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IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

THE UNITED STATES OF AMERICA,	)	
Plaintiff,	)	
vs.	)	No. 78 C 1004
OUTBOARD MARINE CORPORATION and MONSANTO COMPANY,	)	
Defendants.	)	

The deposition of DR. DOUGLAS CHERKAUER, called by the Defendant Monsanto Company for examination, taken pursuant to the Federal Rules of Civil Procedure for the United States District Courts pertaining to the taking of depositions, taken before Jean Korinko Sweeney, R.P.R., a Notary Public within and for the County of Cook, State of Illinois, and a Certified Shorthand Reporter of said state, taken at Suite 1486, 219 South Dearborn Street, Chicago, Illinois, on the 17th day of June, 1982, at 9:30 a.m.

PRESENT:

MR. JAMES T. HYNES
(Deputy Chief, Civil Division
United States Attorney's Office
219 South Dearborn Street, Room 1486
Chicago, Illinois 60604),

-and-

Thea L. Urban
Certified Shorthand Reporter
134 South La Salle Street
Chicago, Illinois 60603
312 782 3332

PRESENT: (Continued)

MR. SEBASTIAN T. PATTI,
(Enforcement Division
U. S. Environmental Protection Agency
230 South Dearborn Street
Chicago, Illinois 60604),

appeared on behalf of the United States of America;

MS. ROSEANN OLIVER,
(Phelan, Pope & John, Ltd.
180 North Wacker Drive
Chicago, Illinois)

appeared on behalf of Defendant Outboard Marine Corporation;

MESSRS. ROBERT E. SHAPIRO and
BRUCE A. FEATHERSTONE
(Kirkland & Ellis
200 East Randolph Drive
Chicago, Illinois 60611),

appeared on behalf of Defendant Monsanto Company;

ALSO PRESENT:

MS. CAROL DORGE.

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* * * * *

MR. SHAPIRO: Would you mark these two exhibits.

(Said documents were marked Cherkauer Deposition Exhibits 1 and 2 for identification (Monsanto), as of 6/17/82, JKS.)

MR. SHAPIRO: Would you swear the witness in, please.

(Witness sworn.)

DR. DOUGLAS CHERKAUER,

called as a witness by the Defendant Monsanto Company for examination, having been first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. SHAPIRO:

Q What is your name?

A Douglas Cherkauer.

Q Where do you live?

A Whitefish Bay, Wisconsin.

Do you want the full address?

Q Yes, please.

A 5314 North Lydell, Whitefish Bay, Wisconsin.

MR. SHAPIRO: Let the record show that this is the deposition of Douglas Cherkauer, taken pursuant to notice and agreement of the parties, and pursuant

to the Federal Rules of Civil Procedure.

BY MR. SHAPIRO:

Q Where do you work?

A University of Wisconsin, Milwaukee.

Q What is your position there?

A I am the Chairman of the Geological Sciences Department.

Q What does that Geological Sciences Department include?

A It includes 16 faculty members in geology and meteorology.

Q Any other disciplines?

A Not any other major disciplines, no.

Q Well, minor disciplines, or sub-disciplines?

A Yes.

Q What would those be?

A There are hundreds of them.

Q Well, give me some examples.

A Paleontology, hydrogeology --

MR. FEATHERSTONE: Spell some of those words for the court reporter.

BY THE WITNESS:

A P-a-l-e-o-n-t-o-l-o-g-y.

BY MR. SHAPIRO:

Q Hydrology.

A Hydrology, geophysics, petrology, stratigraphy.

Q What is stratigraphy?

A The study of strata, layers of rock.

Q Have you been asked to be a witness in this case?

A Not to the best of my knowledge.

Yes?

MR. HYNES: Yes.

BY THE WITNESS:

A I don't know that terminology. I am somebody --

BY MR. SHAPIRO:

Q Let me go back. Have you been asked to testify as a witness on behalf of the Government in the Outboard Marine case?

A Yes.

Q When were you first asked to become a witness?

A Well, again I am not sure what you mean by asked to become a witness. That is what is confusing me.

Q Well, is it your understanding that you

will testify in the Outboard Marine case?

A Yes.

Q When did you first learn that you would - testify in the Outboard Marine case?

A I was initially contacted to begin looking at the groundwater situation, I believe.

Q When was that?

A That I am not sure of. I am guessing at 1979.

Q The beginning of 1979?

A March or April.

Q Who contacted you?

A Well, the initial contact was through a -- Well, okay. The initial contact was through a company, JRB and Associates in Virginia, and then Ed DiDomenico of the US EPA.

Q Who is the person who contacted you from JRB and Associates?

A I believe his name is Ed Salzberg.

Q He is the person who contacted you in March or April of 1979?

A Yes.

Q He told you at that time that you would be

expected to testify in this case?

A I don't believe he told me that. I believe that DiDomenico told me that, yes.

Q When did Mr. DiDomenico contact you, first contact you?

A Shortly after Salzberg did.

Q I would like to show you what has been provided to us by the Government in response to some interrogatories that the Monsanto Company served and which I have marked as Exhibit 1. If you will turn to Page 3. It says under Subsection (a), "Dr. Cherkauer is being offered as an expert in the field of hydrogeology."

Is that your understanding of your role in this case?

A Yes.

Q What is hydrogeology?

A Well, it is the study of movement of water through geologic strata, rocks, and sediments.

Q What type of water, surface water, rain-water?

A Groundwater.

Q Just groundwater?

A That's all that moves through -- Yes. That is all that moves through rocks and strata.

Q What is groundwater?

A Subsurface water which moves through porous or fractured media.

Q Is there anything else that a hydrogeologist studies, or a person who is an expert in hydrogeology studies?

A Yes.

Q What other types of things?

A Well, one, as a sub-area of that, one looks at the chemistry of that water, changes in its quality.

Q Including contamination?

A Right.

Q Anything else?

A The development of subsurface water resources, in other words, the quantity available.

Q Anything else?

A Well, how much detail would you like?

Q Well, is there anything else that you study as part of the field of hydrogeology?

A Well, in the most general terms I guess I would answer no to that. That those encompass just

about everything.

Q So basically you look at groundwater, study its movement and the chemistry, and its quantity?

A Yes.

Q What kinds of areas do hydrogeologists look at, or does someone who is an expert in hydrogeology look at, open areas, narrow areas, limited areas?

A I guess I don't understand what you mean by an area.

Q Well, what does the field of study, I mean where do you look to study groundwater?

A Groundwater exists virtually everywhere. So everywhere under land.

Q What is the purpose of doing a study in hydrogeology?

A To find sufficient water for people to use, to determine what the quality of that water is, is it usable or not, and to give them some idea as to how much is available for their use.

Q Basically a description of the way in which the groundwater acts in the media?

A Well, I wouldn't call it a description. I

call it a quantification.

Q Does it include predictions about groundwater?

A Yes.

Q What sorts of predictions?

A Oh, where the flow is going, how long it will take to get there. What the future chemical composition of a site might be, what the effects of human usage of the water might be on the natural system.

Q If you were doing a study as a hydrogeologist, what kind of information would you look for?

A Well, basically you need to know information about the containing medium, the geologic system. You need to know what its hydraulic properties are, what its extent is, and what the boundaries of that medium are. You need information about the hydraulics of the system. In other words, how much water is there, what energies or forces are working on it, what its chemical composition is. I guess I would add also you need another chemical composition, or the composition, let's say, of the containing medium.

Q Anything else?

A Again, in generalities, that covers it.

Q Well, do you have to measure the amount of water that is in the medium?

A Yes. Haven't I said that?

Q Would you have to study the effects of the surface water in the area as well?

A Yes, but again that is within the realm of what I am determining the hydraulics and the boundaries of the system. A surface water body very often serves as a boundary to a counter-water boundary.

Q What do you mean by a boundary?

A Simply a limit. In the case of the surface water groundwater boundary, it is really a semantic limit. Where the groundwater ceases to be below ground and hence becomes surface water. But physically the physics controlling the flow of surface and groundwater, the physics are the same, but there are more different types of forces operating in surface water systems than there are in groundwater, and so hydrologists tend to separate the two, because it's easier to deal with them as independent entities.

Q What kind of forces are there for surface

water that there are not for groundwater?

A Wind, tides. To a lesser extent human activity.

Q Is it important to understand how those forces act on the surface water in interpreting a groundwater system that is bounded by that surface water?

A It could be. It would depend upon the case.

Q Well, under what circumstances would it be?

A Well, where the surface water body was a contributing factor to either groundwater quantity or quality, it would be relevant to know information about the surface water.

MR. SHAPIRO: Could I have that answer back, please.

(Record read.)

BY MR. SHAPIRO:

Q What information would you want in that case?

A Again, it would depend upon what you were looking for. So unless you have something specific in mind, I don't know how to answer that.

Q Well, what about in the case where you

are trying to measure the quantity of groundwater that is available?

A Well, then, you would be interested in what would be termed the hydraulic connection between the ground and surface waters. In other words, the ability of groundwater to move into the surface water body or vice versa.

Q How about the quality of the groundwater?

A Then you would want to know something about the relative compositions of the surface and groundwaters, and in which direction the water was moving.

Q What do you mean by composition?

A Chemical composition.

Q How do you determine the composition, the chemical composition of the water in the various medium?

A Well, one would take a sample and analyze that sample chemically for whatever the material you were interested in was. If you were just looking for a total chemical composition, you would have to do a total spectrum analysis, examine it for everything.

Q Is that something that a hydrologist usually does?

A Which?

Q That analysis of chemical composition.

A Hydrologists often do chemical analysis, yes. Some do and some don't. But many of them do.

Q Have you done such analyses?

A Yes.

Q Turning back to Exhibit No. 1, under subsection (c) it says, "Dr. Cherkauer will testify as to the extent of PCB contamination in the groundwater and sediment under OMC's property, and the flux of these PCB's over time."

Is that your understanding of what you have been asked to testify about?

A Yes.

Q Is there anything else that you have been asked to testify about?

A No.

Q So this is a complete statement of what your testimony will involve?

A Yes.

Q You seemed to hesitate. Is it an accurate statement of what your testimony will involve?

A No. I am hesitating because I am reading

it again. Yes, it is an accurate statement.

Q How would you describe the testimony in terms of the types of analyses that a hydrogeologist does? What type of analysis is that?

A I am not sure I understand your question.

Q Well, it says that you are going to testify about the extent of PCB contamination in the groundwater and sediment under OMC's property, and the flux of these PCBs over time. You have given me a description of the number of things that a hydrogeologist does. How would you classify this kind of analysis or this kind of testimony?

A Well, here I am examining the contamination of a groundwater body, groundwater system, and attempting to project -- well, attempting to reconstruct through time where that contamination is, and then project through time where it will move in the future.

Q To do that you would have to know the nature of the geologic system?

A Yes.

Q And the hydraulics involved?

A Yes.

Q And the hydraulic connection to say surface

water boundaries that exist?

A Yes. Those surface water boundaries that exist.

Q And the chemical composition of the water?

A Yes.

Q The direction of flow?

A Yes.

Q Anything else?

THE WITNESS: Could you tell me what he has listed?

(Record read.)

BY THE WITNESS:

A No.

BY MR. SHAPIRO:

Q In looking at the surface water boundaries, would you have to know the forces that acted on those surface water boundaries in order to complete your analysis?

A Perhaps. It may depend -- Are we now talking specifically about this site?

Q I am just asking generally.

A Okay. Again, I would say that it would depend upon the surface water boundary and the

condition at the site, and the problem we were examining.

Q Subsection (d) of Exhibit 1 --

MR. HYNES: The one with the typo in it that says Mr. Hughes instead of Dr. Cherkauer, that I missed when it was typed.

MR. SHAPIRO: I noticed that.

BY MR. SHAPIRO:

Q It says that, "The testimony of," it says Mr. Hughes, but as Mr. Hynes pointed out, it should say Dr. Cherkauer, "will consist of opinions as disclosed in his report dated February 10, 1981."

Is that correct?

A Yes.

Q I would like to show you what has been marked as Exhibit No. 2. Is that the report that is indicated in Subsection (d)?

A Yes, I believe so.

Q Did you draft that report?

A Yes.

Q The entire report?

A By draft, you mean write? I wrote it.

Q You wrote it?

A Yes.

Q The entire report?

A There are a couple of minor sections in there which were written by or extracted from reports written by Warzyn Engineering, or I think there may be a chemical section in here briefly from the EPA personnel. But otherwise, I wrote the report.

Q Which portions were taken from EPA personnel?

A Any sections dealing with the analytical work. It would be Section 2.5.2.

MR. SHAPIRO: Off the record.

(Discussion had off the record.)

MR. SHAPIRO: Let's go back on the record.

MR. HYNES: All right. Just explain what 2.5.2 is.

BY THE WITNESS:

A I recall what happened. It was decided it didn't belong in here at all, because I had not done the analyses, and therefore it didn't belong in my opinions. But I see we failed to extract it from the table of contents.

BY MR. SHAPIRO:

Q Let me make sure I understand you. The

EPA provided you with information that you originally incorporated in your report as Section 2.5.2, is that correct?

A Yes.

Q That part of the report has been deleted in the final product.

A Yes.

Q Who provided you with that information?

A I don't recall the person's name. It was an EPA staff member working with Ed DiDomenico.

Q Who made the decision to leave it out of the final report?

A I am not positive. Again, I think it was Ed DiDomenico's suggestion, but I am not certain of that.

Q Did you rely on that information in drawing the conclusions in your report?

A No.

Q Well, what was the information that was in Section 2.5.2?

A The information was a simple description of how the samples were analyzed.

Q Did you review that descrption?

A I reviewed it, yes.

Q Were you satisfied that it was a proper analytical procedure?

A Yes.

Q Were there any other sections of the report that were provided you by US EPA?

A No.

Q Which part came from Warzyn Engineering?

A That may be a slightly more complicated answer. Most of the Section 2.3, "Establishment of Well Field" is drawn from Warzyn Engineering input, however, some of it is not in their exact words. I have editied it, cut down their descriptions out of that section.

Section 2.3.6, "Baildown Testing," has been largely rewritten by me, simply to make it more concise.

Q Any other parts?

A Yes. The early -- Well, I guess it is the entire Section 2.4 which is, "Water Level Monitoring Program." Again, that has been extracted from their information. It is in my own words, but it has been extracted from their information.

Finally, Section 2.5.1, "Soil Classification and Testing," which is simply two paragraphs, also drawn largely from the Warzyn reports.

Q So it is fair to say that Warzyn provided you with reports, and that you either summarized them or edited them or rewrote them on the basis of the information you found in those reports in these sections you just identified?

A Yes.

Q Which Warzyn reports were you relying on?

A I don't know the exact names, but the reports that dealt with emplacement of the well field and collection of sediment samples during the drilling operation.

Q Is there someone you dealt with at Warzyn who provided you with these reports?

A Yes. I don't recall if the reports came directly from Warzyn or if they were sent to JRB and then to me. But my contact was with a hydrogeologist named Daniel Hall.

Q Were those reports prepared exclusively by Warzyn, or did you contribute also to the preparation of those reports?

A I didn't contribute anything to the preparation of their reports, but I don't know whether it was exclusive to Warzyn or not.

Q If the reports had been forwarded to you through JRB, it would have been Mr. Salzberg who sent them to you?

A Initially, yes. Somewhere midway through the whole program another man came on board at Warzyn -- or at JRB. I don't remember his name. It was an Oriental name. So for a period of time I was dealing with him as a subordinate of Mr. Salzberg.

Q Would that be Mr. Shrivastava?

A No. That is an Indian or Pakistani name. Whan or Whang.

MS. OLIVER: Whang?

THE WITNESS: Yes.

MS. OLIVER: I saw a reference to Dr. Whang, W-h-a-n-g.

BY MR. SHAPIRO:

Q Did you ever deal with anybody else at JRB?

A Yes. A woman by the name of Claudia Wiegand, who was the person who actually put this report into its final printed form. W-i-e-g-a-n-d.

Q What do you mean by put it into its final form?

A Well, she was the word processor.

Q Anybody else?

A Not that I recall.

Q Did you ever deal with a Dr. Hornberger?

A Oh, yes. Well, the only time I had contact with Dr. Hornberger was my initial meeting with the JRB people and the EPA people at the OMC site.

Q When was that?

A That was again in April or whatever, March or April of 1979.

Q You didn't meet him again?

A No.

Q Or have contact with him?

A No.

Q How about Mr. Kufs?

A No.

Q Dr. Dimenico?

A DiDomenico?

Q No. Patrick Dimenico.

A No.

Q Dr. Feter?

A No.

Q Dr. Hoffman?

A Again, you are asking if I have had contact with those people relative to this case?

Q Right.

A No.

Q You said you didn't know Mr. Shrivastava?

A I may have received communication from him in that transition period between Salzberg and Whang, because that name does sound familiar. But I don't believe the communication was of a technical nature. It had to do with the operations of getting materials to them and back from them.

Q How about Mr. Twedell, T-w-e-d-e-l-l?

A No.

Q You never encountered him during the course of the study?

A No.

Q Your answer is no?

A No.

Q Other than Warzyn and US EPA information that was provided by Warzyn and US EPA, did you rely on any other materials in preparing this report?

A Well, materials provided by JRB. At least that is who I ultimately ended up getting the information from. I believe it was Mason and Hanger which provided the analytical information.

Q Which information is that?

A The PCB analyses.

Q The actual amounts that were found in the particular samples?

A Right. I am not certain if they are the ones who did the analyses, but the information came, I believe, and I am not certain of this, on their letterhead.

Q Was it in the form a report?

A No. Most often it was in the form of loose sheets of data.

Q Blue sheets of data?

A Loose.

Q Is there any other information that JRB provided you with that you relied upon in this report?

A No.

Q Did you have an assistant in preparing this report?

A No.

Q You did it exclusively by yourself at the University of Wisconsin?

A No. I did it at my home.

Q Are all your opinions about the OMC site contained in this report?

A No.

Q Well, are all the opinions that you are going to testify about contained in this report?

A Yes.

Q Did you prepare other reports?

A Other than this one?

Q Yes.

A Well, there were earlier drafts of this report, but this was the ultimate report and the only final report.

Q When were the earlier drafts prepared?

A Probably the date on it would have been early 1980, but I am not, again, I am not certain of the exact date.

Q There was just one earlier draft?

A Yes.

Q Did you circulate that draft?

A No. My role was to send the draft to JRB, and then they took care of it from there.

Q What did they do with it, do you know?

A I don't know.

Q Do you know of anybody else who received it?

A No, I don't. As a matter of fact, I never received a final form of it.

Q This earlier draft was turned into a final draft that you never received a copy of?

A Well, no. I wouldn't call it a final draft. When I initially began writing it we thought it was the final draft, and we thought we would be done. During the writing process, I believe as soil borings were being done at the site, it was discovered that PCB contaminated sediment existed in areas that we had not anticipated, and therefore some of the information that we had in there was incomplete. So I am not really sure that it ever went to final form. It simply got reworked into this report.

Q So you prepared a draft in early 1980 and it was sent to JRB, and you did not hear about it after that except that there was more information

coming that might make the report incomplete.

A Right. At that point we began the data collection of which allowed the completion of the final report.

Q Did you ever discuss the draft report with anybody?

A I am not certain of this, but I believe I had brief telephone conversations with Mr. DiDomenico about it. I hesitate on that because I am not even sure he had the full report or the full draft, but rather just portions of it, and we were talking about what other information might be necessary.

Q He made suggestions about the report?

A Excuse me. I didn't hear you.

Q He made suggestions about the report?

A He made comments on the report, or comments on what has happened at the site, and attempted to provide some additional information as to the physical system at the site. By that I mean the layout of the plant and the land surface and so on.

Q So Mr. DiDomenico gave you information that you were going to use in preparing a final version of this draft report?

A Yes.

Q Did Mr. DiDomenico do the same thing in the preparation of the 1981 final report?

A Yes. Again, he answered my questions, if there was something I was not aware of on the site or couldn't recall.

Q Do you have a copy of this draft report that you prepared in 1980?

A No, I do not.

Q Do you recall what conclusion you reached in the draft?

A Well, I have been attempting to do that, and to the best of my recollection the conclusions were never reached, because of the discovery that there was a serious oversight or serious lack of information because of this new discovery. That discovery occurred before we actually came or I had actually come to the conclusion stage. So I don't believe there were any conclusions.

Q Were there any preliminary versions of the final report?

A Yes.

Q Do you recall how many?

A I believe it was one.

Q When was that prepared?

A Well, late in 1980.

Q You sent that to JRB Associates?

A Yes.

Q Anybody else?

A I did not send it to anyone else.

Q Do you know if they did?

A I believe they -- Well, I am certain they sent it to Ed DiDomenico.

Q How do you know that?

A Well, because he sent it out for peer review, and then the reviews came back, and I had seen the reviews.

Q Who provided reviews of the draft?

A I don't know.

Q Would that be in your files?

A No.

Q Well, you did retain the review sheets, though.

A Yes.

Q Or the review copies.

A Excuse me. I have the review sheets.

Q Those are in your files?

A Yes.

MR. SHAPIRO: Jim, I think we would like to see the peer review sheets.

MR. HYNES: It is my understanding they were provided by Kaye when the draft reports were provided.

MR. SHAPIRO: Well, I know that from our review of it --

MR. HYNES: Okay. I can provide it. I can copy them right now. It is my understanding she had provided those.

MS. OLIVER: No.

MR. HYNES: That is what I asked you the other day.

MS. OLIVER: You said draft.

MR. HYNES: I said draft and peer reviews. Okay, I will get copies right now. Let's take a break.

(A recess was had.)

MR. SHAPIRO: Back on the record.

Mr. Hynes has provided us with some sheets which I would like to mark as Exhibit 3.

(Said document was marked Cherkauer Deposition Exhibit No. 3 for identification (Monsanto), as of 6/17/82, JKS.)

BY MR. SHAPIRO:

Q Dr. Cherkauer, I would like to show you what has been marked as Exhibit 3. Are those the peer review sheets that you reviewed after circulating the report that you prepared in late 1980?

A Yes.

Q I would like to ask you in particular about the second of the review sheets, which is a letter to Dr. John F. Paul of the U.S. Environmental Protection Agency from Dwight A. Sangrey, who appears to be a professor and head at Carnegie-Mellon University, Department of Civil Engineering. Do you know Dr. Paul?

A No, I don't.

Q You have never heard of him?

A I have heard of him, yes.

Q In what context have you heard of him?

A Through my discussions with Ed DiDomenico.

Q Was it Ed DiDomenico who sent you these peer review sheets?

A I believe so.

Q He explained to you who Dr. Paul was?

A Yes. He indicated he worked at the Grosse Ile EPA office.

Q Is he said to be the person who was responsible for circulating your report for peer review?

A Yes, I believe so.

Q Are you familiar with Dwight Sangrey?

A No, I am not.

Q Do you know whether he is the professor and head of the Department of Civil Engineering at Carnegie-Mellon University?

A No, I don't.

Q You are not familiar with his work at all?

A No.

MR. SHAPIRO: Would you mark this as No. 4.

(Said document was marked Cherkauer Deposition Exhibit No. 4, for identification, (Monsanto), as of 6/17/82, JKS.)

BY MR. SHAPIRO:

Q Can you tell me what that is, what Exhibit No. 4 is?

A Yes. It is the early version, called the first draft of the final report, which was, I believe

this is what was sent around for peer review.

Q On the third page of the draft report is numbered by Monsanto US 40834 at the bottom, it gives the date of the report as January 23rd, 1980, is that correct?

A Yes.

Q Do you know whether that is the correct date for the preparation of that report?

A No, I don't. I think it is reasonable, but I don't know the exact date.

Q Well, didn't you tell me you prepared the report at the end of 1980, or the beginning of 1981?

A I don't recall what I said, but again I am not certain of any of the dates.

Q But that is the report that you submitted for peer review?

A Yes.

Q Referring back to Exhibit No. 3, the portion that contained the letter from Professor Sangrey to Dr. Paul, it says in the first sentence, "At your request I have reviewed the report entitled OMC Technical and Witnessing Case Support Hydrological Study of Groundwater, (Draft Review Copy dated

January 23, 1980)." Is it your understanding that he is referring to Exhibit No. 4?

A Yes.

Q Did you read Professor Sangrey's letter to Dr. Paul?

A Yes.

Q Did you consider it in preparing the final draft of your report?

A Yes.

Q Did you make any changes in the final report as a result of Professor Sangrey's letter?

A I believe so, yes.

Q What changes did you make?

A Well, I am not absolutely certain, but I suspect, I believe I recall having rephrased certain sections to allay some of the concerns that he had expressed. I don't recall exactly what the concerns were.

Q Well, would you review Exhibit No. 3 and take a moment now and see if that refreshes your recollection about what changes you made in the final report as a result of Professor Sangrey's letter?

A Okay. The two that I recall as direct let us

say responses to this letter, first he points out that the part beginning on Page 3-44, Section 3.2, "The writing deteriorates significantly." Much of that section had been in haste, and was reworded, reworked to eliminate that concern.

Q So you improved the writing of Section 3.2?

A Right.

Q Did that involve any substantive changes in Section 3.2?

A Well, there were some changes, technical changes made in Section 3.2, but they were not in response to this.

The other was my attempt to respond to his major concern regarding the transition flow. I am not sure I had been successful in rewording -- I believe the problem that the professor has with the report is simply a lack of communicative abilities on my part. I have not gotten the point across. I attempted to reword that. But I am not certain that I have succeeded in rewording it to the point where it is as clear as I would like.

Q Well, have you resubmitted it to Professor Sangrey to find out?

A No. As a matter of fact, this is the first time I had any idea who either of the reviewers were.

Q What changes did you make in order to take care of his concern, his major concern with the report?

A Well, his major concern is what I am calling Type I to Type II transition flow, is supported only by a single data point. That is what he is indicating in here. He has gotten the impression, at least this is my impression from his discussion here, that what I am proposing is that all of the movement of the eastern enclave of PCB contaminated water is through this trough that developed, that was observed on one of the sampling dates.

In reality, the migration of the PCB contamined water eastward is not restricted to within the trough, but rather it occurs over the entire area. But in doing my calculations, in attempting to be conservative to minimize the effect, I have arbitrarily restricted it to the trough, rather than to the entire zone that it might occupy. I have tried to reword it in here, but again I am not sure that that point comes across as well as I would like.

Q Could you show me the parts of your report where you have done that.

A Well, they would be --

Q I was talking about the final report.

MR. HYNES: Use the exhibit that he provided you.

BY THE WITNESS:

A The sections that have been -- they have been reworked partially in response to attempting to make it more clear, but also partially to become more conservative, begin I believe on Page 3-72, which deals with the migration of the eastern enclave of PCB water. It would also --

BY MR. SHAPIRO:

Q Page 3-72?

A 3-72. Now, this is the section where -- It begins on Page 3-72 and continues. But this is the section where the eastward migration of PCBs as a result of this transition flow are discussed. Now, the transition flow section is earlier. I have to find that.

The discussion of the transition flow itself begins on Page 3-25, and I believe there was some,

I made some modifications of that, the discussion in the last two paragraphs on that page, I believe. As I read it, I am not certain that I did make any changes.

Q You mentioned that you were responding only in part to the letter of Professor Sangrey. Was there somebody else that provided you with comment or criticism upon whose comments you based revisions in the report?

A No.

Q Well, did Mr. DiDomenico, for example, comment on the report and give you suggestions?

A He commented on the report. I wouldn't call the discussions we had on his part suggestions, but rather there were questions, he raised questions.

Q Did you make changes in the report as a result of his questions?

A Well, let me put it this way. His questions opened up questions in my own mind as to the conservativeness of my calculations, and in reviewing those calculations I decided that there would be a more conservative procedure to follow than what I had originally used.

Q Did you make changes as a result of that conclusion?

A Yes.

Q What changes did you make?

A Well, essentially in the mechanism that I used for calculation of the PCB flux rates.

Q Starting on Page 3-72?

A Yes.

Q Is it a fair summary to say that as a result of the comments of Professor Sangrey and the questions raised by Mr. DiDomenico that the major changes that you made in the report was to change the mechanism for calculating the PCB flux rates?

A Yes.

Q You basically changed the formula for how you went about determining how much PCB was flowing toward the Lake?

A Right. The formula. And I was able to, in my opinion, use a method that required fewer assumptions than the first method, and more justifiable assumptions.

Q You did not have any more data after you got the comments from Professor Sangrey and Mr.

DiDomenico?

A No.

Q You said you made changes in the formula so that it would require fewer assumptions and more justifiable assumptions. Does that mean that the assumptions that you used in coming up with the conclusions in the draft report you did not consider justifiable ultimately?

A No. I considered them justifiable, but less certain than the ones in the final revision.

Q You would not, for example, have a reasonable degree of scientific certainty in the figures in the draft report, then?

A I would, in the draft report I would have an order of magnitude degree of certainty in the assumptions, or those that were changed, but not a precise knowledge.

Q So you really would not have any confidence in the figures that you came up with in the draft report for the flux of PCBs toward the Lake?

A I didn't say that, no.

What I am attempting to do here is come up with a conservative estimate, the best possible case,

and I have more confidence in the final draft estimates than in the earlier draft estimates.

Q Well, would it not be true that the estimates that you come up with in the final draft are the only ones that you can say with a reasonable degree of scientific certainty would be representative of what has happened with the flux toward the Lake?

A No. When I am talking about a conservative estimate of what is going on, I am talking about a minimum possible flux, and so I would be able to express confidence in the final report that that is the minimum that is going on, or will go on, and whatever really does go on will be equal to or greater than that.

Q But you do not have any other figure for what might be going on. You only have the one which is in the final report, the one which you have some confidence in.

MR. HYNES: I object to that. That is about the fourth different way you have asked the same question, Rob.

BY MR. SHAPIRO:

Q You can answer the question.

A I can't. You can't.

Q You can't --

MR. HYNES: Why don't you read back the question.

(Record read.)

BY THE WITNESS:

A There are many other possible figures. The only other ones that I have calculated other than what is in the final report are what are in the preliminary report, and so again I would repeat that I have much greater confidence that the actual conditions will exceed, equal or exceed what I have in the final report than in the preliminary report.

BY MR. SHAPIRO:

Q The figures in the final report are the only ones that you have any reasonable confidence in?

MR. HYNES: Objection. That is not a correct characterization.

BY THE WITNESS:

A That is not what I am saying, no.

BY MR. SHAPIRO:

Q Well, let me ask you this. Are there any other figures other than the ones in the two reports

that you have any confidence in?

A There would be other --

Q My question is, are there any others that you have any reasonable confidence in?

MR. HYNES: Are there any others that he calculated, or others that are possible to calculate?

BY MR. SHAPIRO:

Q Others that he has calculated.

MR. HYNES: He has already answered that question.

BY THE WITNESS:

A No, not that I have calculated.

BY MR. SHAPIRO:

Q What conclusion do you reach in your final report about the expected PCB fluxes toward the Lake?

A Well, my conclusions are summarized in Figure 46.

MR. HYNES: Page 3-79.

BY THE WITNESS:

A Page 3-79, which basically says -- Again, the lines which are drawn there represent for the most conservative situation what I am terming the minimum and maximum probable fluxes of PCBs to Lake

Michigan.

BY MR. SHAPIRO:

Q Those are based on the figures that you have calculated?

A Right. So these are showing that at present, and at the time the report was written, the fluxes to Lake Michigan are small, but that as time progresses the fluxes will increase, they will increase exponentially as this is showing for at least 80 years from the time the report was written.

Q So at the present time, according to your calculations, the amount of PCBs reaching Lake Michigan through the groundwaters are small or insignificant?

A Small, yes.

Q When would you say, according to your calculations, that the amount of PCBs reaching the Lake would be no longer small, or would begin to be significant?

A Well, that gets out of my area of expertise. I am not a toxicologist, so I don't know what is significant or insignificant relative to Lake Michigan.

Q Let me ask you this. Is there a time when the amount of PCBs reaching the Lake suddenly becomes

dramatically higher?

A It never suddenly becomes dramatically higher. It progressively becomes dramatically higher.

Q What level does it reach over this 80-year period?

A Well, about the year 2060 the projection is that for those periods when this transition flow is going on the fluxes will range between five and approximately 30 grams per day of PCBs.

Q Is that every day?

A Every day that this kind of transition flow occurs.

Q You will have between five and 30 grams per day on those days in which the transition flow occurs that was responsible for the flux toward the Lake?

A Yes.

Q Which transition flow is that you are referring to?

A This is the transition from -- I term it in the report as transition between Type I and Type II flow. It essentially occurs when the water levels in the ditch rise.

Q How many times during the course of your study did that occur?

A Well, I don't know the answer to how many times during the course of the study it occurred.

Q How many times did your measurements show that that flow had occurred?

A Out of our 12 sets of measurements, it occurred once.

Q So the flow occurred one out of 12 times of measurements?

A On the random dates of measurement, yes.

Q Do you have any idea how many times that flow would occur over the course of a year?

A No.

Q Is it likely to be more than one in 12?

A I have no idea.

Q Assuming that this type of flow occurs one day out of every 12 during the course of the year, what would be your calculation at the end of this 80-year period for the amount of PCBs that would be flowing into the Lake over the course of a year?

