STATE OF MICHIGAN

STATE OFFICE OF ADMINISTRATIVE HEARINGS AND RULES

In the matter of: The Petitions of the Keweenaw Bay Indian Community, Huron Mountain Club, National Wildlife Federation, and Yellow Dog Watershed Environmental Preserve, Inc., on permits issued to Kennecott Eagle Minerals Company. ______________________________/	File Nos.: GW1810162 and MP 01 2007 Part: 31, Groundwater Discharge 632, Nonferrous Metallic Mineral Mining Agency: Department of Environmental Quality Case Type: Water Bureau and Office of Geological Survey

D R A F T   T R A N S C R I P T

HEARING - VOLUME NO. XXIII (23)

BEFORE RICHARD A. PATTERSON, ADMINISTRATIVE LAW JUDGE

Constitution Hall, 525 West Allegan, Lansing, Michigan

Monday, June 9, 2008, 9:30 a.m.

APPEARANCES:

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Lansing, Michigan
Monday, June 9, 2008 - 9:38 a.m.
JUDGE PATTERSON: Okay. Ready?
MS. LINDSEY: Yes, we are.
JUDGE PATTERSON: Okay.
MS. LINDSEY: Intervenor calls Michael Liebman.
REPORTER: Do you solemnly swear or affirm the testimony you're about to give will be the truth?
MR. LIEBMAN: I do.

MICHAEL LIEBMAN

having been called by the Intervenor and sworn:

DIRECT EXAMINATION

BY MS. LINDSEY:
Q Good morning.
A Good morning.
Q Mr. Liebman, to orient the court to your testimony, can you just tell generally the topic that you're here to testify to today?
A Basically the storm water management, managing the storm water at the site.
Q Where were you formally educated?
JUDGE PATTERSON: Can you spell your last name for me?
THE WITNESS: Liebman, L-i-e-b-m-a-n.
JUDGE PATTERSON: L-i-e-b-m-a-n?

THE WITNESS: Yeah.

JUDGE PATTERSON: Okay. Thank you.

A What was --

Q Where were you formally educated?

A I started at Michigan Tech, but I got my bachelor's of science degree at the University of Wisconsin, Madison.

Q And what was that in? What was your major?

A Civil and environmental engineering.

Q And have you completed any additional training or education in addition to that?

A Yeah. Through the years I've attended tens of -- 30-some different continuing education courses to stay current in the storm water management field.

Q And where did you start working after you graduated from the University of Wisconsin?

A I first started at Donohue and Associates in Cheboygan and after two years then went to Foth.

Q Is that where you currently are employed?

A Where I am, yes.

Q What's your current title or position?

A Senior water resources engineer.

Q Is that your main focus is water resources?

A Water resources. Through the years -- and that includes water distribution and supply and that type of thing, which I've worked on through the years. But the last 20 years probably I have kind of focused more on the storm water management field, that portion of water resources. That's been a changing environment in terms of permitting and whatnot. And so I kind of lead the company in that regard. We have technical competency leaders, and I am that for surface and storm water management.

Q And why don't you give us a little bit of background about -- of your work experience over the last 20 years or so with the types of projects you've worked on?

A As I mentioned, through the years, a lot of municipal work, even sewer system evaluations for sanitary systems to see how much rainfall is getting into the systems, that type of thing, water distribution and supply for drinking water systems for communities. That was earlier in my career. And then later in my career now more focused on the water resources and storm water management end; flood plane studies, for instance, dam design, flood plane studies for FEMA and communities and sites, the storm water management aspects for developments for communities doing storm water management plans, looking at communities overall planning for meeting the new water quality requirements that EPA has mandated, a lot of riverine studies, sampling studies. And then one of the main treatment aspects for water quality is detention pond sizing and design, which I've done an awful lot of that as well.

Q Okay. And have you worked on sort of -- so there's retention, detention basins?
A Correct.
Q You've worked -- can you give us an idea of how much of your time is devoted to that?
A I've probably done hundreds of different designs through the years along with storm sewer system design, culverts, roadway drainage. Any kind of drainage in storm water management aspects I've been involved with.
Q And have you lectured or given any presentations on storm water management issues?
A I have given a handful, yes.
Q And I understand you said techni- -- I don't know -- technical competency leader in storm water management for both. What does that mean?
A That I'm responsible for the entire company across all their offices throughout the Midwest here to make sure that the storm water management technical approach is sound on projects and the resources are there to properly provide the project, the client, with storm water management.
Q Do you have any licenses or certifications?
A PE in Wisconsin.
Q Okay. That is professional engineer?
A Yes.
Q Okay. And did you perform any work on the Kennecott Eagle

project?
A Yes, I did.
Q What did you do?
A I oversaw the storm water management aspects of the project. I was deeply involved in the actual sizing of the basins to store the runoff generated at the site.
Q And did you prepare or supervise the preparation of any appendices to the mine permit application?
A Yes. Appendix E, which I believe is also Appendix H in the groundwater permit.
Q Okay. And that's --
MS. LINDSEY: For the record, that's the mine permit application. Appendices E through J are Intervenor Exhibit 5.
Q So you specifically talk just Appendix E; correct?
A Correct.
Q Now, you've talked a bit about your experience in storm water management. Have you done any mining projects; worked on any mining projects?
A I've worked on a number of mining projects through the years including some work in the Flambeau Mine, the Crandon Mine, some different -- the Badger Mine in central Wisconsin, some different quarry sites and that type of thing working with storm water management to properly handle runoff from those sites.

Q Okay. And have you worked on any other projects that require the type of analysis that you did for the Eagle project in terms of determining sizing for basins?
A Well, as I said, I've done hundreds of detention -- wet detention pond sizes, designs, and they all require a similar type of approach to determine what is a reasonable size for these facilities.
Q Let's talk about what it is you did for the Kennecott Eagle project. And I think we'll turn to Appendix E.
A Okay.
Q And you have in front of you just a copy of that; is that right?
A Correct.
Q Okay. What I'd like to turn to is Figure 1 in that exhibit, which is a few pages in. And can you give us just generally -- while we're waiting for that, can you tell us what is the purpose or the goal really of a storm water management plan? What are you attempting to accomplish?
A Well, in any development be it a residential development, industrial site or a mine site like this, there's going to be runoff coming from rainfall, snow melt, whatever. And you want to make sure that there is no harm caused from that. And typically on a site, that harm might be, as it's generated and flows downhill, it gets into a ditch and it might cause some erosion or something like that. So we want

to make sure that that doesn't happen. Also in a -- with the new storm water regulations, there's some water quality aspects that they want to try to provide infiltration to storm water to meet more of a natural condition before the site is developed. And in this case, there's a third issue, and that is that some of the storm water will be in contact with some possible pollutants. And that's what this diagram shows. The green here is the area that's designated as the contact drainage area. That will -- any storm water, any rainfall, whatever, that falls on that green area is graded with, you know, slopes to flow into the contact basins right here. Any water that falls -- the pink area here is the non-contact area. So any drop water that falls right there is going to go over here (indicating). If it falls here, it's going to go into these non-contact water basins.

Q And can you point out where -- I think you just did, but can you point out again where are the contact basins?

A The contact basins are right there (indicating).

Q Okay. So are there two of them? Is that --

A There's two of them. They kind of act as one, but you can shut one down and maintain the other one. So there's dual pumping systems in them and whatever. The water from this entire drainage area then is directed through ditches and culverts and just over land flow to get into the contact water basins for storage. And then it's ultimately pumped

then to the wastewater treatment plant to clean the water up before discharge.
Q Okay. And can you point out where the non-contact water infiltration basins are?
A Because of the grades to -- in the different operations in the site, there are several different -- four different non-contact storage basins, infiltration basins. There's one here that will take any runoff in this area (indicating). This area will go here. This is going down this roadway to this site. And another non-contact storage area is taking care of any activities in that area.
Q Okay. And are these labeled -- on this exhibit are they labeled as contact basins and non-contact basins?
A Yes.
Q So how is it that you accomplished separating the contact area from the non-contact area?
A As I said, it was basically grading. This is the high point in the -- in the design at the site so that any water that drops on this side flows downhill into here. Any water that drops on this side flows downhill into here. You look at it as a ridge. It's not a real defined ridge. But it's a high point so the water goes in both directions.
Q So just for the record, what you're describing is the high point is essentially the demarcation line between the contact and the non-contact?

A Correct.

Q Okay. So that -- and just clarifying for the record, it will be that -- what you're saying is water will flow from the contact area. It flow down into those contact basins?

A Correct.

Q And then the non-contact area will flow in the opposite direction based on that grading?

A Yes.

Q All right. And you also mentioned -- you said -- you made mention of culverts and ditches. Are those -- can you tell us a little bit about how those are used to accomplish that as well?

A Well, there's -- for instance, in the contact drainage basin, you know, there's roads. And as the flow flows off the surface, it might go into a ditch and go under a culvert and flow along another ditch and then into a culvert or a ditch system to get into the basin. So it's just a matter so you don't have overland flow just flowing across the land. It's collected, conveyed through the ditch and culvert system and into the basins. And a good example of that here is, on this side, you know, obviously you crown your road a little bit to have the runoff go off the road into some ditches, and so they would direct and then have a culvert here and then direct it into that non-contact basin at the bottom.

Q Now, what are the potential sources of water? Let's take the contact basins first. What are the potential sources of water that might be stored or directed to that contact basin?
A Well, there will be some from the rock storage areas directed in there, some from the mine processes will be directed in there for temporary storage on its way to the treatment plant. And then -- at some times the biggest part of the storage would be rainfall and/or snow melt.
Q And how does the -- how does it get from the mine into the contact water basins? How does that water get there?
A That would be pumped.
Q Now, the non-contact infiltration basin, what water is that designed for generally or what is the source of that water?
A Really the only source of that water will be storm water runoff. And storm water runoff includes both rainfall and snow melt.
Q I'd like to talk for a minute about the non-contact water infiltration basins. What -- are you familiar with the process for how that water infiltrates into the ground and the design of those?
A Yes. Typically again the storm water regulations are such now that you do try to provide some infiltration of storm water runoff from a development site. And the soils in this entire area are really good for infiltrating into

groundwater. So the storm water runoff that comes off of these basins -- off of the drainage basins, as I said, will be directed into the non-contact infiltration basins where they will be set and be infiltrated into the soils.

There are certain parameters you have to be careful with in infiltration, one of which is that the groundwater table has to be a safe distance below. And usually 5 feet is a safe distance. And here the groundwater table is as much as 40 feet below. And in that process of infiltrating the water, you not only get rid of the runoff, but you're helping the natural system to get back to a natural condition where it typically does infiltrate anyway. But in that process, you're -- the infiltration process does drop out any pollutants that might be in the non-contact water. Now, we don't expect to have the type of pollutants that we might have here where there's potential contact with the waste rock and that type of thing. But even, you know, from a parking lot, any street out here, there are pollutants that rainfall and runoff are going to collect and discharge someplace. In this case, they're discharged into the infiltration basins where they basically stop. They're being treated. They're not going anywhere then. So it's an awfully good system, 100 percent infiltration for providing good water quality and storm water management for the site.

Q You said earlier that you were involved in the sizing --

determining the sizes for these basins; correct?
A Uh-huh (affirmative).
Q Okay. What analysis do you need to determine -- or what factors do you look at to determine the sizing needed for these basins?
A Well, because you're dealing with Mother Nature -- this isn't like a wastewater treatment plant, you know what the parameters are, you know what the flow is and you know what treatment you have to size to meet that. With Mother Nature, with the natural storm water process, you have to get into statistics a little bit because it's different every day. You know, today there would be no runoff. Yesterday there was an awful lot of runoff. How do you design for that? So the standard of the industry is to pick a certain level frequency event. And typically from a water quality standpoint like for the infiltration basins, those are done as typically like a two-year event, because that's where most of the pollutants are coming from. It's an event that might happen once every two years. Yesterday might have been maybe a one-year at best. So it's a pretty bad rainfall. But for a situation -- for the contact water, we want to make sure that the water is not leaving the contact basins for a real, real severe event, that it's just not going to happen reasonably in the life of the project.
The life of the project here is maybe seven years.

So you could design it on a seven-year event. But then that has a one chance in happening in that life of the project. That's not quite enough. So typically you might use a 25-, maybe a 50-year event. To be really conservative, we went to a 100-year event here to determine the sizing of the basins. That was our starting point.

Q And by a 100-year event, what you mean then is you're talking about a once every hundred year precipitation event?

A Correct. That's kind of the standard of the industry where that event will give you this bar that we're trying to reach; you know, what's a reasonable bar in this natural system. It's hard to determine that. Well, a 100-year event is considered a pretty high bar, and it generally covers snow melt and everything. If you do a 100-year rainfall event, you're in pretty good shape in terms of meeting a high level of safety.

Q Okay. And the rainfall event, what period is that considered? A hundred years during what period of time?

A Well, you can do it on a 20-minute. But a 24-hour event is the typical standard of the industry to determine -- because that gives you enough volume -- more volume than -- a more severe but shorter duration event is less volume. So 24-hour event is typically what's used. And there's records on hand for those types of events, too. So statistically you have a fallback to determine what is this event. For

this area, a 100-year, 24-hour rainfall is about 4-1/2 inches.
Q So you did that analysis?
A Yes.
Q And did you do any further analysis?
A Well, because this location of the mine is in what's considered the snow belt -- they do get lake effect snow and a lot of it -- we thought it prudent even though a 100-year rainfall event is a pretty conservative level of design here, we felt it prudent to check some level that included snow melt as well and chose a 50-year event combination snow melt/rainfall event.
Q All right. So let's talk about how you did that analysis. And if we could turn two pages, get down to -- all right.
A Yes.
Q All right. Can you tell us what we're looking at here and what you used this to determine?
A Well, yeah. The tricky part about trying to properly cover the snow melt issue is it doesn't matter how much snow is on the site or how much rain there is or how much temperature -- how warm it is. It's this combination. It's an event. So what we tried to find is, well, what is -- what would be this 50-year event for this area, this combination of temperature and everything else. So the -- one of the things USGS, the United States Geological Survey,

has gauging stations. And all these numbers are gauging stations in the Upper Peninsula on rivers. And rivers are a good indication of such an event, because they have big drainage basins. When they get the snow melt, the rainfall, they react. They flood, there's bigger depth.

So we looked at two of the closest -- you can see. There's the mine site right there (indicating). There's no gauge on that river. But there's some gauges on the Peshekee River and the middle branch of the Escanaba River. The beauty of looking at a stream gauge station is that it does have a history enough to determine what is statistically a 2-year flow, a 5-year flow, a 100-year flow. So now we can relate to this 100-year event, this 50-year event. So we looked at these gauging stations. And I don't know if you want to go to the graph?

Q Yeah. Well, one question there. Why -- I think you covered this. But why didn't you use anything right on the mine site or the river that's right there?

A Well, there are no gauging stations any -- we chose the two closest gauging stations that we could find. And we felt, through my engineering judgment, that they were close enough to give real good reasonable parameters that would apply to the mine. It's close enough. It's still in the snow belt that it would be reasonable.

