THE COURT: Can't you do it for the wells you have got there? You have two sets of figures for each well.

THE WITNESS: Two for one well and one set of figures for all the other wells. We don't have the Woodward-Clyde figures for 13 and 92.

End H

Q Have you seen that document before?

THE COURT: Are the Woodward-Clyde figures, the 13 and 92, different from the Weston figures?

THE WITNESS: I will let you know.

MR. SCHLICHTMANN: For this hundredth of a foot.

THE COURT: I misunderstood you. I thought you found discrepancies in several of these wells.

THE WITNESS: There are several wells. It may not be Well 13. There are a whole bunch of wells in the area.

THE COURT: I see. I thought you were getting double figures on all of these.

THE WITNESS: Not all of these.

THE COURT: Perhaps I should come down and look at the diagram.

MR. FACHER: I don't know if it will help.

Q (by Mr. Schlichtmann) Weren't you provided by Beatrice Foods a water level data at the end of the pump test for January 3rd? You were not provided that document?

A I will show you what I have. I won't say it doesn't mean we weren't provided with that information.

THE COURT: Well, if you don't have the

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data that I asked for, I won't press the matter.

MR. SCHLICHTMANN: I don't think there is any dispute between me and Mr. Facher. I have been provided a document which has the numbers on it. Mr. Facher can tell Dr. Guswa if that is the document I received.

MR. FACHER: That is the letter you received yesterday when you said you didn't know where the data comes from. You did know where it came from. I have no objection.

MR. SCHLICHTMANN: I didn't say that.

MR. FACHER: You said yesterday you had no idea where it came from.

THE COURT: Never mind, we agree on it now.

MR. FACHER: We know where it came from.

MR. SCHLICHTMANN: Where the letter came from.

A All right. So we just plot these water elevations?

Q Yes, for 13.

What does Woodward-Clyde data indicate were the water level measurements for Cluster 13?

A All right.

Q On January 3rd.

A (Witness writing on the diagram.)

MR. FACHER: It is actually Geraghty &

Miller data.

THE WITNESS: Yes, it is, Geraghty & Miller.

THE COURT: Geraghty & Miller, Woodward-Clyde, I don't care, get the figures out.

Q (by Mr. Schlichtmann) Now, would you read to the jury what the values were that Geraghty & Miller determined?

A 41.4 feet.

Q What did Weston Geophysical determine?

A 41.4 feet.

Q The top of the next well?

A 41.20 versus 41.20. 41.24 versus 41.24.

Q There is no dispute?

THE COURT: There is no difference?

THE WITNESS: No difference there.

THE COURT: So my question has no bearing. It is not useful in this context. Let's get on to something else.

MR. FACHER: That is for 13.

Q (by Mr. Schlichtmann) Now, Dr. Guswa, I show you a diagram with an overlay that was done by Mr. Koch in which he used the values which you put down for Woodward-Clyde.

THE COURT: Geraghty & Miller, didn't

we just learn it was Geraghty & Miller and not Woodward-Clyde?

THE WITNESS: Geraghty & Miller.

Q Here are the values down here and here are the values which you put down for Geraghty & Miller, GM. Make a GM.

A Oh, yes.

MR. FACHER: Some were and some weren't, to be accurate.

Q Now, Dr. Guswa, in your talk yesterday you mentioned the word "triangle."

You recognize in your profession, do you not, it is an acceptable practice in your profession in determining local flow to make triangles between three well points, that is an acceptable procedure that you in your profession use?

A I never use it myself. I know other people do it.

MR. FACHER: Objection.

Q You have never done it yourself?

A I never have.

Q Is it an acceptable procedure in your profession?

A For some people, yes.

THE COURT: You have to say it loud enough so they stop.

MR. FACHER: They are having their own

conversation.

THE COURT: By the time I get around to ruling, it doesn't make much difference anymore, so shout it out good and loud.

What was the question, Mr. Schlichtmann, please?

MR. SCHLICHTMANN: The question is: You are familiar with Freeze and Cherry and their book on groundwater?

A Yes.

Q You are familiar that in their book on groundwater they certainly talk about the fact you can take three well points to draw a triangle to determine local groundwater flow?

MR. FACHER: Objection.

THE COURT: Overruled.

MR. FACHER: The question is they talk about it in the book?

THE COURT: They talk about it in the book, yes. I suppose some other question will have to flow from that.

A The principle assumes that when --

THE COURT: There is no question, as I understand it, right now.

MR. SCHLICHTMANN: There is. Is he

familiar with it?

THE COURT: Is he familiar with the fact that they talk about it in the book? He says yes. Now we have to have another question beyond that before any of this makes any sense.

Q (by Mr. Schlichtmann) And in the book is it talked about as an acceptable procedure, the fact they talk about it in terms of this is an acceptable procedure in determining groundwater flow

by using three well points, don't they?

MR. FACHER: Objection.