A Well, off the top of my head, I can't give

you a number. You take 12 percent of 365 days, and multiply it by those daily fluxes, and you can get an annual total.

Q Well, would you do that for me.

Have you been able to calculate it?

A It would range between 150 and 1320 grams per year.

Q That would be between .15 and 1.3 kilograms per year?

A Yes.

Q So at the end of this 80-year period your projection, based on the figures that you had of the amount of flux reaching the Lake, would be between .15 and 1.3 kilograms per year?

A Yes.

Q Dr. Cherkauer, have you ever studied the amount of PCB loading there is for Lake Michigan?

A No, I have not.

Q Do you have any knowledge of what the current PCB loading to Lake Michigan is?

A No, not really.

Q Would it surprise you to know that the PCB loading for Lake Michigan was between 7,000 and 8,000

kilograms per year?

A No, it wouldn't.

Q Would it surprise you that it has been estimated that the PCB loadings to Lake Michigan 80 years from now was about 5,000 kilograms per year?

A No, it wouldn't.

Q Can you tell me what percentage of that total PCB loading would be accounted for by the flux from the groundwater that you have projected?

MR. HYNES: I am not sure I understand the question. The numbers you just recited, the annual loadings, either presently or 80 years future, what percentage of that total loading would come from groundwater?

BY MR. SHAPIRO:

Q Well, what I am asking is assuming that the total PCB loading to the lake were 5,000 kilograms per year 80 years from now, what percentage would this .15 to 1.3 kilgrams per year be of that total loading?

A You are asking me what percentage of 5,000 is 1.3?

Q That is right.

A Well, the percentage is about two-tenths of one percent, or two-hundredths of one percent.

MR. HYNES: Just for the record, I object to the figures you are using in terms of the 5,000.

BY MR. SHAPIRO:

Q So that assuming that the total loading to the Lake during the 80-year period, at the end of the 80-year period is 5,000 kilograms per year, the groundwater fluxes that you have calculated would be responsible for approximately two-one hundredths of one percent of that total loading?

MR. HYNES: I think you mis-stated the percentages.

BY THE WITNESS:

A No.

MR. HYNES: Did you say two-one hundredths?

THE WITNESS: Two-hundredths of a percent. Could I hear the question again, please.

(Record read.)

MR. HYNES: I am still objecting to the foundation on the 5,000 kilograms, but he may answer.

BY MR. SHAPIRO:

Q You can answer.

MR. HYNES: You can answer the question.

BY THE WITNESS:

A The conservative number that I have come up with for the groundwater flux from this site would be two-hundredths of one percent of the 5,000 kilograms per year.

BY MR. SHAPIRO:

Q Well, you don't have any other numbers that you are going on the basis of, is that right?

A Any other numbers for what?

Q For the flux of PCBs to the Lake.

MR. HYNES: From the groundwater on this site?

MR. SHAPIRO: Right.

BY THE WITNESS:

A No. The only point --

BY MR. SHAPIRO:

Q So the only numbers which you have calculated for PCB fluxes to the Lake would account for only two-one hundredths of one percent of the total loading for the Lake, assuming that the loading at the end of that 80-year period is 5,000 kilograms per year.

A The absolute minimum would be two-one hundredths

of one percent.

Q The only numbers you have would be two-one hundredths of one percent.

A The conservative number that I have.

Q The only number that you have which you have calculated with a reasonable degree of scientific certainty.

MR. HYNES: I object. You are putting "a reasonable degree of scientific certainty" in. You have asked that same question about ten different ways, and I object again to the characterization.

BY MR. SHAPIRO:

Q You don't have any other numbers that you have calculated, isn't that correct?

A I have calculated a minimum number.

Q Well, that is the number that you have set out in your report, is that correct?

A Specifically stating in there that it is a conservative, i.e., minimum number, yes.

Q But it is the only number that appears in your report.

A For the year 2060 as a maximum probable, yes.

Cherkauer - direct (Shapiro)

Q It is the one you are going to testify during this trial?

A Well, I certainly will testify to the fact that it is the minimum number that I calculated, yes.

Q But it is also the only number that you are going to testify about?

A Presumably, yes.

Q Are there any conclusions in your report that the PCBs in the groundwater are affecting the drinking water in the Waukegan Harbor area?

A That was not part of my investigation.

Q So you have no opinions about that?

A None that would be -- No, none that I would like to make.

Q You have not been asked to testify about the effect on the drinking water of any PCBs that might be in the groundwater at the OMC site?

A No, I have not.

Q Are there any conclusions about PCB volatilization into the air from the groundwater in your report?

A No, there are not.

Q Do you have any opinions that you are going to testify about regarding that?

A No.

Q Do you have any opinions based on your study about exposure of humans to PCBs as a result of the PCBs in the Outboard Marine area?

A No.

Q How about exposure to fish?

A What about exposure to fish?

Q Have you formed any opinions as a result of your study of the area about the level of exposure of fish in the Waukegan Harbor area?

A No, I have not.

Q You said that you are not a toxicologist, is that correct?

A That is correct.

Q You don't have any expertise in toxicology.

A No, I do not.

Q Do you have any expertise in aquatic biology?

A No.

Q Do you have any expertise in analytical chemistry?

MR. HYNES: What do you mean by expertise?

BY MR. SHAPIRO:

Q Do you regard yourself as an expert in

analytical chemistry?

A No.

Q Is there any other field besides hydrogeology in which you consider yourself an expert?

A Well, what would be termed environmental geology.

Q Environmental geology?

A Yes.

Q Anything else?

A Well, semantic difference, also hydrology.

Q What is hydrology?

A Hydrology is a more encompassing term than hydrogeology. Hydrology is the science of the study of water.

Q So it would include surface water as well as groundwater?

A Yes.

Q Rainfall?

A Yes. In the sense once it becomes water.

Q It doesn't include clouds?

A Once it becomes liquid water, right. Not water vapor.

Q What is environmental geology?

A Well, it is a very poorly defined term, in fact, it is redundant. But it is a term that is used to describe the field where various facets of geology are applied to human environment. So it is water resources, mineral resources, geologic hazards, that sort of thing.

Q Do you have any opinion that you are going to give in your role of considering yourself as an environmental geologist in this case?

A No.

Q How about as a hydrologist?

A Well, because hydrogeology is encompassed within hydrology, yes.

Q But the opinions that you are going to give are specifically limited to those that you have considering yourself as an expert in hydrogeology?

A Right. They relate to the groundwater.

Q Have you completed your work in the Outboard Marine area?

A Yes.

Q US EPA or JRB has not asked you to do anything further?

A No.

Q Did you do any additional work after preparing the report that we have been discussing, the February 10th report?

A At the OMC site?

Q Yes.

A No.

Q Have you done other work for US EPA?

MR. HYNES: You mean other than in this case?

MR. SHAPIRO: Yes.

MR. HYNES: Okay.

BY THE WITNESS:

A No.

BY MR. SHAPIRO:

Q You have never done any other work for US EPA other than the work that was completed with the filing of the February 10th report, February 10, 1981 report?

A To the best of my knowledge, no.

Q How about for JRB?

A No.

Q Have you done other studies of this sort, the sort that you did at the Outboard Marine site?

A You mean involving groundwater contamination?

Q Yes.

A I guess I'd ask you to define -- Okay. Yes.

Q How would you define the kind of study that you have done at the Outboard Marine site?

A Well, I would define it as, in technical terms, as examining the effects of point source contamination on groundwater quality.

Q Have you done other studies of that sort?

A Yes.

Q Could you tell me what they are?

A Well, one that I have been involved in from a research aspect has been the contamination of a groundwater system in southeastern Wisconsin from the deposition of coal ash in a landfill site.

Q Any others?

A No. Another recent one has been the contamination of groundwater again in southeastern Wisconsin from the disposal of cheese wheys and animal manures through surface spreading.

Q Any others?

A Well, there have been others, but those are the most recent.

Q Well, how many others have there been?

A Well, I have been involved in the assessment

of two or three landfill sites, and then as a matter of classroom investigation in my role as a professor, we as a class have examined a number of sites where the potential for contamination exists.

Q Those would be studies like the study that you did at the Outboard Marine site?

A Yes.

Q Turning back for a moment to Exhibit No. 1, there is attached at the back a copy of your resume that was provided by US EPA. Would you look at the resume and can you tell me whether that is an up-to-date resume?

A Well, as of October, 1981, yes.

Q Is there anything relevant that has happened since October of 1981 that you would add to your resume?

A The Department of Commerce grant to examine the hydraulic connection between Lake Michigan and surrounding aquifers has been continued into this year and next.

About two years ago I presented a paper in Philadelphia on the incidence of induced recharge along the Lake Michigan shoreline, which falls under

the papers presented category.

MR. SHAPIRO: Could I have that again, please.

(Record read.)

BY MR. SHAPIRO:

Q What does the ongoing EPA investigation involve?

MR. HYNES: You mean the Department of Interior grant?

BY THE WITNESS:

A No. The Sea Grant, Department of Commerce.

BY MR. SHAPIRO:

Q I am sorry. The Department of Commerce grant.

A What we are doing there is looking at the fluxes of water from groundwater aquifers into Lake Michigan and vice versa, along the Wisconsin shoreline of Lake Michigan and Green Bay.

Q What have you concluded from that study so far?

A Well, I wouldn't say that we have concluded anything, because it's an ongoing study. But we have been able to ascertain that there is a significant

flux of groundwater into the Lake, and if conditions are right that flux can be reversed and well users can draw Lake Michigan water if they have the proper conditions.

Q What do you mean by the incidence of induced recharge along the Lake Michigan shore, which is the subject of your paper?

A Induced recharge is a situation where by human activity you cause water to flow in an aquifer. The example I was giving of pumping near the shoreline of Lake Michigan and inducing that water to flow from the Lake into the aquifer is induced recharge.

(Discussion had off the record.)

BY MR. SHAPIRO:

Q Have you ever done any other studies involving PCBs?

A No.

Q The study that you did at the Outboard Marine is the only study you have ever done involving PCBs?

A Correct.

Q When was the study of the deposition of cold ash in the landfill site conducted?

A That was initiated in probably 1976 or

thereabouts. And in one fashion or another it is still going on.

Q It is continuing to the present day?

A Right. We are no longer doing the field studies, but are conducting controlled laboratory studies.

Q How long were you doing the field studies for?

A From 1976 until I think it was April of 1980.

Q What do the field studies involve?

A Installation of a piezometer field, collection of samples, measurement of water levels and analysis of the direction and rates of chemical migration.

Q You took those measurements over a period of about four years?

A Yes, myself and graduate students involved in the project.

Q How often did you measure in that study?

A It ranged from anywhere to weekly to bimonthly, depending upon the conditions, what it was we were looking for at the time.

Q How many measurements total do you think you took in that case?

A We probably had something on the order of seven to 800 samples.

Q How large an area were you dealing with in that case?

A It's about 40 acres, 40 to 60 acres.

Q What kind of conclusions have you reached in that study?

A Well, the conclusions to this point from the field studies which we are trying to verify with the lab studies are that coal ash, particularly since the development of stack precipitators, provide a very major source of sulphur contamination to groundwater. It does not provide or had not within the course of our study provided a source of heavy metal contamination.

Q You have been calculating the fluxes of the sulphur contamination in the area that you are studying?

A Indirectly. We have not calculated the fluxes we have done in here, for example, because we weren't interested in the rates, the flux rate

of movement. We were rather interested in the qualitative assessment of what is coming out of the ash, and how far does it go.

Q But you are interested in the direction of flow and the extent of the flow?

A Yes.

Q Did you say that you are now connecting lab studies to try to verify your initial conclusions?

A Yes.

Q Why are you doing that?

A Well, the thing that concerned us about the field study is that we did not see any heavy metals, and it was our interpretation that that is probably because we had not monitored for a long enough period of time. That it would be several decades before the metals got out. So in the laboratory we are effectively trying to speed time up by flushing the water through more rapidly than it occurs in nature.

Q Any other reasons for doing the verification?

A Scientific curiosity.

Q In what sense?

A It's always nice to know that your field

studies can be verified independently.

Q Something you like to do to find out whether the field study is giving you accurate results?

A Yes. Something that I like to do periodically just to confirm that the field procedures are giving valid results.

Q Does this ever involve going back out into the field afterwards to verify your conclusions?

A It could. It hasn't to this point.

Q In this particular study?

A In this particular study. Actually, the power company that owns the site is conducting their own field investigations now. I presume when I convince them to let me see the data, that it will show what we have seen before.

Q By the way, how many wells were involved in this coal ash study?

A Thirty to 35.

Q What about the contamination study for cheese wheys, is that what it is, and animal manure?

A Yes.

Q When did you start that study?

A That was a study that was conducted --

Actually, I served on a panel which organized the study at the request of the State of Wisconsin Public Intervenor, who was trying to resolve a situation whereby local residents were arguing that a particular cheese company was contaminating their wells. That began in March or April, I believe, of 1981, the study itself. The contamination problem or alleged contamination problem had occurred or existed long before that.

Q How long did it continue for?

A We wrote the final report on that last December, December of 1981.

Q So that wouldn't be on your resume, that report?

A No. In fact, I don't believe there are any reports listed on that resume.

Q You haven't published that report?

A Well --

Q Let me rephrase it. Have you published that report?

A No. Now, I am answering that from the perspective of the university professor. We don't consider any of these reports published. So this

would not be listed on my resume either.

Q "This" being Exhibit 2?

A Yes.

Q Do you plan to publish that report?

A The individuals involved on the panel have discussed it. We have not approached the public intervenor to see if he feels that the information should be released.

Q Who is on the panel?

A That consisted of Dan Willard from Indiana University, and Bill Feter from the University of Wisconsin, Oshkosh.

Q Who is the Public Intervenor, is that just the State of Wisconsin?

A No. It's a man by the name of Peter Pesek, who is an employee, a member of the Wisconsin Department of Justice. It is a specific office in the state.

Q Trying to resolve the dispute?

A Yes.

Q How many wells did you install in the cheese whey study?

A Well, now, here I will make a distinction

between wells and piezometers. We installed no wells. We installed perhaps a dozen shallow piezometers.

Q What is the difference between a well and a piezometer?

A Well, technically a piezometer is what is referred to as a neutral well. In other words, one which is not pumped as a water supply, nor is anything put down it as a recharge source.

A well is a water source or a supply.

So piezometers are the neutral observation point.

Q A point for measuring?

A Right.

Q Which is what was used in the Outboard Marine report.

A Yes, exactly.

So we installed, to get back to your question, we installed about a dozen, had installed about a dozen piezometers, and in addition we used as monitoring sites the domestic wells of each of the claimants. There were roughly 24 claimants.

Q You took measurements of those wells, too,

the claimant's wells?

A Yes. Let me clarify that. The three of us on the panel did none of the field work ourselves. We simply directed it, and then the consulting company of the cheese firm did all the measurements.

Q Who was that?

A Warzyn Engineering.

Q Was Mr. Hall involved in that study, too?

A He did ultimately become involved in it, yes. He was not the initial hydrogeologist.

Q Have you used him in other studies as well?

MR. HYNES: The characterization have you used him in other studies as well?

MR. SHAPIRO: The characterization have you used him implies that he hired him or asked for him to do the work.

BY MR. SHAPIRO:

Q Have you worked with him in other studies as well?

A Yes, at other times.

Q What other times?

A He was also involved briefly in the fly

ash study, the coal ash.

Q Any others?

A Probably. None come to mind right offhand. He was a student of mine.

Q He being Mr. Hall?

A Yes.

Q Do you know if Mr. Hall was the reason why JRB originally contacted you to do the study in this case?

A No, I don't, actually.

Q Do you know why JRB contacted you?

A They were looking -- I don't know the exact reason. They were looking for a hydrogeologist who was familiar with the area. The "area" being northeastern Illinois, southeastern Wisconsin.

Q But you don't know who gave your name to JRB as a likely candidate for that?

A I don't know exactly, no. It wouldn't surprise me if it were Warzyn or Bill Feter.

Q Does Bill Feter work for JRB?

A I don't know.

Q How many samples did you take in the cheese whey study?

A I am not certain. I know that the wells and piezometers were sampled at least twice. I think there may have been one or two more samplings, but I am not certain of that. They were incomplete.

Q So there were 36 wells and piezometers. So there would be at least 72 samples that would be taken, measurements that were taken?

A Yes.

Q Were there water samples taken as well, water quality samples?

A That is what you asked me.

Q Well, were you also measuring the water table at these sites?

A Measuring the water level within the well, yes.

Q What conclusions did you reach in this study, that is, the cheese whey study?

A The conclusions we reached were that yes, the cheese company was responsible for some ground-water contamination. But that apparently they had improved conditions significantly since the original complaints were made, and they could only be identified as the primary cause of contamination

in about half a dozen of the claimant's wells.

Q You reached that conclusion as a result of looking at the source and direction of the possible contamination?

A Yes, and also the nature of the aquifer itself.

Q Did you do any laboratory verification of those conclusions?

A Not in that case, no.

Q How about field verification?

A I guess I don't know what you mean by field verification.

Q Did you go out into the field later to take more samples and more measurements to see whether you could confirm your conclusions?

A That wouldn't have been appropriate in this case. This was a case in which the contamination had occurred in the past, and the conditions were getting better. So we were actually trying to project back through time. Therefore, it is impossible to go back and verify.

Q It's only appropriate when you are predicting into the future?

A Yes.

Q Did you make a prediction about what was going to happen in the coal ash study, or have you made predictions about what is going to happen in that study?

A We have projected where we think the contaminants will move to, yes.

Q What period of time have you projected that for?

A Well, we are only projecting there for a few years. Five, at the most.

Q You mentioned that you have done a number of other studies of this sort with your classes as a professor. What on the average is the length of time that those studies last?

A Well, a class study generally only lasts a month or so. Basically that is a matter of going out and either collecting samples, if samples don't exist, or using existing data, published data, to confirm or deny the presence of a contamination situation.

Q Well, do those studies include an analysis of the flow of contamination?

A Sometimes. They include analysis of the direction and the magnitude of the flow of the water, and where appropriate, also contaminants.

Q How many samples do you usually use in one of those classroom cases?

A It highly varies. It depends upon the number of students. The purpose is to get each of them involved. Collect a few samples, have them analyze those samples. Anywhere from five to 50, probably.

Q You don't do them on very complex flow systems?

A No. At least we don't intend to.

Q You also mentioned that you have done a number of assessments of landfill sites. Can you give me some examples of those?

A Well, in those cases I will be approached by a community that is interested in establishing a landfill, or a group of citizens who are interested in preventing the establishment of a landfill, and I will be asked to evaluate whether the site has potential for contamination. So these are projections of whether contamination might occur.

Q Give me some examples of times that you have done that?

A Well, for the most recent citizens group in Milwaukee County, north of Milwaukee, which is looking to prevent the establishment of a landfill near their subdivision. They have collected the information that the State Department of Natural Resources has collected, and have asked me to review it and give my opinion as to whether this is a good site, or one which has high potential for contamination.

Q You haven't actually designed a field for analyzing the site?

A No.

Q How many measurements or samples did you have in that case to work from?

A Five.

Q Were you able to do an evaluation on that basis?

A Yes. But the evaluation basically said that we needed a lot more information.

Q Were you attempting to make a prediction into the future of what would happen at that site?

A In strictly qualitative terms, yes. In other words, what would happen if garbage were disposed of here. Would there be contamination, and which direction would it move. Yes.

Q Over what period of time?

A No particular time frame established on that one at all.

Q Just general direction?

A Yes.

Q And the likelihood of it escaping from the site?

A Yes.

Q Have you ever done a study before of predicting 60 or 80 years into the future of what would happen with groundwater or groundwater contamination?

A No.

Q So the analysis in this report is really a first time thing for you?

A Well, to directly answer your question, yes. But the analysis is time independent.

Q But you never made such a prediction before on any of the studies that you have been

involved with?

A Correct. Nor have I been around long enough to field check them.

Q That would be a good thing to do, though, wouldn't it, if you could verify it?

A Oh, I'd very much like to.

MR. HYNES: You mean be around 80 years from now to field check your progress?

MR. SHAPIRO: Off the record.

(Discussion had off the record.)

BY MR. SHAPIRO:

Q Would it be possible to do any verification now of the information that you originally accumulated and the conclusions that you reached?

MR. HYNES: On the Outboard Marine site?

BY MR. SHAPIRO:

Q On the Outboard Marine site, yes.

A It would be, but I don't think they'd be definitive. Only a year or two has elapsed, and the rate of movement is only a few feet per year. Our resolution wasn't good enough to pinpoint something to within a foot the first time.

Q So because you were only dealing with

uncertain amounts to begin with, you wouldn't be able to exactly verify them at this point?

A Correct.

Q You had to make a lot of assumptions in order to make this prediction, isn't that true?

A Yes.

Q Where did you get most of those assumptions that you used in the course of making your study?

A Well, what do you mean where did I get them?

Q How did you develop the assumptions that you used?

A Well, the assumptions -- Do you mean --

Q I am talking about in making the predictions. You didn't have any information --

A Are you asking me why I assumed a certain number?

Q Let's go back a little bit. You had a certain amount of data upon which you were performing your analysis, is that correct?

A Yes.

Q You were then taking that data and projecting it into the future --

A Yes.

Q -- what would happen several years hence.

A Yes.

Q In order to do that you had to make some assumptions about what the data said, and then a large number of assumptions of what would happen in the future?

A No. Most of the assumptions have dealt with or had to deal with what went on in the past. In other words, what was deposited, where was it deposited, how and when.

Q Why is that information important?

A Well, because to do any kind of projection of what is going to happen in the future of a contaminant migration, you have to have some idea how or when it started.

Q You didn't have any of that information?

A No. I had no exact information on that, so I had to make -- that is where I had to make the assumptions.

Q You made assumptions about what was deposited originally?

A I made the assumption that there was PCB

contamination of the sediment in this eastern area.

Q You are referring now to the eastern area of the ditch at the Outboard Marine site?

A What I term the eastern enclave in here.

Q What assumptions did you make about that?

A Well, I had to assume, or I have assumed in here, and again I reiterate that I believe they are all very conservative, I have assumed -- Let's see, I think they are even listed on Page 3-72.

I had to assume that the deposition occurred approximately 1960; that the material, the PCB, is what the material is, was deposited in the fill on the then existing ground surface within the boundaries of what is now the 10,000 milligrams per kilogram contour; that the PCB contamination had an average thickness of three inches. The fill itself is perhaps five feet thick. That there has been no subsequent artificial relocation of the original material; and that we were starting with essentially pristine sediments and water. There was no major PCB contamination prior to that time.

Q You keep saying these are conservative assumptions. Do you have any other assumptions that

you can testify to with a reasonable degree of scientific certainty?

A No. I don't believe there is an answer to that question.

Q With respect to these five categories that are laid out here on Page 3-72.

A The reason I say that is that when one makes an assumption, one cannot attach a degree of scientific certainty to it.

Q Do you have any other assumption that you can testify to at this point regarding these five matters? These are the assumptions that you used in reaching your conclusion.

A These are the assumptions I used in making the calculations.

Q You have not made calculations based on any other assumptions?

A Correct.

Q With respect to assumption no. 1, if it turned out to be true that the deposition of PCB-contaminated sediments occurred about 1955, would that change your conclusion about the amount of PCBs that were contained in the groundwater flux?

A Yes.

Q Would it make it lower?

A It would not make them lower, but it would elongate the time period necessary to get to the Lake.

Q So it might be 100 years instead of 80 years?

A Yes.

Q If they were deposited later --

A It would speed it up.

Q With respect to the third assumption, if the average thickness were a foot, would that change your ultimate conclusion?

A If the thickness increased, it would have -- If I were to assume a larger thickness, it would change to an extent the calculations that I would do. It would simply mean that I would assume a greater body of PCBs was available as a source. Since I have not done those calculations, I can only say that I believe yes, it would change the numbers.

Q But you don't know whether it would increase it or decrease the ultimate flux?

A It would increase the flux, simply because there would be more of a source.

Thomas L. Urban
Official Reporter

Q If there had been subsequent relocation of the original material, would that change your conclusion?

A Yes.

Q In what way?

A Well, it would depend upon what the relocation was and where it was.

Q It might lengthen the time it would take to get to the Lake, or shorten the time it would take to get to the Lake?

A Right.

Q If it turned out that there were fairly significant concentrations of PCBs in the natural sediment before any artificial deposition, that would also change your conclusions?

A Yes, it would.

Q In what way?

A Well, that would -- If that were to be the case, that would cause the fluxes to drop. Well, no, it wouldn't. It would cause the fluxes associated with this particular contamination event to drop. But the overall PCB fluxes would remain the same, approximately.

Q It wouldn't change your conclusion about the time it would take for there to be a signifiant increase in the amount of PCBs flowing into the Lake?

A I don't believe so, because I believe that the sediment sampling program was extensive enough that I can say that between this enclave of contaminated materials and the Lake, the sediments don't contain large or even significant concentrations of PCBs.

Q Are there any other assumptions that you have made in order to complete your prediction of the time it would take for the PCBs to reach the Lake?

A Yes.

Q What other assumptions did you have to make?

A Well, right underneath there, "Furthermore, it is logical to assume that the distributions of PCBs in the sediment and water which exist at present are the result of advective and dispersive transport from the assumed initial position in 1960."

In other words, what this assumption is saying is that there has been no human intervention

causing the movement of these PCBs, but rather it was the natural processes carrying them.

Q You don't know that that is true?

A No. I am having to assume that.

Q Right. Any other assumptions?

A The next sentence, ". . . that any transport of PCBs toward the Lake via the groundwater will be confined to a narrow zone similar to that shown on Figure 19." Which is what we had talked about earlier. This is the professor from Carnegie-Mellon's concern with that trough. All I am doing here is making the assumption, a simplifying assumption, that I will consider only the flux that is going through that narrow little zone.

Q You don't know that that is true?

A No, I don't know that that is true. In fact, I suspect that it is not.

Q But you had assumed that for purposes of your analysis?

A Right. In order to be conservative and to deminimize the effect.

So specifically what I am saying here is that I will assume the transport zone is 120 feet wide.

Urban
Court Reporters
Street
512 - 7

Q Any other assumptions?

A Well, I am assuming that, and it is always an assumption, that the transport of the PCBs which would be termed a non-conservative or reactive chemical, can be defined by this dispersion and advection transport equation which is on Page 3-74. I say it is always an assumption because that is an empirical equation. It is an empirical equation which has been tried time and time again and works, but it can never be proven because it is empirical.

Q Have you ever used that equation before?

A In classroom, yes.

Q But you have never used it in a study that you have performed, an on-site study that you have performed?

A No.

Q So it has worked in the past, but you don't know that it necessarily will work in the future, is that a fair statement of what you are saying?

A No. I wouldn't say the time has anything to do with it. Rather, it is the situation -- In fact, as I look at that equation I see an error in it.

Thos L Urban
Certified Shorthand Reporter
Street

I lost my train of thought. You are asking me -- I am sorry.

Q Let me rephrase the question. What do you mean by saying it is an empirical equation that has worked in the past?

A Well, most scientific formulas or equations are not the result of establishing a pure theoretical base for what should happen, and thereby predicting what should happen. But rather they are based on the empirical observation of what does happen, and then writing an equation which describes that. So based on undoubtedly thousands of studies that have been done in the past and cited in the literature, this equation works for non-conservative chemicals being transported by advection through a porous medium.

So I would attach a 99 percent probability that it would work on some future problem. It would only be in cases where the underlying basic assumptions for this equation didn't occur that it wouldn't be appropriate.

Q So this equation is based on other assumptions as well?

A Well, the assumptions are that it is a porous

homogeneous isotropic medium. I guess those are the only ones.

Q Was that true in this case?

A To a large extent, and on the scale that we are looking at here, yes.

Q What do you mean on the scale that we are looking at here?

A Well, the medium that we have at this site is heterogeneous, meaning there are pockets of gravel inside the sand.

Q Right.

A But based on the drilling records they are small. They don't extend over large distances. So when we are talking about trying to project the movement of chemical over 450 feet, which is what we are trying to do here, that distance is much greater than the size of the heterogeneities. Therefore, it is in my opinion a valid assumption to say that the system is homogeneous on the large scale.

Q I must have misunderstood you. This equation relies on the medium being homogeneous?

A Yes. Homogeneous on the scale on which it is being applied, yes.

Q But there isn't an exact correlation between what this equation is normally used for and the actual conditions out at the Outboard Marine site?

A No. In reality, there is never an exact duplication of the conditions that are necessary, because there is no such thing as a real homogeneous system.

Q It is a kind of estimate.

A Yes.

Q Any other assumptions that you made?

A Yes. On the start of Page 3-75 I have made another assumption regarding -- this is initial conditions again -- regarding the composition of the water at the 10,000 milligram per kilogram sediment line. I have assumed -- I guess that is not the spot where I discussed that. Well, I take that back.

What I have assumed is that there is 5,000 milligrams per liter -- microgram per liter water currently present at the 10,000 milligram per kilogram sediment contour. We have no samples directly on that contour, but based on the graph here which shows the relationship between sediment and water concentration, I would anticipate that the water in the vicinity of

the 10,000 sediment contours is probably 50 ot 60,000. So again it is a conservative assumption.

Q It is an estimate that you have made?

A Yes.

Q Any other assumptions?

A I think not. I think that is all of them.

Q That is it?

A Well, okay. In calculating the fluxes -- Now, what everything that I have said to this point allows me to do is calculate what the concentrations of PCBs in the water will be. In order to calculate a flux, I must multiply those concentrations by groundwater flow. So I am assuming that the groundwater flows that I have calculated earlier in the report are valid.

Q Did those depend on other assumptions? Let me withdraw that for a moment.

Which section of the report are you now referring to?

A Well, Section 3 deals with the -- Chapter 3 or Section 3 deals, which is the bulk of the report, deals with the calculation of the flow rates, and so it is that section there that I am referring to.

Reporter
Street

Q What assumption have you made there for which you didn't have actual information?

A The only assumption there is that the flow within the system is what is called Darcian flow, D-a-r-c-i-a-n, which simply means that it is a laminar flow through a porous medium.

Q What do you mean by laminar flow?

A Non-turbulent.

Q You don't know whether that is true or not in this particular case?

A I cannot prove that it is true, but I would estimate the probability of its being true is 99.99999.

Q Can you say with a reasonable degree of scientific certainty that it is true?

A I just don't like that phrase.

Yes. That assumption has to be made in every single groundwater study that is done dealing with porous media.

Q I am not asking you whether it has to be made. I am asking you whether you can make it in this case with a reasonable degree of scientific certainty.

MR. HYNES: He already answered that.

MR. SHAPIRO: I want to make sure I understand the answer.

BY THE WITNESS:

A Yes.

BY MR. SHAPIRO:

Q Yes. Okay. What assumptions have you made in using those groundwater flow calculations and then calculating the PCB fluxes at the end of the report?

A Calculating the PCB fluxes at the end, now if we are talking just about the eastern enclave which has been what we have been talking about, the only assumption is -- No, it is not an assumption. It is a fact that the mass flux is the product of the water flux, and the mass concentration in the fluid. So that is not an assumption.

Q Didn't you just tell me that you made an assumption when you were calculating the fluxes?

A Oh. Well, simply that I was transposing these numbers from Section 3 back into Section 4, and using those to calculate my fluxes. That the number in Section 3 being the flow magnitudes of the groundwater.

Q You have to be able to take those and

The L. Urban
Court Reporter

relate those to the flow magnitudes of contaminated groundwater?

A Contaminant flux is equal to the groundwater flux multiplied by the concentration.

Q Could you have gotten sufficient information to avoid making these assumptions in this case, instead of relying upon specific information?

MR. HYNES: What do you mean by "these assumptions"? All the assumptions he has stated?

MR. SHAPIRO: Yes.

MR. HYNES: Or just the assumptions --

MR. SHAPIRO: No, all the assumptions.

MR. HYNES: You are talking about all the assumptions in the report.

MR.SHAPIRO: Yes.

MR. HYNES: All right.

BY THE WITNESS:

A I doubt it.

BY MR. SHAPIRO:

Q Well, are there any that you could have gotten the specific information for?

A Well, those that deal with the initial conditions, the initial deposition of contaminated sediments

could only be obtained if records exist.

Q Did you ask anybody for records of that sort?

A I asked Ed DiDomenico if such records existed, and his response was that not that he knew of, or not that he had access to. But I am not sure what he said.

Q We are talking about the first five assumptions on Page 3-72.

A Right.

Q Did you ask anybody else?

A No.

Q How about the assumption relating to human intervention in the groundwater system?

A Well, I have a reasonable degree of scientific -- I have forgotten the term. I do believe that one is true, and the only reason I can say that is that when one drills boring, it is fairly easy to recognize the difference between disturbed sediments and natural sediments, and except for the fill on the top of the site, the drillers never noted any disturbed sediments.

Q You didn't do those drills yourself, though?

A No.

Q So you didn't see the sediment.

A No.

Q You relied on Warzyn to do that.

A Yes.

Q You have had to make a fair number of assumptions in reaching your conclusions at the end of the report, haven't you?

MR. HYNES: What do you mean by a fair number of assumptions? He already stated what assumptions he made. It is your characterization as to whether they are -- I don't know if you mean fair, or unfair, or fair in terms of the small number versus the large number.