Q Okay. So let's turn to the next one. And if you could tell

us what you -- this is really hard to read.
A There you go. Okay. So this is the Peshekee River. That was one of the ones that we just looked at.
Q Yeah. Let's get that -- the first third of that up where the --
A And -- well, you can see here. These are the frequencies here. You've got a 5, 10, 25, 50 and 100. This is the 100-year -- statistically how much flow you're going to find in this river on a 100-year event. Okay. So that's 40- -- 4,240 cubic feet per second. So for that river -- now, we can graph -- we can provide a graph to determine, you know, what flow is at what frequency, what recurrence interval.
Q Okay. And so which -- it looks like from the highlighting, did you look at 50-year and 100-year frequency for your graph?
A Well, our main goal here was to be able to plot this on the frequency graph paper so that we could go back to that later to determine. Because now -- okay -- we know what the flows are in the stream, but what does that mean to the mine site? Now what we have to do is determine what event -- what happened to make a storm on the stream -- the runoff on the stream come up so high. Okay.
Q Okay. So how do you determine that?
A I think, if we go to that graph --
Q All right. Let's go the --

A And as ugly as this is, I hope I don't lose everybody on this. That doesn't show up very well.
Q Well, if we turn it first and then --
A It's upside down.
Q There we go.
A Okay. So we looked at the Peshekee River. And that's what this -- this line is here (indicating). So this is a recurrence frequency paper, a special paper that kind of -- you can see it stretches out the ordinates here. So you have flow on one side and recurrence interval on the other. So here's the 2-, 5-, 10-, 50-, 100-year. Okay. So the Peshekee River, when you plot those from the previous page, you know, the 2-year, the 100-year, that gives us this graph (indicating). Okay. Similarly for the middle branch, the Embarrass (sic), that has this kind of statistical frequency of runoff. Okay. So now that we're plotted there, now -- you can see we have two dates here, 1965 and 1985. What we wanted to do is find two pretty bad runoff events on these rivers and then see what was the rainfall, what was the snow melt, what was the temperature that caused them and then apply those parameters, that event, that runoff event, onto the mine site. Okay. So if we go back now to -- a little more -- okay. This is good. One more.
Q Okay.
A Okay. So now we're back to the Peshekee River. And this is

the history of events of that -- in that stream gauge. These are the records of that stream gauge. And we wanted to pick one of the bad storms in the past that had good rainfall, snow melt, depth of snow information. So we picked this storm, which is April 1965. There was a flow of 3500 cfs. Okay. Next slide. This is blown up. This is what that looked like. So this is a flow over here and time on the bottom. So around the end of April, there was this combination -- this event, this runoff event which included the temperature and the rain and the snow melt that caused this high flow. Okay. And we did that same thing for the Escanaba. Now -- okay. Continue on.

Q So the next two -- these two graphs are the same analysis?

A Are the Escanaba River, same type of thing. Now, this one, you can see, there's a real high peak here April of 1985 on the Escanaba River. Okay.

Q And just for -- if we can go back one more. That period looks like it goes from 1960 -- sometime in the 1960's through 2000?

A 50's even.

Q 50. And so that -- to me, that looks like the highest event you had, period?

A Yes.

Q All right. If we can go then -- so after you have this event --

A Now we know these dates. Okay.
Q And then what do you do? Where do you take the data from there?
A The next one -- one more. Okay. Now we want to -- on these dates, what happened. Okay. So we go to the climatological data that's put out by -- I believe ultimately the National Oceanic and Atmospheric Administration. Okay. Next slide. So here we have -- if you can blow that up a little bit. April of 1965. We went to the nearest climatological station that had good precipitation and depth of snow data. And this particular one was in Houghton, which again is in the snow belt. And it was judged to be certainly close enough to be applicable to the mine site. And so now this is -- where this rain occurred, this is the precipitation that helped make that happen. So it's that precipitation then that we used in conjunction with the next slide, which is depth of snow. Okay. So similarly is the depth of snow that was used. And it started out at 39 inches. And in whatever -- 20 days, 26 days or something it melted and went away as runoff that filled up the stream that caused this event. Okay. So now we know what this event was. It was a combination of this fast snow melt, 39 inches of snow, and that rainfall, whatever it was, 1.7 inches or whatever. So it's that event then that we put over the site to determine -- as a starting point to determine the basin

sizing for a rainfall/snow melt event.
Q Okay. And did you do the same analysis for the other river?
A Exactly, yes.
Q So the next -- if we can go through the next couple of pages.
A Yeah.
Q So this is -- you had determined that was in April of 1985, the other event?
A Yes.
Q Okay.
A You can continue. It's the same thing for the other river then.
Q Okay.
A One more yet. Okay. Now, we know the rainfall and we know the depth of snow. Now, what does the depth of snow mean to us in terms of runoff, in terms of inches of water. Typically snow you figure is about -- 10 inches of snow is 1 inch of water generally. But we wanted to be more exact than that, so this is an evaluation that was done spring 2002 across the upper -- central upper Michigan where the site is. And in this particular -- and this was a bad event. This is where that dam washed out on one of the rivers in 2002. At any rate, here their study found that 41 inches of snow that they had on the ground held over 11 inches of actual water. So that's a pretty high density of

water in the snow. That's what we used to be conservative, which is about 28 percent water. So now we have our arms around this event. It's a rainfall event of whatever inches it was, the 39 inches of snow, 28 percent of which was water. So now we've dropped that on -- on the site, both the contact and the non-contact water site to make sure that we were properly designed on the basins on the storage.

Now, if you go back to the graph, which is about four more --

Q Yeah.

A No. One more, I guess. So what we did is we dropped that 1965 event on the basin. Now, look at the contact -- this is the contact storage up here (indicating). Now, on this graph, I -- instead of the flow on the upper end here, I put the required storage in millions of gallons. Okay. So for this event, dropped over that drainage basin, it turned out that we needed -- what? -- 7.2 million gallons of storage. And that was -- if you look, this event like a 20-year event, once in 20 years. The 1985 event was like 150-year event. That required about 8.2 million gallons. So on this frequency paper, we straight-lined that to come up with what the 50-year event was, and that was 7.8 million gallons that we used for the contact storage. So that gives us this 50-year rain/snow melt event that we designed for.

Q Okay. Now, when you're making that calculation, you said

you sort of dropped that snow and that rain on the mine site. What do you take into consideration to determine how that will affect the mine site, how much runoff of water will be created for that site?
A It's really simple math. The site is -- the contact, site, for instance, is about 32 acres. Well, this volume of water, the 28 percent of the 39 inches of snow, the 1.7 inches of rainfall, that dropped onto this 32 acres will give you so many cubic feet, which equals so many gallons which equals 7.8 gallons of water. So for this huge event, we're sized to handle that much water.
Q And, now, what did you do for the non-contact basin?
A Actually we did the same thing. That's what the rest of these are. This is non-contact basin number three. And again the reason these are all different lines is because they're all different drainage areas that go into them. So the bigger the drainage area with this much storm water dropping on it, the bigger the basin needs to be.
Q So you took into consideration that same analysis for the contact and the non-contact basin?
A Yes. Now, the only difference was that, for the contact basin, the calculation includes the water going in but it then subtracts out the 100 gallons per minute drawdown during the period of this 20 days or 26 days or whatever this event happened. It's taking that out of it. For the

infiltration for the non-contact, we did not subtract out the infiltration, which would occur during the event. But again to be conservative, we did not subtract that out. So we've very conservative on those as well.
Q So you were not assuming any infiltration during that event?
A Correct.
Q And what was the period of the event --
A The 20 days, whatever that event was, that snow melt event. 20 days, I think, was one, and 26 was the other, I believe. I'd have to check.
Q Now, normally would you expect some infiltration to be going on during that period?
A Yes.
Q So why did you assume no infiltration?
A To be conservative and the fact that we didn't know how much infiltration. You're coming off a frozen -- potentially frozen period. Although with that kind of snow cover, it does provide insulation and so infiltration would likely occur. But we wanted to be -- as we have been in all of our calculations, we wanted to be conservative, play it on the safe side.
Q For the non-contact infiltration basin, did you look at any other potential event to determine the size?
A We did want to make sure that they were sized large enough for an annual event. Okay. So now we looked at this big,

bad event. But that comes and goes. Annually there might be 30 inches of rain that drops on this drainage basin. So we wanted to make sure that these basins were sized to handle that as well. For that, we used infiltration but only for six months out of the year, which again was very conservative, and found that the basins were five to ten times bigger than they needed to be from an annual water budget standpoint.
Q So have we covered all of scenarios that you looked at for sizing these basins? Let's start with the non-contact.
A For non-contact, again we wanted -- we looked at the 100-year, the combination -- the 50-year combination runoff/rainfall, which turned out to be far -- like three times larger than the strict rainfall 100-year, and then the annual water budget, yes.
Q And was it sized to hold each of those --
A Well, we sized it for the worst condition, which was that combined 50-year snow melt/rainfall.
Q And what about the contact basin?
A Same thing except we also looked at the possibility that the treatment plant would be in service or out of service for maintenance or whatever for 14 days and found that, yeah, the sizing of our contact basins certainly have enough size for that event -- if you call it an event -- as well.
Q What is -- you told us earlier. What's the projected length

of use of these basins or of the project?
A Well, my understanding is something like seven years.
Q And so typically in the industry what event would you use in that -- in an 8-year event? What precipitation event would you use?
A Well, for the non-contact basins, in a typical situation where you're not dealing with some special pollutants, a 25-year, be real conservative and use a 50-. As I said before, this time we went up to the 100- and even went beyond that to the 50 rainfall/snow melt. So I feel we were excessively conservative on these sizings. For the contact basin, because there are some special pollutants that we just plain to not want to discharge, I feel we're conservative as well, especially when you consider that there's another 2 feet of freeboard available above the 7.8 which gets us to about 10 million. And if you look at the graph here, we designed it at 7.8. This 150-year event, is 8.2. That extra 2 feet of freeboard gets us out to almost 10 million, which is, you know, like a 900-year event or something. So basically water isn't going to get out of that basin.
Q You've told us 2 feet of freeboard. What's freeboard?
A It's the contingency that's built in. It's in the Michigan regs. They have freeboard. But it's a contingency that's there for safety reasons, factors of safety, wave action,

things like that.

Q Is freeboard of a similar or different design than the rest of the size of the basin?

A Well, it's -- we're designing this vessel to hold 7.8 million gallons. Then on top of that, we go 2 feet up so that we're at 7.8 million -- we're at like 10 million if you go to the very top before there's an overtopping event. So it's just that extra factor of safety, that contingency that gives us a better comfort zone. But in this case, it brings us way out on the curve to a real safe frequency.

Q And are there any other contingencies in the permit if you exceed that capacity?

A Yeah. The rock storage area can be used for storage. And the mine itself can be used for water storage in the event that you almost have a very, very severe -- I'm talking about a really, really severe event anyway. But if something goes beyond even that, with those other contingencies, there just plain should not be any discharge of contact water outside of that site, because again it can go back into the waste rock storage area, which is quite large, and even back into the mine if need be on an emergency-type situation, which that would certainly be if you get a flood like that.

Q And when we talked -- you talked about the non-contact basins and their sizing. And there was some testimony in the case about planned discharges from those basins. Based on how they are sized, do you think in your experience there's going to be a -- is there a plan to discharge?

A Well, again this is such a conservative design especially for the non-contact that, no, there is no planned discharge. On typical infiltration basins, detention ponds, you do like to put in an emergency spillway so that, if the water does get up that high, it can overtop where you want it to overtop. It won't just overtop the berm and wash out the berm or something. So it armored. You put riprap in there and -- so you have a controlled discharge if there is. So we added that as part of the design, because it's just a good design feature. But is it what I would say a planned discharge? We're not planning on discharging, because our numbers show that the infiltration rate annually is going to keep the thing dry, that the size of the things are sized large enough to handle these really severe events. So I wouldn't say it's planned. If it is discharged, that's fine. That's typically. Normally you don't provide that kind of storage for a non-contact infiltration basin. Like I said, if you're doing it for a Shopco or a Target, a building like that that has pollutants on their parking lot, it would discharge typically on a five-year level. So here we're way beyond that.

MS. LINDSEY: Thank you. I have no other

questions.

MR. REICHEL: I have no questions at this time.

MR. EGGAN: I have no questions.

MS. HALLEY: I have just a few questions.

THE WITNESS: Okay.

CROSS-EXAMINATION

BY MS. HALLEY:

Q Have you ever been to the site, Mr. Liebman?

A No.

Q Now, you're aware that before operation begins, the company needs to obtain what's called a notice of intent; is that right?

A Yes.

Q And has the company filed this notice of intent that you're aware of?

A My understanding of the process is that that's kind of the second part of the -- I can't remember what the name of it is. But it's the erosion control construction permit, storm water permit, which they have applied for and have obtained, I believe. The -- you go through the process, and then you go for a notice of intent for operation of the site. And I believe that's through Marquette County. And so that would be one of the next steps that has to be done.

Q But that step hasn't occurred yet?

A Not to my knowledge.

Q And what would the notice of intent normally include?
A It would include everything I just talking about. So applying for that notice of intent, we've got all the information, all the facts that proper storm water management of the site, so it should be, in my view, a real easy thing to take care of.
Q Have you ever been called in to correct a situation where contaminated water has overflown or -- overflowed from a holding facility that was designed to contain storm water or contaminated water and to redesign a --
A I've been involved with some projects in the industrial sector where they have what they call storm water pollution prevention plans, SWPPP's. And those efforts typically look at a site to make sure that areas of pollutant like oil drums, salt piles, things like that, are properly handled either through covering them so that rainfall doesn't hit them or providing treatment to any runoff that does contact them. So in that regard, I've been involved in trying to fix those problems possibly as part of permitting and whatnot. Have I done where it's failed and I came in to help solve it? Possibly through the years.
Q You mentioned that you did something at the Flambeau Mine site. What did you do there?
A I -- it's so long ago. Looked at, I believe, some of the restoration things after it was wrapped up, helped review

some fo the storm water management features on the site.
Q Are you aware that there is contaminated runoff going into the stream that it's exceeding Wisconsin's water quality standard at this point?
A I'm not aware of the details of that.
Q Now, you said you worked on the Crandon Mine project?
A Uh-huh (affirmative).
Q What did you do there?
A The same kind of thing in terms of looking at the storm water management, making sure it was properly handled. We didn't get in in any of the final design or anything on that but went well into the permitting process.
Q So at the Flambeau Mine site, were you responsible for ensuring that segregation of contaminated water or that the contact water and non-contaminated or non-contact water -- that those two types of water would be completely separated?
A I can't recall what my responsibilities were on that. As I said, I know I was involved with some storm water management issues, some culvert sizing. I don't know if some basin sizings or not. I don't remember.
Q Well, have you ever been responsible for assuring that contact water and non-contact water are completely segregated?
A In industrial applications, yes.
Q And what kind of contaminants were involved in those sites?

A Well, you get in different industries. There's a number of different potential contaminations. So it was a matter of designating just like this contact versus non-contact area. The office parking lots and stuff are non-contact. They're under different kind of scrutiny. But the contact areas, yes, major industries like Procter and Gamble, Tropicana, a number of them to make sure --
Q And do you think the segregation is 100 percent effective?
A I think it's -- 100 percent effective is a tough one to call. It's effective in terms of keeping the contact away from the non-contact. Where that divide is, if a truck rolls by and splashes a couple drops on the other side of that divide or something, that's possible. But any significant pollutant movement into the non-contacts areas, I think, are properly taken care of.
Q Now, you said that you did design an emergency spillway for any discharge that might come into the non-contact water infiltration basins. What is the receding water for those emergency spillways?
A That would drop down off the berm in a safe manner and be dissipated into the surrounding soils ultimately, I would think, going into -- well, it depends on what's around it. So if there's a woods there, if there's a wetlands there, that's where it would go.
Q Well, would it help you to look at the map --

A Sure.

Q -- to see sort of what is around there? Okay.

MS. HALLEY: Maybe we should take a break. It'll take a minute for us to --

JUDGE PATTERSON: Okay.

(Off the record)

Q All right. We were talking about the emergency spillways from the noncontact water filtration basins. Okay? Now, this is similar to the map that you had before with the purple areas here being the noncontact water areas; right?

A Correct.

Q And the green in the middle there is the contact area; right?

A Correct.

Q Now, let's take -- well, this is a -- do you have a pointer up there?

A I do.

Q Why don't you point out for us the infiltration basins -- the noncontact water infiltration basins?