THE COURT: It is not in compliance with the rule, and the objection is sustained.

Q (by Mr. Schlichtmann) Do people in your profession use that technique, sir?

A Yes.

Q And have you ever seen a book, any journal in your profession that says this is an improper technique, it is not acceptable?

MR. FACHER: Objection.

THE COURT: Overruled.

A I never saw anything that said it is not a proper technique.

Q Now, you are familiar with the technique?

A Oh, yes.

Q In fact, yesterday you were doing it in front of the jury, weren't you?

A Yes.

THE COURT: Not voluntarily.

Q Take the values for Wl4. I show you a diagram that was done by Mr. Koch, and he put the values in -- you have put down there for Geraghty & Miller Wl4, and you used the values at 95, these values here, and I asked him to draw a triangle between 93 and 14 and 95. Do you see that?

A Yes.

Q Now, I want you to examine the triangle, examine the values, and I want to ask you if the drawing of those flow lines based on those values in that triangle is proper and acceptable?

MR. FACHER: Objection, your Honor.

THE COURT: Overruled.

A This is exactly why the triangle is not appropriate. You have a river running right down through the triangle. The fundamental assumption, when you draw the triangles, is that you are approximating the water table surface or water level surface, a series of plane -- are tri-surfaces that intersect each other. It assumes the properties within the wells are uniform, and it assumes there is no water flowing out or in within the triangle.

This is the wrong place to draw triangles.

Q This is the wrong place to draw a triangle?

A Yes, sir.

Q Well, suppose we just stop at the river, suppose we say, oh, let's go to 92, let's not go across that river, how would you draw the triangle then?

MR. FACHER: Objection.

A I will draw it whatever way you would tell me to draw it. I wouldn't draw it myself.

THE COURT: You wouldn't draw any triangle?

THE WITNESS: I wouldn't.

Q (by Mr. Schlichtmann) You wouldn't go near a triangle. You can't tell us whether that is acceptable or not?

MR. FACHER: Objection.

THE COURT: Overruled.

A Mr. Schlichtmann, if you only have three points to make a determination on water levels, you use the three points as best you can. When you have 20 points, you look at 20 points. If you have two points, you use the two points. What makes it acceptable or not acceptable is whether or not the fundamental underlying assumptions are valid or invalid.

Q All right.

Now, I'm asking you --

A Sometimes we have to apply it when it is not valid because we have no other choice.

Q If you use Geraghty & Miller's values or Weston Geophysical's values at W14 and at 92 and at 95, would this be, if you just had those three points, you had nothing else, all you could work with was these three points, is that arrow directly, is that directly drawn above groundwater flow between those two points, is it or is it not?

MR. FACHER: Objection.

THE COURT: Sustained.

Q Sir, did you make any attempt to take all of the well water level measurements on the Beatrice site, on the Beatrice property, did you make any attempt at all to draw triangles or to make any other attempt using any other tool of your profession to try to determine the local groundwater flow on that site or you made no such determination?

A The determination I made and the precision of that determination is this water table map here. You have just seen for the last hour or hour and a half we have been frustrated over the measuring point of the elevations. We were not hired to look at the Beatrice site. We were hired to look at W. R. Grace. I have so many

people that work for me. I have to direct our efforts at our problem. Beatrice has to take care of their problem. You have to take care of your problem.

Q Okay, you can return to the stand and see if I can't take care of my problem.

P-905.

A (Witness complied.)

Q Now, Dr. Guswa, you were asked several questions about the role of the river in this aquifer?

A Yes.

Q And do you agree that -- You've studied the underlying geology of that area, is that right?

A Yes.

Q And you'll agree that the river is underlain with swamp deposits, that's in your diagram?

A That's correct.

Q As you go deeper down into the aquifer, you go from swamp deposits, which is decayed organic matter, and then silt and sand, and then, as you go deeper, it gets into more gravelly sand, then you get into more gravel and cobbles, as you go down deeper into the aquifer?

A The progression would be from the swamp deposits to a silty sand, not silt itself, but to a silty sand to coarser material.

Q Coarser sand, coarser gravel?

A Yes.

Q And permeabilities did differ horizontally as well as vertically, is that right?

A That's correct.

Q And permeabilities did differ in glacial deposits for one reason in that when glacial deposits are deposited, they tend to be deposited pretty much in layers, and they are in water and so they tend to fall down on their flat sides so that it is easier for the water to move horizontally, that is one reason, than it is to move vertically; is that right, you have this kind of a layering effect?

A The ground moraine deposits that are ice deposits would not have that restriction on it.

Stream deposits, where there is a preferential sorting, would tend to be a layer deposit, and there would be a contrast between the vertical and horizontal permeability.

Q There are two reasons, one is the physical reason, the little particles that tend to fall down, tend to fall on their flat side, that is one layer horizontally.

A That is correct.

Q The other is it is easier to go through one layer which has one conductivity than it is to go up through

many layers which have different conductivities?