BY MR. SHAPIRO:

Q Would you say you had to make a large number of assumptions in reaching your conclusion at the end of the report?

A Again, I don't know how to quantify it. I have not had to make an unusual number of assumptions.

Q In the other studies that you have done, have you made this number of assumptions in reaching your final results?

A Yes. Where the system was as complicated or -- where the system was parallel to this one, put it that way.

Q In which case?

A Certainly in the coal ash case, and for that matter in the induced recharge case, one has to make the similar assumptions about initial-final conditions.

Q But you were not making predictions for 60 or 80 years in the future for those cases, were you?

A No.

Q But each of these assumptions in your terms is really an estimate of what the reality might have been in any particular case.

A I am not sure that I used the term "estimate." But each assumption is a conservative approximation of what must have gone on. I can't emphasize that "conservative" enough.

Q Well, the only assumptions you made in this report, isn't that correct?

A Correct. But please understand that one makes conservative assumptions, and therefore, you know, if you have erred, you have erred on the safe side.

Things can only get worse.

Q But you may very well have erred?

A Yes.

Q There is a certain amount of guesswork involved?

A Yes.

MR. SHAPIRO: Why don't we break for lunch.

MR. HYNES: Okay.

(A recess was had until 1:45 of this date, June 17, 1982.)

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

THE UNITED STATES OF AMERICA,	)	
	)	
Plaintiff,	)	
	)	
vs.	)	No. 78 C 1004
	)	
OUTBOARD MARINE CORPORATION and MONSANTO COMPANY,	)	
	)	
Defendants.	)	

June 17, 198

1:45 o'clock p.m.

The deposition of DR. DOUGLAS CHERKAUER resumed, pursuant to recess, at 219 South Dearborn Street, Suite 1486, Chicago, Illinois, before Jean Korinko Sweeney.

PRESENT:

MR. JAMES T. HYNES,

MS. ROSEANN OLIVER,

MR. ROBERT E. SHAPIRO.

ALSO PRESENT:

MS. CAROL DORGE.

DR. DOUGLAS CHERKAUER,

called as a witness by the defendant Monsanto Company, having been previously duly sworn, was examined and testified further as follows:

DIRECT EXAMINATION - (Resumed)

BY MR. SHAPIRO:

Q Dr. Cherkauer, is it fair to say that you conclude in your final report that the transition flow between Type I and Type II is the dominant mechanism for transport of contaminated groundwater to the east, to Lake Michigan?

A Yes.

Q I would like to call your attention once again to what we have marked earlier as Deposition Exhibit No. 3, which are the peer review sheets that you said you received. Did you receive any other peer review sheets besides the two that are part of Exhibit No. 3?

A No.

Q But you did receive these particular reports, is that right?

A Yes.

Q These particular sheets?

A Yes.

Q Do you recall when you received them?

A No.

Q It was before you prepared your final report?

A To the best of my recollection, yes.

Q Do you know who Vincent T. Ricca is, who wrote the first of these peer reviews?

A No, I don't.

Q Did you know at the time who Vincent Ricca was when you received the reports?

A No. As I indicated earlier, this is the first I have seen the names on either of those.

Q Did you ask anybody who they were?

A No.

Q Why not?

A Well, when one does peer reviews in my profession, if the reviewer asks to remain anonymous, one doesn't ask who they are.

Q But you knew the names, the names appeared on the peer review sheets when you received them.

A No.

MR. HYNES: No. That is what he is saying. The names of the reviewers did not appear on the

documents.

BY MR. SHAPIRO:

Q Well, what form did you receive these in? Was it the letter without the signature, is that it?

A Yes. This and that would be have been blocked out (indicating).

Q "This" being the --

MR. HYNES: The letterhead.

BY THE WITNESS:

A The letterhead.

BY MR. SHAPIRO:

Q The letterhead and the signature.

A And the signature.

Q To this day you still do not know who Vincent Ricca is or Dwight Sangrey?

A That is correct.

Q But you would expect they would be experts in the field?

A What field?

Q Well, experts --

A They are not hydrogeologists.

Q They would be experts in the field for purposes of reviewing the report.

A They are hydrologic engineers or hydraulic engineers. So they would certainly be qualified to comment.

Q Did you discuss the comment that you got from Professor Ricca and Professor Sangrey with anybody else?

A Other than who? Anyone else other than?

Q Did you discuss them with Ed DiDomenico?

A As I said earlier, yes.

Q Anybody else?

A No.

Q Did you discuss them with Dr. Whang?

MR. HYNES: He already answered that he did not discuss them with anyone else.

MR. SHAPIRO: I am just asking whether Dr. Whang's name perhaps refreshes his recollection.

MR. HYNES: That is different.

BY THE WITNESS:

A No.

BY MR. SHAPIRO:

Q So you did not discuss them, as far as you recall, with Dr. Whang?

A I have only spoken to Dr. Whang once in my

entire life.

Q How about Dr. Salzberg?

A No.

Q I believe you testified this morning that you had your first contact with JRB regarding this case in March or April of 1979, is that right?

A To the best of my recollection, yes.

Q You don't recall who it was who originally contacted you from JRB?

A No. I believe it was Ed Salzberg.

Q What did he tell you at that point about the case, or about the study that you were to do?

A Well, essentially that there was an alleged PCB contamination problem, and they were looking for a hydrogeologist to be part of a larger program. Someone who could look at the groundwater, potential for contamination, or the contamination at the site.

Q Well, did he ask you about your qualifications, or offer you the opportunity to work on it, or what did he do?

A Yes. As is very typical in this kind of a situation, he asked, well, he asked if I would be interested. First he asked if his information on my

background was correct. He asked if I would be interested. In responding yes, he then said, "Could you send me your resume." That was probably all.

Q And you did that?

A Yes. Then they supplied me a contract which I signed, and that is where we proceeded from.

Q What did the contract say about your responsibilities for the analysis, the report that was to be prepared?

A I really don't recall.

Q Well, what did Dr. Salzberg tell you were to be your responsibilities?

A That I would be looking at the groundwater cotamination problem.

Q What did you understand that to mean? What were you to do as a result?

A Well, basically that someone would need to -- that they, they being JRB, were contracted by EPA to analyze the groundwater contamination situation. They needed someone familiar with the local geology to design their program, their testing program -- piezometer field, I should say, and then analyze and interpret the results that were collected.

Q Did you design the piezometer program?

A Yes.

Q Did anybody assist you in designing the program?

A Well, indirectly, yes. The initial design was largely decided upon as a result of a site visit in March or April of that first year. Salzberg was present, Hornberger was present, DiDomenico was present, and a representative from Warzyn, Dan Viste, V-i-s-t-e, was present. There was also a representative from OMC's environmental consulting firm, whose name I don't remember.

We discussed what those individuals thought the history of PCB use at the site was, or disposal at the site; and what was perceived then as the major problem, mainly the movement of PCBs into the ditch and down the ditch; and then designed the initial piezometer field on that basis.

Q Well, did they make suggestions about the design of the piezometer field?

A Well, the only real suggestions were that at that point in time it appeared we were dealing with what would be termed the lion source of contamination,

namely the ditch, and therefore the piezometer array should be concentrated in the vicinity of the ditch.

Q They suggested that to you?

A I wouldn't say -- It was a consensus.

Q Do you know what they were relying on in telling you that this is the nature of the PCB contamination in the area?

A No, I don't.

Q Was it Mr. DiDomenico who basically provided that information?

A Yes.

Q Did you believe on the basis of that that the groundwater monitoring field that you established would be adequate to do the analysis that was required or requested?

A Right, yes.

Q How many monitoring wells did you decide to install as a result, or for that purpose?

A I think it was 15 the first year.

Q At how many sites?

A Nine.

Q So at several of the sites there were clusters of wells?

A At three of the sites there were nests of piezometers, yes.

Q And by "nests of piezometers," you mean piezometers at different heights, vertical heights or depths?

A Different depths within the unit, within the aquifer, yes.

Q Did you specify how large the monitoring wells should be?

A No. Well, I probably put a minimum specification on it that they obviously have to be big enough to accept the sampler that is available to be used. But that was a condition that was established by what EPA had available.

Q How big was that, do you recall?

A I don't. I think there were two-inch wells, but I am not certain of that.

Q Does anything depend upon the size of the well?

A Anything?

Q Well, would it be easier to conduct your study with a smaller well or a larger well?

A It shouldn't make much difference relative

to the study itself. The primary difference would be cost.

Q Which would be?

A The smaller the well, the less expensive.

Q So the primary reason you see a one-and-a-quarter inch well, a well that is one-and-a-quarter inches versus two inches, would be that the one-and-a-quarter inch well would be less expensive?

A Right. You need to drill a smaller hole to put it in, and the pipe itself is less expensive.

Q Does the size of the well affect the reliability of the measurements of the water table within the well?

A I don't believe so.

Q How are those measurements taken?

A Well, there are many number of ways. Are you asking about this particular case?

Q In this case.

A In this case, they were using a fibreglas tape, I believe, with a device on the end of it. It is just simply a weight with a hollowed-out bottom, so that when it hits the water surface it makes a perceptible sound at the top of the well. By raising

and lowering that in small increments, you can narrow down the position of the water surface.

Q Is that an accurate way to determine the water suface?

A It is a precise way.

Q Precise in the sense that if you do it a certain number of times you will get pretty much the same reading each time?

A Yes.

Q But not necessarily representative of what is there.

A It is just as representative as any other mechanism for measuring water levels in a well.

Q Well, does it give you a reading that is say within an order of magnitude that is correct, or is it more accurate than that?

A Well, an order of magnitude using what unit? It can be read to the nearest millimeter.

Q But is it accurate to the nearest millimeter?

A I am making a distinction between precision and accurate.

Q I understand.

A It is precise to the nearest millimeter.

Q But it is not necessarily accurate to the nearest millimeter?

A That has nothing to do with the measurement procedure. It has to do with the well and its emplacement.

Q I don't understand that. Would you explain that to me.

A Accuracy is the representativeness of the sample that you are taking, and that has nothing to do with how you measure it. It has to do with the device which allows you to collect the sample, or collect the water level measurement.

So if you are looking for an accurate water table measurement, you have to have a piezometer which is installed with a screen across the water table, which is the way this system was designed.

You could not get an accurate water table measurement from one of the deeper piezometers, simply because it is not designed to measure that.

Q In other words, the piezometer has to extend from below the water line to above the water line?

A Correct.

Q So long as that is true the measurements that you get from this sounding device will be accurate?

A Yes.

Q You seem to hesitate there. Did you have any concern that --

A No, I am not.

Q I am just trying to make certain I understand your answer. Is it liable to be more accurate with a larger or a smaller well?

A I suppose there is a possibility that a larger bore well might give you a more accurate representation of the water level. However, that is a guess. I have never seen nor done any scientific investigation to that effect.

Q You can't say that with a reasonable degree of scientific certainty?

A Correct.

Q Why would that be, though?

A Well, as with any free water surface where you have got non-aqueous boundaries, you are going to have a miniscus develop. Surface tension causes the water to rise along the outside of the well. It

is a boundary effect, and the further away you can get from your boundaries the less effect of the boundaries. The bigger the diameter of the well, the less the boundary effect.

The reason that I am not certain that it would provide a more accurate thing is that the larger the bore of the well, the slower the response to any changes in the natural conditions, or in the water conditions. So if you have a rapidly fluctuating water level, the small diameter well will respond to it very quickly and very accurately. The large diameter well will not.

Q Well, would it be true that if you had a large two-inch diameter well and a one-and-a-quarter inch diameter well in the same kinds of soil, in the same soil, equal permeability, that the two-inch diameter well would reflect a change in the amount of water there much more slowly than --

A No. I don't think you could measure the difference in response between one-and-a-quarter and a two-inch well.

Q You said that you thought that this sounding device would be accurate to one millimeter.

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A Yes, precise to one millimeter.

Q What would that be in feet?

A It's about two-and-a-half hundredths of a foot. Wait a minute. Have I got that backwards? 254 millimeters in a foot -- no -- Yes. 254 millimeters in a foot. So about four-thousandths of a foot. I added backwards.

Q Did you visit the site again after this initial site visit?

A No.

Q Never again in the course of your study of the area?

A Yes, never again.

Q So you did not see the wells being installed?

A No.

Q Or any of the samples or measurements being taken?

A No.

Q Are you familiar with the procedures that were used in those cases to do those things?

A Yes.

Q I would like to refer you to Page 2-7 of your report. In the middle of the page there are

three special procedures that were used in the establishment of the well fields. Is it your understanding that those were the procedures that were followed in this case?

A That is my understanding, yes.

Q Can you tell me what your understanding is of what was done to prevent intra-bore hold contamination?

A To prevent intra-bore hole contamination?

Q Yes. It says --

A The two items prior to that were both done with that in mind, as well as -- Well, that is what was understood by me, during the boring and sampling procedures.

Q What specific steps are you aware of that were taken to prevent intra-bore hole contamination?

A As it says here, the drilling rigs were completely flushed down, regreased, as I understand it, with a silicone-base grease, and all items that were to be put in the hole were cleansed with acetone. That includes the drill stem and pipe points and so on.

Q How often was that done in the course of the boring?

A That I don't know.

Q Well, how often should it have been done in the course of the boring?

A Once. You are only using the drill stem once as you go down the hole.

Q Well, so you do it before you put the drill in the hole?

A Right.

Q How does that prevent intra-bore hole contamination?

A Because you are not introducing potential contaminants from the drill rig, potential PCB contaminants from the drill rig into the hole.

Q Maybe we don't understand each other. What is inter-bore hole contamination?

MR. HYNES: Are you saying inter now?

BY MR. SHAPIRO:

Q Inter, yes.

A You are saying inter?

Q Inter.

A You have been saying intra.

Q That's right. Now I am asking you what is inter-bore hole contamination?

A Excuse me. How do you prevent inter-bore

hole contamination? The same process. After you are done with one bore hole, you cleanse everything that has been in that hole before you go into the next one.

Q Which is what you just described to prevent the intra-bore hole contamination.

A Yes.

Q So there was nothing different done?

A To the best of my knowledge. I was not involved in that operation.

Q Let me just make certain I have my question clear.

There was no separate step taken to prevent intra-bore hole contamination, other than what was already done to prevent inter-bore hole contamination.

A I don't know the answer to that question.

Q So you don't know whether the intra-bore hole contamination was prevented or not?

A I didn't say that. I don't know that there was a separate step taken.

Q Should there have been?

A No.

Q So there are no procedures that were necessary

to prevent intra-bore hole contamination?

MR. HYNES: He already testified to what the procedures were to prevent intra-bore hole contamination, and then as to inter, he already testified what that means is that if you drill one hole before you drill the next one, you clean it off to prevent inter- as you did to prevent intra-bore hole contamination.

BY MR. SHAPIRO:

Q Do you remember my question?

A Which one?

MR. SHAPIRO: Would you read back my last question.

(Record read.)

BY THE WITNESS:

A Certainly there are procedures necessary to prevent intra-bore hole contamination.

BY MR. SHAPIRO:

Q Well, were there any separate procedures that you know of that were designed to prevent inter-bore hole contamination?

A I have already said no to that.

Q You don't know of any that should have been?

A In addition to these, no.

Q Which you say are designed to prevent inter-bore hole contamination.

A And intra.

Q Let me ask it this way. Is there any procedure to make certain that contamination at the top of the well is not carried down to the bottom of the well in the course of the drilling procedure?

A Yes. Their drilling operation, which was a wash boring technique, in which case the fluid movement in the drilling operation is always upward, where it's in contact with the sediments. In other words, water, I believe, was the drilling lubricant they were using, pumped down the center, and then it comes back up the outside carrying the well cuttings with it.

Q So that the contamination may have been carried up the well, but not down the well?

A Well, it's carried up the well within a pipe. Yes, conceivably it could be carried up.

Q You mean there were no procedures designed to prevent that from happening?

A Not that I know of.

Q Do you know whether that water was re-used in the course of further drilling?

A I don't believe so, but this is just a recollection of reading one of the Warzyn reports. I believe it was changed between holes.

Q It should be, should it not?

A Yes.

Q Should it be also changed within the same hole?

A Probably so, if it is showing any evidence of foreign material in it.

Q In other words, it should be sampled to find out whether it is receiving any contamination?

A That would be one way to do it.

Q Do you know whether that was done?

A No, I don't.

Q Is there any other way to do it?

A I don't know.

Q You don't know of any?

A No.

Q Are there procedures that are used to insure that a well after it's dug or created has not received contamination, or that no contamination has been

introduced into that well in the course of the boring?

A Procedures to determine if an individual well has not received contamination?

Q Let me withdraw the question. I will try to rephrase it.

Are there any procedures that are ordinarily used to insure that the well once it's created has not been contaminated, or the water in the well that has been created has not been contaminated in the course of the boring process?

A The normal procedure is to develop what is known as a control well or several control wells, which can be sampled, which are outside the zone of supposed contamination. Then a comparison can be made. That would be the only assurance.

Normally you would also pump a well, bail it heavily upon completion, to make sure that any drilling fluids that were introduced during the drilling operation had been removed, and that you are then dealing with ambient groundwater.

Q That is what you call in your report pump-down of the well?

A Well, yes. I believe they are calling it a pump-down, although there is also the subsequent testing which they may also have called a pump-down. I am not certain.

Q That would not be the bail-down? Is that another term that you use?

A Yes, the bail-down.

Q Just for the next set of questions I will ask you we will refer to the preliminary one as the pump-down, and the later one as the bail-down.

A Okay.

Q Just so we are clear.

Why is the pump-down done?

A Well, at that point what you are doing is creating a gradient, a hydraulic gradient toward the well, which causes, induces any liquid in the immediate vicinity in the well to flow into the well. It can then be pumped out and disposed of somehow.

What you are doing is removing any water which may have moved into the aquifer around the confines of the well during the drilling operation.

Q So it is of concern that there may have been some contamination placed in the well?

MR. HYNES: Are you asking is that the purpose of the pump-down?

BY MR. SHAPIRO:

Q Yes, yes.

A That is part of the purpose.

Q What other purpose is there?

A Well, number one, to make sure that the well will pass water. Number two, to seat the surrounding material on the well, to stabilize things, which then allows you to ascertain whether your packing above that point is stable or not.

Q But one of the reasons is to insure that there is no contamination that might be introduced into the well that remains in the well once the actual monitoring begins.

A Yes.

Q How long does it take to insure that all the contamination is removed?

A It varies, depending upon the drilling method and the conditions, aquifer conditions.

Q How do you determine that?

A That's generally done by experience of the driller. Essentially they try to be conservative

again, and use a safe length of time, a long time, in their way of thinking.

Q Well, have you ever been responsible for installing wells?

A Yes.

Q How long do you usually use for a pump-down?

A In the cases where I have installed wells myself, we are not looking at what I would call trace contaminants. So we simply bail the well until it's dry, and then allow the water to flow back in. So that takes half an hour, something on that order.

Q Well, do you know how long pump-down lasted in this case?

A No, I don't.

Q Let me refer you to Page 2-11, at the bottom of the page it says, "After each installation was complete, the wells were pumped for about one hour, using a three horsepower gasoline-driven pump. . ."

A Okay.

Q Is that the pump-down we have been talking about?

A Yes.

Q So they were pumping for one hour?

The answer is yes?

A Yes.

Q Was that long enough?

A In my opinion it probably was, yes.

Q What do you base that opinion on?

A Just the diameter of the wells, the hole that was being drilled, and the fact that we are dealing with a fairly permeable sand that responds fairly quickly to pumping.

Q Is there anything that you could do to insure that that one hour was sufficient?

A You could monitor the quality of the water as it came out.

I am not certain in this case, but in many cases temperature would tell you. In this case it might not, but normally groundwater temperature is somewhat different from surface water temperature. At this time of the year it would be cooler, and you could simply run until your temperature has stabilized as a temperature that is recognized as groundwater temperature.

Q Or you could sample for trace contaminants. Could you do that as well?

A Yes, you could, but the only reason I hesitate there is it is going to take you weeks to get the analysis done, and in the meantime what do - you do with the pump.

Q But that would be a more conservative way of going about it, wouldn't it?

A Hydrologically conservative; economically not.

Q It would cost a lot?

A Yes.

Q But it would be more conservative, hydrogeologically speaking.

A Yes. But I would think that temperature or some other parameter would be simpler and as precise.

Q So you could use some other parameter, some other chemical constituent of the water?

A If the wash water in the hole and the ambient groundwater were qualitatively different, yes.

Q Well, could you insure that at the outset by say putting something in the wash water that you would be able to detect in the well once completed?

A You could, but then you also know you are

introducing contamination.

Q What is a slug test?

A A slug test is just where you pour a slug of water into a well and watch the decay of the water level, watch how it declines through time.

Q Is that ever used to determine or to insure that monitoring wells after they are installed are free of contaminants?

A No. That would enhance contamination. You are putting water into the system rather than taking it out.

Q Based on your review of the procedures that were used by Warzyn, were there any contaminants that you might expect to have been introduced into the well?

A I have never thought along those lines. Yes, iron compounds would have to be introduced.

Q From the drill?

A From the drill. They are in any drilling operation.

Q What about acetone?

A Given the technique that they used, yes, acetone could well have been introduced.

Q In significant quantities?

MR.HYNES: Did you say in significant quantities or --

BY MR. SHAPIRO:

Q Would there be significant quantities of acetone introduced?

A In my opinion no, but unless you can define significant.

Q Well, what do you define significant as?

A I guess I would define it as measurable quantities. When I consider the volume of water that was used, and the volume of acetone involved here, I don't think the concentration of acetone in the wash water that would be introduced would be significant. It would highly dilute.

Q Well, there was acetone on the drill as well, right?

A Correct. They swabbed the pipe and the drills with acetone.

Q And the sampler as well, that went into the wells?

A Yes. Acetone is a volatile gas that evaporates -- or a volatile liquid that evaporates

very quickly.

Q But it would also move into the groundwater if it were exposed to the groundwater, would it not?

A Sure, yes.

Q What kind of measurements were taken in the monitoring wells during the 1979 period?

A Water levels and water samples, I believe.

Q The water samples were, I assume, sampled or analyzed for PCBs, is that correct?

A Yes.

Q Do you know who did those analyses?

A For 1979, I am not at all certain. I think it may have been a company by the name of Raltech.

Q But you don't know for sure?

A No.

Q Where did you receive the information from?

A As I said, I believe it primarily came from JRB. In a few instances I may have received copies of the data directly from Mason and Hanger, and there may have been instances where I got it via telephone from Ed DiDomenico.

Q But never from Raltech?

MR. HYNES: Do you mean Raltech direct?

BY MR. SHAPIRO:

Q Right.

A Yes. I don't believe I ever got any directly from them.

Q Do you know what procedures were used in the analyses of those samples?

A I have read that section, but I don't recall.

Q Is that what was originally Section 2.5.2 of your report?

A To some extent. That dealt to a large extent with the collection and handling of the samples from the time they were collected until they were analyzed. But yes, that information was in there.

Q By "handling," you mean chain of custody?

A Yes.

Q You don't recall where you got that information?

A Which now?

Q The information about the analysis and the chain of custody.

A No. The information on the analysis came from EPA.

Q Ed DiDomenico, or his assistants?

A Yes. One of his people. It wasn't Ed. There was another fellow.

Q Howard Czar?

A No. I don't remember the name.

MR. SHAPIRO: Off the record.

(Discussion had off the record.)

MR. SHAPIRO: Back on the record.

BY MR. SHAPIRO:

Q Did you receive all the information from the 1979 sampling period all at once?

A No.

Q It came to you in bits and pieces?

A Yes.

Q Over a period of time.

A I believe so.

Q When did you start receiving it?

A I don't have any idea.

Q Do you recall when you had enough to begin preparing your report?

A Well, it came in two fashions. The water level information came much earlier than the PCB information. So as soon as I had water level information I could begin on interpretation of the

flow system.

Q Did you come to any conclusions about the flow system as a result of that information?

A Just that the basic idea that we are dealing with a system that is controlled by water levels in the ditch. Sometimes it flows towards, and sometimes it flows away from the ditch.

Q Any other conclusions you were able to draw from those water table measurements?

A There is a vertical component to flow. It is not totally horizontal.

Q Did you reach any conclusions about transitional flows? Speaking now in 1979.

A Right. At that point I had not developed the nomenclature, if you will, that is used in the final report. I can't be certain what conclusions I came to at that point. But if you have a flow system that vacillates from flow in that direction to flow in that direction, you have to have some transition in between, it cannot occur instantaneously.

Q But you had not reached any conclusions about the direction of that flow, or the nature of that flow, or the volume of that flow?

A Well, the direction, there is only one choice. If you initially have water flowing in one direction, and then subsequently water begins to flow in the other direction, water cannot simply pile up. So it has to go in the direction now of the path of least resistance, if you want to call it that, which has to be toward the Lake, in this particular case, because the Lake level is lower than the groundwater anywhere else on the site. I had not attempted to do any assessment of the quantity of flow at that time.

Q Could you have?

A Probably not. The well field was insufficient to determine flow into the Lake at that point.

Q So what you are saying is that the original design of the monitoring field was insufficient for you to be able to draw conclusions about the amount of flow toward the Lake.

A In the vicinity of the eastern end of the site, yes.

Q You just did not have enough sampling data for that?

A No. The well field was not extensive enough.

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Q Not enough wells.

A Right.

Q Did you have enough information about the boundaries of the well field?

A I don't understand what you mean by boundaries of the well field.

Q Or the boundaries of the aquifer that you were looking at?

A Yes, for the ditch boundary; no, for the Lake boundary.

Q What were you lacking with respect to the Lake?

A Well, again, we simply didn't have enough wells in the vicinity of the Lake to determine what the gradient in the direction or in the vicinity of the Lake was.

Q Let me make certain I understand you. So at the end of the 1979 sampling period you did not have enough wells to determine that the flow, the transitional flow in the eastern end of the Lake would be toward the Lake, because you didn't know which way the gradient went at that point.

A No, I could not calculate a quantity of flow.

I would have sufficient information to infer it would have to be toward the Lake, simply because every well that we have on the site has a water level in it that is higher than Lake Michigan.

Q Would it not depend upon the nature of the aquifer between the wells you had and the Lake?

MR. HYNES: I am not sure I understand the question.

BY MR. SHAPIRO:

Q Let me withdraw the question.

A I think I do.

Q I will withdraw the question.

Did any of your measurements during the 1979 period show any movement of groundwater toward the Lake?

A Well, measurements of groundwater systems never show movements at all. You have to infer the movements from the relative water levels that you are dealing with. So as I said, since all of the wells on the site have higher water levels than the Lake, there must be a component of flow in that direction. It is physically impossible for it to move from the Lake into the aquifer under the conditions

as we saw them in the 1979 well field.

Q But it would be possible for them to be moving exclusively from the aquifer into the ditch.

A Given the geologic understanding that we had based on the borings, not strictly exclusively the well information, but rather the initial 1979 soil borings that were done, I would argue that there would be a high degree of scientific probability that sand extended all the way into the Lake, and therefore there was a hydraulic connection between the aquifer and the Lake.

Q So even though there was a hydraulic connection, there might not be any significant discharge from the aquifer into the Lake.

A That is conceivable, yes.

Q Did you have measurements in 1979 that led you believe that there was movement toward the Lake of the groundwater?

A I don't recall whether I thought that in 1979 or not.

Q You mentioned earlier that you did a draft report or began a draft report in 1979 or early 1980 as a result of the 1979 monitoring. Did you begin

that after you received the water quality information?

A Well, no. It was begun as soon as I received some of the drilling and water level information.

Q You said you don't have a copy of that report, is that right?

A Right.

MR. SHAPIRO: Let's mark this as Exhibit No. 5.

(Said document was marked Cherkauer Deposition Exhibit No. 5 for identification (Monsanto), as of 6/17/82, JKS.)

BY MR. SHAPIRO:

Q Dr. Cherkauer, take a look at Deposition Exhibit 5, and see if you can identify it for me.

A Well, it's an early draft of the final report.

Q By the "Final Report," you mean the report that ultimately was finished on February 10, 1981?

A Correct.

Q So this is not the report that you did at the end of 1979 or the beginning of 1980, as far as you can tell?

A As far as I can tell no, because --

Q Let's see if I can clear this up for you a little bit.

Would you take a look at the page marked US 39092, as has been marked by Monsanto.

A Okay.

Q First, do you know --

MS. OLIVER: Just for the record, so we can follow, what is the -- How does that page begin?

MR. SHAPIRO: Beginning at the top of the page, ". . . of the aquifer, with high concentrations developing where substantial clay is available to absorb it."

BY MR. SHAPIRO:

Q First, do you know whose writing that is at the top of the page?

A No, I don't.

Q Could that be Mr. DiDomenico's writing?

MR. HYNES: That is an unfair question.

BY THE WITNESS:

A I have no idea.

MR. HYNES: There is no foundation for it at all.

BY MR. SHAPIRO:

Q Take a look at, if you will, Pages US 39092 up through US 39100. Take a minute to look at that. I would like to ask you a couple of questions.

Have you had a chance to look at the pages that I indicated?

A Yes.

Q Do you recognize those pages as being anything different from the rest of the report?

A Anything different from the rest of the report?

Q Are they part of the draft that you did prior to February 10, 1981?

A They appear to be. I don't know, I am having some difficulty identifying them. They are definitely my writing.

Q They don't fit with the rest of the report though, do they?

A I haven't looked at the rest of the report.

Q Maybe I can simplify it. Do those appear to be pages from the original draft that you did in 1979?

A Yes and no. In that they refer only to

MR. HYNES: If the Court rules it should be, fine. But I have no ability to predict in the future if it will ever be found somewhere.

MR. SHAPIRO: Well, as I said, I would like it on the record that it is our position that we have the right to reopen the deposition.

MR. HYNES: That is fine, you have got it on the record.

MR.SHAPIRO: If the draft report is ever produced.

BY MR. SHAPIRO:

Q Dr. Cherkauer, you said this morning --

MR. HYNES: Are you through with this exhibit right now?

MR. SHAPIRO: For the moment, yes.

BY MR. SHAPIRO:

Q You said here this morning that you broke off completion of the 1979-early 1980 draft report because of the discovery of new areas of contamination of PCBs, is that correct?

A That is my recollection, yes.

Q Apart from that information about new areas of contamination, was there other information

that you were lacking or that you needed in order to complete the 1979 report?

MR. HYNES: Do you mean data that had not been sampled or taken in the field versus something that had been taken, but final analysis of the samples had not been completed?

BY MR. SHAPIRO:

Q Either one.

A Well, all of the analyses I believe had been completed at the time I was writing. But certainly all of the stuff we have discussed this morning relative to the initial conditions on the site was lacking at that time.

Q Such as?

A The time of deposition, location of deposition, and so on. That is all I can think of at this point.

Q Well, did you have enough information, for example, about the water sample collection and handling methods that were used?

A I think so. I don't recall when I got that information.

Q You had enough to complete the final report?

A Yes.

Q How about the methodology for water sample analysis?

A Well, just like the method for sample collection, that isn't relevant, it is not directly relevant to the interpretation of flow or the conclusions drawn therefrom.

Q In other words, you relied on somebody else to do that?

A Right, right. I have to assume that they were doing it properly. And then ultimately when I obtained a description of what they were doing, it was reasonable.

Q But you never saw them do any of these analyses?

A No.

Q So you basically had to take it on faith that they were doing it properly?

MR.HYNES: I object to the characterization of taking it on faith.

BY MR. SHAPIRO:

Q Well, you never saw them do the actual analyses?

A Correct.

Q What they provided you with is a description of what they had done, is that correct?

A Yes.

Q But you never saw them actually follow those procedures?

A No.

Q So you never knew whether they followed those procedures or not, or you never knew if they followed those procedures or not.

A Not through direct observation, no.

Q Is there any way that you satisfied yourself that they were following those procedures?

A The only thing that -- Well, there is no direct evidence that I can cite.

The only thing that I used as a hydrologist in determining whether I find the data reliable or let's say consistent, is to look for internal consistency within that data. Does the same well show similar patterns time after time.

Q Did you find such consistencies in the data?

A To a large extent, yes.

Q Did you ever find inconsistencies in the data?

A Certainly.

Q When did you find any inconsistencies?

A Well, inconsistencies in the sense that there were times when well samples or sediment samples appeared anomalous. They didn't follow the pattern they had been following.

Q What did you do in those cases?

A Most of them are described in the report.

Q Could you show me some examples of that.

MR. HYNES: Exhibit 2?

THE WITNESS: Yes.

There is a discussion -- Well, the Pages 3-60 through 3-63 show that the distribution of PCBs through time in each of the individual wells, and there is a discussion which begins probably following -- Yes, there is a discussion that begins in the middle of Page 3-64 which talks about what I term anomalous spikes of high PCB concentrations.

Q Did any of these inconsistencies ever lead you to believe that either the sampling, the analytical or chain of custody procedures were not being followed?

A No.

Q Never?

A I had at one point in time, and actually the error is still here, I had concern that perhaps on the 1979 data the samples from well 7-A and 7-C, this is on Figure 40, Page 3-60, might have been reversed.