A Okay. This one up here (indicating) is basically going to store and infiltrate the water generated from this drainage basin. This one here (indicating) is storing the water from this drainage basin. This one here is storing and infiltrating the water from basically the road, that drainage basin. And this one here is doing the same for

this drainage basin on the side.
Q Okay. Now, starting with the one you just highlighted on the left-hand side, where is the emergency spillway for that basin? Where is it in relation to the basin?
A You know, I'm not exactly sure. I'm thinking it's probably right in this (indicating) corner.
Q Okay. And going in which direction and toward what?
A Given this very severe event that water would get high enough to activate the emergency spillway, it would overflow and dissipate along the ground in this area.
Q What kind of volume would be coming out of that emergency spillway? Do you have any idea?
A Based on the calculations up to 100-year time frame, zero, you know, because it's all infiltrating. It's sized large enough that for this big event, past 100-year event or 50-year event or greater, there will be no discharge.
Q Okay. But you've included a spillway; right?
A As a common design practice. We don't intend -- we expect that there's going to be -- in the life of this mine that any water will go over that spillway.
Q All right. But you've included it because it's a standard design practice?
A Yes.
Q If water were to come out of that spillway, particularly the last one there that you were looking at on the left, --

A This one? Yes.
Q -- which direction would it go?
A Well, once it gets over the spillway and down the berm, it would follow whatever grades or contours and natural lay of the land -- you know, it would move downhill. You know, and that's the other part of it. Water now that falls in that drainage basin goes someplace. So this water would do the same thing except --
Q So you understand this is a topographic map we're looking at; right?
A Correct.
Q Now, do you see the river, the blue line on the left sort of --
A That dark blue one right there (indicating)?
Q Right. Now, can you see from the map that river is sort of down a very steep bank from that particular noncontact water infiltration basin?
A Yes.
Q Now, you said that you would expect some pollutants in the noncontact water from the parking lot and from the roadways and that sort of thing. What types of pollutants would you expect in that water?
A Typical urban stormwater pollutants; might be some lead and zinc or heavy metals from cars. You know, someone may drop a McDonald's shake on the ground and then there will be some

VOD's or something associated with that. I mean, just typical urban constituents in an urban stormwater runoff.
Q Do you know if there's a weather station on the site?
A I don't.
Q Well, would you believe me if I told you that there is a weather station on the site and that it's been there for -- my guess would be at least three or four years? I mean, do you have any reason to disagree with that?
A No. I mean, you look fairly honest.
Q Thanks. Now, were there any actual snowfall measurements used in your analysis -- I mean, actual snowfall measurements at the site?
A No.
Q "No." And it sounds like you understand that there's a wide variation in the UP of snowfall -- amounts of snowfall based on a number of different variables, weather variables, landscape, et cetera, et cetera.
A From year to year it's a wide variation. In any given one year it's a wide variation. That's this unknown thing with Mother Nature that I was talking about.
Q Of course. Now, you said that you believe that the Peshekee Rivers and the Escanaba Rivers are still in the snow belt. That's what you called it. Why do you believe that?
A Based on my understanding of the UP and the weather and whatnot, and the other thing is the actual data of the

snowmelt, snow depth data and rainfall data, were taken from weather stations that -- like, for instance, Houghton which is definitely in the snow belt as is -- the Herman was the other weather station that we used which is right in that same area.
Q Now, given that there is a weather station right at the site, would it be your preference to use the actual data from the site if you had it available to you?
A Our attempt was to use the best information available --
Q But my question was --
A -- as close to the site as possible, so, yes, if --
Q But if you had had information from that site, would that have been your preference to use?
A Yes.
Q Now, do you know if there's any change in elevation between the Peshekee Rivers, the -- the Peshekee and Escanaba Rivers and the Yellow Dog Plains?
A I expect they're at a different elevation.
Q Do you know the difference?
A No.
Q Do you think that elevation is important when we're looking at snowfall?
A Locally there may be some -- you know, in mountainous regions different elevations would have a big effect on snowmelt. In a wide area like this I would expect that

elevations would have a pretty minimal effect.

Q Right. I want to ask you a couple of questions about the Peshekee River and the Escanaba Rivers. Now, do you know the base flow of the Salmon Trout River at the mine site?

A No, I don't.

Q Do you know the base flow of the Peshekee River?

A No.

Q The base flow of the Escanaba River?

A No.

Q Do you know if they're groundwater fed or surface water fed?

A I don't know what percentage of each that would contribute to the runoff. Typically these types of streams have some component of groundwater. And for the major events that we're talking about, these big 50-year events or whatever, the groundwater portion of their flow becomes insignificant 'cause we're looking at surface water, these big storms with a huge amount of water going into the river. So the spring fed, the groundwater portion of the streams that are typically -- have a lot to do with dry weather flow and the base flow, but when you're looking at these big storms, that amount of flow is pretty insignificant.

Q Would you be surprised if I told you that the base flow for the Salmon Trout River at the site is anywhere between 1 and 4 CFS?

A I guess that wouldn't surprise me.

Q Okay. Now, all of the factors that we just talked about, the percentage of groundwater feeding, the percentage of surface water feeding, whether it's a gaining stream or losing stream, don't all of those things affect the flashiness of a stream and how the stream responds to large surface water events?
A Well, there's so many parameters that --
Q Right. But my question is, do those parameters matter?
A And what parameters were those again?
Q Well, we talked about the base flows. We talked about whether they are groundwater fed or surface water fed or what combination of the two in some instances and whether they're gaining or losing streams.
A All those factors would have what I would call insignificant effects on the flood flows, on the major flood flows. Major flood flows are based more on the drainage area, how big the drainage is feeding these streams, the amount of the rainfall and snowmelt that are running off. The steepness of the stream system is a big factor in terms of the peak flows. But those other things that you mentioned are pretty minor when it comes to these big floods.
Q What is the steepness you just referred to?
A A real flat watershed with, you know, slopes of, you know, less than 1 percent in an entire drainage basin would tend to have less of a peakiness. It takes longer for all this

rainfall and runoff to get into the stream. And when it's steeper, the whole drainage basin kind of adds together at the same time to get a higher peak. When it's flatter, that's less of an issue. So that's one factor that might affect the magnitude of these floods.
Q Did you compare the steepness of the Salmon Trout River Watershed with the Peshekee and the Escanaba?
A No, I didn't.
Q All right. Now, you understand that the UP's a pretty cold place. It sounds like you started your schooling at Michigan Tech, --
A Uh-huh (affirmative).
Q -- so you have some experience with that. All right. Now, it's probably no surprise to you that the ground is frozen for a good amount of the year in the UP, particularly above the frost line, which the Yellow Dog Plains is above.
A Well, it's my understanding that, again, because of the large snow pack which is an insulator, that the actual length of time that the ground is frozen in this area is, I think, sometimes misunderstood. I don't think it's the frozen tundra that I think many people believe it is.
Q Okay. So how many days of the year did you assume that infiltration would occur?
A To be conservative we assumed only six months of the year. My personal belief is that it's closer to nine or ten

months, but --

Q But for these calculations you use six?

A Six months.

Q Do you know anything about the water quality in the Salmon Trout River?

A Not specifically.

MS. HALLEY: No further questions.

MS. LINDSEY: I just have a couple of questions. First of all, your Honor, I neglected to move the admission of Appendix E which Mr. Liebman talked about, and I would do that now. This is -- as I had said, it's one part of Intervenor Exhibit 5 and we move the admission of just this appendix.

MR. REICHEL: We have no objection, your Honor. I would also note for the record that that is also contained within Respondent's Exhibit Number 30.

MS. HALLEY: No objection.

MR. EGGAN: No objection, your Honor.

JUDGE PATTERSON: Okay. Thank you. No objection, it will be entered as offered.

(Intervenor's Exhibit 5, Appendix E received)

REDIRECT EXAMINATION

BY MS. LINDSEY:

Q Okay. And, Mr. Liebman, you were asked about this discharge in the emergency spillway and whether there was a permit

obtained from that. You said that the Notice of Intent, it was your understanding, was the second part of the process. Can you tell us, what is your understanding of the first part of the process?
A Well, the first part, I believe, is the Notice of Coverage, which is the construction site stormwater management permit which, my understanding is, has been approved.
Q So that's the part needed for, would you say, construction?
A Yes.
Q If the water were to fall on the noncontact areas and there were no basins, where would that water go?
A Well, it's kind of what I mentioned as we were talking about flowing over the emergency spillway. That water is all going someplace now, and so if it did overflow in this wild event, that it would overflow in this infiltration basin, it would go on the land and basically go -- follow the contours and go where it goes now. So I don't know. It might be a little more concentrated because it's coming off of one area, but in some cases I would expect, for instance, where that steep slope was going down to the river, I would expect because of the infrequency of any overflow from the infiltration there, that there's going to be a better condition with a mine place. You're not going to have a potential erosion going down that slope that might occur now from that small drainage basin.

Q When you did your calculation and got the 50-year event, were you concerned with how much snow fell during the entire winter? What was the snowmelt? What do you look at?
A Well, again, the depth of the snow isn't -- that isn't telling the story. It's the snowmelt event that tells the story. So that's why we went through all these contortions with the stream gages and everything else to gain an understanding of event is going to cause these high flows that we want to make sure are properly handled. And so the amount of snow -- yeah, there's records of deeper snow in Yellow Dog Plains, but how does that -- what kind of runoff is that going to generate? That's the key. It's this event. And it's not just the snow depth. It's the temperature, how long it takes to melt and the rainfall that goes with it. And so the events that we looked at, the process that we went through, was to properly cover those situations and get a good understanding of what's going on there so that we could properly provide storage for it.
Q And can you, if you can remember -- otherwise we can look at the report, but what was the sort of largest snow melt that you looked at of those events, anything --
A Well, the depth of snow during those events that we looked at, one was 39 inches and one was 26 inches.
Q So that was essentially 39 inches of snow that melted within that period?

A Within that 20- or 26-day period, yes, with our conservative estimate of 28 percent water in that 39 and 26 inches of snow. You know, that's the other thing. When you take a snow measurement in the end of January, you might get 48 inches of snow, but the percent of water at that time is maybe around 10 percent. So that's why you have to look at that whole event.

Q So the rivers that you looked at, the Peshekee and the Escanaba, and the flow rate, does it matter to you whether those rivers have different parameters than, for example, the Salmon Trout River? Would that affect your analysis in terms of getting that peak event?

A Many of the parameters that were talked about, again, have very little to do with a flooding event, and we were concerned with a flooding event. So I don't believe that the slight differences in the drainage basin for this river versus that river versus this stream are going to have any significant change to that flooding evaluation that we did as long as the rivers that we chose were close enough to the site to be meaningful, and we feel that they are.

MS. LINDSEY: Thank you. I have no more questions.

MR. REICHEL: I have no questions.

MS. HALLEY: No questions.

MR. EGGAN: Nothing, your Honor.

JUDGE PATTERSON: Thank you, sir. So you want to take a break, or are you ready with another witness?

MS. LINDSEY: If we could take just a couple of minutes?

JUDGE PATTERSON: Yeah, sure.

(Off the record)

JUDGE PATTERSON: Ready?

MS. LINDSEY: Yes, we are. Intervenor calls John Starke.

REPORTER: Do you solemnly swear or affirm the testimony you're about to give will be the whole truth?

MR. STARKE: I do.

JOHN STARKE

having been called by the Intervenor and sworn:

DIRECT EXAMINATION

BY MS. LINDSEY:

Q Good morning, Mr. Starke. Could you please state your full name and spell your last name for the record?

A John Starke, S-t-a-r-k-e.

Q Thank you. And what is the general area that you're here to testify about today, the topic?

A I'm here to testify regarding the Temporary Development Rock Storage Area, the TDRSA, its design and its applications for the Eagle Humboldt Project.

Q And can you just give us your educational background?

A I went through schooling at the University of Wisconsin, Madison. I have both a master's and a bachelor's degree in mining engineering.
Q What did you do after you graduated from the University of Wisconsin?
A I have been employed in a number of different engineering consulting firms starting off with Warzyn Engineering and worked there was three years primarily as a geotechnical capacity related to supervising the geotechnical lab and then followed that up with Donohue & Associates in Sheboygan, Wisconsin. I worked there for ten years primarily in the capacity of solid waste facility design engineer for their solid waste program, and then moved on to Emcon Engineering primarily as a project manager and design engineer for solid waste disposal facilities. And in the last seven years I've been employed at Foth with the capacity of a senior environmental engineer primarily related to mining, solid waste aspects and geotechnical-related topics.
Q So those are the -- mining, solid waste and geotechnical are sort of the three areas you've focused on?
A Yes, that's correct.
Q Can you give us a bit of background? Start with your experience in mining and what you've done in that regard.
A Well, over the number of years I've worked with the mining

industry primarily with hard-rock quarry operations, although recently here at Foth with the recent development of the Eagle Mine, that I've been involved with that project as a design engineer for the TDRSA. I've also been involved with some other mining operations; Badger Mining Complex in Wisconsin. I've been involved with a number of quarry operations that -- quarry hard-rock limestone down in Missouri, also in Wisconsin been involved with some other sand and gravel pit operations, mining operations associated with mine plannings and design of those facilities also.
Q And what type of facilities were you designing for those applications?
A Those tend to be more related to operations planning and management, how to best manage their facilities with the reserves that are on the property, how to extract the reserve efficiently, cost effectively, how to manage that in compliance with their permits and also how to design certain aspects of their operations plants such as conveyor system and crushing systems.
Q And with respect to solid waste management, what type of projects have you worked on?
A I've -- primarily for design of solid waste and hazardous waste, disposal facilities looking at liner system designs with the use of geosynthetics, clay liners, soil liners, have worked in that industry for probably -- primarily for

the public solid waste and also for the private industry for 20-some years.
Q And in the geotechnical area what types of projects have you worked on?
A Primarily related to the solid waste and mining industry, looking at different liners, components, designs, how to ensure that these facilities will be stable during operations and into closure so that we don't have any concerns about the stability of the designs.
Q Do you have any idea sort of how many solid waste projects you've worked on or --
A Probably over the last 20 years I've been involved in maybe over 100 designs associated with liner systems.
Q I'm sorry. How --
A Over 100 designs.
Q And those are -- basically is this -- are we talking about landfills essentially?
A Primarily, yes, landfills. Those would be landfills for industrial facilities, landfills for hazardous waste facilities, landfills for municipal waste facilities.
Q And specifically what is your role in designing those landfills?
A Those were designs to provide protection to the human health and the welfare to ensure that the potential contaminants that were generated with the waste that was being placed

within these facilities was contained and controlled so there wasn't -- or their release, so that there would not be any release to the environment.
Q And what sort of methods are used to control that or to prevent the release to the environment?
A Well, the industry standard is to use combinations of soils and geosynthetic products to design a facility, a containment facility, that will provide protection to the environment, minimize any release of potential contaminants and collection of any -- also contaminants that were transmitted through the liquid and to be able to, therefore, allow treatment of those liquids.
Q So have you worked with different types of liner systems and different types of methods?
A Yes.
Q You told us you're here to talk about the development of the TDRSA -- of the design -- sorry -- of the TDRSA.
A That's correct.
Q What work did you perform for the Kennecott Project?
A I was involved with the design of the liner systems and design of the operations for the TDRSA as well as integrating the HELP model that will be discussed by Jerry Eykholt a little later and how that applies to the TDRSA design and then also the extraction system of contact water that is collected within the TDRSA to be treated through the

wastewater treatment plant.
Q And did you work on any of the reports that were part of the application -- the mine permit application?
A Yes. I prepared the quality control construction CQA plan that's in the mine permit application. And I don't recall which appendix that is, but --
MS. LINDSEY: Just for the record, that appendix -- that's Appendix I to the Mine Permit Application.
Q And was there any revision to that plan?
A Yes. There was a revised plan that was prepared as part of the response to the '91 comments, and I believe that was 2006; July of 2006.
MS. LINDSEY: And for the record, that's Intervenor Exhibit 21.
Q And we'll talk more about that later, but that's -- talking about the TDRSA specifically, what is that designed to hold? I mean, what is the purpose of it?
A Well, the purpose of the temporary development storage rock area, or again, the TDRSA, is to hold rock that's excavated, mine development rock. It is that rock that will be extracted out of the ground that has no value, no economic value prior to mining the ore. So the facility has been designed to hold this rock on a temporary basis. Once the mine is starting to backfill, this rock will then be taken

out of the TDRSA and go back underground as backfill.
Q Now, did you perform the calculation to determine how much storage capacity was needed for that rock, or did somebody else?
A The actual rock volume was conducted by someone else. We took the rock volume, the volume of broken rock that would need to be stored, and designed our TDRSA based upon that broken rock volume.
Q So what was your -- what did you design it to hold if you remember approximately?
A The design has the ability to hold -- the TDRSA has ability, or capacity, as we refer to it, for 285,000 cubic yards. Now, the amount of development rock, broken development rock that's going to be stored in it is approximately 247,000 cubic yards. So we've added a 15 percent contingency on what the demand is for the development rock for potential operation contingencies and also for additional storage for the limestone amendment.
Q Okay. So that the limestone amendment, generally that's something that will be added to the development rock as well?
A That's correct. 20 tons per 1,000 tons of development rock.
Q Speaking of the TDRSA design, could you give us kind of first an overview of the liner system that you talked about?
A Do you want me to --