A Well --

Q Or down?

A I think you used two ways to describe the same physical thing. It is easier to move horizontal than it is to move vertical.

Q And that is something that you often see, that is what you experience in the field when you examine aquifers like this one?

A Yes.

Q And we have a diagram of the aquifer around G and 92?

MR. KEATING: Is that one of ours?

MR. SCHLICHTMANN: Yes. The one you used yesterday.

MR. KEATING: This one?

MR. SCHLICHTMANN: That is it.

THE COURT: That one is known as sunshine.

MR. SCHLICHTMANN: Right, sunshine.

THE COURT: As opposed to blue Mediterranean.

MR. SCHLICHTMANN: They are both sunny.

Q Now, on this cross section of the aquifer, you actually have two different layers that you put here graphically?

A Three.

Q Three, excuse me.

Each layer has a different permeability than the other one?

A That's correct.

Q This permeability is higher, meaning water can move faster and easier through this one than this one (indicating)?

A Yes.

Q And water can move faster and easier through this one than this one (indicating)?

A I don't think so.

Q You think they are about the same?

A Close.

Q Did you say it is a hydraulic conductivity factor?

A Yes.

Q What is that?

A 8.3 feet per day.

Q This one (indicating)?

A 18 feet per day.

Q Hydraulic conductivity is 18 feet per day and this one 8 feet?

A Yes.

End I
MC:ls

Q And this one here?

A Hundred and 13.

Q That is a difference, isn't it, between your opinion about hydrologic conductivity, and the ability of water to move through this and this layer?

A Yes.

Q Now, it is easier for water to move out this way than it is for water to move down this way in this part of the aquifer. You agree with that?

A Yes.

THE COURT: Is that a yes answer?

THE WITNESS: That was yes.

THE COURT: All right.

Q And when you look at your flow lines, they're very interesting because they demonstrate a convincing principle, and tell me if I am wrong --

MR. FACHER: Your Honor, please.

THE COURT: Just the question, Mr. Schlichtmann, please.

Q All right.

The arrows in the lower part of the aquifer are coming out toward the jury, aren't they?

A Yes.

Q And the arrows in the middle part of the layer are right here coming out towards the jury?

A Yes.

Q And it's only over here that you have chosen to place an arrow which tends to go in the direction of the river, is that right?

A Yes.

Q All right.

Now --

MR. FACHER: We can't hear you, sir.

THE WITNESS: Yes, that is the only arrow that shows up to the river, yes.

Q Correct me if I am wrong, but the reason there is a difference is that the arrows are an indication of different properties that are taking place in the aquifer at different layers?

A The arrows represent my interpretation of the ground-water flow directions on a gross scale and that flow direction results from all combinations of properties in the aquifer.

Q And one of them is the hydraulic connection between the stream with the aquifer. That is one property?

A That is correct.

Q And that property is one which is going to affect how the aquifer relates to the stream?

A Yes.

Q And the other properties are the transmissivity test or

J3

the permeable test of the different layers?

A Yes.

Q As well as the depth of the material that this water is moving through? That is another property?

A Yes.

Q And the stream has a certain depth to it?

A Yes.

Q And the depth of the stream is another property which is going to affect how it interrelates with the aquifer, is that right?

A Yes.

Q Now, when a well pumps, all right? Under normal conditions we have no well. And the groundwater is going to move this way, as you have demonstrated, and up here on the top layer near the stream will be actually discharging to the river?

A Yes.

Q And the stream is going to, from this part of the aquifer, that is providing water to it?

A Yes.

Q Giving water to it?

A Yes.

Q It's gaining?

A Yes.

Q And this is a discharge point, am I correct?

A Yes.

Q Now, when you turn on the well, say, over here, what the well does is it draws water from the aquifer?

A That is correct.

Q And it becomes a discharge point, water is discharging out of the well?

A Yes.

Q Now the river is a discharge point?

A Yes.

Q And the well is a discharge point?

A Yes.

Q Now, when the well pumps and it has a certain demand, it wants so much water, it's going to get that water from the aquifer, right? That is where it will go to for its water?

A That is the first place.

Q First place it looks right in the aquifer?

A That is right.

Q Now, this well is down deep, G?

A Yes, right there.

Q Yes. That is deep into the aquifer?

A Yes.

Q How many feet down?

A Eighty feet, about.

Q What is it to bedrock in that area?

here,

aquifer?

about a

is discharging

nt?

it has a certain demand,

ng to get that water from

where it will go to for its

right in the aquifer?

own deep, G?

eep into the aquifer?

down?

, about.

bedrock in that area?

down pretty far

his material here.

e zone, comparatively?

at is the one that has the

because this is the easiest to get

judgment to go down deep to get the

the well pumps, as I think you testified to, it

ng water from the bottom of the aquifer. That

ere it's first asking for water to come?

First asking water to come from right opposi

A

interval of the well. So it's the middle. Wherever it is.