So I called DiDomenico, and was put through to whoever had done it, and assured that no, they had turned out that way, but in fact as I look at this figure, if you have got Figure 40 there, the right-hand A and C are inverted. They should be simply turned around. That is just a drafting error.

Q You are talking now about Figure 40, is that what you said?

A Right.

Q Which of the graphs on Figure 40 are you referring to?

A The top one, well nest No. 7. You will notice on the left-hand side the C is associated with triangles.

Q Right.

A Then as you move over to the right the C is

associated with circles. The A also inverts that way. As I was looking through it last night, if you go back and look at the raw data, the A and C on the right-hand side of the chart should be inverted. C should still be associated with the triangles, and A would be the circles. This is simply a coincidence, but I believe I had also questioned that pair of data once before.

Q In other words, you had thought that there may have been a mistake in the chain of custody procedures, so that the samples that you have labeled A here on the right-hand side may actually be A, even through in drafting it you should have drafted it the other way.

A That is what I thought. However, I was assured that that was not the case. I would argue that the 1980 data pretty much confirmed that.

Q You now believe that there was no such reversal?

A Right.

Q Are there any others that you were concerned about?

A That is the only one I recall, yes.

MR.HYNES: The only thing is, though, there is just a correction to be made, that the A and C should switch designations. The A consistently should be circles, and the C throughout the draft should be triangles.

BY MR. SHAPIRO:

Q While we are talking about inconsistencies, remember this morning you were talking about the equation on Page 3-73, and you said there was a typographical error in that equation.

A Yes.

Q Where is that?

A 3-74. The square root symbol should extend over the T, in each case where the square root symbol exists. So that the term D_{Lt} is taken to the one-half power.

Q That is the only mistake?

A Yes.

Q So your testimony is that you are now satisfied that there was no switching among the samples, the chain of custody samples?

A Yes.

MR. HYNES: Do you understand what he means?

He understands what you are trying to say.

BY MR. SHAPIRO:

Q Let me just state the question again.

Your testimony is that from what you know now you do not believe there was any error in the chain of custody with respect to those particular samples. The samples were not switched.

A Yes.

Q At the time of the 1979 study, did you have water level records for the drainage ditch?

A Yes, at a gauging site that the U.S. Geological Survey maintained.

Q Where was that?

A I believe it's near the mouth of the ditch. There was a small bridge across it, and I think they were taken from that bridge.

Q Why are those important?

A Well, as it turns out, whenever the ditch goes up rapidly, that totally reverses the groundwater flow in the system. Normally the water is flowing toward the ditch, but when water levels in the ditch rise rapidly, they flow out of the ditch. If so, instead of a simple line sink kind of flow system,

where all the water always flows to the ditch, we have it alternating between a line sync and a line source.

Q That happens fairly rapidly.

A Based on the sampling we have done, yes.

Q Do you know what causes that?

A Causes the reversal?

Q Yes.

A The change in water level in the ditch.

Q But do you know what causes the water level to change so rapidly in the ditch?

A Well, during the time we were there -- There are a number of things that could have caused it. But during the time we were collecting data --

Q You are talking about both 1979 and 1980, now?

A Yes. During those periods there was no heavy rainfall that would have caused rapid influx of water into the ditch.

So the only other thing that can cause fluxations in a surface water body like that would be what are termed changes in the base level of that surface water body. In other words, changes in

either the Lake Michigan level, or something at the mouth of the ditch which was prohibiting efflux from the ditch.

Q Do you know which of those was the cause of the rapid changes in the water level in the ditch?

A No, I don't.

Q Do you know to this day?

A No.

Q Wouldn't that be something important to know about, that particular boundary to the ground-water system?

A Not particularly.

MR. HYNES: You mean what causes the rise, rapid rise in the water, rather than the rapid occurs -- Your question concerns whether it is important to know what causes the rapid rise of water, is that correct?

BY MR. SHAPIRO:

Q That is correct.

A My response to that is no, the cause is not important. The rapid rise is.

Q If you were trying to predict when the rise was going to occur, wouldn't you have to know what

caused it?

A Yes. But I have not tried to do that.

Q Let's go back a second. You said that the normal flow in the area is into the ditch, is that correct?

A Yes.

Q Is that Type I flow?

A Yes.

Q There is another type of flow which is Type II flow, which is caused when the level of the ditch rises and the flow is predominantly away from the ditch.

A Yes.

Q There is flow, transitional flow between Type I and Type II. Type I to Type II, and --

A Also in the other direction, yes.

Q On the basis of the pattern of flows and the transitional flow, you have made a prediction about the amount of flow toward the Lake, isn't that correct?

A Yes.

Q Wouldn't it be necessary in order to be able to predict how often Type II flow occurred and how

often Type I to II flow occurred to be able to know what caused the rise in levels of the ditch, and how often that was going to occur?

A To know the frequency of those occurrences, yes.

Q But you did not find that out?

A No. Nor have I addressed their frequency.

Q Well, don't you have to know the frequency of the various types of flow in order to be able to calculate the flow towards the Lake?

A No. In order to be able to calculate the net annual flux, which is what you asked me to do this morning, yes, you would. But we had to make an assumption at that point that the frequency of that kind of flow was the same as the frequency of our observations.

Q In other words, that it would occur the same number of times that you had gotten measurements of that sort.

A Correct.

Q One out of 12.

A Yes.

MR. HYNES: That is the assumption you are

talking about.

MR. SHAPIRO: Right.

BY MR. SHAPIRO:

Q But if you had known what caused the rapid rises in the level of the ditch, you would not have had to make that assumption. You would have been able to make a determination on the basis of the actual facts.

A Perhaps. I don't think it would have been quite that simple, because the factor would include wind direction, duration of wind direction.

Q How do you know that if you don't know what caused the increase in levels in the ditch?

A Because there are only two possibilities, other than human intervention. The two possibilities are either a seiche -- the Lake levels on the western side rising because of strong easterly wind effectively pushing the water across the Lake; or the base level is increased by sand migration in response to the along shore current in the Lake.

In most cases in the Waukegan area, that would be induced by a strong northeasterly wind forcing sand southward.

Q Let us assume it is the latter. Would it not be possible then to get records for the direction and force of the wind, and be able to say on that basis how often the level of water in the ditch was likely to rise suddenly?

A Yes, it would be possible to obtain the wind records, and yes it would be possible to come up with, making more assumptions, to come up with an estimation of the frequency of the rise. But the reason -- Let me drop back just a second here. The reason I said there were only two possible causes during the period of study, is that we are talking about summer. When you throw winter in there, then you are talking about ice. There is no way that weather information is going to tell you the size or configuration of the ice berms on the shoreline.

So the reason we didn't attempt to do that, to go back through time, is simply we would only be dealing with eight months out of the year or something. Then there is this four-month gap each year that you cannot reconstruct from weather records.

Q Is it not true that your study as a whole -- I mean, you haven't, you don't have any measurements

except for that eight-month period, is that not correct?

A Correct.

Q So that your entire study is affected by that limitation.

A Correct, as I think it's been said many times in here.

Q Well, wouldn't it have been more accurate to have relied on the specific information for that eight-month period, than to rely on an assumption, as you did in the report?

MR. HYNES: In what regards?

BY MR. SHAPIRO:

Q More accurate for calculating the flux towards the Lake.

A No, because the calculation of the number -- or the frequency of type changes would involve some additional assumptions. So the accuracy is probably roughly the same in both cases, probably.

Q Are you saying it would have been sort of guesswork to deal with the assumptions I am talking about now?

A Which assumptions that you are talking

about now?

Q The additional assumptions that you would have to use in order to be able to --

A They are assumptions that would be well out of my field of expertise. I am not a limnologist. So I felt much more comfortable making the assumptions in my own area, namely groundwater, than outside of it.

Q Are you saying that the reason you did not make this additional determination is that you did not have the expertise to make that determination?

MR. HYNES: What determination? Are you talking about the frequency of the transitional flow?

MR. SHAPIRO: No. I am talking about the -- let me rephrase the question.

BY MR. SHAPIRO:

Q Are you saying that the reason why you didn't take into consideration the forces that were affecting the rapid rise or decline of the water level in the Lake, is that you lacked the expertise to make that determination?

A Well, there are two reasons why I did not take that into account. Number one, I still don't

think that it would provide any additional information, which is why everything in the report is couched in terms of what the flow, what the flux would be under Type I or Type II, or transition one to two, and so on, types of flow.

Number two, yes, I would agree that when it comes to the wintertime, configuration of the shoreline in Lake Michigan, I don't have the expertise to begin to make assessments as to what might be affecting the flow.

Q Let me ask you this. Are you saying that your report does not make any prediction about the frequency of flow toward the Lake?

A Correct.

Q It does not make any projections about that?

MR. HYNES: That is the transition flow toward the Lake you are talking about, is that correct?

BY MR. SHAPIRO:

Q I am just talking about the flux toward the Lake.

A It does not say anything about the frequency

with which flux will occur toward the Lake.

Q So it could occur one out of every 12 days, it could occur one out of every 100 days?

A It could. I have no idea.

Q You have no idea how often it will occur?

A No.

Q It would not help you to reach a determination of how often it would occur to know how often the levels in the ditch, the water levels in the ditch suddenly rose dramatically?

A Well, okay. I may be seeing where I am not communicating here.

It is not simply a matter of the water level in the ditch rising rapidly, but rather the water level in the ditch must rise rapidly above the water level in the surrounding aquifer. So unless we have both sets of information, it is never possible to assess -- I will take that back. The only time that it is possible to assess that the water in the ditch is truly above the water table is when there is a flood, and when the water is visibly spilling out over the surface. Otherwise one would always have to assume, with no scientific

basis whatsoever, that the water level in the ditch when it is high, is higher than the water table. So I just don't think it would -- It is going a step beyond what I attempted to do in here, and it is introducing many more questions than it answers.

Q You are basically saying that you do not have the information to be able to use that variable in your analysis.

A Correct.

Q Did you have any contact with members of or employees of the USGS in the course of your investigation?

A I probably -- At one point I did obtain the water level measurements, and I don't recall how I did that, whether it was by calling USGS people, or writing them, or having Ed DiDomenico do that. But indirectly that is where the water levels in the ditch came from.

Q Did you ever see any reports by USGS on the water levels or the water flow in the North Ditch?

A No, not that I recall.

Q So you did not rely upon them at all in

forming your opinions that appear in your report?

A Well, the water levels which are in the report --

Q Are from USGS?

A Yes.

Q I am talking about you didn't rely upon any report by USGS for purposes of forming your opinions in your report.

A Yes. There is one USGS report. I think it is USGS or maybe it is Illinois Survey, which deals with the geology. I don't recall.

Q I am speaking now specifically about flow and --

A Okay. In that case --

Q -- gauge, and stuff in the North Ditch.

A No report.

Q Would that have been useful in conducting your analysis?

A It could have been. I believe that the gauge which is maintained at the site is a float gauge, which is monitored daily,and they generally are not used in the wintertime.

Q Because the ditch freezes?

A Yes. So as a consequence I don't know that the water level information would have provided any more clues.

Q But if somebody had done an anlysis of the water levels and the water flow in the North Ditch, that might have been useful for you in conducting your analysis of the groundwater?

A It might have been, yes.

Q You said that the ditch level changed fairly rapidly. Is it useful in that case to get daily records for the height of the ditch, or the height of the water in the ditch?

A Yes, it might be useful to obtain them more frequently than that.

Q Well, how frequently did you have them for the purposes of the study?

A I think they are daily, I don't recall.

Q Do they appear in your report?

A There is a graph in here showing them.

Q Where is that?

A Figure 20, Page 3-22. Yes, they are daily.

Q Is that for both 1980 and 1979?

A No. This was only 1979.

Q Are there any such data for 1980?

A There may well be. I did not request them.

Q Why not?

A Because I had already come to the conclusion that there was very little I could do with them.

Q This Figure 20 also includes rainfall measurements for the period, is that correct?

A Yes.

Q Why are those important?

A Well, what Figure 20 is attempting to show is that the fluctuations in the water level in the ditch are at least in part independent of rainfall. So there is a period of no precipitation during which in fact the major fluctuations in water level occur.

Q That confirmed your conclusion that it was something that had to do with Lake Michigan that might be causing these fluctuations in the ditch?

A Yes.

Q Rather than rainfall.

A In my opinion, yes.

Q Is there any human intervention that might

have caused these fluctuations?

A There could be, there could be. That was the one kicker I threw in earlier. I don't know. There could be two possibilities, as I would see it. Either somebody is blocking up the lower end with logs, or whatever, which I cannot see happening very frequently. Or water is being released from somewhere up ditch and is moving down through.

Q Do you have any reason to believe that was happening?

A No, I don't.

Q There are sewage lagoons north of the ditch, are there not?

A Yes.

Q Could those be causing the rapid variations in the level of the water in the ditch?

A In my opinion, no, not this rapid. We are seeing a rise here for example of over a foot in a day or two.

The only way you can get that rapid a rise is through surface flow or lack of surface flow, damming up the surface water. Groundwater just does not move that rapidly.

So the sewage people, I cannot think of the name of the -- Jakitis, Jake Jakitis, J-a-k-i-t-i-s, I think, assured me the one time I spoke with him that they did not release surface water into the North Ditch. So that is the basis for my opinion that the sewage plant is not causing it.

Q What affect do the sewage lagoons have on the water in the ditch?

A Undoubtedly they cause, when there is water in the lagoons, they cause groundwater flow from the north side of the ditch into the ditch. It is probably fairly substantial. We have only one well really on that side of the ditch, on the north side, and it does fluctuate in water level.

Q That is Well No. 3?

A No, it's actually, it is Well No. 5. Well 3 is on that side also, but it is down below what I would anticipate, where I would anticipate the influence of the lagoons would be felt. So I would say it was Well No. 5. I think that is the number, yes. It is conceivable that a fair amount of water can flow into the ditch from the north. I think the

data show that.

Q Would it be possible to control the water level in the ditch by monitoring the level of the water in the sewage lagoons?

A To control it?

Q Yes.

MR. HYNES: How can you control it by monitoring?

BY THE WITNESS:

A No. Monitoring is --

BY MR. SHAPIRO:

Q By monitoring and controlling the levels of water in the sewage lagoons.

A It would be possible to impact the level. By control, do you mean that, or do you mean totally eliminate fluctuation?

Q Would it be possible to totally eliminate fluctuation?

A I don't think so.

Q Would it be possible to restrict fluctuation considerably?

A Perhaps. It would depend on the condition of the sewage lagoons. They were designed as no

leak lagoons. They supposedly have a concrete floor.

Q But they leak substantially?

A Yes.

Q Do they leak contaminants into the ditch?

A I would imagine they probably do. The only thing that was analyzed for was PCBs, and the PCBs in Well 5 were elevated above control, but not much more than most of the other wells outside the enclaves of PCB sediment.

Q Are you now saying it is possible that some PCBs would come into the ditch from the north shore sanitary district lagoons?

A That is certainly a possibility, yes.

(Recess had.)

MR. SHAPIRO: Let's go back on the record.

BY MR. SHAPIRO:

Q Dr. Cherkauer, before we took our break you were saying that it is possible that the sewage lagoons were a possible source of PCBs for the ditch, is that correct?

A Yes.

Q You do not know how much they might be contributing to the ditch, do you?

A The only possible source of information we have is Well 5, and it does not have very high PCB levels in it.

Q It is only for two years as well, is that not correct?

A Correct.

Q It could vary considerably over time, since there is human source of the contamination or human created source of the contamination.

A Well, I would say it could vary considerably over time. It doesn't necessarily have to be because it is a human source.

Q So it could vary considerably over time?

A Yes.

Q You do not know how much in the past or how much in the future has come from that source?

A No.

Q Dr. Cherkauer, do you recall during the course of your review of the material from 1979 ever expressing any concern about the levels of PCBs in the acetone that was used to clean the drill rigs and the drills?

A Yes. There was, it was one of the early

analyses had been done on acetone which indicated higher than trace amounts in the acetone of PCBs. So I don't recall who it was that I mentioned that to. It may have been Salzberg or Whang, that those levels seemed unusually high.

Q Do you recall discussing that with anyone?

A The only thing I definitely recall was a letter to, as I said, either Salzberg or Whang. I don't recall specifically anything else.

Q What did the letter say?

A Well, something to the effect that the levels in that sample -- I guess I was questioning whether the acetone analysis which I believe had been included with the sediment analyses, whether the units it was in were milligrams per kilogram or micrograms per liter, which would be the difference between parts per million and parts per billion. Because if they were the milligrams per kilogram, which the sediment samples had, these levels would be above background levels in the wells.

Q That would create a problem for your analysis?

A It would essentially raise the level that I could treat as background, and it would mean that

I could not accept anything below that as unquestionbly uncontaminated.

Q Well, were you able to clear up what unit it was that was being reported?

A I was afraid you would ask that, because I don't -- I am trying to remember. The answer is yes. But how?

Q Let's start at the beginning. What was the answer, before we find out how you got it?

A Well, I was able to clear it up. I believe that it was either other analyses, or the fact that it had been in micrograms per liter, but mislabeled milligrams per kilogram. But I don't recall which it was. I ended up dismissing it as not a problem.

Q When did you dismiss it as not a problem?

A Probably sometime during the 1979 analysis of data.

Q Before you completed your draft report?

A I think so, yes.

Q Let me make certain I understand you. The problem that you saw was that if the values that you saw were in milligrams per kilogram, would it make meaningless the values that you had had for PCBs

for the various wells?

A No. It would only make meaningless those -- Okay. All right. That jogged my memory a little bit.

It would only make meaningless those wells which had values below the acetone level.

Q Less than a certain amount?

A Two and a half parts per-billion, or whatever the number was, I don't recall.

Q Any value below the number that was found in the acetone would be meaningless?

A Questionable, I guess is a better term.

Q Because it might have been caused by the acetone rather than by the actual contamination in the water?

A Correct.

Now, I remember. Now, as I say, I recall dismissing it simply because those wells which have concentrations in that lower level are not actively part of any PCB transport mechanism. Are not in any active PCB transport mechanism. So the fact that those low concentrations are questionable really does not affect any of the major fluxes on the eastern side.

Q What you are saying is that the wells that were insignificant for your determination of the flux of PCBs all show levels above the amount you found in the acetone.

A Considerably above. Orders of magnitude above.

Q Where are the levels of magnitude that you found for the wells that you regard as significant for determining PCB flux? Where are they found in your report?

A Oh, well, they will be in Chapter 4 somewhere. I am sorry, Chapter 3. On Table 8 and 9, which are Pages 3-57 and 3-58. It is best probably to concentrate on 3-58, where we have the full array of wells in.

Q Which of those wells is significant for your determination of the fluxes?

A Well, the most significant is Well 10, which sits in the middle of the proposed zone of migration. Well 1 is nearby to 10. The nests 2 and 11 are the next closest, and then 12 and 13 are progressively further away.

Q You relied on the data for each of those

wells in order to make your determination of the fluxes of PCBs?

A To an extent. I also relied very heavily on the distribution of PCBs within the sediments.

Q Might those calculations also be affected by the presence of PCBs in the acetone?

MR. HYNES: What do you mean by "those"?

BY MR. SHAPIRO:

Q The sediment samples.

A Highly unlikely. There we are talking about concentrations on the milligram per kilogram level, parts per million; whereas the acetone was three orders of magnitude lower than that. You just wouldn't detect an effect.

Q You said you didn't know what the measurement was of the acetone.

A The more I think about it I think I was told it was the micrograms per liter.

Q Do you recall who told you that?

A Probably Ed DiDomenico.

Q Well, how did he provide that to you? Did you have a telephone conversation?

A Telephone call, yes.

Q Did he ever provide any verification of that in a letter?

A No.

Q So except for Mr. DiDomenico telling you that the correct measurement was micrograms per liter, it may very well have been that measurement was micrograms per kilogram?

A Milligrams per kilogram.

Q I am sorry, milligrams per kilogram.

A Well, the only reason the question arose in the first place is that they were included, the acetone analysis was included in a list of sediment analyses, and there was no indication as to what units were on there. So I was simply attempting to clear it up.

Q What you are saying, Dr. Cherkauer, is that the concentrations for the acetone were listed along with the concentrations in the samples, is that right?

A Yes.

Q And that the samples on the sheets that you were looking at were listed as micrograms -- milligrams per kilogram?

A Yes.

Q So it was reasonable looking at it for the first time to conclude that the acetone levels were also milligrams per kilogram.

A It was reasonable in the sense that there were no units listed. However, normally liquid concentrations are expressed in micrograms per liter, whereas solids are milligrams per kilograms.

Q But there was no indication that it was in micrograms per liter on the form.

A Correct.

Q The way you came to the conclusion that it was micrograms per liter is that Mr. DiDomenico represented to you that that was the case.

A I believe it was him, yes.

Q You had no other basis for that?

A No.

MS. OLIVER: Could you confirm that the concentrations of PCBs were in milligrams per kilogram, or parts per million?

THE WITNESS: Concentrations?

MS. OLIVER: The other concentrations that were listed along with the acetone you assumed were

milligrams per kilogram, right?

THE WITNESS: Yes, I did.

MS. OLIVER: Did you ever confirm that that was the case?

THE WITNESS: I don't recall, and to be very honest with you, I don't know whether there was an absence of units on that page or not. I just don't recall the page.

MS. OLIVER: All the data that you got regarding concentrations from the samples and the analysis were in milligrams per kilograms, wasn't it?

THE WITNESS: For sediments, but not for water.

BY MR. SHAPIRO:

Q But these acetone calculations appeared on the sediment sheets that you received?

A Correct.

Q Looking back at Table 9, these units that are given in the second column for each of the wells are in micrograms per liter, is that right?

A Yes.

Q Taking Well No. 1, for example, it gives 464 micrograms per liter. What would that be in

milligrams per kilogram?

A Approximately .464.

Q So that if the acetone levels had been higher than that, then the information for Well 1 would have been questionable and meaningless?

A Questionable. There is a whole other -- Well, yes, okay. Questionable.

Q What would 2-A be in milligrams per kilogram?

A Approximately .0094.

Q So in each case you would have to move it three decimal places to express it in milligrams per kilogram? Move the decimal three places?

A Yes.

Q Approximately.

A Yes, because we are moving from sediment to liquid.

Q Well, if you were to express these in milligrams per kilogram, is there any of the samples that you mentioned, Wells 1, 2-A, 2-B, 2-C, 10, 11-A, B, and C, 12 and 13, that would be greater than one milligram per kilogram if it were expressed in those units?

A Yes, 10.

Q Any others?

A No.

Q That is the only one?

A Of the ones that you listed, yes.

Q So if the level of the acetone in fact turned out to be greater than one milligram per kilogram, the only non-questionable result that you had in this table would be for Well 10, among the wells that you considered relevant for determining the flux of the eastern lens?

A Correct.

Q Did you have any role in the additional monitoring that was done during the 1980 period?

A My role besides interpreting the data again was to suggest where the additional wells should be located.

Q Did you do that by yourself, or did others contribute as well?

A That was done largely between Ed DiDomenico and myself through telephone discussions. He relayed information as to what they had found in the boring process, and then I suggested what the orientation of the well ought to be. Specific locations were

chosen, I am not sure by whom, but probably by a combination of Ed and the drilling crew.

Q So you only gave general instructions where the additional wells would be placed, and Mr. DiDomenico --

A To the best of my --

Q Let me finish.

-- Mr. DiDomenico, perhaps acting with someone else, actually chose the specific site for the wells?

A To the best of my knowledge, yes.

Q Did Mr. DiDomenico ever check with you afterwards to find out whether he had sited the wells correctly?

A Not that I recall.

Q Were you satisfied with the way they were located?

A Yes.

Q Did you have any other role between the establishing of the new wells or the selection of the sites for the new wells and the analysis of the data that was collected?

A No.

Q Would you tell me what you did once you had all the data collected? Let's go through the steps that you used in preparing and reaching your conclusions.

A Well, the first step -- Well, I am going to start after -- when dealing directly with the EPA data, the geological interpretation had been done prior to that, based on borings and so on.

Q You are talking about the geologic information had been collected in 1979?

A Correct.

Q And that had been sufficient to form a judgment about the geological formulations?

A Yes. All of the newborn data simply confirmed it. It did not modify.

Q Was there anything else that had already been established?

A No, I don't believe so.

Then the first step in virtually any of these types of studies one would do was to take water level data and plot the water table configuration, and infer from that the flow directions.

Q How do you do that?

A You just plot them on the map as they are down here, and contour them. Water flows perpendicular to the lines of equal elevation, flowing downhill, just like it does on the ground surface.

In this particular case, the next step was to examine the vertical distribution of heads or water levels to see if there were any non-horizontal movements of the water, and what they might be associated with.

Q Why was that important?

A To determine whether the -- For one thing, if -- Well, to determine whether or not material could be entering the subsurface from the surface, or would be discharging to the surface from the subsurface.

Q What did you conclude from that?

A I was doing both. It depends on the time and the location.

Q In other words, there is a flow of water down through the aquifer?

A Down into the aquifer, not through it.

Q How far down does that flow reach?

A Well, there is vertical movement down to

the deepest of our piezometers, or at least one would have to infer between the second and third piezometer in nests. Then similarly there is flow upward from as deep as we have seen.

Q You said that it goes down as deep as between the second and third piezometers, not down to the lowest piezometer as well?

A The only way you can tell whether there is water movement or not is to compare two piezometers, and since we have nothing, no information below the third one, we cannot go beyond that except by inference.

Q It is reasonable to conclude, though, it is going down to the third piezometer as well?

A Probably so.

Q Do you find anything that led you to believe otherwise?

A No.

Q Before you go on with the next step, did you calculate permeabilities as well?

A Warzyn calculated the permeabilities based on their bail down tests. I simply ran through many of their calculations to confirm that their numbers

were accurate.

Q Why were permeabilities important?

A In order to determine what the rate of flow is of water, the quantity of water moving, one has to know the hydraulic conductivity of the medium and the hydraulic gradient.

Q Is this a later step in the analysis? I don't want to get ahead of the procedure.

A Right.

Q Let's continue with where we were. So after calculating the vertical distribution, what was the next step that you did or undertook?

A Probably an ideal sequence, and this was not always ideal, because sometimes I was getting data in a different order than I would have liked. But in an ideal situation one would then go to calculating the fluxes of the groundwater, the quantities of water moving. Because at that point you have the hydraulic gradients. You can read those from the water table maps and the cross-sections.

Q In other words, you are saying that after you get your basic geological data you figure out which direction the water would flow in, or is

flowing on any particular day, including the vertical flow.

A Yes.

Q Then you try to determine how much.

A Then I try to quantify how much.

Q What do you need to do that?

A Permeabilities and hydraulic gradients.

Q What is hydraulic gradients?

A In the simplest terms, the slope of the water table. But that's --

Q How much of a difference there is between two water table measurements?

A Correct.

Q You said that Warzyn had conducted permeability tests for the various wells?

A Yes. They have done them for each of the piezometers that was installed.

Q You checked those determinations to make certain that they were accurate?

A That they were correct. In this case accuracy and precision cannot be ascertained.

Q In other words, you checked the formula that they used?

A I checked their calculations, and I checked in reality much of the calculations done graphically by plotting the data. I checked their plots to make sure that the information had been properly transferred and the equation properly applied, and it had been.

Q Are those permeabilities on Pages 2-15 and 2-16?

A Yes.

Q The permeabilities were measured in centimeters per second?

A Correct.

Q What does the designation "a" mean for a particular well?

A Well, it indicates on the next page it simply means the water in the well recovered so fast that there was not time between bailing and the first measurement to see any difference.

Q They couldn't get the sounder down fast enough.

A Fast enough to notice any change. So in other words, it's a very highly permeable material. They are estimating, based on experience, that it

probably is something on the order of five times ten to the minus three. It is probably quite a bit higher than that, but there is no way of knowing how much.

Q Is it reasonable to conclude on the basis of what you just said that permeability higher than five times ten to the minus 3 centimeters per second just cannot be measured in the procedure they were using?

A As far as I know it cannot be, yes.

Q Can you explain to me why it is under Well 2-B they have a permeability that is as high as 8.51 times ten to the minus of three?

A I will have to retract my previous statement.

They are estimating it as somewhere in that neighborhood, and I would not be precise about the five times ten to the minus three. But they are getting something somewhat higher than that, based on the analysis. It could mean that they should list the maximum as ten times ten to the minus three.

Q My question was you said it was reasonable to conclude that they couldn't calculate anything above five times ten to the minus three, isn't that right?

You are now saying that is not the case, that they can calculate permeabilities above five times ten to the minus three.

A But not much. And so this five is again a conservative estimate of what an upper limit might be.

Q Well, it is wrong, isn't it?

MR. HYNES: What is wrong.

BY MR. SHAPIRO:

Q The five point --

MR. HYNES: The five point ten to the minus three being the top measurable limit?

BY MR. SHAPIRO:

Q When they said it is on the order of five times ten to the minus of three, it is wrong.

A No, it is on the order of. It is. The eight times ten to the minus three is on the order of five times ten to the minus three.

Q Let me ask you, they are in fact assuming a permeability for those wells which could not be measured, that is lower than those four wells that they did measure.

A That is lower than one that they were able

to measure.

I would add that that is assuming that these numbers are correct. It could also be a typo, I don't know. It might be 8.5 times ten to the minus four. As I look at all of the other ones now, the second number is usually the lower number. I couldn't, I wouldn't say usually. Sometimes it's lower and sometimes it's higher.

Q Are you now saying that these figures may not be accurate?

A I am saying that there may be a typographical error.

Q Where are you saying there is a typographical error?

A I would have to go back and look at the original sheets or even an earlier copy, and see if the 8.51 times ten to the minus of three has carried through.

Q So you don't know whether these figures that are here listed in Table 1 are in fact the correct figures, because there may be typographical errors.

A I would suggest that the vast majority of

them are correct.

Q You don't know which ones --

A Because I have looked through them. But no, I haven't caught everything.

Q How do you calculate the flux of groundwater from the permeabilities and the hydralic gradients?

A It is the product of the two.

Q What kind of measurement do you get from that product? How is it expressed?

A In this particular case I don't recall what units we were using, but they would be in gallons per day, or cubic meters per day or something, volume per unit time.

Q Does that calculation appear in the report?

A Yes. Page 3-38.

Q The discussion on your report begins on Page 3-38?

A Yes.

Q It is also expressed in the table on Page 3-43?

A Yes.

Q So the basic unit that you used is expressed

Street

in that table, cubic feet per day?

A Yes, that was the unit I was using.

Q Did you ever do any calculations for a period of time less than a day?

A No.

Q How much would occur in less than a day?

A No.

O So this assumes that you are having a steady flow over the period of a day, and it would give you this amount at the end of the day, a day's time?

A Those numbers do, yes.

Q Is it possible from these figures to calculate how much it was per hour, assuming that the flow were not continuous?

A Would it be, you mean, steady, would it be steady for the hour?

Q Let's assume it was for the hour.

A Divide by 24.

Q But not steady from hour to hour.

A Well, then, you express it in cubic feet per hour.

Q Well, if for example you had a flow of 2600

cubic feet per day, could you say from that how much you were having each hour, assuming that your flow over the course of that period of a day were not steady?

A No.

Q It might be so much one hour, so much another hour, and you just add it up to 2600 cubic feet per day.

A No. This is assuming that we have the conditions represented at one instance in time when the samples were taken remaining steady for a 24-hour period.

Q So that instance is how long? Just the period of time it takes to take the measurement?

A Correct.

Q You extrapolate from that over a period of a day.

A Yes.

Q Are the figures that are given in Table 4 absolute minimums and absolute maximums over the course of the day?

A The fact that it is a day is irrelevant. That just happens to be the arbitrary unit that I

have selected to express them in. I could have done it in cubic feet per second, which is a more common unit for surface water. Cubic feet or gallons per day is a more common unit for groundwater.

So it is just a mechanism for expressing what the flux of water is.

Q Believe it or not, I do understand what you are saying. I am just having trouble expressing what I want to ask you.

Well, if, for example, you have 2600 cubic feet per day and you later discovered that the flow occurred only for an hour, you would divide this by 24.

A Yes.

Q That would give you the amount of flow that you had during that period.

A Correct.

Q By the way, on Page 3-7, Figure 7, it is described as "Distribution of Baildown Permeabilities."

A Yes.

Q Is that a plotting of the permeabilities that you had set out in Table No. 1?

A Yes, it is.

Q Why did you do this little figure?

A Well, it is a standard geologic interpretation attempting to see where the distribution of high and low permeability materials is. In this particular case it showed what I am terming high permeabilities are pretty extensive, and really low permeabilities exist only in the fill or the deeper parts of the sand.

Q What would you define as a high permeability?

A Well, for this particular study I have to define it as two times ten to the minus of three or greater.

Q Low permeability would be less than one times ten to the minus of three?

A Yes.

Q Does this figure play a role in any part of your report that you relied on?

A Which figure?

Q Figure 7.

A Oh, the diagram?

Q Yes.

A I thought you meant the numbers.

Only in the sense that by having done this

I can now see that what I am terming medium or high permeability exists over virtually the entire area. So when I do my later flux calculations it allows me to use those numbers or something reasonable within those ranges.

Q It gives you a picture of the permeability of the aquifer in different parts of the same area.