Q Well, tell us generally what's involved and then I think it would be helpful for you to --
A From a design basis?
Q Yes.
A Well, the design basis of the liner system, first of all, you look at how to be most protective to the human health environment. So we look, obviously, very closely at those systems that will provide us that type of insurance. Also we take a look at what the regulatory requirements are and that's being -- those requirements for the temporary development storage rock are under Part 632. In addition to that, we also look at the Public Solid Waste or the Solid Waste of Michigan DEQ Solid Waste Rules, which are Part 115. So with that in addition to what we also consider are relevant are EPA guidance documents that have helped develop design basis for the use of these geosynthetic components over the last 20-some years. So together we applied all the information collected from those different type of information bases and used that for our design basis.
Q Okay. So if you could -- and it would be helpful to illustrate by drawing, but could you describe for us what the liner system is planned to be?
A Well, the liner system will be -- there's two components of the TDRSA that basically has design concepts. One is the contact water collection system. And the contact water

collection system consists of a two-foot granular drainage sand, drainage layer, and below that is a geocomposite drainage fabric. Now, the geocomposite drainage fabric is a manufactured product that has HDPE webbing, high transmissity, high velocity trans-HDPE webbing that allows water to move very rapidly that's encased and sandwiched between two geotextiles on both sides. That is our contact water collection system. Water that drains or contact water that drains into that system is collected into one centralized collection pipe, a six-inch diameter HDPE pipe which then routes that water down to a collection sump which it is then extracted by a submersible pump that's placed within the collection sump. Now, below the contact water collection system is, first of all, our primary liner. This system with the TDRSA has two liner systems, a primary and a secondary liner system. Our primary liner system is a 60-mil HDPE high-density polyethylene.
Q Now, what does 60-mil refer to?
A Well, 60-mil is -- there's 1 mil per thousandths of an inch. 60 mil is 60 thousandths of an inch. Now, in comparison, let's say that 1/4 of an inch, which you all know you can measure on your ruler, is 250 thousandths of an inch. 1/8 is 125 thousandths. Okay? And 1/16 of an inch is 62 thousandths. So 60 mil is approximately -- a 60-mil liner is approximately about 1/16 of an inch thick. Then below

our primary 60 mil geomembrane liner we also have what's referred to a GCL which is a geocomposite clay liner. Again, this is a manufactured clay liner that is -- again, has geotextile which has sodium bentonite encased within this geotextile. What it affords is a system of very, very low hydraulic conductivity or very, very small amount of water can move through this system combined with the overlying primary geomembrane. So those two systems combined are our primary liner system.

Now, below our primary liner system we have the leak detection system. And that again is consistent -- consists of a geocomposite drainage fabric just like we had in our contact collection system. And what that affords is for any water that may be present in the detection system will be rapidly transmitted to a detection sump for monitoring and removal. Now, finally then below our leak detection system we have our secondary liner. And our secondary liner is comprised of a 40-mil high-density polyethylene liner. And then below that system is our foundation which is the native sands and gravels that are present at the site.

Q Okay. If you could -- maybe so we could get a better picture of this, if you could draw, if you don't mind.

A I'll do the best I can.

Q And, Mr. Starke, is there a complete design in the

application that encompasses all of these features?
A The original application did not include the continuous leak detection system and the secondary liner. That was a requirement -- or that has been provided at part of F1 and F2 of the permit conditions.
Q So you're referring to condition F1 and special condition F2 of the permit?
A Yes; yeah. That's right. And that redesign, including the entire leak detection system and the secondary liner system has been submitted to the DEQ for their review and approval. Let's talk a little bit from top to bottom, and I'll try to draw this as clear as I can because it is quite a complicated system, but -- so on top we have -- I'm going to use these (indicating) triangles here to kind of designate the development rock. Bear with me here for a little bit.
(Witness draws diagram)
Q Now, what you're drawing there, is that the standard -- the development rock that you would expect to be placed in the TDRSA?
A Right. This would be what we would say is the mine run development, unprocessed development rock that's broken up during blast and taken directly to the TDRSA for storage. And this will range in porosity from 20 to 50 feet thick depending on the location. Now, below this development rock, this mine run, we also have development rock, but this

is processed development rock. So it's processed down to a smaller size of three to four inches. And I'm using these (indicating) little triangles here to kind of illustrate development rock only smaller because it is smaller in size. And we have two feet of that. This is three to four inches in size.
Q Now, why do you -- why do you have that layer? What's the function?
A Well, this is for protection of underlying contact collection system and liner system. Some of this rock may come in in pretty oversize, maybe up to 12 inches. So when this material is dropped or dumped from the load haul dumps we want to have adequate protection to underlying liner system and contact collection system. So we're requiring the contractor to process two feet of this development rock entirely across the base for that added protection. Now, below the two feet of processed development rock you now have -- I'm going to show this (indicating) little symbol here 'cause it's smaller in size. Again, it's two feet, two feet of sand. Now, we place two feet of sand below the processed development rock.
Q And what's the function of the sand?
A The sand has two purposes. One is, again, protection to the underlying liner system for the overlying rock and also to manage contact water that flows through our system, will be

collected and managed in the sand drainage layer.

Q If I could take a step back, how large is the TDRSA? How many acres?

A The TDRSA is approximately 5.9 acres or approximately 6 acres all together.

Q Okay. And what is the depth?

A Depth ranges from at the perimeter about -- through the floor, about 15 feet deep. And then at the peak it's about 30 feet above grade, so we get a maximal height somewhere around 50 feet, you know, and probably in the average, around 20 to 25 feet.

Q So what's below the sand layer?

A Okay. Below the sand layer then also, as I mentioned, as part of our contact water collection system is our geocomposite. I'm going to use this line again to show that geocomposite. And again, what that is is the meshed membrane of HDPE that looks kind of like a meshing aura on our webbing that's sandwiched between two geotextiles. And again, that has two purposes only also. One is for protection to the underlying liner system because these geotextiles are very thick and they provide that protection, but also has a very high what we refer to as transmisivity. So water that flows through this system is managed through the sand and then collected in this geocomposite and then rapidly moved down toward our sump for collection.

Q So for this you -- it has a high conductivity?
A High conductivity or what they refer to as -- lateral conductivity is transmisivity. So it has a very high lateral flow capacity. So water that comes through this (indicating) impinges onto this system right here (indicating), flows very rapidly to the sump for removal.
Q And did you tell us what an ADPE is?
A Yes. It's high-density polyethylene. Okay? High density is a molecular structure of polyethylene products. There's different -- low density, very low, high density. They all have different density structures that are characteristic of the product. Then below, again, our contact water collection system we have our -- I use a straight line, is our primary 60-mil liner. And these come in rolls to the site from 20 to 30 feet wide and are about 300 feet long. They are rolled off across the underlying components and then welded.
And there's two procedures commonly used today in the industry that are ANCI standards, accepted standards for welding. One is called fusion welding. The other is called extrusion welding. The primary method of how they weld these two parent panels, it would be slightly overlapped. They have a device that applies pressure and heat and welds the two panels together. In here (indicating) is an air pocket. That air pocket is left in there intentionally so

they can then pressurize a pocket between the two wells and test the integrity of the well. If they have a leak or if they notice any dissipation of that air pressure over a period of time, they know that there's a failing weld. And then what they have to do is repair that weld. They have to cut that weld out or cap that weld with another piece of HDPE. And that's talked about in our CQA plan, is that process of documenting how the welding is occurring.

Then again, below our primary 60 mil you have -- and I'll use this (indicating) symbol for our GCL, our geosynthetic clay liner. And again, that is a product of sodium bentonite that's encased within two geotextiles, provides a very, very low hydraulic conductivity or the ability to transmit water through the system is very, very, very low. So combined, these (indicating) two systems are the primary liner system. Then again, below our primary liner system, like I mentioned, we now have another geocomposite drainage fabric which then is used for collection of water that may be present in the detection system. And that drains it to our secondary sump for monitoring.

Q Okay. So this is that same -- the same material that will allow -- that was above?

A Yeah, that's correct, the same that has a very, very high transmisivity that allows water to move very rapidly at a

rapid rate to be collected, monitored and extracted.
Q Okay. And is there anything below that?
A Yes. Again, below that then we have our secondary HDPE liner which is our 40 mil. And then below -- and, again, that is constructed and seamed the same way as our primary, with using the fusion and extrusion. They overlap the panelage. They'll seam them together. They'll do the quality assurance testing to document that it is a tight integrity. Then finally below that, we have our foundation of on-site sands and gravels. And, again, you know by testing out there and by conducting borings on site that these soils across the site are very uniform and consistent, and we -- upon excavation down to the sub grade, soils will be inspected and be densified to ensure that we'll have a stable foundation for the TDRSA.
Q What do you mean by "densified"?
A Well, what they'll do upon excavation down here, there will be a series inspection, and then in our CQA plan, there's testing that will be conducted to ensure that it has proper density. Prior to doing that testing the contractor will go out there and densify it. And he'll use what they call a piece of equipment which is a compactor. And we've all seen compactors on the roadway. But they will compact that sub-grade surface, smooth that surface.
And then there's also certification of that

surface that's signed off by the certifying engineer, by the owner and the geomembrane installer to attest to the suitability of that sub-grade prior to placement of any liner component. So it's a very rigorous program of inspection, documentation, inspection and documentation and acceptance. As we move through each one of these components, they all have a series of inspection, documentation and certification requirements as --

Q Is that part of the CQA plan?

A That is part of the CQA plan. That is correct.

Q Okay. And if you want to take your seat -- well, actually I think maybe -- I'd like to talk a little bit about the actual pump. How is this water -- once it reaches that liner system, how is it pumped out of the TDRSA?

A Do you want me to --

Q Yeah. Why don't you -- if you can, explain this and illustrate it, that would help.

A So I'll draw a little schematic like I did previously of the sumps and how the water is taken from the base of the floor of the liner system and the contact water collection system to the sump areas where it will be extracted. And what we have here -- bear with me here, is the side slope coming down to two sumps. This (indicating) is called our primary sump -- and remember we had that two feet of sand -- and our geocomposite drainage fabric. That water in our contact collection system goes into what we call our primary sump. Below that system is our second sump. And a second sump collects water that may be present in the leak detection system.

Now, within the primary sump we have what's called a side-slope riser. And this riser is a large diameter plastic pipe, 18-inch diameter HDPE pipe, same HDPE that's used for the liner system, but it's rolled into a large tube, very thick. They're about a half inch thick. And within this side-slope riser we have a pump and also a pressure transducer. The pump --

Q What's a pressure transducer?

A Well, the pressure transducer is kind of like the mechanism used to observe or monitor the liquid level in the sump. It's based upon pressure. So when a water level is at a certain height, the pressure transducer records that pressure, and up in the -- what they call the pump house up here (indicating) there's a little monitor that identified that elevation associated with that pressure.

So the brains of the system up here, it takes this message of pressure, records it up here (indicating) and computes that to elevation. So you know at what elevation the water level is in within the detection or the extraction sump. And there's three points that we used these pressure transducers. One is for "pump off," and that's usually set up about eight inches off the floor because the pumps don't operate unless you have some water in it. Then you have "pump on," and that's about three feet. The sump here is three feet also. And then -- so your "pump on" would be right here (indicating).

And then we have an "alarm" setting. And the "alarm" setting is set at three and a half feet. And again, the rule requirement is that we need to maintain less than one foot ahead at the lowest point within the cell development. So we have to maintain less than one foot of water head at this point right here (indicating). So that would be three feet plus one foot; that's four feet. Our alarm is set at three and a half feet. So if the water level goes up to three and a half feet, there's an alarm beacon that is constructed on top of the pump house. Operators then know if they've got a problem. Either the pump has malfunctioned or the flow into the system exceeds the capacity to the pump.

Now, the advantage of this system here is we designed a pump to be able to manage the annual average precipitation based upon our HELP modeling. And Jerry -- Dr. Eykholt will come in here a little later to talk about that. But if that pump capacity is exceeded, this system affords us to rapidly pull that pump out and put a larger diameter pump in, a larger capacity pump if need be. But

operational practices, we like to have a pump designed that will annualize the flow coming into the system. If we take a look at a peak daily event, which is a very rare occurrence, and size a pump for that, potentially that pump would cycle too fast, and we could burn out the pump. So we'd like to install a pump that will be a reasonable operational practice for water inflow into the system.
Q   So do you know the capacity of the pump that's planned here?
A   We're using a -- we planned a 50-gallon-per-minute pump.
Q   Okay. And what -- again, what happens if it reaches that 3-1/2-feet mark and the alarm goes off? What are some of the contingencies that could be used if they need more capacity?
A   All right. We've got a 50-gallon-per-minute pump. The average annual flow into the system based upon our modeling is approximately 11 gallons per minute. So we have sufficient capacity to deal with an average annual condition. Now, peak daily conditions come in, that's that one occurrence over a seven-year cycle that includes snow melt and a 24- to 25-hour storm event. Under those circumstances, the pump is less than that flow coming into that, but if that doesn't happen and the water level does rise, then the alarm will be indicated on top of the riser. There's sufficient capacity within the drainage stone itself below 1 foot to be able to hold 2 days of that peak event

which would give them time to react to decide whether or not they need to place another pump within the system to be able to take a liquid back down.

The design of the basis, especially for pumping, we provide a specification that we believe is the best operational practices for the site. Pumping is really an operational art. The selection of the actual pump out there may change from year to year, month to month, depending on their demand, their needs. But the idea is, as a permit ticket addition, is that the one-foot head on the base will not be exceeded, and that is being managed by the pump and the pressure transducer.

Q Okay. And you said earlier that that was designed for two days' worth of storage?

A There would be an additional two days' worth of storage capacity with the sand granular drainage layer based upon that peak seven-year event including snow pack and precipitation.

Q Is that two days' worth of storage and still not exceeding the one-foot head?

A That's correct.

Q Is there additional storage if you exceeded that one-foot head?

A Well, there is always additional storage not within the TDRSA. The additional storage that -- that is the amount

that they will be able to store, so there would be no more additional storage within the TDRSA.
Q Now, where is this being pumped to?
A This liquid is being pumped to the contact water basins. So if -- is there additional storage capacity within the contact water basins? Certainly. All they would have to do is then install a larger pump and they could pump more liquid out of the TDRSA into the contact water basins.
Q Well, I guess, putting aside the permit at the moment, --
A Yes.
Q -- will the TDRSA hold more than that one-foot head? Is it --
A Well, yes. Yeah. I mean, it can certainly hold more than that. I mean, it can hold probably 24 million gallons of liquid. It can hold a large amount of liquid.
Q And the liner system that you've talked about, is that designed to handle that volume any larger than the one-foot head?
A Certainly. I mean, it will be as protective with one foot as to 15 feet.
Q Now, you've talked about the primary collection system and the pump that's in that sump pumping out the primary; correct?
A Primary, yes. Yup.
Q Now, how does it work if anything leaks through that and

gets to the secondary system?