Q Middle. Now, you know from your experience that a well which demands water can receive water from an aquifer at the very same time -- this can occur -- at the very same time that an aquifer can still provide the water to a river?

A Yes, sir.

Q That can happen. Both things can occur together?

A Yes, sir.

Q This can still get water and this can still get water?

A Yes.

Q And there will come a time, there can come a time when a well demands so much water that it will not only be taking water from the highly transmissive zone, but it will also be looking elsewhere for water or the pressure from its demand will actually be forcing water to come from less permeable areas of the aquifer, as well. Am I right about that?

A Yes.

Q Now, when a well pumps it has a cone of depression, am I right?

A Yes.

Q Now, a cone of depression, if it goes through a highly impermeable zone, is going to make that cone of depression really steep, compared to a cone of depression which is in

a more transmissive zone in which case the cone of depression is going to be much flatter and go over a much wider area, am I right about that?

A That is correct.

Q That is a basic principle on your side?

A Yes.

Q When Well G pumped its cone of depression went out over a fairly wide area, large area, would you agree?

MR. FACHER: Objection. I don't think there was data -- no foundaton on Well G pumping alone.

THE COURT: Well G pumping alone.

MR. FACHER: That was the question.

THE COURT: Well, do you have an opinion about the character of the zone of depression, what the character of the cone of depression would be if Well G were pumping?

THE WITNESS: Alone. Less than when Wells G and H were pumping.

Q Would it be a wide-spread cone or a steep cone?

A General response would be the same, whether G is pumping --

Q Generally a wide-spread cone, flat, rather than steep?

A It would be wide-spread on one side and steep on the other.

THE COURT: All right.

Q Well, it certainly is going to be wide during the, in the trasmissive, the highly transmissive zone, isn't it?

THE COURT: Is the reason it's steep on the other is you run into a different kind of material?

THE WITNESS: You run into the low permeability material.

Q As you move in which direction?

A East toward the Cryovac Plant.

THE COURT: You come into this moraine-filled material?

THE WITNESS: Yes, sir.

Q So you tend to see a steeper cone on the Grace side of the well and a more flattened cone on the Beatrice side of the well?

A That is correct.

Q And in your profession you have encountered many, many examples of a well pumping in a highly transmissive zone near a river in which the cone of depression has extended beyond the river?

A Yes.

Q That happens?

A Yes.

Q And the way for you to determine whether in fact it happens over here on the other side of the river is to watch whether the water levels drop in wells, in the monitoring wells on that side of the river. That is one of the things you look at.

MR. FACHER: Objection.

THE COURT: Overruled.

A You look at the drop and pattern of the drop.

Q And the pattern of the drop. And is it not also true this can occur, that is, that the well, when it's looking for water, could satisfy itself in the highly transmissive zone, could satisfy itself for its demand, without actually forcing water from a river through the more or, excuse me, the less permeable areas? That can happen, can't it?

MR. KEATING: I object. Are we talking a theoretical situation?

MR. SCHLICHTMANN: Theoretical situation.

MR. KEATING: Oh.

Q It can happen?

MR. FACHER: Wait a minute.

THE COURT: I thought it was withdrawn.

MR. SCHLICHTMANN: No. I thought the objection was withdrawn.

MR. KEATING: As long as it's just theoretical representation.

THE COURT: That is what I understood.

MR. FACHER: I'm sorry. Proceed.

A If a cone of depression spreads beneath a river, regardless of the permeability, if the elevation of the river is greater than the elevation, the water level

elevation in the aquifer, there will be a component of downard flow. The rate at which water moves into the ground in response to that cone of depression is a function of the permeability of the material. Nothing is completely impermeable. The general characterization of getting no water from the river is not correct. However, under some conditions, extreme conditions, if there is extremely low permeability material here, a little water would come out of the river.

Q That can occur?

A Yes.

THE COURT: I'm sorry?

MR. SCHLICHTMANN: That can occur.

THE COURT: That can occur.

Q And you stated, and correct me if I am wrong, that a gradient, the more steep the gradient is, is an indication to you as a hydrgeologist that water is having a harder time going through a medium, a porous medium, than comparatively elsewhere and that is why the gradient may be higher at one place and lower in other parts of the aquifer?

A Yes.

Q That is what you used to explain the Grace site?

A Yes.

Q On the Grace site the gradients are quite steep?

A Yes.

Q That is an indication of the water having a harder time getting through this material?

A Yes.

Q In relationship to the other parts?

A It's an indication of the energy required to get the water through.

Q Don't we see the very same thing in the measurements at S-92 when we compare the values at the shallow well with the values deeper down in the aquifer? Don't we see a difference?

A Yes.

Q And isn't that difference an indication that the water, the gradient is greater up above than it is down here?

A Yes.

Q And that is an indication to you as a scientist, as a hydrogeologist, that the water is having a little harder time getting down than it is in this area?