A Correct. It also allows, going back to one of our earlier discussions, it allows the interpretation that this material is on a large scale relatively homogeneous. The permeabilities are not that variable over the extent of the study area.

Q You are basing that statement on the permeabilities that are listed for each of the various sections that appear in Figure 7?

A Correct.

Q What was the next step after calculating the groundwater flux?

A Oh, then I would begin looking at the distribution of PCBs to get into the quality aspect. Initially I did that starting with the sediment PCBs. I looked at the distribution of sediments or PCBs in the sediments, simply because -- well, for two reasons.

They are more stable, they are not ephemeral. They don't move around as rapidly. We had much more information on the PCB distribution in the sediments, many more samples, distributed across the study area than for water.

Q Let us go back a second. I just want to go through these steps one by one.

You had the geological data already established. Then you plotted the water table data which told you about water direction. What conclusion did you draw about water direction on the basis of that?

A Well, it was at that point I was able to establish the Type I and Type II transition flows, to establish a basic framework within which the flow is occurring.

Q Type I flow was primarily a flow towards the ditch, is that right?

A Yes.

Q Type II is flow away from the ditch.

A Primarily, yes.

Q In which direction?

A Southward.

Q We are talking now about the eastward end

of the ditch?

A Well, Type I and Type II occur everywhere. At the very western end of the site the predominant flow is almost always southeastward into the ditch from the area to the west of the study area. But there is evidence on a couple of occasions that the water level in the ditch rises high enough that Type II flow does flow a little bit to the northwest, not particularly far, but predominantly on the eastern end is where this flow was occurring.

Q It was your conclusion, was it not, that the western end of the ditch was not really relevant for determining the contamination of the groundwater and the flux toward Lake Michigan?

A Not at this point. That wasn't my conclusion.

Q Was that your ultimate conclusion in the report?

A Yes.

Q So it does not affect your ultimate calculation for the contamination of the groundwater and the flux toward Lake Michigan.

A At this point in the progression I cannot make that assumption.

Q No. I am just asking ultimately in the report, your ultimate conclusion is that it is not really relevant for determining either the flux of the PCBs into the groundwater or the flux of the groundwater -- PCB contaminated groundwater into Lake Michigan.

A Yes, via the groundwater, yes.

Q If it has an effect, it is by way of the ditch.

A Through the ditch.

Q So for purposes of my questions from now on, let's just talk about the eastern end of the ditch.

A Okay.

Q So by plotting the water table data you came up with Type I flow, which is into the ditch; Type II flow, which is away from the ditch, down in the southerly direction. Transition from I to II, which flows in which direction?

A Predominantly from I to II, it is going to flow eastward.

Q Toward the Lake?

A Yes.

Q How about transition from II to I?

A That's predominantly going to move -- Now, there you have a situation where your ditch is dropping, and your water table is high. So that particular transition is going to revert fairly quickly into Type I flow. So the predominant flow should be northward in that situation, toward the ditch.

Q Now, on how many of the 12 sampling dates did you fine Type I flow?

A I don't recall.

Q Can you find it in your report?

A There is no summarizing table. I would have to go through the maps.

Q Well, as long as you are going to do it, let's do it only once. See if you can come up with the number of days for each.

A The exact number necessary, it was approximately six.

Q Six days for Type I?

A Approximately. One for --

Q One for transition to I to II.

A Probably three for Type II, and two for the

other transition. Those are approximates.

Q So roughly eight or nine of the twelve days there was flow toward the ditch, and on the remaining days there was one day there was flow toward the Lake. What does that leave, two or three days there was flow in a southerly direction?

A Yes. I would agree with the numbers. The only thing that I would add to that is that on all of these occasions there is a slight component toward the Lake. So it is not restricted to just that transition. But that is the only time it is predominant.

Q What did you conclude about the fluxes of groundwater? Is that what is set out on Page 3-38 of the report?

A Whatever that table was we were just looking at, 3-43.

Q Now, after you looked at the sediment data, what did you conclude about the distribution of PCBs?

A Well, that is shown on both Figures 36 and probably 37. Page 3-50 and 3-51. Basically what it shows is, if you look at Page 3-50, there are two lenses of PCB contaminated sediment, and these

contours shown in milligrams per kilogram. They are the average soil composition for the top five feet within the aquifer.

Then the following page shows what that looks like in the vertical cross-section, indicating that those two lenses extend to depths below the base of the fill.

Q What was the next step?

A Well, then I plotted the PCB concentrations in the water samples themselves. Figure 38, which is 3-53. Now, we have fewer points here, fewer data points, but there is a very similar pattern as one would probably expect between the water concentrations and the sediment concentrations. There are two zones of high water PCB concentrations. They happen to coincide with the two zones of high PCB sediments.

Q Why would you expect the two to be the same?

A Well, because the composition of groundwater basically reflects the composition of the material in which it is located.

Q Is that true even when the groundwater is moving?

A Yes. To the best of my knowledge virtually all groundwater is always moving.

Q What was the next step?

A At that point after comparing the sediment and water distributions, I then decided -- then I took a look at how that water composition distribution would fit within the flow framework that I had previously developed. It was at that point that I concluded that the western enclave probably is not going anywhere because of the centrally sloshing back and forth from Type I to Type II. They counterbalance one another. There is little indication from the distribution in the sediment that there has been much lateral movement. There has been vertical movement.

Q You are talking about the western enclave?

A On the western enclave, right.

I also was able to do fairly quick calculations as to the PCB fluxes that might be moving into the ditch from that western enclave, and from areas downflow from it, and --

Q Where do those appear in your report?

A They ultimately occur in the last table,

which has all of the fluxes in it, 3-70, Table 10. So the first three lines of information across there, the southeast flow, the northward flow, and the southward flow were all calculated at that point just using the average concentrations listed in the second column, and the groundwater fluxes, and they were calculated then as the product concentration times groundwater flux. The eastern enclave is what this eastward to Lake Michigan segment of data in Table 10 is about.

Q There are no figures in Table 10 regarding the flow in the eastern enclave into the ditch?

A No.

Q Doesn't that flow occur?

A Yes, but it's of the order of magnitude of the northward to ditch flow, simply because the --

Q You are referring to Line 2, then?

A Yes. The high concentration sediments are not, as far as I can tell, not immediately adjacent to the ditch, but there is some distance between them.

Q Let me make sure I understand you. We said that the flow toward the ditch in the eastern

enclave occurred approximately eight or nine times out of the total 12 days of sampling, that right?

A Yes.

Q On those days isn't there a flux of PCBs from the lens into the ditch that is carried by that groundwater?

A Yes.

Q It would be fairly significant, wouldn't it?

A I am saying that it probably isn't very major, simply because that flow is apparently balanced by the southward component during Type II.

Q Except that it occurs three times as often.

A Well, you are making extrapolations that the frequencies we have are valid.

Q Well, do you have any other frequencies that you think might better represent?

A I have no other frequencies, no.

Q Well, do you have any opinion about what the real frequency might be?

A Yes. I believe that the Type I and Type II flow occur. They have to occur -- Well, I take that back. They don't have to occur. But I believe that

they do occur with approximately the same frequency.

Q On what do you base that opinion?

A On the configuration of -- largely on the configuration of PCBs within the sediment. Distribution is not asymmetric, not highly asymmetric. I should add, in either direction, north or south.

Q There is no bulge toward the ditch, is that what you are saying? No bulge of high concentrations of PCBs towards the ditch?

A Yes.

Q Wouldn't that depend upon what the original distribution of PCBs was in that lens or enclave?

A Yes, to an extent it would.

Q But you don't know what that was?

A No.

Q So it is entirely possible that there is in fact a movement of this enclave or lens towards the ditch?

A Yes, it is.

Q Let us assume for a moment that there is a migration of this lens or enclave toward the ditch. How long do you think it would take for a breakthrough into the ditch, of the lens or the enclave?

A Well, when you use that term breakthrough, a breakthrough of what?

Q Well, let me rephrase the question. If it is true that the enclave is moving toward the ditch, then the ditch at some point would begin to syphon off large amounts of the PCBs from that lens or enclave, wouldn't it?

A It wouldn't syphon it off. The PCBs would flow into the ditch, yes.

Q It would reduce the reservoir, if you will, of PCBs that exist in that lens or enclave.

A Correct.

Q Wouldn't it also decrease the amount of PCBs that would exist as a source of flowing to the Lake as well?

A Flow through the groundwater?

Q Yes.

A Yes.

Q So if there is a movement of PCBs towards the ditch it might reduce the amount of PCBs that would ultimately flow into the Lake.

A Through the groundwater?

Q Through the groundwater.

A Yes, it could.

Q So that your conservative estimate at the end might in fact turn out to be much too large.

A I would argue --

Q No. I am asking you based on the assumption that I just gave you that the PCBs are moving toward the ditch, it's entirely possible that your estimate at the end of the report would prove to be too large.

A It's not entirely possible, no. That is what I was about to say. I would argue with that. That yes, there is some possibility that it may prove somewhat too large. But I would argue that it is such a conservative estimate that the chances of that are not very great.

Q But the estimate does depend upon your conclusion earlier in the report that the PCBs are not moving toward the ditch.

A To an extent, yes, it does.

Q If they were moving towards the ditch, then your calculations would change.

A They might.

Q They would be lower, would they not?

A Yes, if they were to change.

Q So if you make the assumption that I am making, it might very well turn out to be true that the conclusion that you reached for the flux of PCBs into the Lake after 60 or 80 years would prove to be too high.

A It could.

Q Are PCBs heavy?

A Relative to what?

Q Well, relative to other things that you find in the aquifer.

MR. HYNES: The aquifer here or in general?

BY MR. SHAPIRO:

Q In general.

A Do you mean dissolved in the water?

Q Okay, let's take dissolved in the water.

A Yes.

Q They tend to sink?

A They are heavier than water. Their molecular weight is greater than the molecular weight of water.

Q Let's assume you have a lens or enclave of PCBs. Is there a likelihood that they begin to move down lower in the aquifer, to a deeper level

in the aquifer?

A If there is a component of flow in that direction, yes.

Q But only if there is a component of flow in that direction?

A No. If there was horizontal flow, you could also get some migration downward through the aquifer.

Q Just because PCBs themselves are fairly heavy relative to the water.

A Yes.

Q Any other reason?

A Well, if you have got downward movement water, then you have effective transport.

Q In other words, if you had a downward flow, in addition to the weight of the PCBs, the water carrying the PCBs lower.

A Correct. If you have downward flow the water is carrying with it everything that is dissolved in it. If you have horizontal flow over long distances, there tends to be a segregation of heavier things toward the bottom of the contamination, and lighter things toward the top.

Q So in this case you would have sort of a double effect of the PCBs moving lower in the enclave or the lens, both because they are heavier and the horizontal flow, they tend to move down farther in the aquifer, and because of this vertical flow downward.

A In the locations where there is vertical downward flow. That is not everywhere. There are substantial areas and times when there is vertical upward flow.

Q Is there anyplace in this site where in the aquifer there was no vertical flow at any time?

A I don't like to speak in absolutes, as you probably are aware already.

That central zone under the parking lot has only minute vertical flow, components to flow. It is basically horizontal in the vicinity of Well 4, Well nest 4.

Q How about at Well nest 2?

A That, I would have to look. There is fairly often an upward flow at Well nest 2. I would anticipate that there would be an upward flow eastward along Lake Michigan, simply because this water is

now moving into the Lake, and discharges through the Lake bed.

Q Well, is there downward flow also at Well nest 2?

A Yes, I would imagine. I don't see one that shows that right offhand. But during Type II flow, if I remember correctly, there is downward flow in the vicinity of nest 2.

Q During that flow there is likely to be some PCBs carried downward into the aquifer?

A From where, are you saying?

Q From the aquifer near the surface at Well nest 2.

A I don't know the answer to that. There isn't much in the way of PCBs at the surface at Well nest 2, or is there?

Q Are you talking about the same lens?

A Yes. But it's less than ten milligrams per kilogram. So the answer to your question is yes, there would be some, but not a great deal.

Q Well nest 2 is north of the eastern lens or enclave?

A Yes, really. On Figure 35, Page 3-47,

the ten contour goes between the enclave and Well nest 2.

Q I understand.

You said that after you calculated the PCB contamination of water, you calculated the PCB movement, and we just talked about the movement in the western enclave not really being relevant for your ultimate conclusion of the groundwater. What was your conclusion with respect to the eastern enclave?

A Well, the conclusion there is that there is evidence that the PCBs in that enclave are migrating toward the Lake, and the fluxes that one could anticipate in the Lake, or going into the Lake, the conservative fluxes, are those which are projected on Figure 46, which is Page 3-79.

Q Well, let's go step by step. How did you reach those figures that are plotted on Page 3-79?

A Well, the progression is shown essentially starting on Page 3-72, where we discuss the underlying assumptions initially. Page 3-74 shows what is known as the breakthrough equation.

Q What is that?

A That is that equation in the middle of the page which allowed one to calculate the distribution of relative concentrations as a function of distance and time.

Q We are on Page 3-73?

A 3-74.

Q I am sorry.

A The c over c subzero.

Q When you sav breakthrough equation, that does not mean that it breaks through to the Lake in any particular point, does it?

A Well, that is really where the term came from. In fact, if you were to plot the distribution at any point in time of a reactive substance moving through an aquifer where -- Well, how can I do this. The horizontal axis is the relative concentration. This is totally contaminated. This is pure, down here. This is distance (indicating).

Q You have got to do this for the record.

A Okay.

Q For the court reporter as well.

A Okay. The vertical axis is relative

concentration. The horizontal axis is location, distance.

Q Right.

A If my source is here on your right, then -- Does that work? The source is on the right. Then we will have a curve that starts off here at the source on the right-hand side at 100 percent contaminated, and will progressively decay. It will decay exponentially as we move away from the source until we get to a point out here at some unknown distance where the relative concentration is 50 percent. It will then continue --

Q You are talking about the relative concentration now of the enclave?

A No. The relative concentration is this term C over C zero, where it is the actual concentration in the aquifer, in the water, as compared to the contaminated source back here.

So just as an example, in here I am using 5,000 micrograms per liter as the source concentration.

Q That is your estimate for the concentration of PCBs in the enclave, the water that is right there on the eastern end of the ditch, is that right?

A Yes.

So we will start off at 5,000 right at that point, and it will decline until eventually we get to 2,500, which is a 50 percent decline, at some distance away from the source, and it is an exponentially down decline.

Q In other words,as you move away from the lens you will get decreasing concentrations of PCBs.

A Correct. The decrease starts off very slowly. That is what I mean by exponentially.

Q Right.

A And then begins to plummet quite rapidly with respect to distance.

Q I understand.

A Once we pass that 50 percent point, the curve is totally a mere image. If you project a mere image along that 50 percent plane. The curve is simply exponential, but it is decelerating the whole way. The rate of decline is decreasing.

So what this says is that you will have a slug of relatively highly concentrated water near

the source. You get a fairly rapid decline away from the source, and then a very, very long tail of minutely contaminated material at a distance from the source.

The shape of that curve, or not even the shape, that curve is what is called the breakthrough curve. The breakthrough point is where that 50 percent point crosses whatever boundary that you are interested in.

Q What is the relevance of that?

A Well, the relevance is that using that equation, which is the empirical equation that we talked about this morning, and given my assumptions about the configuration and initial conditions at the source over here, I can plug into that equation any time and any distance that I would like and solve for what the concentration should be using the breakthrough curve.

Q So in other words, just to summarize, the groundwater according to your calculations is always reaching the Lake. The question is when the groundwater reaching the Lake contains significant quantities of PCBs, and you can use the breakthrough equation to determine when it is or

what the level of PCBs will be at any point in time in that groundwater reaching the Lake.

A Given all the assumptions that had been made going into that, yes.

Q Right. But there is no point at which there is a dramatic increase in the amount of PCBs reaching the Lake through the eastward flow of the groundwater.

A Well, I guess I am not sure what you mean by dramatic.

MR. HYNES: Do you mean from year to year, year one and year two, and all of a sudden you get out to year twelve and all of a sudden from eleven to twelve there is a dramatic jump, is that what you mean?

MR. SHAPIRO: Yes.

BY THE WITNESS:

A Well, I am projecting that one will never see a slug arrival, which is what you are describing.

BY MR. SHAPIRO:

Q You mean a sudden heavy concentration of PCBs?

A A sudden surge from 100 to 10,000.

Q It's over these 60-80 years you have projected

that the amount of PCBs will increase to the point where it would be as high as ten grams per day for the flow in that direction.

A Yes. I am not sure if the ten is correct.

Q Whatever it is.

A Yes.

Q Five to 30, I think you said this morning, is that right?

A Yes.

Q So that you have projected over time that will reach a level of 5 to 30 grams per day for flow, when there is flow in that direction.

A Correct.

Q Back on Page 3-55 you refer to the distribution coefficient. What is that, and what is it used for?

A Well, in simplest terms it is if you take a liquid containing a dissolved material and put it in an aquifer with which it reacts, it's the ratio at which that dissolved material will distribute itself between the solid aquifer and the liquid water. So the 150 means that approximately the concentration in the sediment should be about 150

times greater than the concentrations in the water at any particular location.

Q Is this for PCBs or any contaminant?

A It's for anything which reacts via adsorption or ion exchange, or some other surface reaction phenomenon with aquifer material.

Q Wouldn't it depend on the solubility of the contaminant in the water and also the attractiveness to the sediment?

A Oh, yes. That 150 is a number developed for PCBs at that site.

Q How did you develop this?

A Using Figure 39, which is Page 3-54, where I have simply plotted there the concentrations of PCBs in the water along the horizontal scale versus the concentration of PCBs in the sediment for the wells, samples taken out of the well borings on the vertical scale, and the slope of that line which goes through those points is 150.

Q You did this for Wells 13, 9, 2, 4, 7 and 10?

A Yes. All the wells for which PCB analyses in sediment were done.

Q What about Well 11?

A I don't believe anything was collected there. I have no data on that.

Q I am not certain what you mean. You mean you have no analyses of the level of PCBs in the water, in the water in Well 11?

A No. I have the water, but I don't have the sediment. I have to have both in order to plot them on that.

Q Is that because there was not a boring near Well 11, a sediment boring?

A No. Samples were not collected in the boring for Well 11.

Q Well, which of the these wells is in the eastern lens and enclave?

A Well 13 is near it, and 10 is near it.

Q Well 13 is actually outside the enclave, is it not, according to the Figure 38?

A Correct.

Q So really only Well 10 is the only well for which you had both water quality and the sediment quality in the well.

A Specifically in the eastern enclave?

Q Yes.

A Yes.

Q Did you make your calculations of the level of PCBs in the water in the soil there solely on the basis of Well 10?

A No.

Q What else did you use?

A The other ones shown on that diagram.

Q Which diagram?

A Figure 39.

Q In other words, you came up with the distribution coefficient based on all of the wells for which you had that data, only one of which appeared in the eastern enclave, and then you used that figure to determine what it would be for the other wells which you did not have data.

A No, I haven't used it to figure what it would be for the other wells. All I have done is to take the existing data from the site, plot it in this form, and determine the distribution coefficient from it.

Q Well, what would happen if the distribution coefficient were lower than 150, what would it do

to your results?

A It would increase the retardation factor, which would -- let's see, that would tend to reduce the magnitude of the terms, in parentheses, for complementary error function, which in turn --

Q You are referring to the formula on Page 3-74?

A Yes. I am just trying to figure what it would do.

It would slow the arrival at the Lake. It would make it take longer, and it would tend to store more PCB in the sediment.

Q In other words, since the coefficient is lower, less of the PCBs that were in the sediment would actually get into the water, or would be dissolved in the water. So the flux moving toward the Lake --

A Wait a minute. I am sorry, I was answering that as if the coefficient were larger.

If the coefficient were lower, it would be the reverse of what I said. It would actually mean that the PCBs had a lesser affinity for the sediment, and would speed things up, and increase

the net amount going into the Lake.

MS. OLIVER: Off the record.

(Discussion had off the record.)

MR. SHAPIRO: Back on the record.

BY MR. SHAPIRO:

Q On Page 3-59, Dr. Cherkauer, at the top of the page, the paragraph which relates to another item that you said you thought should be noted, and in the middle of the paragraph, it says: "The fluid in the wells may contain either non-aqueous chemical solvents or fine grained particulate matter, either of which would allow total PCB concentrations in excess of 1,000 micrograms per liter to occur."

Why did you make that statement?

A Because in the sampling of wells that has been done there are reported and they are listed on the preceding two pages, PCB concentrations in the water which are in excess of the reported solubility of PCBs in water. Now, I hasten to add that that thousand micrograms per liter solubility is a time-dependent variable, dependent on probably other factors that I am unaware of. But some of the

numbers that we are getting, some of the averages are an order of magnitude higher than that solubility.

It is conceivable that we could be dealing with some sort of supersaturation of PCBs in a pure aqueous solution, but it's also equally likely that there is some other factor in there than water, which is allowing that elevated concentration to develop.

Q You don't know which it is?

A No, I don't.

Q Which is the explanation.

Did anyone ever do any analysis to discover whether there were chemical solvents or fine grained particulate matter in the groundwater?

A Not that I am aware of.

Q Did you ever suggest that to anyone?

A No.

Q Well, if you found that there were no solvents or fine grain particulate matter in the groundwater, what conclusion would you reach?

A I would reach -- Well, there are several possible conclusions that I could reach. One would be that we were dealing with some sort of

supersaturation or complexing of PCBs with something else, so that they were not truly in solution, but were rather being carried through the water in a non-dissolved state. That would be one possibility.

Another possibility would be that the -- I lost my train of thought I had three a minute ago.

Another possibility would be that the solubilities for PCBs are affected by some factor which I am unaware of, and which may not have been discussed in this particular source that I was quoting. I don't know what, something like pH, or something like that, which might enhance the solubility of the PCBs in water.

A third possibility, which can never be eliminated, is that the analyses are in error.

Q You don't know which among all those possible explanations is the one that would be responsible for these apparent disparities.

A Well, I wouldn't suggest any of them, because I am suggesting that it is the non-aqueous solvent or the sediment.

Q Do you have any reason to believe that that is true? I mean, do you have any evidence

that there was such a thing in the water?

A I have no direct evidence, no.

Q Well, do you have any indirect evidence? Aren't you just inferring it from the fact of the higher solubility?

A I am inferring it partly from that, and partly from the fact that in fact most groundwater does contain, particularly moving through a sand aquifer, will contain some fine grain particulates; not much, but some.

Q A sufficient amount to account for the disparity?

A That I don't know. But remember there is that 150 distribution coefficient. So all it takes is a few parts per billion of sediment to result in a 150 parts per billion, 300 parts per billion rise in the PCB concentration in the water.

Q But that wouldn't account for the order of magnitude difference in the PCB concentrations in the water, would it?

A No. But what I am saying there is all we need would be a very minute concentration of sediments, when you multiply it by 150, to produce

an order of magnitude, and an increase of tenfold.

Q But again, you don't have any direct evidence.

A No. You asked me for indirect evidence.

Similarly, all I can go on is relative to non-aqeous chemical solvents. That is just strictly inference. We are dealing with an industrial site. There is no telling. We are also dealing with an area that is below a parking lot, and gasoline is a fine non-aqueous chemical solvent.

Q Is it also possible that those disparities could be caused by acetone that had been gotten into the wells in the course of the boring of the wells?

A For the first sets of samples, it is a definite possibility. But recognizing that this water is moving, and unless we put inordinate quantities of acetone in there, it is not going to be there a year and a half later. As I indicated earlier, unless we are pouring acetone down the hole, we are not going to have concentrations that will still show up a year later. Yet these large concentrations of PCBs do remain for that period of time.

Q Well, let me just go back. You said it is possible that it is gasoline from the parking lot. Wouldn't you have to have the same kind of continuous flow of gasoline from the parking lot in order to have that account for the disparity?

A Sure. But they park in there five or six days a week.

Q Well, what quantity of gasoline were you talking about?

A I don't know.

MR. SHAPIRO: Why don't we break here.

(The deposition was continued to August 10, 1982, at the hour of ten o'clock a.m.)

53 cont'd

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

THE UNITED STATES OF AMERICA,	)	
	)	
Plaintiff,	)	
	)	
Vs.	)	No. 78 C 1004
	)	
OUTBOARD MARINE CORPORATION and MONSANTO COMPANY,	)	
	)	
Defendant.	)	

The deposition of DR. DOUGLAS CHERKAUER resumed pursuant to adjournment, on the 18th day of November, 1982, before Jean Korinko Sweeney, Certified Shorthand Reporter and Notary Public, at 219 South Dearborn Street, Chicago, Illinois, Suite 1486, at the hour of 9:30 a.m.

PRESENT:

MR. JAMES T. HYNES,
(Deputy Chief, Civil Division
United States Attorney's Office
219 South Dearborn Street, Room 1486
Chicago. Illinois 60604),

appeared on behalf of the United States of America;

MS. ROSEANN OLIVER,
(Phelan, Pope & John, Ltd.
180 North Wacker Drive
Chicago, Illinois)

appeared on behalf of Defendant Outboard Marine;

Thea L. Urban
Certified Shorthand Reporter
134 South La Salle Street
Chicago, Illinois 60603
312 - 782-3332

PRESENT: (Continued)

MR. ROBERT E. SHAPIRO
(Kirkland & Ellis
200 East Randolph Street
Chicago, Illinois 60611),

appeared on behalf of Defendant
Monsanto Company.

ALSO PRESENT:

MS. CAROL DORGE.

* * * * *

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DR. DOUGLAS CHERKAUER,

called as a witness by the Defendant Monsanto Company, having been previously duly sworn, was examined and testified further as follows:

DIRECT EXAMINATION (Resumed)

BY MR. SHAPIRO:

Q Dr. Cherkauer, you realize that you are still under oath from your previous time being with us?

A Yes.

Q Have you had a chance to review the transcript of your testimony, your prior testimony in this deposition?

A No, I haven't.

Q Before the deposition began, Mr. Hynes, your counsel, mentioned to me that you had found some typographical errors in your report which is marked I think as Exhibit 2. Would you tell me at this point what those typographical errors are?

MR. HYNES: He told me there is one -- There are two figures, Figure 36, Figure 34.

MR. SHAPIRO: Jim, could I have Dr. Cherkauer do it.

MR. HYNES: Okay.

BY THE WITNESS:

A Well, I need a copy of it.

MR. SHAPIRO: He needs a copy of the report.

MR. HYNES: I just wrote on my notes what he told me.

BY THE WITNESS:

A Figure 36.

BY MR. SHAPIRO:

Q Here is Exhibit 2. Figure 36.

A Which is Page 3-50. Figure 36.

Page 3-50. It is a map showing the PCB concentration in the soil. And in the eastern lens, just to the left of the well 10 there is the number 100,000. It should read 10,000. The 10,000 is referred to in the text. So it probably has led to some confusion.

Q That 100,000, which should now read 10,000, specifies what?

A That is a contour line showing the concentrations of PCBs milligrams per kilogram in the sediment. So that that is showing that sediments within that line have concentrations in excess of 10,000.

The other two, one is on Page --

MR. HYNES: 74.

BY THE WITNESS:

A Page 74.

MR. HYNES: 3-74.

BY THE WITNESS:

A 3-74. The second equation down near the bottom of the page which presently reads, "V bar over V bar zero," that left-hand side is inverted. It doesn't make any sense the way it is presently written.

Q It should be --

A It should be V bar zero over V bar. That is referred to in the text in its proper form. That's just an error that I didn't catch on editing the thing.

Then the final one is on Page 3-76, Figure 44. The solid line on that curve, or on that graph is improperly located. As I was reviewing this last night I noticed that. The values for that solid line should be twice what they are. So it would move vertically upward on that graph.

Q What does that line show?

A Well, that line is showing -- I lost the

page. -- the distribution of PCBs in the water column, that is in the groundwater, which have been derived by looking at the distribution within the sediment, and then referring as it says back to Figure 39, which is the plot showing the relationship between sediment and water concentrations.

Q That is the distribution coefficient?

A Yes. So it doesn't affect the distribution coefficient. It simply affects the position of the line on this particular graph.

Q Does the text properly refer to the correct amount here, or is the text also in error?

A Right. Well, the equation or the line of primary importance in this particular figure is the dashed one, which is unaffected by the change. The dashed one is the one which is utilized for projections, or actually the dashed line is a result of the model that has been used for projections of future PCB concentrations. So that one is unaffected.

Q Well, perhaps I don't understand you. Then what does the solid line show?

A Basically what the solid line shows is what I interpret to be the real present distribution of

PCBs within the water column, and as long as the dashed line falls below that solid line on this particular graph, that indicates that my assumptions are indeed conservative. In other words, the model is predicting lower PCB concentrations for 1980 than what exists.

Q Do I understand you correctly that you used your model to predict what should exist today, as well as what should exist in the future?

A Well, this is -- Perhaps predict is not the proper term, but that is a calibration. Essentially what I did was run the model through to 1980, and see what it showed as should exist at that time, and that's the dash line on that figure.

Q Can you take your model and put it in any year and ask, basically ask the model or get the model to give you a result for the distribution of PCBs for that year?

A Yes, that's what has been done.

Q Okay. Just trying to make certain I understand you.

Are there any other typographical errors or mistakes that you found in your report?

A Not that I -- I believe there were some that we talked about the previous time.

Q Right.

A So there weren't any additional to that that I have noted.

Q So far as you can tell, your report is now correct, with the typographical errors that you have now corrected?

A To the best of my knowledge, yes.

Q Referring to Page 3-67 of your recport, it says, now quoting in the second paragraph, second sentence, "Furthermore, it has been shown that the groundwater flow at the site is unsteady and three-dimensional in a heterogeneous aquifer. A very complex flow system."

Is that right? Is that what it says?

A Yes.

Q Is it your opinion that this is a very complex flow system that is found at the Outboard Marine site?

A Yes.

Q Nothing has changed your opinion about that since the time you wrote this report?

A No.

Q By the way, have you done any further work with respect to the Outboard Marine site other than reading through your report another time?

A No. I simply read through it to review.

Q You don't expect to do any more work with respect to that site?

A No.

Q Nobody at either the Department of Justice or EPA has asked you to do any more work?

A No, they haven't.

Q I think we talked earlier about some other studies that you had done, that you mentioned to me; the fly ash or coal ash, the cheese whey study, various classroom studies, or studies that you have done with your classes, is that right?

A Yes.

Q Are there other studies that you have done in the last say ten years that I have omitted from that list?

MR. HYNES: Wait.

BY THE WITNESS:

A What type of studies?

MR. HYNES: Okay.

BY MR. SHAPIRO:

Q Ground water studies.

MR. HYNES: That is the question.

BY THE WITNESS:

A Yes, there are others.

BY MR. SHAPIRO:

Q Would you tell me what those are?

A Well, the major one involves the groundwater movement into and out of Lake Michigan throughout southeastern -- northeastern Wisconsin.

Q Any others?

A Not that I would deem major.

Q Well, any minor ones?

A There have been some minor ones which I have conducted with graduate students, which involve the flux of groundwaterthrough inland lakes, as we call them, in Wisconsin and wet lands.

Q When were those studies conducted?

A Oh, there have been several of them, and they have been within the past five years.

Q Where were they conducted?

A Throughout various locations in southeastern Wisconsin.

Q Which of these studies that you have mentioned to me or that I summarized from your previous testimony would you describe as showing a very complex flow system, if any?

A Well, certainly the whey study, the cheese waste, is a complex flow system.

The groundwater interaction with Lake Michigan is complex. Most of the groundwater, wet land and groundwater inland lake ones, lake studies, are also complex, but on a smaller scale than those previous to.

Q Let me make certain you understand my question. Which of them have shown a very complex flow system. Is your answer still the same?

A Yes.

Q What makes a groundwater flow system complex?

A Well, what I have listed in the sentence that you quoted me, that it is three-dimentional in nature, that it is moving through heterogenous materials and that it is unsteady, changes with respect to time.

Q When you say it is heterogeneous, are you talking about the medium that it moves through?

A Correct.

Q So you were describing the Outboard Marine

site as consisting of a heterogenous medium?

A Yes, as described in the text.

Q And by three-dimensional, you mean it moves up and down and sideways, both?

A I mean vertically as well as horizontally, yes.

Q And by unsteady, you said you mean changes over time. What do you mean changes over time, in what respect?

A Water levels change, flow rates change, flow directions change with respect to time.

Q Well, in an unsteady flow system, is it possible that the type of flow that you will get over a ten-year period will change?

A I guess I don't understand the question. Yes. There is no specific time frame involved in whether something is steady or unsteady. So it could change over a long period or short period. Both, is generally the case.

Q By "change," I mean that the types of flows that you get within the flow system will be different after a period of ten years from what it was ten years earlier?

A No, that's not what I mean.

Q What do you mean?

A What I mean by "unsteady," is that this particular flow system demonstrates a Type I flow and Type II flow, which are different from one another, and which occur at different times.

But in this particular case, Type I and Type II flows would persist for the next ten years.

Q By Type 1 flow you mean the flow that is primarily into -- we are talking about the eastern lens now -- primarily toward the ditch, is that right?

A Yes.

Q And Type II flow is a flow primarily in the southerly --

A Away from the ditch.

Q Away from the ditch.

Is it possible that there could be other types of flow other than those two types and the transition between those two types that could develop at the Outboard Marine site?