A Anything that would leak through the primary liner and gets down into our secondary, that -- again, that is a very unlikely occurrence. We have designed the system basically not to leak. We have -- if we look at the amount of water impinges on our collection system through our modeling and determine what amount has leaked, we have collected in our design 99.9 percent of that liquid. So an effect of it, it's not a measurable leak that is going through the system based upon our design. But if water is present in that system -- and that may be other sources of water, not just water that may seep through it. There's construction water, there's water that may come in from surface water flowing down through here (indicating). So there's other sources of water that may be present in the secondary sump. Those sources of water would be measured by a pressure transducer and also a riser down here (indicating), and that elevation would be recorded out in the readout in the pump house. So we'd be -- constantly we'd be able to monitor the water level in here and determine whether or not they exceed the requirement for the response action plan under the permit conditions, which is --

Q And do you know what that response action plan is under the permit?

A It's -- 25 gallons per acre per day is what the DEQ has established for this facility. So for the 6 acres, it's approximately 150 gallons per day.

Q   And if you -- you can take your seat. Thank you. So how is it that that system -- what method is used to detect whether there's any -- you mentioned a pressure transducer?

A   There's a pressure transducer in the secondary sump that would monitor presence of liquid in there. And the level of liquid in there would be based upon the response of 150 gallons, so we'll take the size, the volume of the sump. We know at what elevation 150 gallons would require an elevation setting. So when the operator looks at the readout panel and he says, "The elevation there say 2.6 feet," he'll know either that's above the 150 gallon mark or below the 150 gallon mark, or even if there's presence of water in there.

Then what he would do is initiate pumping out of that system. And he would pump it to determine how much liquid came out in that period of time. And he would go back the next day and pump again. And if he had 150 gallons being pumped out of that system within one day, then he'd have to implement the response action plan.

Q   So you've talked about monitoring in this leak detection system. Are you aware of any other monitoring required in the permit?

A   Now, there is other monitoring that is required in the

permit, and that is groundwater monitoring wells that are installed around the TDRSA and the contact water basins. So not only will there be monitoring of the contact or the detection sump but also monitoring in wells surrounding the TDRSA and contact water collection system.
Q Have you ever used or designed a leak detection system like this one in any other applications?
A Yes, I have.
Q Okay. Have they successfully prevented leaks?
A They have -- successfully, the designs have, yes.
Q How do you know whether they are successful?
A They are successful based upon two criteria: One, have they exceeded a -- have they had a Notice of Violation? And that's being, after a point of compliance, whether it's a well or a detection system, whether or not they've had exceedance to the parameters that they're permitted under. And the designs -- all the designs that I'm aware of that I've worked on, I'm not aware of any exceedances at either point of compliance, which could either be a leak detection system or a monitoring well.
Q And how would you compare this design to others that you have used in terms of either the presence of potential contaminants?
A With other industry standards?
Q Yes.

A This is a very rigorous robust design for the protection of the human health and environment. For example, the Part 115, the DEQ solid waste standards, does require a secondary liner system, let alone leachate. The liquid water that passes through the system is much more rigorous, much more -- has a much higher toxicity level than what the contact water here is. This design is very close to what is used by subtitle -- UEPA on Subtitle C for hazardous waste facilities where, again, the leachate in that stuff is very nasty. And so, again getting back to the protection of the human health and environment, this system will provide that very, very well.
Q And you talked a little bit about the CQA plan.
A Yes.
Q What's the purpose of that plan?
A That plan is to ensure that the -- and to demonstrate that the facility be constructed in accordance with acceptable industry practices and permit conditions.
MS. LINDSEY: Okay. And if we could have Intervenor Exhibit 21.
Q And is this the plan that you prepared -- and actually if we can go to the next page, did you prepare this plan or supervise the preparation of this plan?
A Yes.
Q Now, this says, "Revised July 2006." Was this part of the

original permit application?
A No. This was revised as part of the Part 91 comments that were submitted, I believe in July of 2006.
Q So is this similar to the original with updates or is it different?
A That's correct. It's similar. There were some slight differences for additional testing and documentation that were inserted into this document.
Q Okay. So these were an additional part of -- these are permit conditions that were added or response to comments?
A Yes; yes.
Q If we could, turn a few pages to page 2 of the document. Okay. So if you could, go through with us briefly in reference to what you've already talked about, what are the quality assurance features that are included in this plan?
A Well, there's basically -- this section here talks a little bit about the record keeping, the overview of the construction, observation. And here we have the construction observation report, daily summary reports and the photographs. These are reports that -- or actions that would be conducted by the field inspector during actual construction to observe and document the liner system construction. So this section here talks about more of the record keeping process that's involved with that documentation. Okay?

Q Okay. If we could go to the next page, please, is this more of the --
A Yes. How we document -- again, how we document that information with the data tests seats, how we control that document so it's secure and it's defendable so that, again, if we have to support that in front of the regulatory agency, that how we secure these documents and record those documents. And then they actually -- down in Section 3 we get into the actual construction observation, what is physically done for that observation and documentation.
Q Okay. So just generally this document, if you can give us an overview, what are the main requirements in terms of quality assurance that are contained in this.
A Well, for each of the liner components that we discussed about before and the sub grade, will have to go through a series of observation, documentation and certification. So for instance, there will be survey requirements, and those survey requirements will document the sub grades of the liner system. It will also document where the locations of repairs that would be placed within the liner systems and also provide thickness verification of the contact water collection system to make sure that it meets the design thickness of two feet. So that's one component is survey documentation.
Now, there's other components of this whole

process which would include documentation requirements, say, for the geomembrane during its installation. We talked a little bit about how they would inspect and document integrity of that seam by air pressure testing. That's discussed in here. There's other procedures for seam testing. There's what's called destructive testing. There's nondestructive testing and destructive testing. Destructive testing is where they'll actually take samples of those seams, take them to the laboratory, test those seams to make sure they have the adequate strength. If they don't have the adequate strength, then those seams are repaired out in the field. So there's a series of documentation processes that go for each of the different components. It will require a certain type of observation, a certain type of documentation and certification.

Q Okay. And are all those procedures and requirements included in this report?

A That's correct.

MS. LINDSEY: Your Honor, we would move for the admission of Intervenor Exhibit 21.

MR. REICHEL: No objection.

MS. HALLEY: No objection.

MR. EGGAN: No objection, you guys.

JUDGE PATTERSON: Thank you. No objection, it will be entered.

(Intervenor's Exhibit 21 received)

MS. LINDSEY: I'd like to switch topics real quickly and this is just -- I think we're going to wrap up in a couple of minutes.

JUDGE PATTERSON: Okay.

Q There was some testimony about snow storage in the TDRSA. And did you review the testimony of Dr. Coleman with the --

A I had reviewed his testimony, the admission, about small storage; there's correct.

Q Okay. Are you aware, is there a planned storage of snow in the TDRSA?

A On a temporary basis the TDRSA can be used for snow storage during operations. However, once it's been built out to its final configuration and then has a geomembrane cover, no, then snow storage cannot be used in that facility at that time.

Q Okay. So if there's not capacity in the TDRSA, where could snow be stored?

A There's other areas on the property where snow can also be stored. In the area on the north just -- on the north northeast corner there's the area where the sanitary septic field will be in the contact water area. That can also be used for snow storage. The contact water basins likewise can also be used for snow storage. So there's areas on the property that be used for snow storage.

Q And if snow is stored in the TDRSA because there's capacity, where will it go, I guess, when it melts?
A Well, obviously when it melts it would melt and collect down into the -- and drain down into the contact water collection system. And then it will be drained in to the contact water collection system which would be routed to the sump and be pumped out through the submersible pump in the collection sump.
Q Okay. And we just heard testimony from Mr. Liebman about the sizing of those basins to include that snow.
A Yes.
Q All right. Just as a -- going back to the liner system, what is your opinion or in your experience are you expecting to see measurable leaks from this -- from the liner system?
A In my experience, no.
Q Is that from the primary liner system?
A Through the primary liner system. That's correct.
Q And this has two liner systems?
A That's correct. There's a primary and a secondary liner system.
MS. LINDSEY: Okay. Thank you. I have no more questions.
JUDGE PATTERSON: Okay. Let's break for lunch.
(Off the record)
JUDGE PATTERSON: Okay.

MS. HALLEY: Okay. Mr. Starke, I'm Michelle Halley and I represent the National Wildlife Federation and the Yellow Dog Watershed Preserve. I just have a few questions.

THE WITNESS: Okay.

CROSS-EXAMINATION

BY MS. HALLEY:

Q So I'm wondering if you have designed a facility like this before to hold acid generating rock.

A Off the top of my head no, I can't -- acid-generating rock -- specifically for acid-generating rock I can't recall.

Q Okay. Now, does the liner that you proposed here take into account the impacts of the acidity that this acid-generating rock would produce?

A Yes.

Q How so?

A The liner systems have looked at compatibility of those components with that type of impingement of that contact type liquid.

Q So has there been benchmark testing or what -- how do you --

A Well, what we do is typically the industry standard is we compare what we believe are the effluent characteristics or the characters of the contact water and compare those specifically to the liner system components based upon testing that's been conducted by the manufacturers and they've screened a number of -- and I can't explain all of them, but they go through a series of testing based upon acidity, based upon high pH, low pH; based upon transmissivity of different type of organic compounds to see how these products behave with those type of characteristics.

Q It sounded from the experience you described as if most of the liner systems you've developed have been used for municipal solid waste scenarios; is that correct?

A That's correct, and for industrial facilities. And the reason being is that there aren't a lot of mines out there that are employing these technologies. This is a relatively new concept for the mining industry to be using this, and also from a standpoint that there aren't too many mines here in the Upper Midwest that have -- basically are looking at permitting mining. But it's been widely used through the solid waste industry for the last 20-some years for hazardous waste facilities, municipal waste facilities, for containment of industrial waste.

Q What is the average weight per cubic foot of municipal solid waste?

A Municipal solid waste will range from anywhere to 45 to about 80 pounds per cubic foot, averaging probably about 65 pounds per cubic foot.

Q And you used 125 pounds per cubic foot; correct?

A 125 pounds for the -- I believe for the contact water collection system; however, I believe looking at the stone it's 145 pounds for the development rock. I'm not too sure off the top of my head, but I thought that was it.
Q And what did you based that figure on?
A Those are based upon -- as provided to us by M3 -- or not M3, MacIntosh Engineering who provided the design of the underground. They estimated what the volume of that material was broken and it was based upon a certain unit weight, so they gave us and provided us to that volume and also the unit weight.
Q Okay. So let me get this straight. The actual material that the TDRSA would be made of -- and I'm talking about the geosynthetic liner --
A Yes.
Q -- is designed to basically support a weight of 140 cubic pounds per foot?
A 145 pounds per cubic foot, yes.
Q Okay. And that number was just provided to you by someone else?
A We looked at those numbers based upon what our experience are, but also what MacIntosh Engineering used for their bank run for breaking up the rock and how they estimated the volume, so we also applied that to our design. That unit weight was used in our stability calculations as well as

what we used in the testing for the -- or the design analysis for the geotextile product.
Q Now, do you know what the size distribution of the development rock will be?
A It'll range from as small as small size particle -- probably to sand size particle all the way up through 24 inches with the majority of it probably being the range of eight to ten inches.
Q Now, do you know if that rock is going to be crushed in any way or if that's the size distribution coming out of the mine?
A The bank run rock will come out as blasted. The process development rock, which is above the contact water collection system will be processed before it's placed down to three to four inches.
Q Could you repeat that? I'm not --
A The process development rock --
Q Okay. What's that?
A That's the two-foot process development rock that's directly above the contact water collection system. That will be processed to three to four inches. So bank run is that rock that's basically blasted -- or mine run, that's blasted rock and taken directly to the TDRSA without processing. That will range from anywhere from small sand size to 24 inches. Some of that material would be processed down to three to

four inches for that two-foot protection layer of development rock that's placed above the contact water collection system.
Q And how will the rock be placed upon the liner?
A What the requirements are, they use low contact dozers, so low contact pressure dozers. And also there's a -- they place it down -- first of all, the sand layer goes down and the sand layer is graded approximately two feet across -- it's pushed across the liner system by low contact pressure dozers, so there isn't any vehicle traffic: truck tire traffic allowed on that -- directly on the sand drainage layer until that material is directly placed. No vehicles will be allowed -- "vehicle" being truck traffic or dozers -- along -- allowed on the liner itself during construction.
Q So what would be the maximum height of the drop?
A Well, once they have the two-foot protective development rock stone they may drop as high probably as probably two to three feet.
Q Now, can you just clarify for me whether the volume the TDRSA is designed to accommodate is 200-and -- roughly 248- cubic yards or 285- cubic yards?
A The TDRSA is designed -- has a design capacity of 285,000 cubic yards. The development rock based upon, again, MacIntosh estimates -- broken development rock is estimated at 248,000 cubic yards. So the difference between 248- to

285- is the contingency and that includes the limestone amendment.
Q What is your understanding of how the limestone would be added to the development rock?
A Well, my understanding is that would be -- that's primarily an operational procedure, but they would use that and apply that during placement with the development rock as it's placed down; during placement they would apply a certain amount of development rock during those procedures.
Q How big would the limestone -- what size are we talking about here for the limestone pieces?
A Well, right now they are -- they're determining what size is appropriate size, but I would suspect it's going to be on the order of an inch to an inch and a half particle size.
Q What do you mean right now they're determining that?
A Well, they haven't -- we haven't designed the final specification for the limestone.
Q I see.
A So we're in the process of developing that specification for the limestone.
Q Okay. Why is the size of the limestone important?
A Well, it's important from a filtration standpoint. You don't want to have it so large that you have a large -- too small of a surface area. So surface area is important but you don't want to have it too small that it filters all the

way down through your development rock and then goes down into the contact water collection system. So we have to balance the size of -- which is small and large that'll be best managed and be appropriate type of limestone addition too.

Q Now, from a practical perspective what sort of limestone mixing would go on, if any, and what would that look like?

A Again, I'm not an operations specialist, but I would imagine that they will bring in a load of limestone based upon how many tons had been deposited in the TDRSA and from there they will mix that or spread that across the surface and intermix it with the TDRSA or the development rock that's been placed previously.

Q How would they spread it across the surface?

A They would probably use dozers by pushing it across the surface and then using probably a dozer to mix it in with the development rock.

Q So you'd have a dozer operating on top of development rock to spread this limestone out across six acres at some point?

A Right; yes. I would imagine something similar to that.

Q And what is an average range of slopes for a storage facility like the TDRSA?

A Well, for example, a municipal landfill has a slope that's required under the Part 115 as being four to one; four horizontal to one vertical. Now, with this material since

it is rock, industrial rock stockpiles can be as steep as the angle of repose, which in certain cases is 45 degrees, which is close to a two to one.
Q And that's what you proposed at this site; right?
A No, we proposed -- I believe the L slope is a three to one for the TDRSA. The interim slopes, which means the operating slopes, can be steeper, but the L slope with -- when the geomembrane cover is placed will be a three to one slope.
Q And so the interim slope angle you proposed here is one to one, or 45 degrees?
A If they can -- if they can manage that one to one; that's correct. Or two to one. But that -- again, that's the operating face slope; that's not the final slope once they have the cover placed on it.
Q And you assumed a friction angle of 45 degrees?
A Yes.
JUDGE PATTERSON: I have to take that break.
MS. HALLEY: Oh.
JUDGE PATTERSON: I'll be right back.
(Off the record)
Q All right. Get back to it here. We were talking about slopes and I believe you testified that a normal slope for a municipal waste hill would be about four to one?
A That's correct.