A Yes.

MR. SCHLICHTMANN: We can have a break now.

THE COURT: All right. We will take the morning recess.

(Recess.)

End J

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MR. KEATING: I think it's one of the pages from what is not in evidence.

THE COURT: That is excluded. Out.

Q Did the investigators for E and E come to any conclusions about the groundwater flow in a particular area of the study area?

MR. KEATING: I object, your Honor.

THE COURT: Sustained.

Q Did you use any information obtained by E and E concerning groundwater flow in the East Woburn area? Did you use any of that information in forming your opinions?

A Well, when I first started that was the water table information that was in the report.

Q You used that?

A In a general sense, yes.

Q You analyzed it?

A Yes.

Q And you came to the conclusion that the groundwater flow as shown in that area by the E and E, by EPA, was correct, in your opinion, based on what you knew about the area?

A The water table map they had in their report has an implicit five-foot elevation area in it because it was based on topographic maps with 10-foot contour spacing and the elevations of the measurement points are estimated from the topographic map. There is a five-foot, generally, five-foot

discrepancy in it. The general pattern is what I would expect.

Q The general pattern you saw in that report is what you would expect?

A That is right.

Q And that report was based on the work done by the USGS?

A Not that.

Q They used their topographic map?

A They did that, use that map, yes.

Q In forming their conclusions about how the groundwater flowed?

A Yes.

Q Now, is there anything about that groundwater flow pattern that they concluded with which you disagree?

MR. KEATING: Object.

MR. FACHER: Object.

THE COURT: Sustained.

Q Did you use that information in forming your opinion?

A I --

MR. KEATING: I object. What information are we talking about?

MR. SCHLICHTMANN: The groundwater flow pattern in East Central Woburn.

MR. KEATING: I still object.

THE COURT: Sustained.

MR. SCHLICHTMANN: You may sit down.

Q When you read the EPA report about the contamination of the east drainage ditch, did you accept all of the statements of fact in that report as true?

A I accepted it in the same sense that I accepted the other information. Different kinds of information contained in that report that are geological.

Q You read to the jury at the conclusion of that report that the 27 parts per billion found at Salem Street in the river was from the north?

A Yes, the data that are included in the reports I accept as facts, I have no reason not to accept it.

Q Did you accept that conclusion as a fact, that that is a true statement of reality, that the 27 ppb found at Salem Street in the Aberjona River came from the north?

A I accepted the statement that the Aberjona River was or the drainage ditch was a likely source of contamination in the same way I think that the drainage ditch could be a likely source of contamination.

Q You accepted that statement as a fair and accurate statement of reality. You made that conclusion?

A I -- I found no reason to disagree with their interpretation.

Q All right.

Now, in the E and E report, they made other conclusions about the probable sources of contamination of Wells G and H, did they not?

A That is correct.

MR. FACHER: Well --

MR. KEATING: Is this a reference to an excluded document?

MR. FACHER: What document?

MR. SCHLICHTMANN: March, 1982 report which was incorporated in the report of June, 1982.

MR. KEATING: Are you talking G-321, which has been excluded?

MR. FACHER: Is that March, March of '82?

Q Was that incorporated in the June, '82 report?

A I believe it is or parts of it is, yes.

Q In fact, the reader, in the June, '82 report, is referred back to their March, '82 report, the chlorinated solvent contamination and likely sources of contamination of Wells G and H, is that right?

A I believe so.

Q So that the reports are one and the same, is that correct?

MR. FACHER: Object, your Honor.

THE COURT: Sustained.

Q Now, sir, when you read the E and E's conclusions in

their March, '82 report about the likely sources of contamination to Wells G and H, did you agree that that was essentially correct, that that is what the data had shown to that date, that the likely source of contamination were probably as the E and E had concluded that they were in March of 1982?

A Could you read for me what that statement is, please?

THE COURT: All right.

MR. KEATING: I would only ask that the witness be given an opportunity to read it himself.

THE COURT: Let him read it himself. Show it to him.

MR. KEATING: Could you tell me what page it is, Mr. Schlichtmann?

MR. SCHLICHTMANN: Page 1-2.

MR. FACHER: Is there a stray copy on your Honor's desk?

MR. KEATING: We have an extra here.

MR. FACHER: Maybe one of them was mine. I try not to accumulate that stuff.

Q And 4-1 and 4-6. I will put a little yellow tab on them so there won't be any problem. 4-1 and 4-6. There you are. Please read those to yourself.

A (Witness reading.)

Q Have you had an opportunity to read those pages?

A Yes, I have.

Q Do you agree with them?

A I think on the basis of the information they looked at, I think those are reasonable conclusions to draw.

THE COURT: That is not the question that you have been asked.

Q Do you agree with them?

A Do I agree with them now?

THE COURT: Yes.

A No.

Q They were reasonable at the time?

A Yes.

Q What were those conclusions that were reasonable at the time?