A Certainly that is a possibility, yes.

Q How would that come about?

A I don't know if I can give you an answer to

that. If conditions which presently exist at the site were to change, the nature of the ground cover or the configuration of the ditch, or something like that, that could change the general nature of the flow. Similarly there may be some sort of flow that simply has not been observed in the period of observation. I can't conceive of what that one might be, but I can't eliminate it.

Q Let me just go back through those. You said if there were a change in the configuration of the ditch, that you might get a different type of flow from what you have already observed in the area?

A Yes.

Q Is that true of changing any boundary? By that I mean the water boundary for the area?

A Yes. The flow system will be controlled largely by its boundary conditions, and if you change one of those boundary conditions you are going to change the response of the groundwater system to it.

Q If you change the medium in which the groundwater flows, or change the surface cover, you will also get a change in the flow?

A Yes.

MR. HYNES: By "medium," you mean the type of soil?

MR. SHAPIRO: Yes.

MR. HYNES: Okay.

BY MR. SHAPIRO:

Q Well, let us assume that you were to divert the water that was traveling through the North Ditch, would that have an effect on the groundwater system?

MR. HYNES: Which water do you mean?

BY MR. SHAPIRO:

Q The water that is currently flowing through the North Ditch.

MS. HYNES: You mean from the stormwater runoff at the Western End, or the rainfall, or all the water?

BY MR. SHAPIRO:

Q All of it.

A I guess my question would be what you mean by divert it?

Q Well, have the flow someplace else other than through the ditch.

A What becomes of the ditch, is it still there?

Q Assume first that it is still there.

A All right. In that case you would largely eliminate Type II flow, the flow southward out of the ditch. I guess I should say not largely, but initially you would do that. Type I flow would continue until the ditch filled up with water. I am assuming now that you have blockaded the ditch off. Perhaps I shouldn't do that.

If the ditch is allowed to flow freely, as it presently is, Type I flow will continue. If the ditch is blockaded off so that water stagnates in it, then eventually Type I flow will also cease, because the water in the ditch will rise to the level of the groundwater. And at that point all of your flow would ultimately move eastward toward the lake.

Q Suppose you filled in the ditch in addition to diverting the water, what would happen to the conditions on the site?

A That would have the immediate effect of terminating Type I flow as well as Type II flow, and force all of the flow eastward toward the lake. At that point there is no other outlet for the water.

Q So just to summarize, if you were to divert the water from the ditch, and fill in the ditch, your

testimony is that it would cause the water to move in an easterly direction, because it would have no place else to go?

A Correct.

Q It would carry with it whatever contaminants it had in it?

A Correct.

Q Would that speed up the process of contaminants being carried into the Lake?

A In my estimation, yes.

Q You mentioned a couple of times that you have conducted a study of the interrelationship between Lake Michigan and the groundwater near Lake Michigan.

A Yes.

Q I think you have said that naturally there is a flow into the Lake from the groundwater along the lake shore.

A Correct.

Q Are there ever any natural conditions under which the flow would be in the other direction?

A There are none that I am aware of, but I don't want to be absolute in saying no. Conceivably there could be.

Q Well, suppose you went through an extended perior of drought. Would the flow ever naturally reverse back from the Lake into the groundwater?

A No. Now, I am assuming -- I am answering that question under natural conditions. No would be the answer to that.

Q Well, when you say you are answering under natural conditions, what other conditions are you thinking of that might have an effect?

A Artificial pumping, which would be common during a period of drought.

Q By pumping, you mean people taking water out of the groundwater to drink?

A Or to irrigate, or whatever, yes.

Q Well, under normal conditions during a period of drought, given that kind of human intervention, would there likely be a reverse of the flow from the Lake to the groundwater?

MR. HYNES: By "normal conditions," you mean are you setting up the normal condition would be a pumping of the groundwater, or are you referring --

MR. SHAPIRO: Let me withdraw the question, and start again.

MR. HYNES: He is referring to natural conditions, and you say normal. I want to know if you are using the same --

MR. SHAPIRO: No. I was using the word "normal" as he was trying to use the word "normal." What would normally happen in a drought. But let me just pose the question again.

BY MR. SHAPIRO:

Q Is it likely or possible in a period of drought, given the lack of rainfall and the expected behavior of people living along the lake shore, that the flow of groundwater might reverse and come from the Lake into the immediate onshore area?

MR. HYNES: Again, you are referring to the situation where people were pumping water out of wells, or out of the groundwater, is that part of your question, or an assumption?

BY MR. SHAPIRO:

Q If that is what people ordinarily do in such a case. I understand your answer, Dr. Cherkauer, was that that would happen.

MR. HYNES: I think "ordinarily" is your word.

BY THE WITNESS:

A Perhaps if I rephrase it just slightly.

BY MR. SHAPIRO:

Q Fine, be my guest.

A If there is heavy pumpage on the landward side of the Lake groundwater boundary, yes, it is quite possible to get a reversal of flow, flow from the Lake into the groundwater system. And that heavy pumpage could occur in response to a drought or other conditions.

But it is predicated on the assumption that there is heavy withdrawal of groundwater.

Q Now, it would have to be heavy withdrawal within the boundaries of any particular flow system, or would --

A Correct.

Q -- or would heavy withdrawal in another area also affect other flow systems?

A Primarily it would have to be within the flow system of interest. In other words, the withdrawal would have to be in a flow system that is directly hydraulically connected to the Lake. There would be instances where you could get an indirect influence

from a further removed system, a deeper system, which could be felt and might be felt enough to cause a reversal, but it would be very unusual circumstances.

Q So that talking about the Outboard Marine site, in order for the natural flow toward the Lake to reverse and come back toward the onshore area, there would have to be heavy pumping on the Outboard Marine property, understanding that is the flow system.

A Heavy pumping within that sand aquifer, not necessarily on the Outboard Marine property, but somewhere to the west of the lake shore.

Q Well, could it be be as far away as a mile west?

A I don't really know the answer to that without looking at the topographic map.

Q In other words, you don't know what the western boundary is of the flow system, the subject area of your report?

A I don't know precisely where it is. I know generally where it is, but I don't know what the distance is from the shore line.

Q Well, generally where is it?

A It's at the boundary between that flat sand terrace on which the OMC site sits, and the till, glacial till bluff on which most of Waukegan sits. I don't recall how far inland that is.

Q Would you turn to Page 1-3 of your report, Figure 2. Can you indicate on that map where you believe the western boundary would be?

A Not on that map, because it's to the left, it's further west.

Q Well, how about on the map on Page 1-2, Figure 1?

A Very crudely I can on there, because the topographic contours which I have used to locate the bluff didn't reproduce very well. But it's roughly immediately to the west of what's labeled here as the Chicago and Northwestern Railroads. There is another road to the west of that. The bluff occurs somewhere between that road and the railroad.

Q That road I guess is the Genesse Road?

A Genesse Street, yes.

MR. HYNES: So basically, to clarify that, it is basically, it is somewhere east of Genesse Street, somewhere between that and the railroad track

in there?

THE WITNESS: Yes. Now, that is -- Please recognize this is a very crude location. I would want to see a topographic map of where I could read the contours.

BY MR. SHAPIRO:

Q What would be the northern boundary of the flow system?

A Of this flow system?

Q Yes.

A I don't know. The Illinois Survey, the Geological Survey as quoted in the report, has done some work at I believe it was Zion State Park. I have forgotten the name of the location. Figure 3-3 which -- or Figure 5, which is on Page 3-3, this is taken out of a report from the Illinois Geological Survey.

Q This is of another area, right?

A This is farther to the north. I don't recall how far to the north. I think it's on the order of ten to fifteen miles. That is an estimate. And that shows a very, very similar flow system. So those are the only two locations along the area that

I am familiar with. And I would suggest that they are probably continuous.

Q So in other words, this flow system is directly related to the flow system at the Outboard Marine site?

A Geologically it is the same material, and so it should be connected.

Q Well, does that mean that in cases of extreme conditions affecting groundwater flow, that something that happens in this site could affect what happens at the Outboard Marine site?

A Probably not. The reason that I say that is that the aquifer is only 15 to 30 feet thick, and we are talking about something which may be as far as 15 miles away. In order to have an effect, you are going to have to create what is called a cone of depression, a draw down. In a sand aquifer of this type, you are simply not going to be able to create a depression which is only 30 feet deep at the maximum, which will extend over 15 miles. So this far away it couldn't affect it.

Q Well, perhaps I don't understand you. What do you mean by the boundary of the flow system?

A Where this particular flow system, this sand aquifer terminates.

Q You are talking about the medium in which the water flows?

A Correct.

Q Well, what area north of the investigation area would you consider to be included in that area that might have an affect on the groundwater system at the Outboard Marine site?

MR. HYNES: Are you talking any effect, or are you still on this drought scenario of pumping out the aquifer, or any effect?

BY MR. SHAPIRO:

Q An effect.

A I can't give you a precise answer to that without calculating it.

Q You don't know?

A No, I don't know a specific number.

Q So you haven't studied the entire range or the entire area that might possibly affect the Outboard Marine investigation site from the north?

MR. HYNES: You mean investigate it to the extent that he can answer your question?

BY MR. SHAPIRO:

Q No. I mean investigate it.

A Under present or hypothetical conditions?

Q Well, under any conditions.

A Could you repeat the question. I am not --

Q I will repeat the question.

A I am confused now.

Q You said you don't know how far north the area extends that might have an affect on the Outboard Marine site, is that right?

A Yes. I said I couldn't give you a specific distance.

Q So there is an area that you haven't looked at that could have an impact on the Outboard Marine site. That is my question.

Let me just state it again. There is an area that you have not studied that could conceivably have an impact on the Outboard Marine site?

A Yes.

Q You don't know what has happened in that area, or what could happen in that area?

A No.

Q Dr. Cherkauer, is it a fair summary to say

that major changes in the geology or the configuration of boundaries of the flow system at the Outboard Marine site would have a significant affect on the groundwater flow in that area?

A I would rephrase it. You cannot change the geology, from my perspective. You could change the configuration of what is there, but it is no longer geology, then it is human.

Q I understand.

A I am being picky, but --

Q Well, let me restate the question. Is it fair to say that if you made major changes in the configuration of the boundaries, or the nature of the medium at the Outboard Marine site, that it would have a significant impact on the groundwater flow system in the site?

A It could. It would depend upon the changes to be able to say that it really would.

Q So your answer is yes?

MR. HYNES: No. His answer is what he said it was.

BY THE WITNESS:

A I am changing your "would" to "could" and

then my answer is yes.

BY MR. SHAPIRO:

Q Let me state the question again. Is it fair to say that major changes in the configuration of the boundaries or in the medium through which the groundwater flows could have a significant effect on the groundwater flow at the Outboard Marine site?

A Yes.

Q Has anyone asked you to do a study of any possible changes at the site of that sort, that is changes in the configuration of the boundaries or nature of the medium?

A No.

Q I would like to ask you a couple of questions about the various types of flow. I think the last time you said, and you said again this morning, that there are four types of flow. Type I flow -- We are talking now about the eastern lens. Type I is toward the ditch?

A Yes.

Q Type II flow is away from the ditch. There is transitional flow between, from I to II. What is the direction of the groundwater flow in that case?

A Well, when you change from Type I to Type II there is a period of time where as the new Type II meets the old Type I during this transition that the flow is eastward.

Q And Type II to Type I?

A That is simply a change in flow direction from predominantly south to predominantly north as the water level in the ditch drops.

Q I think you said last time that the conclusion that you reached about the existence of Type I to Type II flow was based on one day out of the twelve days of measurements that you had to go on, is that right?

A There is one set of conditions that demonstrates that transition flow.

Q Those are the conditions that existed on July 15, 1980?

A I believe so, I would have to look up the date.

Yes.

Q How many measurements were taken on July 15, 1980?

A You mean water level measurements?

Q Yes.

A Well, one water level in each of the single wells, and three in each of the nests.

Q In other words, one for each of the wells, basically?

A One for each of the observation wells, yes.

Q So that your measurements for that day told you what the water level was at one particular time, is that right?

A Correct.

Q It is like a snapshot of what is happening at that one moment.

A Yes.

Q The way you determine from that one snapshot what is happening is to compare it to other measurements that were taken on other days?

A I guess -- what do you mean by what is happening?

Q Let me withdraw the question. How do you know from that one snapshot which way the water is moving, if all you have is a single set of measurements of the water table?

A Well, the relative evaluation of the water table -- water levels, let's say, tells us which way the water is moving, it moves from high to low.

Q So if your measurement in one well is low, and your measurement in another well is high, then the movement would be from the second well to the first well?

A Yes.

Q Is there any way to tell from that one measurement how long that flow persists?

A No.

Q Well, is there a minimum amount of time that it could exist?

A There is not a specific minimum or maximum that I could give you.

Q It could be five minutes, or it could be an hour?

MR. HYNES: He just said there is no minimum or maximum.

BY MR. SHAPIRO:

Q I just want to make certain I understand him.

A Well, the reason that I hesitated answering

the previous question, and the reason I am hesitating on this one is if you ask me to put a specific number on it, I can't.

Q It is just impossible to tell how long it occurs?

A The set of conditions in that snapshot, correct.

Q Well, how about the flow that you conclude exists as a result of that snapshot?

A Similarly it is impossible to say what its persistence is with any degree of exactness, yes.

Q So to summarize, you don't know how long the conditions that you observed on July 15, 1980 persisted?

A Correct.

Q Would it be useful at all to know how long that flow persisted?

MR. HYNES: Useful in what respect?

BY MR. SHAPIRO:

Q For doing an analysis of the down water flow system.

A Yes, as we went through the last time, the major problem that I encountered was being able to

specify how frequently that transitional flow occurred, so that I could calculate an annual flux of PCBs into the Lake. So knowing its persistence would allow me to do that.

Q Is there a difference between how frequently it occurred and how long it occurred at each occurrence?

A Not in the sense that I am using it. Basically I would be interested in how many time units out of some length of time this type of flow occurred. So that it doesn't make any difference whether it occurred 500 times for a very short time, or one time for 500 time units.

Q But you would need to know both, how long it occurred and how often it occurred at each occasion. I am sorry.

You would need to know how often it occurred and how long it occurred at each occurrence.

MR. HYNES: You say "need"?

BY MR. SHAPIRO:

Q It would be useful to know how often it occurred and how long it occurred at each occurrence.

A Yes.

Q You didn't have either set of figures.

A No.

Q No, you didn't have either set of figures?

A Correct.

Q To get those figures you would need more wells and more monitoring dates?

A Not necessarily more wells, but certainly more extensive monitoring.

Q Dr. Cherkauer, did you ever obtain any water level records or inflow records for the sewage lagoons that are north of the Outboard Marine site?

A No, I did not.

Q Did you ever receive any chemical analyses of the groundwater at the Outboard Marine site that might indicate sewage contamination?

A No.

Q What kind of analyses would be useful for that?

A You primarily would be interested in the biological oxygen or chemical oxygen demand, the nutrient levels, nitrogen and phosphorus.

Q Chloride?

A Chloride would be another useful indicator.

Q That information would help you identify the

relationship between the sewage lagoons and the groundwater system?

A Yes.

Q What is a water balance record?

A I don't know.

Q It doesn't mean anything to you at all?

A It could mean a variety of things, so I'd have to hear it in context.

Q Well, would you understand what it meant if it were used in reference to the sewage lagoons?

A Presumably it would mean the relative inflows and outflows and storage inflows and outflows to those lagoons and storage within them.

Q Which might tell you how much leakage there is from the lagoons?

A Correct.

Q Did you ever get information of that sort with respect to the lagoons?

A No.

Q How many hours did you spend actually preparing the report that is Exhibit 2?

A I really don't have any idea.

Q Can you give me an estimate?

MR. HYNES: You mean just actually preparing the text, or his calculations and the presentation of the actual text?

BY MR. SHAPIRO:

Q Let's do the whole thing, first. Taking everything from your receipt of the data to the final preparation of the report.

A I really have no idea what the total number is.

Q 500 hours?

A I don't know. I'd have to look at my records.

Q Do you have records of that?

A Yes. Not with me.

MR. HYNES: Time keeping records?

THE WITNESS: Yes.

MR. HYNES: The type you are referring to.

THE WITNESS: The time sheets that were sent to JRB.

Q You have a complete record of all the time sheets you sent?

A I believe so, yes.

Q This is in order to obtain reimbursement for your services?

A Yes.

Q Compensation for your service.

A Yes.

MR. SHAPIRO: Have those been provided?

MR. HYNES: I don't think I have ever seen them, but I think the JRB stuff that had all been turned over, that has been sent to EPA. But I can verify that. I mean, if they have been, I will try and find out. If not we will just get copies of the time sheets from Doug.

MR. SHAPIRO: I would like to see them.

MR. HYNES: Yes.

BY MR. SHAPIRO:

Q Do these time sheets specify the work done for each specific time?

MR. HYNES: You mean by task, or --

BY THE WITNESS:

A By very general task, yes.

MR. SHAPIRO: Off the record.

(Discussion had off the record.)

MR. SHAPIRO: I ask that this be marked as Exhibit 6 as of today's date.

(Said document was marked Cherkauer Depositio Exhibit No. 6 for identification, (Monsanto) as of 11/18/82, JKS.)

BY MR. SHAPIRO:

Q I would like you to look at what has been marked as Exhibit 6, and ask you if you can identify it for me?

A Yes. It is a letter from myself to Dr. James Whang at JRB discussing the OMC case.

Q Do you know what the date of this letter was?

A It isn't on here, is it.

No, not exactly. It would be late 1979 or perhaps very early in 1980.

Q While you were working on the draft report, I think is how we have described it.

A Correct.

Q Distinguishing that from the preliminary final report, which we talked about last time.

A Correct.

Q Now, at the time of this letter, then, you would have completed your survey of the geology of the Outboard Marine site, or all of the wells would have been installed in the first set of installations, is that right?

A Yes.

Q What happened after this was the second set

was installed, and further measurements were taken in all wells.

A Yes.

Q In the fourth paragraph of this letter you say, quoting in part, ". . . there was no apparent reason for the rapid rise in well water levels which occurred during the study. September was an exceptionally dry month. Unless OMC released water or the Sewage Plant raised levels in the sewage lagoons, flow in the ditch should have remained low."

At this time in your study of the area, you believed there were two possibilities for this rapid rise that you had noted in the ditch level?

A In the well water level.

Q I am sorry, in the well water level.

Those were that Outboard Marine might have released, OMC might have released water into the ditch to cause the ditch level to rise, and therefore to affect the flow system.

A Yes, one possibility.

Q An alternative possibility was that the sewage plant lagoon had caused those rises in the wells.

A Yes. That was the second alternative that I was presenting.

Q How would that second alternative have occurred?

A How would it have occurred?

Q Yes.

A It would have occurred or could have occurred, I should say, if the sewage lagoon had been filled with water, and had leaked that water into the subsurface. Those wells in the vicinity of the sewage lagoons could then show a rise in water level in response to that.

Q So it was your view at that time that what could have caused those rises in the wells was the effects that resulted from changes in the water level in the sewage lagoons?

A That was one possibility, yes.

Q You ultimately concluded that the reason for that was actually something at the mouth of the North Ditch?

A Correct.

Q Now, other than the fact that you ultimately concluded that this other cause was the cause of the

rises that you had detected on the particular monitoring dates, did you do any further investigation that led you to believe that the sewage lagoons could not have caused those rises in the wells?

A No further investigations. It was just simply a matter of examining the information that was already at hand.

Q And that information led you to conclude that on those particular dates there was a relationship between a rise in the ditch and the rise in the monitoring wells?

A Correct.

Q What led you to believe, or what led you conclude that that was caused by something at the mouth of the ditch?

A Well, primarily the persistence of the rises -- and I guess I should say the persistence and the magnitude of the rises. The sewage lagoons could produce a persistent rise in the ditch level, but I wouldn't expect it to be very large in magnitude. The release from OMC could provide a very large rise in water levels, but it probably wouldn't persist, because we'd be talking about very vast volumes of water.

So the most logical cause of that was something which effectively blocked off the mouth, and simply caused the water in the ditch, wherever it came from, to stagnate there for a period of time.

Q So it was the most likely of the three possibilities.

A Yes.

Q Did you ever confirm that with any empirical investigation?

A No.

MR. HYNES: By "empirical," you mean calculations, numbers, things?

BY MR. SHAPIRO:

Q No. Observations at the site.

A No.

Q Did you ever confirm it by way of asking somebody else who had had observations of the site, or through any report or study?

A No. Basically I learned that records of the water levels or quantity of the water in the sewage lagoons were not available. They didn't maintain them. And I didn't pursue that any further.

MR. SHAPIRO: I don't have any other questions.

MS. OLIVER: I have a few.

DIRECT EXAMINATION

BY MS. OLIVER:

Q Doctor, you talked about the flow system at the site you investigated as being unsteady, in hydrogeological terms, right?

A Right.

Q Would it be fair to say as a layman that the flow system was unpredictable?

A No. The two terms are not synonymous.

Q They don't mean the same thing to you, okay.

The flow system is unsteady, though, because it changes over time and it changes direction.

A It changes direction over time. The definition of "unsteady" simply means that it is not constant with respect to time.

Q How would you define an unpredictable flow?

A Essentially one in which a person had no idea what the boundary conditions were, and what the response of the system might be to changes in those conditions.

Q Would an unpredictable flow be one that you could not determine in which direction the flow

was occurring at a certain period in time?

A Probably.

Q Measurements of water levels for purposes of determining flow were taken in 1979, right?

A Yes.

Q In the summer of 1979?

A Yes.

Q There were nine days of measurements taken?

A I believe that was the total number.

Q From those nine days you didn't determine or make a determination that there was any flow to the Lake, is that right?

A You mean --

Q From those nine.

A My interpretation at the 1979 --

Q From the nine days of observation, measurement of water levels that were taken in 1979.

A I have not come up with the terminology Type I-Type II transition, but if I remember correctly, each of the major flow patterns does have an eastward component. It's not as predominant a component, but there is some flow eastward to the Lake.

But you didn't base your projections of

PCB movement on the data from 1979 on any one day's observation in 1979, did you?

MR. HYNES: You mean the projections of what is going into the Lake, and what will go in the future?

BY MS. OLIVER:

Q The flux of PCBs.

A No, I guess not.

Q You based your projection of PCB flux eastward from the OMC property into the Lake on the July 15, 1980 observation and measurements, right?

A On the Type I-Type II transition flow which showed up on July 15, yes.

Q So on the data that showed up on, July 15, 1980.

A Yes.

Q Then after the nine measurements in 1979, there were six more in 1980, right?

A That's correct.

Q So you had a total of 15 measurements?

A Although I believe --

Q Fifteen days of measurements?

A I believe I had chosen not to use the first

two or three out of the 1979 data.

Q Right. You only used 12 days of observation.

A Correct.

Q To determine all the flow patterns that you could pick out from that data, correct?

A Right.

Q But you had 15 days of measurements.

A Well, my argument on those early July, 1979 ones are that they are not -- The system has not stabilized, the water levels are still affected by the filling process. So I wouldn't say I have 15 meaningful --

Q So you have got 12?

A I have got 12.

Q Twelve days of measurements.

A Yes.

Q The type flow that you found that went into the Lake, or west eastward toward the Lake, was found or observed on the last day in 1980 that the measurement was taken, right?

A Was it the last day? I don't recall. It was one of the days in 1980.

Q From looking at Table 2 and Table 2-A, it appears that the last day of measurement was July 15, 1980.

Does that look right to you?

A What page is that on?

Q Page 2-20.

A Yes, the last date of measurement in 1980.

Q Did you suggest or recommend that any measurements be taken during the winter months, or from October until June of 1980, October of 1979 until June of 1980?

A I don't recall. Conceivably, yes, but I don't know.

Q But they weren't done,in any event?

A No.

Q Would additional measurements have given you additional data?

A Yes.

Q You could have used that data to determine what the flows were in the area?

A Yes.

Q Over more than the summer months.

A Well, if they were taken at some time other than summer, yes.

Q Do you know what the flow patterns are over the period of October to June?

A No.

Q Do you know what the flow patterns are over any period except the period from July, 1979 to September, 1979, and June, 1980 to July, 1980?

A No, I don't know them on empirical evidence.

Q Well, the patterns, flow patterns that could be present and observable today may not be the same ones you observed in 1980.

A They may not, correct.

Q I think you have testified that you made a prediction of PCB movement from the soil toward the Lake up to a period of 80 years into the future, is that right?

A Something on that order, yes. Yes, it's approximately 80 years.

Q Why did you project that 80 years into the future?

A You mean --

Q Why did you --

A Why 1980?

Q Why 1980?

A Why not? It was just a time when it was convenient to stop the projection. No specific significance to it at all.

Q Did anyone ask you to project for a certain period of time?

A No.

Q I think you testified at your last session that you have never made this type of projection before, a 80-year projection.

A Correct.

Q I think you testified that in one of the other studies you did, you tried to make prediction of five years, on another groundwater study.

A I don't recall specifically whether I testified to that, but that is the case, yes.

Q Did you consider making a prediction of five years and stopping in this case?

A No.

Q Well, it is unusual, isn't it, for a hydrogeologist to make a prediction of flux 80 years into the future?

A It depends upon the type of conditions. Yes, it is unusual for a hydrogeologist as a group.

Q It's unusual for you, isn't it?

A Yes.

Q Because you have never done that.

A Yes.

Q The most you have ever predicted was five years.

A Prior to this, yes.

Q Since doing this study have you made any similar projections into the future?

A No, I have not been involved in this kind of a problem.

Q Have you made any projections of groundwater flux since you did this project?

A Probably not.

Q You mentioned that your opinion is that your calculations are conservative, is that right?

A Yes.

Q The basis for the conservatism is the fact that you restricted the route of movement to one area.

A Well, that is one aspect of the conservatism, yes.

Q Even though you were fairly sure that there was more than one, more than one route of transportation.

A What do you mean by "route of transportation"?

Q Well, you limited your consideration of

movement of PCBs from the soil to one --

A To a very narrow zone.

Q To one zone.

A Okay.

Q I think you testified that even though you thought that the PCBs would probably move outside of that zone as well as through that narrow zone?

A Well, that is still the same zone. I have simply constricted its size to something I am comfortable with.

Q Why did you restrict its size?

A To be conservative.

Q If in your opinion that there is movement outside of that zone, why did you decide to be conservative?

A Because it's a standard hydrologic technique that when you cannot be certain of the precision of the numbers that you are using in terms of prediction, that you recognize that there is error involved, you will always choose on the conservative side. So that if any error does creep into your calculations, it simply makes things worse than what it is you calculated.

Q You calculated that 80 years into the future there could be movement of PCBs of .15 kilograms per year to 1.3 kilograms per year, is that right?

A It would be -- no. It would be closer to -- .15 to 1.3.

Q Kilograms per --

A Kilograms per year.

Q Per year.

A I think that is what was calculated.

MR. SHAPIRO: Eighty years?

THE WITNESS: Eighty years into the future.

MR. SHAPIRO: Yes.

THE WITNESS: She specifically said 80 all the time. Well, I don't recall. The diagram shows, which is Figure 46 --

MR. SHAPIRO: What page is that?

THE WITNESS: 3-79. It shows 80 years in the future, meaning the year 2060. It is more like -- I am just eyeballing it off the curve here, it looks more like between four grams per day and 30.

Q So 80 years into the future you predicted that there could be from four grams per day to 30 grams per day moving eastward?

A Yes.

MR. HYNES: By "moving eastward," you mean eastward and into the Lake?

BY MS. OLIVER:

Q Eastward, is that right?

A Yes.

Q What is that in terms of kilograms? I am not too good at that.

MR. HYNES: Kilograms per year?

MS. OLIVER: Kilograms per day.

MR. HYNES: Kilograms per day.

BY THE WITNESS:

A So you would be talking about .003 to .4 -- No. .004 to .03.

MR. SHAPIRO: .03.

THE WITNESS: .03.

MS. OLIVER: .03?

MR. SHAPIRO: .03.

BY MS. OLIVER:

Q So in 80 years, based on your projections, there could be a movement of PCBs from OMC property or soil to the Lake of between .004 kilgrams per day and .03 kilograms per day, is that right?

A Correct.

Q Am I correct, Doctor, that you don't know whether in fact that flux or movement will occur in-any day in 1980, in 80 years, in 2060?

MR. HYNES: Wait. Could you --

BY MS. OLIVER:

Q I will rephrase the question.

You don't know that that flux or flow will occur on any one day in the year 2060?

A What I am saying is that under Type I to II transition flow conditions, in the year 2060 a flux of that magnitude will occur.

Q Right. But you are assuming in saying that, aren't you, Doctor, that the flow, the transition flow that would cause this movement, would occur over a 24-hour period, aren't you?

A Yes.

Q You haven't measured that at all.

A No.

Q There is no way that you can say that that in fact would occur.

A Not given the information that I have, correct.

Q In fact, the transition flow that you found on July 15, 1980 that shows movement into the Lake could only have occurred for one minute or one hour or twelve hours on that date, right? You have no way of knowing.

A Well, as I hesitated earlier, I will hesitate on this. I can't put a lower or upper limit on it.

Q So your prediction of kilograms or grams per day movement is based on an assumption that that movement that you found toward the Lake would occur during the entire day, and you have no basis for that assumption, isn't that right?

A It is an assumption. There is no empirical basis for it. But groundwater systems change very slowly. So I would argue it's a good assumption.

Q But you have no data to support that?

A No.

Q You wouldn't have any way of knowing similarly how often that flow would occur during a 365-day year?

A Correct. As I answered before.

Q So even assuming that the flow occurred, flow eastward toward the Lake occurred on a whole

24-hour basis, in the year 2060 the maximum flow for a year could be this .004 to .03 kilograms, that can be the total flow or flux that went out toward the Lake in the whole year.

A What was the assumption you made?

Q I am assuming that you are right in fact in assuming that the flux would occur for 24 hours over the whole period.

A During that year.

Q During that year.

A Okay.

Q On one day over that year.

A Yes, if there were that transition flow for one 24-hour period, then that would be the range of flux that I would expect.

Q There is no way for you to predict with any degree of scientific certainty whether in fact that transition flow would occur on one day in the year 2060, or on two days, or on 100 days?

A Not given the present body of information.

Q So you can't make any prediction of what the total movement of PCBs from the soil into the Lake would be over a year, for any year, this year or 80

years from now.

A No, not until or unless I know the frequency of the flows.

Q In fact, if the transition flow does not occur on an entire 24-hour basis or duration, the amount of PCBs that would move from the soil into the Lake could be less than what you have projected.

A Correct. If the duration of the transition flow were less than 24 hours.

Q Have you studied flows, Doctor, that were less than 24 hours, other groundwater systems?

A I don't know what you mean.

Q Well, have you found that there are groundwater systems where the flows change over a period less than 24 hours?

A No, I have never specifically myself investigated that problem.

Q So you don't know one way or the other?

A Well, you asked if I had investigated them, no, I have not. I am not saying I don't know that. I am saying I have not investigated that.

Q Well, it's possible, isn't it, that flows change more than once during a 24-hour period?

A Certainly it's possible.

Q Is it possible that the transition flow that you found would only occur during the summer months?

A In my opinion, and that is the only thing I can go on, it's possible, but not very probable that it would only occur in the summer months.

Q Again, you don't have any data to show it occurs at any other time?

A No, I have no other data.

Q As a matter of fact, the data that you took or got from 1979 didn't show that transition flow?

A It may have.

Q Well, it didn't.

A You are correct. The data did not show, but the well field was not complete at that time.

Q Well, it was complete enough for the 12 measurements that you used.

A Yes. Well, no, I only used nine of them, or whatever it was.

Q That is right. You only used nine.

A Six of the nine.

Q Six of the nine from 1979.

A Yes.

Q In none of those six that you found to be valid measurements was that transition flow demonstrated.

A Probably not.

Q Well, in your opinion it wasn't.

A Yes, I guess is the answer.

Q Just so I understand, you can't say with any degree of scientific certainty that the transition flow that you found on July 15, 1980 will occur on any other day of this year or any year.

A I can tell you when it will occur, but I can't tell you what date.

Q Can you tell me how often it will occur with any degree of scientific certainty?

A At this stage, no.

Q Could you tell me with any degree of scientific certainty how long that transition flow will last on any given day?

A No.

Q Have you done any studies or read any papers, Doctor, relating to the action of PCBs with soil, how PCBs inter-relate or interact with soil?

A Yes.

Q What studies have you done or papers have you read?

A I have not done any myself. I have read one of them. It is referenced in the report, a report by the Illinois Geological Survey again, which examined the interaction of PCBs with sediment.

Q Have you read any papers since then relating to the action of PCBs with soil?

A Probably, but I can't think of any specific ones.

Q Are you familiar, Doctor, with any of the studies showing how much or what amount of PCBs go into Lake Michigan every year from the atmosphere and from other sources?

A No, I am not.

Q What is the projection that you make of the flux or movement of PCBs through the groundwater for 1982? Do you have a projection for that?

A For again transition I to II flow?

Q Right.

A It is very difficult to read it off of this, but it's below -- In fact, it can't be read off of this. It's below one times ten to the minus three grams per day.

Q Is that what I would call non-detectible, or negligible?