Q Okay. And that the slope you proposed here, the interim slope angle you proposed here could be as deep as one to one or 45 degrees?
A About 45 degrees; that's correct.
Q Okay. Now, you used a computer program called PC Stable; right?
A That's correct.
Q Where did that program come from?
A Stable program is a program developed by the University of Purdue and that is a Stable program and it's been used in the industry for probably 15 years or so with certain modifications over the years of development with added features for PC's, for graphics output and those type of things. But it's University of Purdue's program that was developed by the University of Purdue.
Q Now, are you aware of this program being used for modeling rock stability?
A It can be used for all type of stability analysis programs, depending on what type of input parameters you used in it. So it could be used for rock. It could be used for dams. It can be used for landfills. It can be used for foundations. So it's applicable to many sorts of geotechnical type analyses that need to be conducted.
Q Have you used it for rock?
A Yes, I have, for block stockpile stability analysis, quarry

mine stability analysis. I've used it for landfill stability analysis for industrial wastes. So I've used it for many different types of modeling analyses that would need to be conducted.
Q Okay. Now, attachment 2 in Appendix G, which is an appendix that you either authored or oversaw the development of -- right? -- for the mining permit application?
A Could you -- which appendix is it?
Q G.
A Okay. I believe so; that's correct.
Q Familiar with Appendix G?
A Yes.
Q Okay. Now, Appendix G discusses the average blow count development?
A Yes.
Q Familiar with that term?
A Yes.
Q Could you explain it to us?
A Blow counts are a measure of the in situ density of the soil. They conduct that measurement by using an ASTM procedure called Standard Penetration Testing, SPT. And what that is, is a uniform weight that's dropped at a uniform distance on a device that is used to collect a soil sample. And it'll record the number of blows per -- across a two-foot stretch of this recovery sample and for every six

inches it'll record the number of blows. Now, the blow counts that are used to, say, refer to the geotechnical properties are the only two intermediate six inches. So the first two are discounted and the last two are discounted, and so that the only two intermediate six inches I used to evaluate blows per foot. And blows per foot I used to establish certain geotechnical parameters, such as the density of the soil, which can then be related to the unit weight of the soil, which can be used to reflect the friction angle of the soil or the strength of the soil. So there's a number of different empirical relationships that have been developed since the 1940's by using blows per foot or blow counts based upon standard penetration testing.

Q Now, you just described only using the middle two six-inch sections. Is that the only correction that was made to the SPT data?

A Well, depending on the blows that were being recorded at this site, I believe they were recorded over a two-foot interval, so there were 4 six-inch recordings, which the two intermediate ones were used for the blows per foot. That's correct.

Q So were there any other corrections to the data?

A No. What is typically done with that data depending on the number of blows and the density of the material, there are corrections that you can apply. Now, if the material is very dense and typically has blows greater than 15 per foot, there are corrections that you should apply to it based upon the density of that material. Now, standard geotechnical practices for materials that are weaker, that have blows less than 15 per foot, it's generally engineering practice not to apply that adjustment to those blow counts.

Q Now, one of the statements in Appendix G is this: "The blow count data listed is in six-inch increments to calculate the blow count per foot to adjacent datum are summed and averaged." Can you explain what that sentence means?

A Well, it means the -- probably summed and averaged through the length of that boring or the length of that unit of material type. So the consistency and uniformity of the material would be used to develop what is the average range or the average length that was used to sum up the blow counts. For instance, if you have -- an average range would be taking the 12-inch and then applying them across the range of, say, 20 feet and then you could average and say this is an average blow count for that specific unit.

Q Okay. Now, was the SPT data used to estimate the potential settlement of the TDRSA?

A It can also be used to estimate settlement.

Q Was it in this case?

A I don't recall if it was, but it -- but as a parameter that can be used.

Q Do you expect there to be any settlement of the TDRSA?
A Minimal.
Q And did you use any calculations or --
A I don't recall if we did.
Q -- equations or anything to figure that out?
A I know that we looked at the density of the soils and based upon the density of those soils I can say that there will be minimal amount of settlement associated with it.
Q So does that mean that you believe that the foundation load is fairly light?
A I believe that the foundation will be stable.
Q My question was do you believe that the foundation load will be fairly light?
A No; no, the foundation load will be significant. There will be a large load applied to it, but based upon our stability analysis that the foundation will be stable.
Q Okay. What is that opinion based upon?
A Based upon the stability analysis, based upon interpretation of the soil boring information, based upon the uniformity and continuity of the soils across the site it's my professional engineering judgment based on my 20 years of experience that the -- and using that information to do the stability analysis that the foundation will be stable.
Q And do you believe that the unit weight will be at least 5,625 pounds per square foot?

A I don't recall what that unit weight applies to.
Q Now, underneath the liner or sort of embedded within it from your picture there it looks as if the collection -- leachate collection system is sort of incorporated into the design of the TDRSA; is that accurate?
A The leachate collection; are you referring to the contact water collection system?
Q Yes.
A Okay. Yes, that's part of the -- integral part of the design with the TDRSA is the contact water collection system.
Q And is that collection itself designed to handle that type of load?
A Yes. We looked at those products; based upon the 145 cubic foot of material at 50 feet, those products will sustain those loads.
Q And what type of analysis was done to ensure that?
A The geotextile strength calculations in the application. And those products, especially the GCL and the geocomposite are sandwiched with geotextile. There's geotextile strength, puncture, and tear resistance calculations provided in the application to demonstrate their suitability based upon the design -- expected design loads.
Q But that's different than the foundation; right?
A The foundation doesn't have any puncture that would occur to

that system. The foundation analysis is based upon a stability analysis where you look at a shear failure through the foundation.

Q But those are two different analyses; correct?

A That's correct. That's correct.

Q Okay. Are you aware of any landfills with slopes of two to one that have failed?

A There have been interim slopes of some landfills that have actually operating face slopes of as steep as 45 degrees. I'm not aware of any of those landfills failing from an operating slope.

Q Now I want to talk about the HELP model for a few minutes. From your perspective, was the -- did you do a worst-case analysis of the design using the HELP model?

A The information we collected from the HELP model -- yes, we looked at those worst-case parameters from a contact water collection system, the designer contact water collection system to ensure that they'll meet those conditions.

Q And what was the worst-case model?

A There's two different models that we are looking at. One is an open condition where there's a peak seven-year event -- and again, Dr. Eykholt will talk about this a little further, but there's a seven-year event where we look at the worst-case precipitation during that period of time and then also apply a snowpack and also a 24-hour, 25-year storm

event. And there's two different scenarios to look at that, the output of that that helps us with the design of the TDRSA contact water system. One is what's referred to the average annual precipitation; in other words, how that water is annualized over an entire year. And then there's the peak daily, which the peak daily is that one time event within seven years with those worst-case conditions.
Q So you didn't use the same parameters that Mr. Liebman talked about earlier this morning, the 50-year or the hundred-year event?
A No. Not in the HELP model. Dr. Eykholt will talk about the actual input of the precipitation events in there, but I know a 39-inch snowpack was applied in the HELP model.
Q Uh-huh (affirmative). Are you aware of the contingency plan to use the TDRSA to store contact water?
A Yes.
Q And given that are you certain that the depth of the water on the TDRSA would not exceed the 12-inch limit?
A Well, under emergency situations interpretation of the permit conditions, that that can happen under emergency conditions.
Q So you're not certain that the one-foot head would not be exceeded?
A No, I'm not certain.
Q Okay. Now, the HELP model input for snowfall, where did

that number come from?
A Again, I'll defer that to Dr. Eykholt. I'm not -- I believe that information came from Houghton, precipitation data.
Q Okay. Now, are you familiar with snowmelt being a problem with landfills in the Upper Peninsula generally speaking?
A There's always going to be precipitation, whether it's snow, water; it is always a problem managing solid waste at landfills, whether it's a TDRSA or a landfill, yes.
Q When you -- could you flip your chart back over to the previous page?
A To the first?
Q Oh, yeah. I think the picture is on the one that's on ground. Now, down in the right-hand corner there you have a picture of these two wells as you called them with air in between?
A Yes; yes.
Q Is that correct?
A That's correct.
Q Now, that picture is meant to depict how the liner is constructed; right?
A It's how the liner -- liners are seamed together, panel by panel; that's correct.
Q Okay. Now, if we are -- let's assume for a minute that we're in year five of operations and the TDRSA is covered like your picture shows with sand, smaller rocks and then

big chunks, tons -- hundreds of tons, thousands of tons of development rock on top of it?

A Uh-huh (affirmative).

Q And how at that point would anybody know if there is a problem with the liner, you know, in the middle of the TDRSA, for example?

A Well, first of all, if they did have a leak that -- unforeseen leak, an unforeseen event, that would be collected down within the leak detection sump, so that would be the first indicator of any potential problems. And if that did occur more than 25 gallons per acre per day they'd have to put together a assessment plan to the DEQ as to how they're going to assess that leak if it is determined to be a leak. And from there on that would be a -- probably a discussion with the DEQ as to how they would remediate that problem. Now, I have seen it in other facilities, hazardous waste landfills, where they had exceedences in the leak detection system that I haven't designed -- this is when they were first employing the use of these products -- that they actually had to go in and excavate the materials, pull them back and repair that leak. But again, that would be a discussion, an interpretation with the DEQ as to how they would apply the response action plan for that established leak.

Q Have you seen that type of remediation done on a mining

site?
A No, I haven't.
Q Now, the permit application -- this is the text of the application, page 47. I'm just going to read you a portion of it and ask you a question. This section is talking about the geosynthetic clay liner equivalent and how it, in your opinion based on the application, exceeds the regulatory minimum. Okay?
A Okay.
Q Now, it says here that, "The theoretical leakage through the liner design is .000511 inches per acre a day." Does that sound right to you?
A It sounds familiar, yes.
Q Okay. Do you know what that equates to over the life of the mine?
A I do not, but I suppose you could probably calculate that number.
Q So that number represents the amount of leachate that you expect to escape from this system?
A That's based upon the HELP model. Because of the certain hydraulic characteristics you place within the HELP model it generates what is going to be collected and what is going to be transmitted through your liner system. It's a --
Q So your answer is "yes"?
A -- theoretical number. Pardon me?

Q So is your answer "yes" or "no"?
A That this is my expectation of what is the amount? No, it's no my expectation of what is the amount. It's a theoretical number.
Q Then what -- but it's -- the number comes your model, --
A That's right.
Q -- which you've used to design this facility?
A That's right. We use it as a design tool; it doesn't necessarily mean that that's exactly what's going to happen. So I don't really know from a standpoint of a design if that number is going to be at that or less than that. What the important thing is, is whether that number will be detectable in a standpoint of monitoring the facility and how will it be detected.
Q Are you a hundred percent sure that there won't be leachate escaping from your system; none?
A I'm not a hundred percent sure, but I can say that we've designed the facility not to leak.
Q But you're not guaranteeing that that's going to be the performance of the facility?
A I can't guarantee the performance of a facility or an operations.
MS. HALLEY: No further questions.
MR. EGGAN: I have a few questions, Mr. Starke.
THE WITNESS: Yes.

MR. EGGAN: Sir, my name is Eric Eggan and I represent some of the petitioners in this case, particularly with respect to groundwater related issues and I just have a few questions for you.

THE WITNESS: Okay.

CROSS-EXAMINATION

BY MR. EGGAN:

Q And you may have answered at least part of this first question through Ms. Halley, but I'm going to -- I want to begin by asking you, it sounds to me as if you have not specifically designed a mitigation system for an operating mine in your career?

A Not an operating mine; correct.

Q Okay. When we say "not an operating mine," is this the first one you have designed for a mine in your career?

A What is your context of a mine? A mine is a hard rock mine operation, a sand mine, quarry mine?

Q Well, that's a fair question. I'm thinking of a hard rock mine operation.

A Correct.

Q Okay. So you have not developed a mitigation system, including a TDRSA system like this for any mine in your career?

A That's correct, for a hard rock mine.

Q Okay. Or for a sulfide mine?

A That's correct.
Q Okay. Or for a mine that is expected to leach acid from acid rock and acid rock drainage?
A That's correct.
Q Okay. Have you -- did you visit mines to do a survey of what has worked and what has not worked in those mines?
A Yes, we have. We went to Greens Creek site, Kennecott, and see how they're operating their waste products at that facility.
Q I see. And Greens Creek; that is in Utah?
A Alaska.
Q Alaska. And has that been a successful operation?
A To date I believe it has been.
Q Are you aware of the potential problems associated with temporarily storing development rock at a site and the potential for acid rock drainage?
A I am aware of those concerns, yes.
Q Okay. Has there been -- we had witnesses who came in and testified of the importance of handling this rock carefully; handling the development rock itself carefully. It has to be handled with care to assure that that drainage doesn't occur. Have you had interaction with those witnesses, witnesses who would have been called or other consultants in this case?
A I have worked with a number of our folks on our team as far

as the design criteria to use to manage that contact collection water system so that we'd mitigate -- minimize any type of environmental impact.
Q Now, are you aware that the TDRSA area is intended to serve as overflow in the event that the contact water basins overflow?
A I believe that the contact water basins will never overflow.
Q But are you aware at least that as a contingency plan in the groundwater discharge permit application --
A Oh, yes. Yes, I'm aware of that; that that is a contingency that the -- any exceedence would go into the TDRSA potentially as a contingency plan. That's correct.
Q Okay. And you understand that the introduction of water into the TDRSA area is going to also introduce the possibility of acid rock drainage or reactivity between the water that may be inflowing as -- with the rock that is stored there?
A Potentially that could happen.
Q Okay. Has anyone expressed an opinion to you as to the wisdom of that particular plan?
A As far as introducing that water into the TDRSA?
Q Yes.
A From an operational standpoint?
Q Yes.
A We see it as a contingency plan that could provide us a

contingency to manage that worst-case water scenario.
Q I understand that that is the contingency plan. Has anybody expressed to you an opinion as to the wisdom of that particular plan; that it is or is not a good idea to introduce more water to potentially reactive rock?
A I think as long as we assumed it was in a contingency plan that the idea was a good idea.
Q Just listen carefully. Okay? My question is, has anybody on your team expressed an opinion as to the wisdom of that particular contingency plan? Has anybody said, "Boy, that's a great idea. I think we should do that"?
A I'm not too sure what the definition of "wisdom" means with regard to -- it's a technical facet and technically speaking it's a sound idea.
Q Has anybody said that?
A Our team has; otherwise, we wouldn't have had -- put it into the contingency plan.
Q Okay. So your team has expressed that it's a good idea --
A It's in the contingency plan.
Q Sir, let me go ahead and finish the question. Your team has expressed the idea that it is a good idea to introduce water into the TDRSA area?
A A good idea from a standpoint of contingency planning, yes.
Q Okay. You understand that water flowing into that area creates an added risk of acid rock drainage?

A Potentially.
Q Okay. Now, it's my understanding that there's going to be a cover over this stored rock?
A That's correct.
Q Okay. That cover isn't going to be on there a hundred percent of the time I take it?
A That's correct.
Q Okay. So there will be instances where snow or rain or the elements are going to be falling upon the temporary -- the rock that is stored there?
A That's correct.
Q Okay. Now, the cover is intended to prevent moisture from getting in and wind from blowing through the pile?
A And to secure the pile itself, yes. Primarily to minimize water coming into the system.
Q I see. Now, I assume that that cover isn't going to be able to present -- prevent all the moisture from coming in; even when the cover is on I assume that there will be exposed areas that will be subject to water getting in?
A Possibly, yes.
Q Okay. And wind; I assume that it isn't going to be able to prevent all the air from getting into the pile?
A That's correct. We've tried to minimize it as best as most possible, but --
Q Of course. Of course. The whole concept here is mitigation

and so you're trying to mitigate the risk?
A Minimize it, yes. Minimize the generation of low pH contact water.
Q Okay. But it isn't going to prevent -- it isn't going to prevent all of the water or all of the air from getting in?
A That's correct.
Q Okay. Are you familiar with humidity cell testing?
A I know humidity cell testing had been conducted for this facility; at least I believe so, but I'm not familiar with the exact attributes of that test, no.
Q Okay. What do you understand humidity cell testing to be?
A My understanding is a test that looks cycling either rock or another product with a certain type of permeate to see what type of characteristic results of that permeate with that rock and having that water or that permeate moving through that rock mass.
Q I see. And are you familiar with the fact that humidity cell testing is often done with the introduction of air or water or other constituents with the reactive rock to see just how reactive it is?
A Yes, I do understand some of that.
Q And one of the goals is to -- in creating a humidity cell is to introduce water and air and keep it in kind of a confined space?
A Yes.