MR. KEATING: I object.

THE COURT: Sustained.

Q Doctor, do you think it's reasonable to conclude, based on all the information that you have obtained, that one of the sources of pollution or contamination of these chemicals in Wells G and H is coming, one of the areas is coming from the direction of Well 21? Do you think that is a reasonable conclusion?

MR. KEATING: I object.

THE COURT: Overruled.

A Would you repeat the question, please?

MR. SCHLICHTMANN: May I have the question read back?

THE COURT: In light of your present inclination, do you think that the pollution of Wells G and H is coming in part from the direction of Well 21?

A You mean the pollution that reached Wells G and H prior to May, 1979?

Q No, right now, right now.

A I believe there are chemicals moving toward the center of the Aberjona River Valley from the vicinity of Well 21 right now.

THE COURT: Do you believe that or do you have any opinion as to whether that was occurring prior to May of 1979?

THE WITNESS: I believe that the movement was in that direction prior to May of 1979.

THE COURT: From Well 21 toward G and H?

THE WITNESS: That is correct.

THE COURT: All right.

Q Are you aware of the fact that Mr. Maslansky has testified that, in his opinion, the chemicals on the Grace site have moved to Well 21? Are you aware of that?

A I believe he -- Yes, I am aware he has said that.

Q And do you agree with Mr. Maslansky?

A Yes. I don't believe all the chemicals in Well 21 are

from the Grace site.

Q But some?

A Yes.

Q And Well 21 is this well right up here, am I right about that?

A That is correct.

Q All right. Just so I can point it out to the jury.

Now, you say some of the chemicals went to Well 21 and the chemicals at Well 21 are moving towards Wells G and H?

A Pardon me?

Q Part of the chemicals in Well 21 came from Grace and the chemicals in Well 21 are moving to Wells G and H. Is that what you are saying?

MR. KEATING: I object, only from the time.

THE COURT: Are we talking about today? You are lumping in now and prior to '70.

MR. SCHLICHTMANN: I am asking right now.

MR. KEATING: I object on relevance if it is right now.

THE COURT: All right. I will overrule it.

A Yes. The chemicals are moving from the Cryovac Plant towards the center of the Aberjona River Valley right now.

End P

Q1

Q And --

THE COURT: I would like to get this squared off, if I may, as we go along.

MR. SCHLICHTMANN: Please.

THE COURT: Prior to May of 1979, in your opinion or do you have an opinion as to whether chemicals from the Cryovac site had reached Well 21?

THE WITNESS: Prior to 1979?

THE COURT: Prior to May, 1979?

THE WITNESS: I have not analyzed it in that sense.

THE COURT: So you have no opinion?

THE WITNESS: I have no opinion.

THE COURT: Next question.

Q (by Mr. Schlichtmann) Now, Dr. Guswa, you testified -- and correct me if I'm wrong -- about hydraulic conductivity of certain materials, is that right?

A That's correct.

Q And the Grace site is underlain with ground moraine, is that right?

A That's correct.

Q And the hydraulic conductivity of ground moraine -- correct me if I'm wrong -- you have in your opinion is .75?

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Q2

A That's correct.

Q That is not water velocity, that is hydraulic conductivity?

A That's correct.

Q Now, you gave an opinion to the jury about how much water from the Grace site is going to Wells G and H. Do you remember that?

A Yes.

Q And in doing that opinion, if you would just come up here.

A (Witness complied.)

Q It will soon be over. It will only be eight minutes. I can't make you come up here more than once. I probably could, but I won't.

You calculated the water from the Grace site to Wells G and H. That water went through a certain area, is that right?

A Yes.

Q And that went through -- Was it about 600 feet, is that what you said?

A It was an area 600 square, around 600 square.

Q Yes.

A It was based on the water table map, the water level map shows a groundwater divide through Well 8. I went from the divide because on the east side of the divide

water flow is to the east. On the west side of the divide it flows to the west. On the water table map I made a square area and included the Cryovac plant and calculated the divide of water that gets into the ground and that is the volume of water that would move from the Cryovac plant toward wells -- the position of Wells G and H.

Q It would move between these two points, is that right, is that what you figured (indicating)?

A Well, I took the water table map and included an area a little bit larger than the Cryovac plant, but it moves in this general direction, that's correct.

Q About how many feet is that, 600 feet?

A It was 600-foot by 600-foot square.

Q This area here that it moved through, was it about 600 feet (indicating)?

A Yes.

Q About 600 feet?

A Yes.

Q Now, are you aware -- You may sit down now, and I won't ask you to come back until tomorrow.

A (Witness complied.)

Q Dr. Guswa, you are aware of the gradients at the Grace site, is that right?

A Yes, I am.

Q Are you aware of the fact that Mr. Maslansky has concluded that there are .037 from Washington Street up to the area behind the building?

A Well, I wasn't aware that he had said .037, but that is about the range that I would think.