A Well, it's very definitely detectible, because the basis for that number is the water samples that were collected at the site. What you call negligible, I don't know.

Q Well, what is the one times ten to the minus third grams per day?

A .001 grams per day.

Q .001 grams per day, presently?

A Yes.

Q In your opinion, based on your projections, is presently moving from the groundwater.

A Actually it's something below that, is what I said, yes.

Q Below .001 grams per day.

Did you make any actual measurements of the movement or flux of PCBs through the groundwater? Is there any actual data that you have, other than your projections?

A For 1982 are we still talking about?

Q For any year. 1979, 1980.

A Well, one cannot measure flux. One measures

those properties which determine the groundwater movement, and then one measures the concentration of the material that you are interested in. So the answer to that is yes, any of the 1980 data could be utilized to calculate a flux.

Q Well, did you calculate a flux?

A Probably, I don't recall.

Q Do you know whether it's in your report at any place?

A No, it's not in the report.

Q You are not going to give any opinions on what the calculated flux was based on the data that you had in 1979 and 1980?

A Is that a question?

Q Yes.

MR. HYNES: Give an opinion as to what the flux was in 1979, or what the flux was in 1980, is that your question?

BY MR. OLIVER:

Q Yes. Do you understand what I am asking?

Is your testimony limited to the projections that you have made and the model that you have used to make those projections?

A Just a minute, wait a minute, wait a minute. As I think back, isn't there a table in here with -- Okay. I will take that back. Yes, there is a 1980 calculation in here on Page 3-70 for I to II transition for 1980. It says less than 2.8 times 10 to the minus four. One point nine times ten to the minus three grams per days. So there is that number in here.

Q You also on that same page have calculations for the year 2,000, 2,020, 2040 and 2,060.

A Correct.

Q Is that right?

A Yes.

Q Are those based on your model and projections?

A Yes.

Q But the first 1980 flux data is based on calculations, and not the model?

A Well, the model is calculations.

Q What I am asking --

A This is based on real existent data. It is not a projection.

Q Well, it's based on the real existent data that existed on July 15, 1980.

A The flow data is from July 15th. The PCB

information is averaged over the period of the study.

Q But in order to get the flux of PCBs you needed flow data, right?

A Correct.

Q The flow data that you had was the one day's measurement.

A Correct.

Q So am I correct that all of the calculations that you made for the flux of PCBs to the Lake from the groundwater were based on that July, 1980 data, one day's data?

A All of the PCBs for Type I-II transition, or all of the calculations, I mean, for Type I-II transition were based on that one.

Q The Type I-II transition flow is the only flow that you determine would move PCBs toward the Lake?

A No. You will notice that Type II flow has an eastward component in that same table, and is also delivering some flux of PCBs to the Lake.

Q But it is fair to say, isn't it, that the predominant mechanism that you found for the movement of PCBs through groundwater toward the Lake would be

during the Type I-II transition flow?

A I can't answer that directly, again because I don't know the relative frequency of the two flows. But on a 24-hour basis the transition flow delivers more than the Type II flow.

Q So assuming the predominant mode of transportation was during Type II, your predictions would be higher than what would normally occur. Your predictions under Type I-II would be higher than what occur under Type II, right?

A For a given 24-hour period, you mean?

Q Yes.

A Yes.

Q So by using the Type I-II transition, you use the flow that you think would move the most PCBs over a 24-hour period?

A Yes.

Q Do you have a confidence level in your projections?

A No.

Q Why not?

A Well, let me go back and ask to verify that you and I are talking about the same thing when we

talk about confidence level. What do you mean?

Q I always like you to tell me what you mean. What do you mean when you talk about confidence level in your profession, Doctor?

A A confidence level is a degree of probability that a projection is correct, that can be attached to that projection.

Q You don't have a degree of probability of the correctness of your projections?

A No, I don't.

Q Would you be able to give me a degree of probability of the correctness of your projections with additional data?

A Probably with additional data, yes.

Q How much additional data would you need?

A I would need to know more precisely the -- I would need to know the frequency of distributions of types of flow, and --

Q How many years of data would you need in order to find a frequency of distribution in the types of flow?

A Please don't take this as a facetious answer, but I don't know. It would depend upon the variability

of flow at the site. But we would be talking about potentially several years of continuous records.

Q What other data would you want to know or want to have?

A Now, we are still talking about a degree of probability on the projections?

Q Yes.

A I would need to know the precise manner and timing of the deposition of PCBs at the site.

Q You are not satisfied yet that the assumptions you made as to those aspects are correct?

MR. HYNES: Repeat the question.

BY MS. OLIVER:

Q Well, you made some assumptions, Doctor, as to the time of deposition and the amount of deposition that occurred, didn't you?

A Yes.

Q You just told me that you would like additional information on those two aspects.

A Correct. I have been forced to make what I consider conservative assumptions on those aspects.

Q You are not sure whether those assumptions that you have made are right or wrong?

A I am convinced that they are conservative. I don't know that there is a right or wrong.

Q How do you know they are conservative?

A Well, because in terms of the total PCBs deposited, I know that at this point in time there are more there than what I assumed were deposited. So that is conservative. The timing I am less confident on.

Q How many PCBs do you know are there?

A I don't know what you mean by how many.

Q You told me that you knew how many PCBs you --

A Do you mean how much?

Q How much was there that you used in your study was less than what you knew was really there.

A There is a number in here somewhere in the text for the PCB volume in the eastern -- was it western -- I have got 2200 kilograms. This is on Page 3-73, 2,200 kilograms of PCB in the eastern lens as a minimum or conservative value.

MR. SHAPIRO: What page was that?

THE WITNESS: 3-73.

BY MS. OLIVER:

Q How do you know that is a conservative number?

A Because this is PCB which is in the sediment, and the sediment has been sampled, and I have essentially integrated the samples into that final number, and I have used as I believe documented in the text, smaller concentrations than have been sampled. Thinner thicknesses than have been sampled, and smaller lateral extents that have been sampled to come up with that number.

Q Why did you narrow the numbers?

A To be conservative.

Q If you had confidence that the numbers that you were given were correct, why would you want to be conservative?

A Because one can never have 100 percent confidence I was being asked simply to come up with an assessment that I could believe in as to what the effect on the groundwater system were. So I have chosen to calculate minimum possible effects, and that's what is documented here.

Q The minimal possible effect, assuming that this flow occurs over a 24-hour period.

A In terms of fluxes, yes.

Q You talk about the western enclave and the

eastern enclave, the western lens and the eastern lens. Do you differentiate between what you call lens and enclaves?

A Yes.

Q What is the difference?

A The lens is the PCB contaminated sediments. The enclave is the PCB contaminated water.

Q You talk about the western lens not going anywhere, is that right?

MR. HYNES: You mean not going toward the Lake? I mean, everything has got to go somewhere.

BY THE WITNESS:

A It's non-migratory laterally. It does go to the ditch.

BY MS. OLIVER:

Q Now, are you talking about the groundwater going toward the ditch or the PCBs going toward the ditch?

A Both.

Q Did you do any measurements or calculations of PCBs that would go toward the ditch from the western area?

A Yes. Isn't that on that same table?

MR. SHAPIRO: 3-70, the table you were referring to?

BY THE WITNESS:

A Yes. These are the -- This would be the southeast to ditch upstream from well 5 numbers.

BY MS. OLIVER:

Q The southeast to ditch upstream from well 5 refers to the western portion of the area that you studied?

A Yes.

Q Why did you conclude that the groundwater from that area, western area, was not moving toward the Lake?

A The groundwater from the area of the western enclave was not moving toward the Lake?

Q Am I wrong?

A No. Is that what you are asking me?

Q Yes.

A Simply because the gradients are not toward the Lake, they are toward the ditch.

Q So the PCBs that are in that western area would not move toward the Lake either, through groundwater, right?

A Under present conditions, yes.

Q In your opinion are your projections of PCB movement toward the Lake through the groundwater your best scientific estimate?

MR. HYNES: You are talking about the flux calculations?

BY MS. OLIVER:

Q Yes. The projections.

A They are my best scientific estimate of a conservative flux, yes.

Q Well, are they your best scientific estimate of a flux toward the Lake?

A Of a conservative flux.

Q Well, is a conservative flux your best scientific estimate of what will occur in the future?

A Well, I can't answer that yes or no, because it has two parts to it. It is, in my opinion, the best scientific procedure to calculate a conservative flux. In that respect the answer to your question is yes. I don't think that is what you are asking me.

Q No. If you were hired by me and I asked you to do whatever you needed to do to do a projection and give me your best scientific estimate of the flux of

PCBs to the Lake, would you give me this report that you have done and say this is it?

A As long as you are going to call it the best scientific estimate, I would have used this procedure. If you had not restricted the funding available to me to collect information, I would have collected additional information, as I have described before, which would have changed the numbers somewhat.

Q What were the funding limitations that you worked under in this project?

A I am not aware of what they were. I was not involved in the funding.

Q You were paid through JRB, is that right?

A That is correct.

Q What was your total compensation for doing the work that culminated in your final report?

A Again, I don't know, as I don't know the number of days that I worked or hours.

Q Were you paid on an hourly basis?

A I was.

Q Or project.

A Daily rate.

Q A daily rate?

A Yes.

Q You I think testified that you did a draft report in 1979, that was not complete, is that right?

A Yes.

Q Did you do calculations or projections in that draft report?

A To the best of my recollection, yes.

Q Am I correct that your final report was more conservative than your preliminary report?

MR. SHAPIRO: Are you talking about the draft report in 1979, or the preliminary draft report in --

MS. OLIVER: The draft report in 1979.

MR. SHAPIRO: Okay.

BY THE WITNESS:

A Well, I am having difficulty remembering what projections were made in which of the various reports, and without referring to them I don't know specifically what the numbers were. But this was the most conservative set of estimates.

Q And you --

MR. HYNES: By "this," you mean the final report?

THE WITNESS: Yes, the final report.

BY MS. OLIVER:

Q When you say conservative, you mean the lowest projections?

A Correct.

Q Do you remember what the other projections were?

A No.

Q What degree of magnitude were the projections as compared to the final report?

A No, I don't.

Q Were the first calculations you did incorrect?

MR. HYNES: You mean the first calculations on 1979 data?

MS. OLIVER: Yes.

BY THE WITNESS:

A Not incorrect, no.

BY MS. OLIVER:

Q Just not as conservative?

A Yes.

Q In your opinion from the data you had to work with, you wanted to be as conservative as possible.

A Yes.

Q Is that because of the limitations you had on the data, and the limitations you had to make because of the assumptions you were required to make?

A Those are some of the reasons, yes.

Q What other reasons were there?

A Just as I have said many times before, sound scientific procedure to utilize the conservative approach.

Q So the first calculations you did were not sound scientific procedures?

A Given the information at that time -- Well, in hindsight, I would answer the question yes.

Q Given more data, the data that you would want to have to have some degree of probability of the correctness of your 1981 projections, that might change these projections as well, right?

A I can't eliminate the possibility that it might. But having seen the change that occurred between 1979 and 1980, I have been extremely conservative here. I would find it difficult to believe that conditions could -- fluxes could be below this.

Q If they were below this, we wouldn't be able to find them, would we?

A Not true at all.

Q What occurred between 1979 and 1980 which you have just made reference to?

A The discovery of the eastern enclave -- eastern lens is what was discovered, and then we found the enclave after that.

Q Are you saying that even though you didn't know that there was an eastern lens in 1979, your calculations and projections of flux were higher than they were after you found the eastern enclave?

A Well, that is again where I am not certain what the projections were in the various -- in the whole sequence of the report.

Q Well, but --

A I think that is the case, but I am not certain of that.

Q Wouldn't the discovery of the eastern lens confirm your conclusions about flux of PCBs towards the Lake?

A Not necessarily. The discovery of the eastern lens required the implementation, the installation of additional water level measuring location wells.

Q Right. The discovery of the eastern lens

provided you with the one day of data or one moment of data that from which you concluded that there was a movement to the Lake at certain times.

A From which I concluded that there was a transition I-II flow.

Q Which moved groundwater to the Lake.

A Yes.

Q Before the discovery of that eastern lens and that data of July 15, 1980, you had concluded, in any event, that there was flux of PCBs to the Lake, or would be in the future?

A Yes.

Q The projections you made of what that flux would be were higher than the calculations and the projections that you made after you got the July 15, 1980 data?

A They were less conservative, yes.

Q They were higher, in fact?

A The calculated fluxes were higher.

Q You have never recommended or suggested that any additional data be taken in order to verify your projections or to determine what the degree of probability of their correctness would be, is that right?

A No, I have not been asked to.

Q You have not suggested it or recommended it to anyone?

A That is not my role, no. That is not my role in this project.

Q Now, you came up with this nomenclature of Type I, Type II flows in 1980, is that right?

A Yes.

Q How did you identify these flows before 1980?

A Well, I hadn't given them any specific nomenclature. Prior to the 1980 data collection it wasn't as clear what the fluctuations in water flow were at the site. So I hadn't formulated a categorization like that.

Q Doctor, if you look a minute at Exhibit 3 that I think you testified earlier were the peer review comments that you received, is that right?

A Yes.

Q The four page comments by Professor Sangrey refer to your preliminary final report that you did in 1980, right?

A Yes.

Q Did you change your calculations and your projections from your preliminary final report to your final report?

A The preliminary final being the one that the reviewers had examined?

Q Yes.

A Yes, I believe so.

Q Did you change the formulas you used in the calculations?

A I changed the procedure, the logical sequence that I followed in order to come up with the projections.

Q Were the fluxes that you calculated in your preliminary final report higher than the fluxes that you projected?

A I believe so.

Q Would you agree with Professor Sangrey that the data to support the hypothesis about transition flow periods are very sketchy?

A Where are you finding that?

Q The second paragraph, third line from the bottom of Page 1.

MR. HYNES: Page 1.

BY THE WITNESS:

A No, I wouldn't.

BY MS. OLIVER:

Q You thought you had enough data to support the transition flow theory?

A Yes, to support that it occurs.

Q The data you had to support the transition flow from I to II was the July 15, 1980 data?

A Yes.

Q Now, you said that you thought that that one day of measurement was sufficient to conclude that that flow in fact occurs.

A That that type of transition flow does occur, yes.

Q In fact, you found it on July 15, 1980.

A Yes.

Q Would you agree that the one day's data of July 15, 1980 is adequate in order to make projections of flux into the future during that period?

A I guess I am not sure what you are asking me.

Q Well, you took that one day's measurement?

A Right.

Q You not only concluded that that type of flow in fact occurs, but you use that data to make a quantitative estimate of groundwater fluxes in the future, right?

A Oh, I see. Partly. I used it partly. There are other factors involved.

Q Well, do you think that one day's measurement was sufficient water level data in order to make the predictions of PCB flux to Lake Michigan?

A Well, given the assumption that those conditions recur, the answer to that would be yes. The only part of the flux calculation, PCB flux which comes from that specific date, is the groundwater flux, magnitude of water flowing into the Lake.

Q Without the groundwater, the PCBs wouldn't move to the Lake.

A Correct.

Q So you needed those water measurements to make a prediction of the PCB flux to Lake Michigan, right?

A Yes.

Q My question is in your scientific opinion, is the one day's data that you got on July 15, 1980

adequate to be able to predict PCB flux to Lake Michigan with any degree of scientific certainty?

A Yes.

Q What degree of scientific certainty have you predicted that PCB flux, Doctor?

MR. HYNES: Asked and answered.

BY MS. OLIVER:

Q You are not capable of telling me, right?

A As I told you, I didn't have a degree of certainty.

Q Is it a reasonable degree of certainty in your opinion, Doctor?

A Is what?

Q Do you have a reasonable degree of scientific certainty in the calculations or the projections you made based on the one days' data?

MR. HYNES: Again, objection. It has been asked and answered. You can answer.

BY THE WITNESS:

A Well, we have been through that before, and I say yes, I am reasonably certain that it is a conservative estimate.

BY MS. OLIVER:

Q What is the degree of scientific certainty that you have that the transition flux will occur during a 24-hour period on any one day in the future?

MR. HYNES: Do you understand the question?

THE WITNESS: No, I don't.

BY MS. OLIVER:

Q You have made projections, right, based on 24-hour periods. A certain amount of flux over a 24-hour period, right?

A Right.

Q You are assuming that that transition flow from I to II that will move the groundwater to the Lake will occur over a 24-hour period, in order to make those projections, right?

A Again, you have asked me that before, and I am assuming that it occurs over a 24-hour period.

Q Can you say, with any degree of scientific certainty, that that transition flow will occur over a 24-hour period on any day in the future?

A Again, there are two parts to that question, and so I cannot answer it yes or no.

Q What two parts can you answer?

A Well, I can assure the transition flow will occur any time the water level in the ditch drops. But I don't know that it is going to occur for 24 hours during that period.

Q So you can't say with any scientific certainty that whenever that transition flow occurs, it will occur for 24 hours?

MR. SHAPIRO: You cannot say.

BY MS. OLIVER:

Q You cannot say.

A No.

Q You cannot say, Doctor, with any degree of scientific certainty that the transition flow from I to II that will move groundwater and PCBs from the eastern portion of the property to the Lake will occur on any specific number of days in any year in the future?

A Given the present information, no.

Q On Page 3 of Professor Sangrey's letter, he makes a suggestion numbered one. Do you see that?

A Yes.

Q He says, "It would be helpful to have some historical review of the fill which is found on the site."

Did you ask for any historical review of the fill after receiving Professor Sangrey's letter?

A I had asked prior to that of EPA people.

Q Did you add any additional information after reading Professor Sangrey's comment to your final report?

MR. HYNES: With regard to this fill question?

BY MS. OLIVER:

Q Right.

A I didn't add any information that -- The latter part of Chapter 3 was changed, so there is probably different information in there than before that.

Q Chapter 3 referred to what, the interpretation of the results, is that what you are referring to, Chapter 3?

A The flux calculations.

MR. HYNES: I think the question was did you add anything with regard to the historical review of the fill as suggested in numbered paragraph one on Page 3. Is that your question?

BY MS. OLIVER:

Q That is it.

A Again, not recalling what I said in the

preliminary final report, I can't give you a specific answer. I learned nothing more subsequent to this.

Q Did you agree with Professor Sangrey that it would be helpful to have some more information on the fill?

A Oh, yes.

Q What is the fill that he is referring to?

A It is the material that's been deposited on top of the aquifer.

Q Would you agree with Dr. Sangrey's statement on Page 4 under his Comment 4 that several of the conclusions in this report are very vulnerable because of the absence of long-term records of data?

A Are you asking now about the final report or about the preliminary final report?

Q The report that Professor Sangrey read.

A I probably did agree with that, but as I said, I don't recall what was in that.

Q You don't recall which of the conclusions you agreed were vulnerable?

A No.

Q Do you have an opinion that any of the conclusions in your final report are vulnerable because

of the absence of long-term record of data?

A No.

Q Would you agree that any of the conclusions in your final report are limited without more data?

MR. HYNES: Limited in what regard?

BY MS. OLIVER:

Q In any regard.

A Well, yes. We have already been through that.

Q Are you referring to the inability to give any estimates of levels of competence or probability of correctness in your projections?

A Primarily I am referring to my inability to do a frequency analysis, and say here is the frequency with which this flux would be occurring.

Q That would verify, if I can use that word, the projections that you made, wouldn't it?

MR. HYNES: You mean if he could --

BY MS. OLIVER:

Q If he can do the frequency --

MR. HYNES: More frequent.

BY THE WITNESS:

A No. Because the projections that have been made are for one day at a time. They are not for

annual totals. So what I said was that I couldn't make an annual total judgment.

BY MS. OLIVER:

Q I see. That is right. Excuse me. You would need the frequency data to make any type of estimate of annual flux.

A Right.

MS. OLIVER: Let's take a minute.

(Recess had.)

BY MS. OLIVER:

Q Am I correct, Doctor, that you earlier testified that the groundwater in the area that you studied moves at a slow rate?

A In which area study?

Q Well, did it differ in the different areas that you studied?

MR. HYNES: Are you differentiating between a western and eastern end?

BY MS. OLIVER:

Q Yes. The areas you had studied.

A You mean at the OMC site you are talking about?

Q Yes.

A Okay. No, it doesn't differ particularly

at that site, but it does move slowly.

Q How slow is slowly? Did you make any determination?

A No. There is no direct determination, but we are talking a few thousands of feet per year, probably something on that order of magnitude.

Q Was your answer a few thousandths of feet, or a few thousand feet per year?

A I said a few thousands, meaning on the order of magnitude of 10 to the three feet.

MR. SHAPIRO: Thousandths?

THE WITNESS: One thousand, two thousand, ten thousand. T-h-o-u-s-a-n-d-s.

MR. SHAPIRO: Are you taking about one over one thousand?

THE WITNESS: No.

MR. SHAPIRO: You are talking about one thousand?

THE WITNESS: One thousand. Perhaps a mile per year, something on that order.

BY MS. OLIVER:

Q You also testified that the water in the North Ditch affects the groundwater flow.

A Yes.

Q Did you do any study of the surface water in the ditch?

A No.

Q Would you like to have some information about the surface water in the ditch?

MR. HYNES: Like to for what purpose?

BY THE WITNESS:

A That is a good point. I always want data.

BY MS. OLIVER:

Q To come up with some degree of probability of the correctness of your projections.

A Probably the only thing that would help in there would be a continuous record of the water level in the ditch.

Q You don't have those?

A You don't have a continuous record. I have a sequential record in the 1979 season. Those are measurements taken once a day.

Q Did you ask for any measurements in the North Ditch be taken in 1980?

A No, I didn't.

Q When you say you would have liked, you would like to have continuous water levels from the ditch,

over what period of time would continuous mean to you?

A Continuous means continuous.

Q Well, I mean, from 1979 to 1981, every day of the year?

A No. By continuous I mean perpetual -- constantly taken. There is a device in there which continually is measuring water levels.

Q You didn't recommend that that be done, that that instrument be put into the North Ditch, did you?

A No.

Q What is a single line source?

A A single line source? A line source is simply a linear source of water, like the ditch. Singular or just say simple.

Q Single?

A Okay.

Q Am I correct that you refer to the ditch as both a source and a sink for the groundwater?

A Yes.

Q Would you explain to me what that means?

A Well, when it's a source, water is flowing from the ditch into the aquifer, and that would be Type II flow.

A When it's a sink, groundwater is flowing from the aquifer into the ditch, which would be Type I flow.

Q You have made no determination, I take it, Doctor, that any of the projections of future PCB flux to Lake Michigan are significant in terms of loadings of PCBs to the Lake?

A You mean relative to other sources?

Q Relative to what is going into Lake Michigan on a yearly basis or daily basis.

A No, I have not addressed that question at all.

Q Based on your study of the groundwater, do you have an opinion whether the removal of any PCBs in the western lens would affect the groundwater of PCB flux to Lake Michigan?

A The groundwater PCB flux, okay. Yes, I would have an opinion.

Q What is that opinion?

A Well, removal of that western lens wouldn't impact the groundwater flux to the Lake.

Q Would the removal of a portion of the eastern PCB lens affect the movement of PCBs through the

groundwater to Lake Michigan?

A Probably. It would depend on what portion.

Q If all the PCBs are not removed from the eastern lens there would still possibly be PCBs available to move through the groundwater to the Lake, right?

A Correct.

Q Would I be correct then that unl[illegible] ev PCB were removed from the eastern lens, the most t[illegible] would occur would be some reduction of your projection.

A Yes, that is a fair assessment.

Q I take it you have not made any cost benefit study to determine what the cost of removing, how the cost of removing any of the PCBs in the soil would affect the groundwater flux or the reduction in the flux that you have projected in the future?

A No, I have done no cost analyses whatsoever.

MS. OLIVER: I don't have anything else.

REDIRECT EXAMINATION

BY MR. SHAPIRO:

Q Dr. Cherkauer, let me ask you a quick question about the figure on Page 3-79 of your report.

A Yes.

Q There are two lines on that graph. One is identified as the minimum probable flux. Is that a result of your conservative estimate, what you described as your conservative estimate of the flux into Lake Michigan from the eastern lens?

A Both lines are. It's one of the results.

Q What do you mean by both lines are?

A Well, as is explained in the text. And the labels on that diagram may be somewhat misleading. What I mean by probable flux into the Lake is what I am calling my conservative estimate. Minimum and maximum. The differences are based simply upon the minimum and maximum likely hydraulic conductivities in the aquifer.

Q You make different assumptions about the conductivities?

A Correct.

Q Dr. Cherkauer, based on your analysis here, can you give a figure, based on a reasonable degree of scientific certainty, for the amount of PCBs that will be carried into the Lake in the year 2060?

MR. HYNES: For the entire year?

BY MR. SHAPIRO:

Q For the entire year.

A Given the information I have now, no.

Q Could you give a figure, with a reasonable degree of scientific certainty, for the year 1982?

A No.

Q Could you give a figure for the amount of flux of PCBs into Lake Michigan from the Outboard Marine site, with a reasonable degree of scientific certainty, for any year between 1982 and 2060?

A Flux for the entire year?

Q Yes.

A No.

MR. SHAPIRO: I have no further questions.

MS. OLIVER: I have nothing.

MR. HYNES: All right.

(Witness excused.)

(AND FURTHER DEPONENT SAITH NOT.)

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

THE UNITED STATES OF AMERICA,	)	
	)	
Plaintiff,	)	
	)	
Vs.	)	No. 78 C 1004
	)	
OUTBOARD MARINE CORPORATION and MONSANTO COMPANY,	)	
	)	
Defendants.	)	

I hereby certify that I have read the foregoing transcript of my deposition given at the times and place aforesaid, consisting of Pages 1 to 325, inclusive, and I do again subscribe and make oath that the same is a true, correct and complete transcript of my deposition so given as aforesaid, as it now appears.

_____
DR. DOUGLAS CHERKAUER

Subscribed and sworn to
before me this ____ day
of _____,
A.D. 1982.

_____
Notary Public

UNITED STATES OF AMERICA)
NORTHERN DISTRICT OF ILLINOIS)
EASTERN DIVISION) SS:
STATE OF ILLINOIS)
COUNTY OF C O O K)

I, JEAN KORINKO SWEENEY, a notary public in and for the County of Cook and State of Illinois, do hereby certify that DR. DOUGLAS CHERKAUER was by me first duly sworn to testify the whole truth and that the above deposition was recorded stenographically by me and was reduced to typewriting under my personal direction, and that the said deposition constitutes a true record of the testimony given by said witness.

I further certify that the reading and signing of said deposition was not waived by the witness and his counsel.

I further certify that I am not a relative or employee or attorney or counsel of any of the parties, or a relative or employee of such attorney or counsel, or financially interested directly or indirectly in this action.

IN WITNESS WHEREOF, I have hereto set my hand and affixed my seal of office at Chicago, Illinois this 21 day of December, A.D. 1982.

Jean Korinko Sweeney
Notary Public, Cook County, Illinois
My Commission expires April 16, 1984.

Thea L. Urban
Certified Shorthand Reporter
[illegible] South La Salle Street
Chicago, Illinois 60603
[illegible]

A Yes.

MR. HYNES: By "moving eastward," you mean eastward and into the Lake?

BY MS. OLIVER:

Q Eastward, is that right?

A Yes.

Q What is that in terms of kilograms? I am not too good at that.

MR. HYNES: Kilograms per year?

MS. OLIVER: Kilograms per day.

MR. HYNES: Kilograms per day.

BY THE WITNESS:

A So you would be talking about .003 to .4 -- No. .004 to .03.

MR. SHAPIRO: .03.

THE WITNESS: .03.

MS. OLIVER: .03?

MR. SHAPIRO: .03.

BY MS. OLIVER:

Q So in 80 years, based on your projections, there could be a movement of PCBs from OMC property or soil to the Lake of between .004 kilgrams per day and .03 kilograms per day, is that right?

A Correct.

Q Am I correct, Doctor, that you don't know whether in fact that flux or movement will occur in any day in 1980, in 80 years, in 2060?

MR. HYNES: Wait. Could you --

BY MS. OLIVER:

Q I will rephrase the question.

You don't know that that flux or flow will occur on any one day in the year 2060?

A What I am saying is that under Type I to II transition flow conditions, in the year 2060 a flux of that magnitude will occur.

Q Right. But you are assuming in saying that, aren't you, Doctor, that the flow, the transition flow that would cause this movement, would occur over a 24-hour period, aren't you?

A Yes.

Q You haven't measured that at all.

A No.

Q There is no way that you can say that that in fact would occur.

A Not given the information that I have, correct.

Q In fact, the transition flow that you found on July 15, 1980 that shows movement into the Lake could only have occurred for one minute or one hour or twelve hours on that date, right? You have no way of knowing.

A Well, as I hesitated earlier, I will hesitate on this. I can't put a lower or upper limit on it.

Q So your prediction of kilograms or grams per day movement is based on an assumption that that movement that you found toward the Lake would occur during the entire day, and you have no basis for that assumption, isn't that right?

A It is an assumption. There is no empirical basis for it. But groundwater systems change very slowly. So I would argue it's a good assumption.

Q But you have no data to support that?

A No.

Q You wouldn't have any way of knowing similarly how often that flow would occur during a 365-day year?

A Correct. As I answered before.

Q So even assuming that the flow occurred, flow eastward toward the Lake occurred on a whole

24-hour basis, in the year 2060 the maximum flow for a year could be this .004 to .03 kilograms, that can be the total flow or flux that went out toward the Lake in the whole year.

A What was the assumption you made?

Q I am assuming that you are right in fact in assuming that the flux would occur for 24 hours over the whole period.

A During that year.

Q During that year.

A Okay.

Q On one day over that year.

A Yes, if there were that transition flow for one 24-hour period, then that would be the range of flux that I would expect.

Q There is no way for you to predict with any degree of scientific certainty whether in fact that transition flow would occur on one day in the year 2060, or on two days, or on 100 days?

A Not given the present body of information.

Q So you can't make any prediction of what the total movement of PCBs from the soil into the Lake would be over a year, for any year, this year or 80

years from now.

A No, not until or unless I know the frequency of the flows.

Q In fact, if the transition flow does not occur on an entire 24-hour basis or duration, the amount of PCBs that would move from the soil into the Lake could be less than what you have projected.

A Correct. If the duration of the transition flow were less than 24 hours.

Q Have you studied flows, Doctor, that were less than 24 hours, other groundwater systems?

A I don't know what you mean.

Q Well, have you found that there are groundwater systems where the flows change over a period less than 24 hours?

A No, I have never specifically myself investigated that problem.

Q So you don't know one way or the other?

A Well, you asked if I had investigated them, no, I have not. I am not saying I don't know that. I am saying I have not investigated that.

Q Well, it's possible, isn't it, that flows change more than once during a 24-hour period?

A Certainly it's possible.

Q Is it possible that the transition flow that you found would only occur during the summer months?

A In my opinion, and that is the only thing I can go on, it's possible, but not very probable that it would only occur in the summer months.

Q Again, you don't have any data to show it occurs at any other time?

A No, I have no other data.

Q As a matter of fact, the data that you took or got from 1979 didn't show that transition flow?

A It may have.

Q Well, it didn't.

A You are correct. The data did not show, but the well field was not complete at that time.

Q Well, it was complete enough for the 12 measurements that you used.

A Yes. Well, no, I only used nine of them, or whatever it was.

Q That is right. You only used nine.

A Six of the nine.

Q Six of the nine from 1979.

A Yes.

Q In none of those six that you found to be valid measurements was that transition flow demonstrated.

A Probably not.

Q Well, in your opinion it wasn't.

A Yes, I guess is the answer.

Q Just so I understand, you can't say with any degree of scientific certainty that the transition flow that you found on July 15, 1980 will occur on any other day of this year or any year.

A I can tell you when it will occur, but I can't tell you what date.

Q Can you tell me how often it will occur with any degree of scientific certainty?

A At this stage, no.

Q Could you tell me with any degree of scientific certainty how long that transition flow will last on any given day?

A No.

Q Have you done any studies or read any papers, Doctor, relating to the action of PCBs with soil, how PCBs inter-relate or interact with soil?

A Yes.

Q What studies have you done or papers have you read?

A I have not done any myself. I have read one of them. It is referenced in the report, a report by the Illinois Geological Survey again, which examined the interaction of PCBs with sediment.

Q Have you read any papers since then relating to the action of PCBs with soil?

A Probably, but I can't think of any specific ones.

Q Are you familiar, Doctor, with any of the studies showing how much or what amount of PCBs go into Lake Michigan every year from the atmosphere and from other sources?

A No, I am not.

Q What is the projection that you make of the flux or movement of PCBs through the groundwater for 1982? Do you have a projection for that?

A For again transition I to II flow?

Q Right.

A It is very difficult to read it off of this, but it's below -- In fact, it can't be read off of this. It's below one times ten to the minus three grams per day.

Q Is that what I would call non-detectible, or negligible?

A Well, it's very definitely detectible, because the basis for that number is the water samples that were collected at the site. What you call negligible, I don't know.

Q Well, what is the one times ten to the minus third grams per day?

A .001 grams per day.

Q .001 grams per day, presently?

A Yes.

Q In your opinion, based on your projections, is presently moving from the groundwater.

A Actually it's something below that, is what I said, yes.