Q Okay. And you see what the reactivity is?
A Yes.
Q Okay. And when we talk about the TDRSA we're talking about a large area that has a cover over the top?
A Correct.
Q That is intended to hold moisture out but it's also going to prevent moisture from leaving the area I take it?
A That's correct.
Q That's one of the potential results?
A Uh-huh; that's correct.
Q Okay. And there will be water coming in. We know that?
A That's correct.
Q And we know that there's going to be air coming in, and so in many ways the TDRSA could be considered its own humidity cell area all by itself, couldn't it?
A Possibly, yes. I'm not an expert on humidity cell design or applications, but the way that you present it it's possible; I guess it could happen.

MR. EGGAN: Okay. I don't have any other questions. Thank you.

REDIRECT EXAMINATION

BY MS. LINDSEY:

Q Mr. Starke, just following up on that. Mr. Eggan was asking yo about the water coming in and not leaving. The water that comes into the TDRSA, is that designed to be taken out

or carried out?
A Most definitely. All the water that will be introduced through the system will flow down into the contact water collection system and then pass into the sump to be removed.
Q Okay. And where does this water go? We talked about it going into the contact water basin after it's pumped out of the TDRSA. Do you know where it goes after that?
A From the contact water basins all the water will be taken to the wastewater treatment plant and treated at the wastewater treatment plant.
Q Ms. Halley was asking you about this number in the permit application, the .000511 inches per acre per day as the potential leakage using this HELP model through the liner system; right?
A Correct.
Q And is that your understanding, that that model result is the leakage potentially through the primary liner system?
A That's correct.
Q And there's a secondary liner system below that?
A That's correct.
MR. EGGAN: I'm going to object. These are leading questions and this isn't cross-examination; it's direct examination.
MS. LINDSEY: Actually, the last one was leading.
Q Is there any other method below that?

A There is a secondary liner system below the primary liner system so that any water that escapes or is present in the leak detection system will be contained within the leak detection system and routed down to the sump for removal.
Q And Mr. Eggan asked you about whether you had worked on hard rock mines?
A That's correct.
Q Have you worked in any other type of mine or quarry or designed this type of -- this type of design for anything else besides hard rock?
A Well, I said we -- I've used this type of design and the design is similar to other industries that use facilities for containment, such as industrial facilities, model fills, ash facilities, coal stockpiles, coal flyash, municipal solid waste, hazardous waste landfills; they all apply the similar methodology as -- for containment. How do you contain it? How do you control and mitigate environmental impacts? How do you best do that in a responsible manner to the best assure the public health and welfare? So these standards have been developed over the last 20 years that are applicable not only to development rock but also applicable to other industry standards.
MS. LINDSEY: Thank you. I have no more questions.
MR. REICHEL: Mr. Starke, my name is Robert

Reichel; I represent the DEQ. I just have a few follow-up questions based on the cross-examination.

CROSS-EXAMINATION

BY MR. REICHEL:

Q I believe your testimony is that during the course of your professional experience you've been involved in either designing or reviewing designs for a variety of other waste containment facilities; is that correct?
A That's correct.
Q And have those other facilities that you've been involved in the design in -- have they or have they not involved the containment of hazardous materials or substances?
A They have.
Q From your professional experience are the engineering principals involved in the development of the liner systems or containment systems at industrial and hazardous waste landfills that you've been involved in -- how do those engineering principals compare to the engineering principals that were applied to the design of the TDRSA here?
A Well, there are similarities, but there also are differences. The similarities are; one, look at the components for the selection and see if they're compatible with the type of expected contact water or parameters concern. The differences are in the TDRSA. Here we have material that's large, bulky, angular, heavy that we have to

ensure the protection of the bottom liner system more so than we would at a hazardous waste landfill or a municipal waste landfill or an industrial waste landfill. So there are specifics that we have to address from this facility compared to what would be addressed at another facility which would be a municipal facility. However, the design methodology, the design practices are generally accepted across the board as far as how you manage water that comes in contact with a base liner system and how you route that water to an extraction sump for removal. How do you mitigate potential penetrations through the liner system in your design and construction? So those practices are pretty standard for a rock storage pile like the TDRSA or for a hazardous waste disposal facility.

Q And with respect to the TDRSA for this facility, could you identify or summarize what design features that you incorporated in this design to address the particular characteristics of the material that's proposed to be stored here?

A Well, for example, I've talked about the bulkiness or the angularity of that size of that rock, the mass of that. We have three layers of protection to protect the bottom liner system. One is to crush processed development stone to make it into three- or four-inch particle size, then we added another two feet of collection sand below that, and then we

also had the geocomposite drainage fabric which is sandwiched with two heavy geotextiles. So all three of those components provide protection to the liner system which are more and above what we would have typically designed for in a sanitary landfill or a hazardous waste landfill.
Q I believe during cross-examination Ms. Halley asked you about whether or not at some -- she asked you some questions about how the limestone would be added to the development rock during the course of filling the facility. Do you recall that?
A Yes.
Q I believe your testimony was that it was an operational issue, but if I understood your testimony correctly you mentioned the possibility that the material would be spread using a bulldozer or something. Do you recall that?
A That's correct.
Q In your experience working on other industrial hazardous waste and solid waste landfills, is it common or uncommon to operate equipment of that kind within a landfill itself; that is, in an area located above an engineered liner system?
A Very common. For example, when -- in a municipal waste landfill they'll be actually compacting the garbage to densify it. And if you've ever seen a landfill compactor

it's got teeth that are six to eight inches long, so -- but they're required to operate that above the liner at a minimum of ten feet above the liner system. But getting back to your question, yes. These type of equipments are always employed within a cell that has a liner system, but adequate protection and operational practices have to be ensured so they don't penetrate or impact the quality of that liner system.
Q And in the case of the TDRSA that you've designed here, participated in the design, do you anticipate that equipment -- heavy equipment, earth-moving equipment of that kind would be operating directly on or immediately above the engineered liner system?
A Not directly on; no. That will not be permitted. The closest point of contact for any type of equipment will be low contact dozer; in other words, a low contact ground pressure dozer. They have wider tracks so they're distributing the weight more evenly across the area and there will be a minimum of two foot of sand that they will be pushing across the floor. So even that equipment will not be allowed to operate directly on the liner system but be separated by the sand drainage layer of two feet.
Q And with respect to the possibility of using a dozer or some kind of equipment to mix in or spread limestone, where would that activity be taking place in relation to the liner?

A Approximately at a minimum of four feet above the liner system.
Q On cross-examination Ms. Halley asked you if you could guarantee with a hundred percent certainty that there would be no leakage through the primary liner system. I believe you indicated you could not. Let me ask you a somewhat different question. Based upon your professional training and experience and your familiarity with the design involved here, do you have an opinion as to whether or not the design of the TDRSA system is or is not reasonably -- will reasonably minimize actual potential harm to the environment?
A Very much so. It would be very protective to the health and environment and the amount of liquid leaving that system is far -- will be present in the contact -- or the detection system will be small, if not measurable.
Q You were also asked a series of questions about contingent -- references in contingency plans to the possible placement of contact water from the contact water basement -- basins -- excuse me -- into the TDRSA. Do you recall that line of questioning?
A Yes.
Q Let me ask you this. Have you reviewed the permit, the Part 632 mine permit that was issued by the Department of Environmental Quality in this case?

A Yes.
Q Do you recall whether or not that places a limit on the amount of head or the quantity of water that may be allowed at any time to be present above the liner system?
A Yes, 12 inches.
Q And does that limitation to your knowledge exclude -- contain some exception?
A I believe that that contains exceptions for emergency practices.
Q You believe that that's in the test?
A It would be -- that would be -- have to be an interpretation made with the DEQ and the -- Kennecott, but looking at that I believe that under emergency practices it appears that that may be able to do that.
Q Okay. Well, I can -- I'm not trying to trick you or something, sir. I can show you or we can have put up the mining permit application. Would you like to see it -- excuse me -- the mining permit?
A Yup; that's fine.
MR. REICHEL: For the record I'm putting the screen of page seven of the mining permit.
Q I'd like to direct your attention specifically to condition F3. That says, "The permittee shall not allow the hydraulic head on the TDRSA liner to exceed one foot at any time." That's what it says; correct?

A That's correct.
Q There's no exception, is there?
A Not with that statement; that's correct.
MR. REICHEL: Thank you, sir. I have nothing further at this time. Thank you, sir.
MS. HALLEY: I just have one more question.

RECROSS-EXAMINATION

BY MS. HALLEY:
Q Mr. Starke, just so we're clear, are you confident that the TDRSA liner system as it's proposed and designed by you, that it will indeed prevent leaching into groundwater?
A Prevent leaching or prevent leaking?
Q Prevent the escape of any --
A I'm confident that it will not -- that it will not allow liquid to migrate into the groundwater system.
MS. HALLEY: No further questions.
MR. EGGAN: I have nothing further.
MS. LINDSEY: Nothing further, your Honor.
MR. REICHEL: Nothing further.
JUDGE PATTERSON: Okay. Thank you.
THE WITNESS: Okay.
(Witness excused)
JUDGE PATTERSON: Want to take a break before you start the next witness?
MR. REICHEL: We have a line change.

MS. LINDSEY: Yes.

(Off the record)

MR. BRACKEN: Your Honor, Kennecott calls Gerald Eykholt.

REPORTER: Could you raise your hand? Do you solemnly swear or affirm the testimony you are about to give will be the whole truth?

MR. EYKHOLT: I do.

GERALD EYKHOLT, PH.D.

having been called as a witness, testified as follows:

DIRECT EXAMINATION

BY MR. BRACKEN:

Q Would you state your full name and spell your last name for the record?

A Yes. Gerald Robert Eykholt, E-y-k-h-o-l-t.

Q Okay. And what's your educational background, Mr. Eykholt?

A Well, I have a Bachelor's of Science in civil engineering from Purdue University, a Master's of Science and a Ph.D. from the University of Texas at Austin.

Q What's the Ph.D. and Master's in?

A Civil engineering.

Q So "Dr. Eykholt" would be correct; right?

A Yes.

Q Have you had any other training or education, postdoctoral work or anything after your graduation for the Ph.D. from

the University of Texas at Austin?
A Short courses: safety training, professional training courses.
Q Do you hold any licenses or certifications?
A Yes. I am a professional engineer in the states of Wisconsin and Michigan.
Q And who are you employed by currently?
A Foth Infrastructure and Environment.
Q And in what office?
A I'm in Madison, Wisconsin.
Q And how long have you been employed by Foth?
A Since 2003. It's about -- what is that? -- four and a half years now.
Q And did you work with Foth or consult with Foth prior to you becoming employed by them?
A Yes, I was a private consultant with Foth from 2001 to 2003.
Q I'd like to go back and talk about your employment since your graduation from the University of Texas with your Ph.D. What was your first job after that?
A I went to General Electric's Corporate Research and Development Laboratory in Schenectady, New York. I worked with a group of chemists and chemical engineers, environmental scientists and engineers working on environmental remediation technologies for the GE Corporate.
Q Okay. And did you start working there right after you

graduated from the University of Texas?
A Yes.
Q And how long did you stay with General Electric Corporate Research and Development?
A Two and a half years.
Q So that would have put you about -- when? -- 1994 or '-5?
A 1994.
Q And what was the next thing you did after you left GE?
A I became a professor, assistant professor of civil engineering teaching environmental engineering at the University of Wisconsin at Madison.
Q And how long were you employed as an assistant professor at the University of Wisconsin?
A For seven years.
Q And what was your focus there?
A It was environmental engineering, so I taught some of the basic environmental engineering courses as well as environmental modeling, physical, chemical treatment technologies. My research dealt with remediation of contaminated soils, dealing with groundwater contamination problems, fate and transport modeling problems, as well as some other environmental modeling situations.
Q Okay. And you left there in what year?
A In 2001.
Q And where did you go from there?

A I formed my own company called Eykholt Consulting in Madison. I saw it as sort of a springboard into practice from academia.
Q Okay. And what did you do when you were Eykholt Consulting?
A Well, one of my first projects was working on the Fox River project with Foth. I had some -- a subcontact consulting with Foth on the Fox River project and that continued until I became hired as -- in 2003. We also did some other independent consulting with other companies.
Q And what was Fox River; what was that all about?
A Oh, it's a sediment remediation project. It involved actually quite a bit of modeling to determine where contamination was delineating where we would dredge. There's also other processes for evaluating the tonnages and processes that would be involved with sediment remediation.
Q What are your duties at Foth currently?
A I'm a lead environmental engineer and I'm working on several projects. I'm not the project manager but I'm underneath the project manager in this role of sort of a technical leadership role within each project I'm in.
Q Okay. And what kind of specialization do you have as a lead environmental engineer; what kind of projects?
A Well, there's -- sediment remediation is one. In the mining engineering program it's often groundwater or surface water related, water quality. My training is kind of diverse. I

have background and training and experience in geotechnical engineering, environmental engineering and a little bit of hydrogeology.

Q Can you describe any of the projects you've worked on since you -- or consulted on or researched on as an environmental engineer?

A Sure.

Q Okay.

A We'll talk about the -- some of the mining work we've done. On the project is some contaminant transport and flow modeling, mounding analysis, those kind of things. We done hydrologic modeling for watersheds, so we evaluate streams, stream flow and base flow, responses to climatological conditions. We've done the sediment modeling for the Fox River project, which is fairly large, maybe a hundred million dollar project. We are -- I was the lead on coming up with a modeling strategy for finding where the -- after we had collected samples where the contamination is, where it's to be dredged, what kind of volumes and tonnages we're dealing with, the processes related to it. And then there's a whole set of analysis with respect to capping of contaminated sediments and alternatives analysis associated with sediment remediation.

MR. BRACKEN: Your Honor, previously I think there's a stipulation with counsel as to the admissibility of Curriculum Vitae for the experts and I believe Dr. Eykholt's is intervenor Exhibit 125. I believe that's true and I'd move for its admission if it's necessary, but I understand there's a stipulation.

MR. REICHEL: I have no objection, but I don't think it's necessary.

MR. EGGAN: Yeah. I don't think it's necessary, but if it is we stipulate.

JUDGE PATTERSON: Okay.

Q Okay. Dr. Eykholt, are you familiar with the Kennecott Eagle mining project in the Upper Peninsula?

A Yes.

Q And have you worked on that at Foth?

A Yes.

Q And in what capacity did you work at it -- work on it?

A In several capacities. The three main things that I worked on were the mounding analysis for the TWIS. The second one would be the groundwater contaminant transport analysis from the TWIS to the seeps or to the headwaters of the Salmon Trout River. The third issue would be the HELP analysis, the landfill or TDRSA analysis of -- for what I would call the design and selection of drainage systems for the liner systems for the TDRSA.

Q Okay. Well, let's go through those. What did you have to do with the groundwater mounding issue that's of concern at

the Kennecott Mine?
A The first step is to understand the setting, to have a fairly good idea of the geological, hydrogeological setting. So I reviewed reports, got a sense of what that was -- what the site was like. I got an idea of what sort of loadings we were interested in; how much volume per unit time we were interested in looking at responses to. And then --
Q Let me back you up a minute.
A Yeah.
Q So what is the groundwater mounding issue?
A Okay. Well, the main question we're trying to address with the mounding analysis is whether -- when you're introducing water to the groundwater for extended period whether the water will build up to such a level where it may seep out on the surface or cause some sort of interruption to other people's wells or seep out somewhere else.
Q And how is water from the mine being discharged into the groundwater here?
A There is a treated water infiltration system, the TWIS, and that's how it's introduced.
Q And where does the water go -- from where does the water go to the TWIS? The TWIs puts it in the ground; where does it come from?
A It comes from the water treatment system that's been designed by Foth.