Q That would be a proper gradient for that area?

A Yes, that's correct.

Q And the porosity for that area, are you aware Mr. Maslansky used the figure 15. -- .15?

A Yes, he did.

Q Is that proper?

A That is within the range of porosity, yes.

Q And do you have your cross section from Grace to the wells?

MR. KEATING: The long one?

MR. SCHLICHTMANN: Yes.

MR. KEATING: Let me look. I think we brought everything over.

It is not here, but just let me see if it. . . Wait a second -- I'm not sure -- I think. . . Unfortunately, Jan, it is not here.

MR. SCHLICHTMANN: You don't have it?

MR. KEATING: I thought we had all of them here.

THE WITNESS: There are some in the

back room.

MR. KEATING: May I go look in the back room?

THE COURT: Certainly.

MR. KEATING: This?

MR. SCHLICHTMANN: Very good, it is here. I don't want to violate my promise. I won't ask you to come to the thing. You are familiar with it, is that right?

A It depends upon how much detail you want me to talk about.

Q All I want to know, what is the average depth to the bedrock between the water table and the bedrock at the southwestern side of the Grace site?

A G3 at approximately 20 feet.

Q Somewhere around 18 something, isn't it?

A Yes.

Q And is that a -- What you find as probably an acceptable depth of the saturated zone to bedrock on the southwestern side of the Grace site?

A Yes.

Q About 20 feet?

A Yes.

Q And you told the jury, when you made your calculations, that 7400 gallons of water leaves the

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Grace site?

A What was the time frame?

Q On a day.

A 74 gallons a day?

Q That is the amount that flows --

A Yes, that would be about right.

Q That is the amount that flows through the ground-water?

A That's correct.

Q On a daily basis?

A Yes.

Q Through that saturated zone?

A Yes.

Well, flows through the unconsolidated material as well as the bedrock.

Q Yes.

A Bedrock is slower flowing.

Q A foot or something?

A I have not calculated it. I agree the unconsolidated is the more permeable material.

Q That is the area the water is going to flow through, that 20-foot saturated zone?

A Yes.

Q On the southwestern side of the Grace site?

A Yes.

THE COURT: And that ground moraine?

THE WITNESS: Yes.

THE COURT: All right.

MR. SCHLICHTMANN: Well, it is one o'clock.

THE COURT: Is this a place you want to stop?

MR. SCHLICHTMANN: I can go further, but I have a lot more.

THE COURT: It seems to me there is a question missing. We have the 18 feet of unconsolidated ground here, we have water going at a certain rate, there must be something that follows from all of this. There must be something to get from all of this.

MR. SCHLICHTMANN: Can you give us 15 minutes?

THE COURT: Can you stand 15 minutes so we won't have to be in suspense?

MR. KEATING: Your Honor, I think all of us, the lawyers, have an event at two o'clock in line with what we discussed yesterday at the side bar after the -- I can tell you up at the side bar.

MR. SCHLICHTMANN: I can make it 15 minutes later.

THE COURT: You have some control over that.

MR. KEATING: All right, we will go until 1:15.

THE COURT: Let us finish this or we will have to start all over again.

MR. SCHLICHTMANN: All right. We will try to do something.

Q (by Mr. Schlichtmann) Now, I am going to violate my promise, I'm sorry, Mr. Guswa, would you please come up here.

A (Witness complied.)

Q Dr. Guswa, in your profession there is a fundamental principle of science which basically permeates if I might choose that word, the basic area of hydrogeology, which is Darcy's law?

A Yes.

Q What Darcy's law is, what goes in has to come out or is left behind, is that right?

A Yes.

Q Now, Darcy's law has a way, there is a way of using Darcy's law to calculate --

THE COURT: Is that all there is to Darcy's law?

THE WITNESS: No.

THE COURT: Is there more to it?

MR. SCHLICHTMANN: A little more.

THE COURT: Let's have a full statement on Darcy's law.

Q One aspect of Darcy's law is if you want to compute the outflow of water through a porous media, you take the hydraulic conductivity, that's the permeability or the ability of water to move through material, that is one, right?

A Yes.

Q And then you multiply that by the cross sectional area or the end of the area, the opening that the water has to pass through?

A Yes.

Q And then you multiply that by the hydraulic gradient, which is the tilt or the incline the water has to go down?

A Yes.

Q Have I correctly stated that?

A Yes.

Q Would you put that up here? Q is outflow, am I right?

A Yes (writing).

Q And that is equal to K, which is hydraulic conductivity?

A (Writing).

Q Times the aerial cross section, which is A, we

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will call it A.

A (Witness writing.)

Q Times the hydraulic gradient, which you call I, is that right?

A Correct.

Q To figure out the cross section, the area, the opening that water moves through, you take the width, you take the height, and that is the opening?

A Yes.

Q That is the opening?

A That's correct.

Q You have told the jury that in your opinion based on 12 inches of rainfall the Q is 7400 gallons?