Q Below .001 grams per day.

Did you make any actual measurements of the movement or flux of PCBs through the groundwater? Is there any actual data that you have, other than your projections?

A For 1982 are we still talking about?

Q For any year. 1979, 1980.

A Well, one cannot measure flux. One measures

those properties which determine the groundwater movement, and then one measures the concentration of the material that you are interested in. So the answer to that is yes, any of the 1980 data could be utilized to calculate a flux.

Q Well, did you calculate a flux?

A Probably, I don't recall.

Q Do you know whether it's in your report at any place?

A No, it's not in the report.

Q You are not going to give any opinions on what the calculated flux was based on the data that you had in 1979 and 1980?

A Is that a question?

Q Yes.

MR. HYNES: Give an opinion as to what the flux was in 1979, or what the flux was in 1980, is that your question?

BY MR. OLIVER:

Q Yes. Do you understand what I am asking?

Is your testimony limited to the projections that you have made and the model that you have used to make those projections?

A Just a minute, wait a minute, wait a minute. As I think back, isn't there a table in here with -- Okay. I will take that back. Yes, there is a 1980 calculation in here on Page 3-70 for I to II transition for 1980. It says less than 2.8 times 10 to the minus four. One point nine times ten to the minus three grams per days. So there is that number in here.

Q You also on that same page have calculations for the year 2,000, 2,020, 2040 and 2,060.

A Correct.

Q Is that right?

A Yes.

Q Are those based on your model and projections?

A Yes.

Q But the first 1980 flux data is based on calculations, and not the model?

A Well, the model is calculations.

Q What I am asking --

A This is based on real existent data. It is not a projection.

Q Well, it's based on the real existent data that existed on July 15, 1980.

A The flow data is from July 15th. The PCB

information is averaged over the period of the study.

Q But in order to get the flux of PCBs you needed flow data, right?

A Correct.

Q The flow data that you had was the one day's measurement.

A Correct.

Q So am I correct that all of the calculations that you made for the flux of PCBs to the Lake from the groundwater were based on that July, 1980 data, one day's data?

A All of the PCBs for Type I-II transition, or all of the calculations, I mean, for Type I-II transition were based on that one.

Q The Type I-II transition flow is the only flow that you determine would move PCBs toward the Lake?

A No. You will notice that Type II flow has an eastward component in that same table, and is also delivering some flux of PCBs to the Lake.

Q But it is fair to say, isn't it, that the predominant mechanism that you found for the movement of PCBs through groundwater toward the Lake would be

during the Type I-II transition flow?

A I can't answer that directly, again because I don't know the relative frequency of the two flows. But on a 24-hour basis the transition flow delivers more than the Type II flow.

Q So assuming the predominant mode of transportation was during Type II, your predictions would be higher than what would normally occur. Your predictions under Type I-II would be higher than what occur under Type II, right?

A For a given 24-hour period, you mean?

Q Yes.

A Yes.

Q So by using the Type I-II transition, you use the flow that you think would move the most PCBs over a 24-hour period?

A Yes.

Q Do you have a confidence level in your projections?

A No.

Q Why not?

A Well, let me go back and ask to verify that you and I are talking about the same thing when we

talk about confidence level. What do you mean?

Q I always like you to tell me what you mean. What do you mean when you talk about confidence level in your profession, Doctor?

A A confidence level is a degree of probability that a projection is correct, that can be attached to that projection.

Q You don't have a degree of probability of the correctness of your projections?

A No, I don't.

Q Would you be able to give me a degree of probability of the correctness of your projections with additional data?

A Probably with additional data, yes.

Q How much additional data would you need?

A I would need to know more precisely the -- I would need to know the frequency of distributions of types of flow, and --

Q How many years of data would you need in order to find a frequency of distribution in the types of flow?

A Please don't take this as a facetious answer, but I don't know. It would depend upon the variability

of flow at the site. But we would be talking about potentially several years of continuous records.

Q What other data would you want to know or want to have?

A Now, we are still talking about a degree of probability on the projections?

Q Yes.

A I would need to know the precise manner and timing of the deposition of PCBs at the site.

Q You are not satisfied yet that the assumptions you made as to those aspects are correct?

MR. HYNES: Repeat the question.

BY MS. OLIVER:

Q Well, you made some assumptions, Doctor, as to the time of deposition and the amount of deposition that occurred, didn't you?

A Yes.

Q You just told me that you would like additional information on those two aspects.

A Correct. I have been forced to make what I consider conservative assumptions on those aspects.

Q You are not sure whether those assumptions that you have made are right or wrong?

A I am convinced that they are conservative. I don't know that there is a right or wrong.

Q How do you know they are conservative?

A Well, because in terms of the total PCBs deposited, I know that at this point in time there are more there than what I assumed were deposited. So that is conservative. The timing I am less confident on.

Q How many PCBs do you know are there?

A I don't know what you mean by how many.

Q You told me that you knew how many PCBs you --

A Do you mean how much?

Q How much was there that you used in your study was less than what you knew was really there.

A There is a number in here somewhere in the text for the PCB volume in the eastern -- was it western -- I have got 2200 kilograms. This is on Page 3-73, 2,200 kilograms of PCB in the eastern lens as a minimum or conservative value.

MR. SHAPIRO: What page was that?

THE WITNESS: 3-73.

BY MS. OLIVER:

Q How do you know that is a conservative number?

A Because this is PCB which is in the sediment, and the sediment has been sampled, and I have essentially integrated the samples into that final number, and I have used as I believe documented in the text, smaller concentrations than have been sampled. Thinner thicknesses than have been sampled, and smaller lateral extents that have been sampled to come up with that number.

Q Why did you narrow the numbers?

A To be conservative.

Q If you had confidence that the numbers that you were given were correct, why would you want to be conservative?

A Because one can never have 100 percent confidence I was being asked simply to come up with an assessment that I could believe in as to what the effect on the groundwater system were. So I have chosen to calculate minimum possible effects, and that's what is documented here.

Q The minimal possible effect, assuming that this flow occurs over a 24-hour period.

A In terms of fluxes, yes.

Q You talk about the western enclave and the

eastern enclave, the western lens and the eastern lens. Do you differentiate between what you call lens and enclaves?

A Yes.

Q What is the difference?

A The lens is the PCB contaminated sediments. The enclave is the PCB contaminated water.

Q You talk about the western lens not going anywhere, is that right?

MR. HYNES: You mean not going toward the Lake? I mean, everything has got to go somewhere.

BY THE WITNESS:

A It's non-migratory laterally. It does go to the ditch.

BY MS. OLIVER:

Q Now, are you talking about the groundwater going toward the ditch or the PCBs going toward the ditch?

A Both.

Q Did you do any measurements or calculations of PCBs that would go toward the ditch from the western area?

A Yes. Isn't that on that same table?

MR. SHAPIRO: 3-70, the table you were referring to?

BY THE WITNESS:

A Yes. These are the -- This would be the southeast to ditch upstream from well 5 numbers.

BY MS. OLIVER:

Q The southeast to ditch upstream from well 5 refers to the western portion of the area that you studied?

A Yes.

Q Why did you conclude that the groundwater from that area, western area, was not moving toward the Lake?

A The groundwater from the area of the western enclave was not moving toward the Lake?

Q Am I wrong?

A No. Is that what you are asking me?

Q Yes.

A Simply because the gradients are not toward the Lake, they are toward the ditch.

Q So the PCBs that are in that western area would not move toward the Lake either, through groundwater, right?

A Under present conditions, yes.

Q In your opinion are your projections of PCB movement toward the Lake through the groundwater your best scientific estimate?

MR. HYNES: You are talking about the flux calculations?

BY MS. OLIVER:

Q Yes. The projections.

A They are my best scientific estimate of a conservative flux, yes.

Q Well, are they your best scientific estimate of a flux toward the Lake?

A Of a conservative flux.

Q Well, is a conservative flux your best scientific estimate of what will occur in the future?

A Well, I can't answer that yes or no, because it has two parts to it. It is, in my opinion, the best scientific procedure to calculate a conservative flux. In that respect the answer to your question is yes. I don't think that is what you are asking me.

Q No. If you were hired by me and I asked you to do whatever you needed to do to do a projection and give me your best scientific estimate of the flux of

PCBs to the Lake, would you give me this report that you have done and say this is it?

A As long as you are going to call it the best scientific estimate, I would have used this procedure. If you had not restricted the funding available to me to collect information, I would have collected additional information, as I have described before, which would have changed the numbers somewhat.

Q What were the funding limitations that you worked under in this project?

A I am not aware of what they were. I was not involved in the funding.

Q You were paid through JRB, is that right?

A That is correct.

Q What was your total compensation for doing the work that culminated in your final report?

A Again, I don't know, as I don't know the number of days that I worked or hours.

Q Were you paid on an hourly basis?

A I was.

Q Or project.

A Daily rate.

Q A daily rate?

A Yes.

Q You I think testified that you did a draft report in 1979, that was not complete, is that right?

A Yes.

Q Did you do calculations or projections in that draft report?

A To the best of my recollection, yes.

Q Am I correct that your final report was more conservative than your preliminary report?

MR. SHAPIRO: Are you talking about the draft report in 1979, or the preliminary draft report in --

MS. OLIVER: The draft report in 1979.

MR. SHAPIRO: Okay.

BY THE WITNESS:

A Well, I am having difficulty remembering what projections were made in which of the various reports, and without referring to them I don't know specifically what the numbers were. But this was the most conservative set of estimates.

Q And you --

MR. HYNES: By "this," you mean the final report?

THE WITNESS: Yes, the final report.

BY MS. OLIVER:

Q When you say conservative, you mean the lowest projections?

A Correct.

Q Do you remember what the other projections were?

A No.

Q What degree of magnitude were the projections as compared to the final report?

A No, I don't.

Q Were the first calculations you did incorrect?

MR. HYNES: You mean the first calculations on 1979 data?

MS. OLIVER: Yes.

BY THE WITNESS:

A Not incorrect, no.

BY MS. OLIVER:

Q Just not as conservative?

A Yes.

Q In your opinion from the data you had to work with, you wanted to be as conservative as possible.

A Yes.

Q Is that because of the limitations you had on the data, and the limitations you had to make because of the assumptions you were required to make?

A Those are some of the reasons, yes.

Q What other reasons were there?

A Just as I have said many times before, sound scientific procedure to utilize the conservative approach.

Q So the first calculations you did were not sound scientific procedures?

A Given the information at that time -- Well, in hindsight, I would answer the question yes.

Q Given more data, the data that you would want to have to have some degree of probability of the correctness of your 1981 projections, that might change these projections as well, right?

A I can't eliminate the possibility that it might. But having seen the change that occurred between 1979 and 1980, I have been extremely conservative here. I would find it difficult to believe that conditions could -- fluxes could be below this.

Q If they were below this, we wouldn't be able to find them, would we?

A Not true at all.

Q What occurred between 1979 and 1980 which you have just made reference to?

A The discovery of the eastern enclave -- eastern lens is what was discovered, and then we found the enclave after that.

Q Are you saying that even though you didn't know that there was an eastern lens in 1979, your calculations and projections of flux were higher than they were after you found the eastern enclave?

A Well, that is again where I am not certain what the projections were in the various -- in the whole sequence of the report.

Q Well, but --

A I think that is the case, but I am not certain of that.

Q Wouldn't the discovery of the eastern lens confirm your conclusions about flux of PCBs towards the Lake?

A Not necessarily. The discovery of the eastern lens required the implementation, the installation of additional water level measuring location wells.

Q Right. The discovery of the eastern lens

provided you with the one day of data or one moment of data that from which you concluded that there was a movement to the Lake at certain times.

A From which I concluded that there was a transition I-II flow.

Q Which moved groundwater to the Lake.

A Yes.

Q Before the discovery of that eastern lens and that data of July 15, 1980, you had concluded, in any event, that there was flux of PCBs to the Lake, or would be in the future?

A Yes.

Q The projections you made of what that flux would be were higher than the calculations and the projections that you made after you got the July 15, 1980 data?

A They were less conservative, yes.

Q They were higher, in fact?

A The calculated fluxes were higher.

Q You have never recommended or suggested that any additional data be taken in order to verify your projections or to determine what the degree of probability of their correctness would be, is that right?

A No, I have not been asked to.

Q You have not suggested it or recommended it to anyone?

A That is not my role, no. That is not my role in this project.

Q Now, you came up with this nomenclature of Type I, Type II flows in 1980, is that right?

A Yes.

Q How did you identify these flows before 1980?

A Well, I hadn't given them any specific nomenclature. Prior to the 1980 data collection it wasn't as clear what the fluctuations in water flow were at the site. So I hadn't formulated a categorization like that.

Q Doctor, if you look a minute at Exhibit 3 that I think you testified earlier were the peer review comments that you received, is that right?

A Yes.

Q The four page comments by Professor Sangrey refer to your preliminary final report that you did in 1980, right?

A Yes.

Q You not only concluded that that type of flow in fact occurs, but you use that data to make a quantitative estimate of groundwater fluxes in the future, right?

A Oh, I see. Partly. I used it partly. There are other factors involved.

Q Well, do you think that one day's measurement was sufficient water level data in order to make the predictions of PCB flux to Lake Michigan?

A Well, given the assumption that those conditions recur, the answer to that would be yes. The only part of the flux calculation, PCB flux which comes from that specific date, is the groundwater flux, magnitude of water flowing into the Lake.

Q Without the groundwater, the PCBs wouldn't move to the Lake.

A Correct.

Q So you needed those water measurements to make a prediction of the PCB flux to Lake Michigan, right?

A Yes.

Q My question is in your scientific opinion, is the one day's data that you got on July 15, 1980

adequate to be able to predict PCB flux to Lake Michigan with any degree of scientific certainty?

A Yes.

Q What degree of scientific certainty have you predicted that PCB flux, Doctor?

MR. HYNES: Asked and answered.

BY MS. OLIVER:

Q You are not capable of telling me, right?

A As I told you, I didn't have a degree of certainty.

Q Is it a reasonable degree of certainty in your opinion, Doctor?

A Is what?

Q Do you have a reasonable degree of scientific certainty in the calculations or the projections you made based on the one days' data?

MR. HYNES: Again, objection. It has been asked and answered. You can answer.

BY THE WITNESS:

A Well, we have been through that before, and I say yes, I am reasonably certain that it is a conservative estimate.

BY MS. OLIVER:

Q What is the degree of scientific certainty that you have that the transition flux will occur during a 24-hour period on any one day in the future?

MR. HYNES: Do you understand the question?

THE WITNESS: No, I don't.

BY MS. OLIVER:

Q You have made projections, right, based on 24-hour periods. A certain amount of flux over a 24-hour period, right?

A Right.

Q You are assuming that that transition flow from I to II that will move the groundwater to the Lake will occur over a 24-hour period, in order to make those projections, right?

A Again, you have asked me that before, and I am assuming that it occurs over a 24-hour period.

Q Can you say, with any degree of scientific certainty, that that transition flow will occur over a 24-hour period on any day in the future?

A Again, there are two parts to that question, and so I cannot answer it yes or no.

Q What two parts can you answer?

A Well, I can assure the transition flow will occur any time the water level in the ditch drops. But I don't know that it is going to occur for 24 hours during that period.

Q So you can't say with any scientific certainty that whenever that transition flow occurs, it will occur for 24 hours?

MR. SHAPIRO: You cannot say.

BY MS. OLIVER:

Q You cannot say.

A No.

Q You cannot say, Doctor, with any degree of scientific certainty that the transition flow from I to II that will move groundwater and PCBs from the eastern portion of the property to the Lake will occur on any specific number of days in any year in the future?

A Given the present information, no.

Q On Page 3 of Professor Sangrey's letter, he makes a suggestion numbered one. Do you see that?

A Yes.

Q He says, "It would be helpful to have some historical review of the fill which is found on the site."

Did you ask for any historical review of the fill after receiving Professor Sangrey's letter?

A I had asked prior to that of EPA people.

Q Did you add any additional information after reading Professor Sangrey's comment to your final report?

MR. HYNES: With regard to this fill question?

BY MS. OLIVER:

Q Right.

A I didn't add any information that -- The latter part of Chapter 3 was changed, so there is probably different information in there than before that.

Q Chapter 3 referred to what, the interpretation of the results, is that what you are referring to, Chapter 3?

A The flux calculations.

MR. HYNES: I think the question was did you add anything with regard to the historical review of the fill as suggested in numbered paragraph one on Page 3. Is that your question?

BY MS. OLIVER:

Q That is it.

A Again, not recalling what I said in the

of the absence of long-term record of data?

A No.

Q Would you agree that any of the conclusions in your final report are limited without more data?

MR. HYNES: Limited in what regard?

BY MS. OLIVER:

Q In any regard.

A Well, yes. We have already been through that.

Q Are you referring to the inability to give any estimates of levels of competence or probability of correctness in your projections?

A Primarily I am referring to my inability to do a frequency analysis, and say here is the frequency with which this flux would be occurring.

Q That would verify, if I can use that word, the projections that you made, wouldn't it?

MR. HYNES: You mean if he could --

BY MS. OLIVER:

Q If he can do the frequency --

MR. HYNES: More frequent.

BY THE WITNESS:

A No. Because the projections that have been made are for one day at a time. They are not for

annual totals. So what I said was that I couldn't make an annual total judgment.

BY MS. OLIVER:

Q I see. That is right. Excuse me. You would need the frequency data to make any type of estimate of annual flux.

A Right.

MS. OLIVER: Let's take a minute.

(Recess had.)

BY MS. OLIVER:

Q Am I correct, Doctor, that you earlier testified that the groundwater in the area that you studied moves at a slow rate?

A In which area study?

Q Well, did it differ in the different areas that you studied?

MR. HYNES: Are you differentiating between a western and eastern end?

BY MS. OLIVER:

Q Yes. The areas you had studied.

A You mean at the OMC site you are talking about?

Q Yes.

A Okay. No, it doesn't differ particularly

at that site, but it does move slowly.

Q How slow is slowly? Did you make any determination?

A No. There is no direct determination, but we are talking a few thousands of feet per year, probably something on that order of magnitude.

Q Was your answer a few thousandths of feet, or a few thousand feet per year?

A I said a few thousands, meaning on the order of magnitude of 10 to the three feet.

MR. SHAPIRO: Thousandths?

THE WITNESS: One thousand, two thousand, ten thousand. T-h-o-u-s-a-n-d-s.

MR. SHAPIRO: Are you taking about one over one thousand?

THE WITNESS: No.

MR. SHAPIRO: You are talking about one thousand?

THE WITNESS: One thousand. Perhaps a mile per year, something on that order.

BY MS. OLIVER:

Q You also testified that the water in the North Ditch affects the groundwater flow.

A Yes.

Q Did you do any study of the surface water in the ditch?

A No.

Q Would you like to have some information about the surface water in the ditch?

MR. HYNES: Like to for what purpose?

BY THE WITNESS:

A That is a good point. I always want data.

BY MS. OLIVER:

Q To come up with some degree of probability of the correctness of your projections.

A Probably the only thing that would help in there would be a continuous record of the water level in the ditch.

Q You don't have those?

A You don't have a continuous record. I have a sequential record in the 1979 season. Those are measurements taken once a day.

Q Did you ask for any measurements in the North Ditch be taken in 1980?

A No, I didn't.

Q When you say you would have liked, you would like to have continuous water levels from the ditch,

over what period of time would continuous mean to you?

A Continuous means continuous.

Q Well, I mean, from 1979 to 1981, every day of the year?

A No. By continuous I mean perpetual -- constantly taken. There is a device in there which continually is measuring water levels.

Q You didn't recommend that that be done, that that instrument be put into the North Ditch, did you?

A No.

Q What is a single line source?

A A single line source? A line source is simply a linear source of water, like the ditch. Singular or just say simple.

Q Single?

A Okay.

Q Am I correct that you refer to the ditch as both a source and a sink for the groundwater?

A Yes.

Q Would you explain to me what that means?

A Well, when it's a source, water is flowing from the ditch into the aquifer, and that would be Type II flow.

A When it's a sink, groundwater is flowing from the aquifer into the ditch, which would be Type I flow.

Q You have made no determination, I take it, Doctor, that any of the projections of future PCB flux to Lake Michigan are significant in terms of loadings of PCBs to the Lake?

A You mean relative to other sources?

Q Relative to what is going into Lake Michigan on a yearly basis or daily basis.

A No, I have not addressed that question at all.

Q Based on your study of the groundwater, do you have an opinion whether the removal of any PCBs in the western lens would affect the groundwater of PCB flux to Lake Michigan?

A The groundwater PCB flux, okay. Yes, I would have an opinion.

Q What is that opinion?

A Well, removal of that western lens wouldn't impact the groundwater flux to the Lake.

Q Would the removal of a portion of the eastern PCB lens affect the movement of PCBs through the

groundwater to Lake Michigan?

A Probably. It would depend on what portion.

Q If all the PCBs are not removed from the eastern lens there would still possibly be PCBs available to move through the groundwater to the Lake, right?

A Correct.

Q Would I be correct then that unless ev PCB were removed from the eastern lens, the most th would occur would be some reduction of your projection.

A Yes, that is a fair assessment.

Q I take it you have not made any cost benefit study to determine what the cost of removing, how the cost of removing any of the PCBs in the soil would affect the groundwater flux or the reduction in the flux that you have projected in the future?

A No, I have done no cost analyses whatsoever.

MS. OLIVER: I don't have anything else.

REDIRECT EXAMINATION

BY MR. SHAPIRO:

Q Dr. Cherkauer, let me ask you a quick question about the figure on Page 3-79 of your report.

A Yes.

Q There are two lines on that graph. One is identified as the minimum probable flux. Is that a result of your conservative estimate, what you described as your conservative estimate of the flux into Lake Michigan from the eastern lens?

A Both lines are. It's one of the results.

Q What do you mean by both lines are?

A Well, as is explained in the text. And the labels on that diagram may be somewhat misleading. What I mean by probable flux into the Lake is what I am calling my conservative estimate. Minimum and maximum. The differences are based simply upon the minimum and maximum likely hydraulic conductivities in the aquifer.

Q You make different assumptions about the conductivities?

A Correct.

Q Dr. Cherkauer, based on your analysis here, can you give a figure, based on a reasonable degree of scientific certainty, for the amount of PCBs that will be carried into the Lake in the year 2060?

MR. HYNES: For the entire year?

BY MR. SHAPIRO:

Q For the entire year.

A Given the information I have now, no.

Q Could you give a figure, with a reasonable degree of scientific certainty, for the year 1982?

A No.

Q Could you give a figure for the amount of flux of PCBs into Lake Michigan from the Outboard Marine site, with a reasonable degree of scientific certainty, for any year between 1982 and 2060?

A Flux for the entire year?

Q Yes.

A No.

MR. SHAPIRO: I have no further questions.

MS. OLIVER: I have nothing.

MR. HYNES: All right.

(Witness excused.)

(AND FURTHER DEPONENT SAITH NOT.)

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

THE UNITED STATES OF AMERICA,	)	
	)	
Plaintiff,	)	
	)	
Vs.	)	No. 78 C 1004
	)	
OUTBOARD MARINE CORPORATION and MONSANTO COMPANY,	)	
	)	
Defendants.	)	

I hereby certify that I have read the foregoing transcript of my deposition given at the times and place aforesaid, consisting of Pages 1 to 325, inclusive, and I do again subscribe and make oath that the same is a true, correct and complete transcript of my deposition so given as aforesaid, as it now appears.

_____
DR. DOUGLAS CHERKAUER

Subscribed and sworn to
before me this ____ day
of _____,
A.D. 1982.

_____
Notary Public

UNITED STATES OF AMERICA)
NORTHERN DISTRICT OF ILLINOIS)
EASTERN DIVISION) SS:
STATE OF ILLINOIS)
COUNTY OF C O O K)

I, JEAN KORINKO SWEENEY, a notary public in and for the County of Cook and State of Illinois, do hereby certify that DR. DOUGLAS CHERKAUER was by me first duly sworn to testify the whole truth and that the above deposition was recorded stenographically by me and was reduced to typewriting under my personal direction, and that the said deposition constitutes a true record of the testimony given by said witness.

I further certify that the reading and signing of said deposition was not waived by the witness and his counsel.

I further certify that I am not a relative or employee or attorney or counsel of any of the parties, or a relative or employee of such attorney or counsel, or financially interested directly or indirectly in this action.

IN WITNESS WHEREOF, I have hereto set my hand and affixed my seal of office at Chicago, Illinois this 21 day of December, A.D. 1982.

Jean Korinko Sweeney
Notary Public, Cook County, Illinois
My Commission expires April 16, 1984.

Thea L. Urban
Certified Shorthand Reporter
134 South La Salle Street
Chicago, Illinois 60603

(Monsanto)
Cherkauer DEP. EX. NO. X 6
FOR ID. AS OF ~~10/17/82~~
11/18/82

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Re: OMC Technical and Witnessing Case Support
EPA Contract No. 68-01-5052, DOW #3
JRB Project No. 2-800-03-218-03

Dr. Whang:

Within the next few days, under separate cover, I am forwarding to you a partial draft of the OMC report. While the majority of the report and related diagrams are complete, several sections await further information from Mr. DiDomenico's people in Chicago. In Chapter II, sections D-2 and E-2, in Chapter III, parts of sections B and C, and all of Chapter IV, completion is contingent upon my learning from EPA precisely how samples were collected and analyzed. I have written to Mr. DiDomenico, but have not yet received a reply.

As you will learn from reading the draft report, the drainage ditch on the site appears to have acted as a ground water recharge site for part of the study period. When this occurred, a slug of PCB-concentrated water appears to have been introduced into the aquifer and its migration from the ditch is traceable. However, several inconsistencies cloud this interpretation and I'm hoping the EPA information may clear up some of these.

First, on the set of soil sample analyses is one labelled "acetone", for which a value of 5.1 mg/kg is listed. If this is pure acetone and the units are, in fact, mg/kg, then one can question any interpretation of "contamination" from a source at OMC. The 5.1 value is higher than virtually all of the well samples, meaning all sample values could be argued to be just acetone dilution readings. I doubt that this is the case, but cannot be conclusive until EPA responds.

Secondly, there was no apparent reason for the rapid rise in well water levels which occurred during the study. September was an exceptionally dry month. Unless OMC released water of the Sewage Plant raised levels in the sewage lagoons, flow in the ditch should have remained low. I've requested EPA check on these matters.

Next, a quick look at Figure 22 leads me to believe that PCB readings for wells 4A and 4C have been reversed on 8/30, 9/5 and 9/11. After 9/11 the sets of values for the two wells completely reverse themselves - the high value well becomes low and vice versa. I also suspect the same on 8/30 for 7A and 7C. In either case, personell unfamiliar with the site may have confused the A and C wells which were at opposite ends of a line of three wells, a very common error. I have written the report using the

US 33550

the data as they have come from EPA. If revisions in the data are made, changes will be necessary in the report and interpretations. If water samples have been reversed, it is also likely that water level readings are reversed, and revisions in flow interpretations will also be necessary.

Finally, one major inconsistency exists which can't be fully answered by my questions to EPA or to Warzyn. The interpretation I have made of the transport of the PCB's assumesthe PCB's have been introduced to the ditch from the ditch and carried by convective transport toward the monitoring wells. That interpretation is consistent with the flow direction data, but not with the measured permeabilities. The flow rates necessary to carry the PCB-rich waters are two to three orders of magnitude greater than those calculated withthe Darcy equation for the permeability and gradients present. The only other viable interpretation, as I view the data, is the one mentioned in the report - that vertical recharge produced a change in conditions which resulted in desorption of PCB's from clays, or other adsorbants, in situ. This leads back to your earlier question over the phone regarding the need for adsorption capacity measurements. I now believe that in order to fully examine the alternative interpretation, we must determine the adsorption capacity of the aquifer materials (including fill), their desorptive tendencies when encountered by recharge from the atmosphere, and then the quantity and quality of vertical recharge likely at the site in early September. If, as I suspect, too little rain fell in September to overcome soil moisture deficiencies, then we can argue against this interpretation.

I think, at this point, that it will be important to know the adsorption and desorption properties of the aquifer. In addition, if at all possible, aquifer permeability should be estimated by another method, perhaps permeameter or extedded drawdown testing.

When I get the information from EPA, I'll finish the remaining portions of the report. Recognize, however, that their new information may require some revision of parts of the report which you'll be receiving.

Sincerely,

Douglas S. Cherkauer

Thea L. Urban
Certified Shorthand Reporter
134 South LaSalle Street
Chicago, Illinois 60603
312- 782-3332

CORRECTION SHEET

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Thea L. Urban
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134 South LaSalle Street
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(Monsanto)
Cherkauer DEP. EX. NO. X 6
FOR ID. AS OF ~~10/17/82~~
11/18/82

Douglas S. Cherkauer
5314 N. Lydell Ave.
Whitefish Bay, WI 53217

Dr. James S. Whang
JRB Associates, Inc.
8400 Westpark Drive
McLean, Virginia 22102

Re: CMC Technical and Witnessing Case Support
EPA Contract No. 68-01-5052, DOW #3
JRB Project No. 2-800-03-218-03

Dr. Whang:

Within the next few days, under separate cover, I am forwarding to you a partial draft of the CMC report. While the majority of the report and related diagrams are complete, several sections await further information from Mr. DiDomenico's people in Chicago. In Chapter II, sections D-2 and E-2, in Chapter III, parts of sections B and C, and all of Chapter IV, completion is contingent upon my learning from EPA precisely how samples were collected and analyzed. I have written to Mr. DiDomenico, but have not yet received a reply.

As you will learn from reading the draft report, the drainage ditch on the site appears to have acted as a ground water recharge site for part of the study period. When this occurred, a slug of PCB-concentrated water appears to have been introduced into the aquifer and its migration from the ditch is traceable. However, several inconsistencies cloud this interpretation and I'm hoping the EPA information may clear up some of these.

First, on the set of soil sample analyses is one labelled "acetone", for which a value of 5.1 mg/kg is listed. If this is pure acetone and the units are, in fact, mg/kg, then one can question any interpretation of "contamination" from a source at CMC. The 5.1 value is higher than virtually all of the well samples, meaning all sample values could be argued to be just acetone dilution readings. I doubt that this is the case, but cannot be conclusive until EPA responds.

Secondly, there was no apparent reason for the rapid rise in well water levels which occurred during the study. September was an exceptionally dry month. Unless CMC released water of the Sewage Plant raised levels in the sewage lagoons, flow in the ditch should have remained low. I've requested EPA check on these matters.

Next, a quick look at Figure 22 leads me to believe that PCB readings for wells 4A and 4C have been reversed on 8/30, 9/5 and 9/11. After 9/11 the sets of values for the two wells completely reverse themselves - the high value well becomes low and vice versa. I also suspect the same on 8/30 for 7A and 7C. In either case, personell unfamiliar with the site may have confused the A and C wells which were at opposite ends of a line of three wells, a very common error. I have written the report using the

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the data as they have come from EPA. If revisions in the data are made, changes will be necessary in the report and interpretations. If water samples have been reversed, it is also likely that water level readings are reversed, and revisions in flow interpretations will also be necessary.

Finally, one major inconsistency exists which can't be fully answered by my questions to EPA or to Warzyn. The interpretation I have made of the transport of the PCB's assumesthe PCB's have been introduced to the ditch from the ditch and carried by convective transport toward the monitoring wells. That interpretation is consistent with the flow direction data, but not with the measured permeabilities. The flow rates necessary to carry the PCB-rich waters are two to three orders of magnitude greater than those calculated withthe Darcy equation for the permeability and gradients present. The only other viable interpretation, as I view the data, is the one mentioned in the report - that vertical recharge produced a change in conditions which resulted in desorption of PCB's from clays, or other adsorbants, in situ. This leads back to your earlier question over the phone regarding the need for adsorption capacity measurements. I now believe that in order to fully examine the alternative interpretation, we must determine the adsorption capacity of the aquifer materials (including fill), their desorptive tendencies when encountered by recharge from the atmosphere, and then the quantity and quality of vertical recharge likely at the site in early September. If, as I suspect, too little rain fell in September to overcome soil moisture deficiencies, then we can argue against this interpretation.

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Sincerely,

Douglas S. Cherkauer

Thea L. Urban
Certified Shorthand Reporter
134 South LaSalle Street
Chicago, Illinois 60603
312-782-3332

22 December 1982

Mr. James T. Hynes
Deputy Chief, Civil Division
United Statess Attorney's Office
219 South State Street, Room 1486
Chicago, Illinois 60604

Re: Case No. 78C1004- United States of America vs. Outboard Marine Corporation and Monsanto Company - Deposition, resumed of Dr. Douglas Cherkauer

Dear Jim:

Enclosed with your copy is the original transcript of testimony taken at the resumed deposition of Dr. Douglas Cherkauer on November 18, 1982 at your offices.

The first session was delivered to your office on June 8, 1982.

I appreciate your help in submitting the original to the deponent for reading and signing.

Thank you.

Sincerely,

Thea

Thea L. Urban

TLU/
Enc.

cc Ms. Roseann Oliver
Mr. Robert E. Shapiro
Ms. Carol Dorge
File

Thea L. Urban
Certified Shorthand Reporter
134 South LaSalle Street
Chicago, Illinois 60603
312- 782-3332

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