A Per day.

Q Put down 7400 gallons per day.

A (Witness writing.)

Q To make sure the gallons per day are equal to the same units we are using in our formula, you have to change the gallons per day into cubic feet?

A Yes.

Q So you use the formula 7.48 gallons per cubic foot?

A That's correct.

Q So you take 7.48 cubic feet and you divide it into 7400 gallons?

A That's correct.

Q And you come to a number?

A That's correct.

Q Do you have your calculator?

A Yes.

THE COURT: You take 7.48 gallons, you can't come up with a result in cubic feet.

MR. SCHLICHTMANN: Divide 7 to come up with the cubic feet per day.

THE COURT: Divide it by 7.48 gallons. It doesn't matter, the number will be the same.

MR. SCHLICHTMANN: Thank you, your Honor. I am glad you are here.

THE COURT: Some days you are and some days you are not.

MR. SCHLICHTMANN: We will see what we say about today.

Q Do you have your calculator?

THE COURT: What are these figures, again? 7400 gallons per day times 7.48. Okay.

THE WITNESS: We have to go back to basic math.

Q I have a calculator. 7400 divided by 7.48.

A 989 cubic feet per day.

Q Do you want to call it 990?

A Sure.

Q It is easier.

A (Witness writing.)

Q Now, so we have 990 cubic feet per day on this side of the equation?

A Okay (writing).

Q And that's going to be equal to the hydraulic conductivity, which is .75.

A (Witness writing.)

Q Times the hydraulic gradient, which is .037.

A (Witness writing.)

Q Times the cross sectional area. And the cross section area we have a value of 600 opening, is that right, by 20? Is that right?

A Yes (writing).

Q Now, if we wanted to find out -- If we didn't know how high the opening was, if all we knew was how wide the opening was --

A Yes.

Q -- we could with very simple algebra arrange the equation so that since we know all of these values and the only value we don't know is the height, we can make height X, right? We can put it over in our equation here and the height X would equal Q over the hydraulic conductivity times the length times the hydraulic gradient, am I right in using algebra if

you make this X, if you don't know what the height is you only know what the width of that opening is?

A Yes.

Q Make that X. Am I not right that X will equal --

A (Writing).

Q -- 990 cubic feet over -- The hydraulic gradient .75?

A Hydraulic conductivity.

End Q

Q Excuse me. Hydraulic conductivity times the length, which is 600, times the hydraulic gradient, .037.

Now, would you do that math for us and tell us what the height is of the opening?

A Fifty-nine feet.

Q Fifty-nine feet?

A Yes.

Q That is the height of our opening?

A That is correct.

Q Now, could I have an overlay? Or why don't I do it this way: How about, if you could, at Well G-3, which would be the area of our opening, would you please measure off the height of the opening from the bedrock and put a line through the dot as to where that height is. Fifty-nine feet from the bedrock.

A It's about 10 feet above land surface.

Q That is the height of the opening?

A That is correct.

Q And so is it not true, then, Dr. Guswa, that what we have just calculated is if 7,400 gallons of water a day were leaving the Grace site on a daily basis and it was trying to get through that ground moraine at the hydraulic conductivity of .75 and it was going down an incline which was .037 and the opening that it was trying to get through was 600 feet wide --

A Yes.

Q -- it would need an opening that was 59 feet high, which would be 10 feet above the surface of the ground, am I right?

A That is correct.

MR. SCHLICHTMANN: Thank you very much.

I will have that marked as P-908.

THE COURT: Does that conclude that particular demonstration or is there more to come?

MR. SCHLICHTMANN: No, I think we can stop right there.

THE COURT: All right. Tomorrow morning at 9 o'clock. Monday morning will be at 9:30. Monday morning at 9:30. Tomorrow at 9 o'clock. All right.

(Whereupon the jury left the courtroom.)

MR. NESSON: Your Honor, can we just see you for a second?

(CONFERENCE AT THE BENCH AS FOLLOWS:

MR. NESSON: Your Honor, we'd like to request that we be given by the other side Dr. Guswa's model.

THE COURT: It's in evidence.

MR. NESSON: Well, a picture of it is. But the model is actually a computer model and when it was the other way around with Pinder, he had his model ready and we

delivered to the other side a floppy disk so they could run the model. That is what we want. We have a picture.

MR. KEATING: If we have got it, if he can give it, I have no objection. I don't know what form the program is in. I will ask him.

Let me talk to Dr. Guswa. You want the program?

MR. SCHLICHTMANN: Yes.

MR. NESSON: I want it on a disk so I can put it in a machine and run it.

MR. KEATING: I just don't know.

(Pause.)

THE COURT: Have we resolved our problems so we can go to lunch?

MR. KEATING: Yes.

THE COURT: Good.

(Whereupon the 69th day of trial was adjourned, to be reconvened on Friday, June 27, 1986 at 9 a.m.)