Q So the water comes from the treatment system, goes through the TWIS and then is discharged into the groundwater?
A Right.
Q And with respect to the determining what effect that would have; what did you do or what were you -- what did you have to do on this project?
A Well, like I said, it's understanding the loadings, understanding the groundwater settings and then applying an appropriate solution to understand the estimate of its effect. And I can elaborate on that if you want.
Q And did your analysis that you conducted have anything to do with the way the TWIS was laid out?
A Yes, to some degree. Mainly in that one of the major questions was whether -- what was the infiltration rate that would be allowed. And so that would set -- knowing the rate that we wanted to discharge or we wanted to look at for this problem and the allowable infiltration rate, it sort of set the scale of infiltration system.
Q Okay. We'll get in -- we'll talk about that in a little more detail what you actually found from your analysis. You said you also did an analysis of the groundwater contaminant transportation from the TWIS to the seeps; you worked on that in this project?
A Yes.
Q Tell us what that's about.

A Well, the question we're trying to address with that modeling project was to estimate what would happen to groundwater concentrations from the point of discharge and then to a downgradient position. We looked at several downgradient positions, but one of the most interest -- we were most interested in concentrations that we're calling "the seeps," which may be 4- to 5,000 feet away from the TWIS.
Q When we talk about concentrations we're talking about what?
A Concentrations of constituents in the wastewater -- treated wastewater.
Q Okay. So waste treatment comes out of the treatment plant, goes to the TWIS it still has some constituents in it?
A Right. And we want to know how that -- those concentrations will change as they go from the TWIS to, let's say, the seeps.
Q Okay. And you said that you were involved in one other aspect of the mine and that was -- is it HELP modeling; is that how I understand it?
A Yes.
Q And what's that have to do with it?
A Well, "HELP" stands for hydrological evaluation of landfill performance. It's a very commonly used model for -- developed by the USEPA for evaluation of landfill performance. What we're doing there is using climatological

records -- daily climatological records, loading the system, evaluating where moisture goes or water goes and then how it drains through our drainage systems and possibly percolates through the liners.

Q Now, you've talked a lot in describing these three areas that you've worked on in modeling. Tell me what modeling is.

A In my phrase it's really expanding our views based on -- to answer questions. We're using numerical tools, analytical tools to evaluate potential impacts from a impulse or from a loading. This is one form of modeling that we have some sort of loading like a TWIS discharge. We want to understand its outcome. And so it's testing to better understand potential outcomes.

Q In a situation like this is it practical from an engineering standpoint to actually replicate the conditions you're going to have so that you wouldn't have to model?

A In this situation it would be very difficult for the three situations I listed.

Q So is that why we do modeling; that's why you do modeling in your area of expertise?

A Yes.

Q And is it a well accepted and well established way of doing these things?

A Yes.

Q Okay. So let's go over and talk about what you did regarding groundwater mounding. How did you go about -- after you did your investigation and the background go about modeling the groundwater mounding issue?
A Once we understand the inputs and the general scale of the problem and have an understanding of the groundwater that we're discharging to we look for the appropriate solution to -- the appropriate model to apply. And in this case it made sense to me to employ a solution -- a 1967 solution by Antush and an analytical solution method -- computer method that was developed by Finnemore on that solution.
Q So these ways of modeling this groundwater mounding -- these are generally accepted ways to do this in your specialty?
A Yes.
Q Okay. And did you use any other peer-reviewed materials to do this?
A Yes.
Q Okay. I'm going to put some up on the board. This looks like the first page of Intervenor Exhibit 127. It's been put up on the screen to your left. Do you see that?
A Yes.
Q What is that?
A This is John Finnemore's paper that gives a computer method for solving the Hantush solution -- analytical solution that Hantush developed.

Q I've had Intervenor Exhibit 128 now placed on the screen, at least the first page of it. And what is it?
A This is the "Guidance for Evaluation of Potential Groundwater Mounding Associated with Cluster and High Density Wastewater Soil Absorption Systems," essentially a guidance for infiltration systems developed by the International Groundwater Modeling Center in the Colorado School of Mines.
Q What did you do with -- how did you use these with respect to the work you did on mounding?
A Finnemore's solution is very helpful because it laid out the steps to apply Hantush's solution, which is several pages of analytical solutions. And Finnemore gives a step-by-step way of applying those solutions in an efficient form. And so once I understood Finnemore's paper and applied it, I pretty much had the analytical solution.
Q When you talk about the analytical solution, what do you mean?
A It means that the solution comes from metathetical expressions, usually a direct integration of differential equations rather than an approximation of the differential equations. Typically a numerical model takes a numerical approximation of the differential equation and applies it a step in time. The analytical solution gives you essentially all times once you've solved the solution. I don't know if

that explains it.

Q What's the solution we're looking for as a result of this?

A Well, we're looking for the head levels or the water table levels after the mound is formed.

Q Now, let's talk about mounding a little bit. When this water is discharged into the ground from the TWIS, it's already, I assume, a water level -- a water table level in the ground; correct?

A Correct.

Q What do you expect to happen when you bring this other -- or discharge this other water into the ground?

A The water table especially closest to the TWIS should increase due to the new mounding.

Q And the solution that you're looking for in doing these analytical modelings is to do what?

A To evaluate how that increase in water table level is situated in space, you know, in the horizontal plane.

Q Okay. So you're going to tell us how high the mound is? That's vertical?

A Yes.

Q And how it affects the water table even in a horizontal way as well?

A Right, essentially understanding the bell it shapes around the TWIS.

Q A bell curve would be two-dimensional, but this is going to

be three-dimensional; right?
A Right.
Q So did you, as part of the groundwater discharge permit application that Kennecott submitted to the state, do an analytical model calculation for the TWIS?
A Yes.
Q And is that Appendix E-2?
A I just want to make sure. Yes; that's right.
Q Okay. There's the next page. Does that look more familiar?
A Yes.
Q January 11th, 2006, memorandum that's been attached to the application is Appendix E-2?
A Yes.
Q And this is the calculations or the report on the calculations you did with respect to the mounding of the TWIS?
A Yes.
Q Now, this is a computer application of some sort; correct? Computer solution to it?
A Yes.
Q Now, do you just take one set of assumptions and put them in and say, "Okay. I've got the answer"?
A Well, to get one output, yes. We look at many different inputs to and look at the outputs from -- many different outputs.

Q So what kind of inputs would you put in here to -- or what did you put in here to come up with your final opinion with respect to the mounding?
A Knowing the input conditions, first of all, that's somewhat of a given, we're assuming it's a half foot a day over, let's say, a three-and-a-half acre footprint. And so we know how fast water is coming into the mound. And that gives us our -- an input condition. The parameters that we use in the model are the hydraulic conductivity of the sand or the aquifer, the saturated thickness of the aquifer, specific yield of the sand or the aquifer. I'm trying to think. Time is a variable. This is a transient analytical solution.
Q Let's back up a little bit. You said that there's a certain discharge rate into the ground. What is that set by?
A That was set by an upper bound estimate -- an early upper bound estimate for the TWIS discharge.
Q Okay. You said there was an area, too, of the TWIS. How did you come up with that?
A We looked at -- actually varied that. We looked at two scenarios. One is to have the infiltration rate of 3 percent of our measured infiltration rate, which our measured infiltration rate, I believe, was 62 feet per day. And 3 percent of that is close to 1.5 feet per day. So we looked at a footprint that would give us a 400 GPM input

with 1.5 feet per day infiltration. We looked at another one with a third of that, .5 feet per day. So scenario one was the 1.5 feet per day. Scenario two was .5 feet per day.
Q Which would have been the more conservative way to discharge water into the well?
A Well, in terms of reducing the amount of mounding, generally you would be better to have a lower infiltration rate.
Q Is that what they chose to do or you chose to do in this case?
A Yes.
Q You finished the modeling on this work, and did you come to a conclusion of how high the mound would be?
A Yes.
Q How high did you conclude that the mound would be?
A As a result of the analytical model and the work we've done -- work I did, I came up with an estimate of somewhere between 30 and 33 feet of mounding right under the TWIS.
Q And do you come up with different levels away from the TWIS -- as you moved away from the TWIS?
A Yes. The head levels mounding generally dropped fairly quickly away from the TWIS. I'm trying to recall the exact levels. But it's in the appendix. Generally at the seeps we are seeing -- 4,000 to 5,000 feet away from the TWIS, we're seeing maybe 2 feet of mound as --
Q Now, is -- the 30 to 33 foot mound right directly into the

TWIS, was that acceptable under the conditions that you had out at the site?
A Yes.
Q And why is that acceptable?
A Well, there's about 80 feet of space above the water table existing currently. So adding 30 would be 50. And in terms of -- we don't have much risk at all of a breakthrough condition directly under the TWIS because of that.
Q And as you modeled this, did you find anyplace where there is a breakthrough near the TWIS at all? Any possibility of a breakthrough?
A No. Well, the seeps on the -- other than the seeps, yes. There's really no significant breakthrough on the surface.
Q And the seeps are located how far away from the TWIS approximately?
A Approximately 4500 to 5500 feet away.
Q Just so we're very clear, there's going to be above this mounding 50 feet before you get to ground level of unsaturated material; dirt, rock?
A Right.
Q It's not rock, though, is it?
A It's mostly sand.
Q Now, in doing this modeling of the mounding, did you have to make assumptions that fit into the computer solution or into the computer program?

A Sure.
Q And what kind of assumptions were they?
A Well, the solution limits what we could do to some degree. Analytical solutions -- one of the disadvantages is that they're limited in the scope of the problem. And so it's somewhat of an idealized situation where we have a flat initial groundwater surface without any slope and so completely flat homogenous sands in this case and -- for loading. And in a sense, the analytical solution did not care, if you will. The analytical solution was applied without respect to a seep or anything else. But the solution was looked at relative to the existing groundwater table and additional topography.
Q Okay. So you talked about -- assumed a flat geology, I guess you'd say?
A Yes.
Q And is that the case out there at the mine?
A No.
Q What is the geology under the TWIS like?
A It's what we call unsaturated, unconsolidated -- I'm sorry -- unconfined aquifer; mostly sands. It's a quaternary aquifer we've called it -- referred to it before. The -- it's a sloping table. It slopes towards the headwaters of the Salmon -- east branch of the Salmon Trout River.

Q So it goes downgrade?
A Right, to the northeast.
Q And what does that do with respect to looking at your results from your modeling?
A Well, when you tilt the table, if you will, of the mound, you should expect to see a greater withdrawal of the water -- greater base flow of that water as it enters the mound so that it should drop the mound heights that you see. It also will tend to elongate the mound closer to the -- in the direction of flow.
Q So does that mean that we should expect outside the model that 30 to 33 feet would be lesser on a sloped -- if it had sloped geology underneath it?
A We would expect to see less mounding in that situation.
Q Have you had the opportunity since you've been involved in this matter to look at a groundwater mounding analysis that was submitted in a report by Stratus Consulting?
A Yes.
Q On behalf of the Petitioners or one of the Petitioners?
A Yes.
Q And was there in there a report of the mounding that they had expected?
A Yes.
Q And do you remember what that was like?
A Yes.

Q Okay. And what was that? Was it consistent or inconsistent with your model?
A Generally the mounding was much less than we'd expect for the same levels of flow.
Q Yours was less than that predicted by Petitioner's expert Stratus consultant?
A Yes.

MR. BRACKEN: Your Honor, at this time I'd move for admission of Appendix E-2 to the Intervenor's Exhibit -- I don't -- it's E-2 to the groundwater permit application. And I'm always confused as to whether the application is in or out. But --

JUDGE PATTERSON: Parts are and parts aren't, I think.

MR. BRACKEN: It's already in?

JUDGE PATTERSON: Any objections?

MR. REICHEL: No objection.

MR. EGGAN: Did you say it's already in?

JUDGE PATTERSON: I'm not sure whether it is. I think some parts are and some aren't.

MR. BRACKEN: This one would not have been moved for admission before.

MR. REICHEL: I believe this is one of --

JUDGE PATTERSON: I don't have my list.

MR. REICHEL: This is one of the appendices to the water permit application. In the DEQ list it's DEQ Exhibit Number 147, I believe. And we have no objection.

MS. HALLEY: No objection.

MR. EGGAN: Just a question or two.

VOIR DIRE EXAMINATION

BY MR. EGGAN:

Q This is a document you created and prepared?

A Yes, with -- Steve Donohue was the other author.

Q Okay.

MR. EGGAN: I have no objection, your Honor.

JUDGE PATTERSON: Okay. Thank you. No objection, it will be entered.

(Respondent's Exhibit 147, Appendix E-2 received)

DIRECT EXAMINATION

BY MR. BRACKEN: (continued)

Q Now, I'd like to move on, if I could, to the contaminant transport modeling that you did. And you explained that, but let's go back. What was the purpose of this modeling?

A Was to understand the changes in concentrations that we expect to see with an upper bound release condition, treated water leaving the TWIS. All of the discharge standards and again 290 GPM, I think, was one of the cases we looked at. The concentrations that would change from the TWIS down gradient to the seeps.

Q We've heard testimony before about what we believe the

quality of the water is as it's coming out of the wastewater treatment plant. And you weren't here. Now, there's an issue of quality of water again that's addressed by your modeling?
A Yes.
Q And what's that exactly?
A Well, the concern or the question is what would be the constituent concentrations at the seeps relative to what we're calling the GSI water quality standards for the Salmon Trout River.
Q Now, GSI is a fancy way of saying seeps in this case?
A Right. Well, it's the groundwater surface water interface would be a groundwater venting problem.
Q So the issue is what's the quality at the seeps compared to what the quality was at the TWIS when it was put into the ground. Is that what we're talking about?
A Right.
Q And how did you model for this issue?
A Well, we applied another analytical solution. And the start again was understand the loading conditions, understand the geology -- the hydrogeology of the site. In this case, looking for available solutions it made sense again to use a conservation modeling strategy. And we had available to us another analytical solution, which was called the horizontal plane source model.

Q Okay. Let's see if I can find which model that is. Is that one with the papers you relied one or one of the fairly late peer reviewed papers?
A Yeah. It'd be the -- let's see. I think Exhibit Number 126, groundwater contamination transport remediation.
Q Groundwater contamination transport remediation is the page that's up on the screen right now; is that correct?
A Right.
Q Is that the first page of something you relied upon in doing your modeling for the contamination transport analysis?
A Yes.
Q Okay. Tell me what that is.
A Well, this is a book. And the solution is the horizontal plane source model which is a analytical expression, an equation. It has relatively few inputs. And it gives a solution in two-D, an XY and concentrations based on loading -- continuous loading of a fixed concentration over a rectangular.
Q And is a TWIS a rectangular source?
A Yes.
Q And we assessed a fixed loading?
A Yes.
Q Okay. And what was the loading that you assumed?
A I assumed a couple different loadings. I think one was 81 GPM. Another was 290 GPM. And I think there was an

intermediate case as well.
Q Okay. That's the amount of discharge going into the ground?
A Yes.
Q And did you assume the constituent levels that Mr. Fassbender had calculated?
A Yes. We were using the standards for discharge at the TWIS or at the wastewater treatment system. So water that would be meeting but just barely meeting the standards would be discharged according to the solution.
Q So those are the ones that Mr. Fassbender came up with or are those the ones that were set by the state, if you know?
A Those were not John Fassbender's expected discharges. Those were the discharge standards for the -- at the TWIS.
Q Okay. If he testified that his were all below the standards, these were higher concentrations than he anticipated?
A Yes.
Q Is that the sole peer reviewed report that you relied on for the contaminant transport?
A There's another book that I referred as Charbeneau. It's not an exhibit.
Q Okay.
A It is referenced in Appendix M for the groundwater discharge permit. There's -- I found an error in that book actually. And I called Professor Charbeneau to let him know.

Q I hope he's a friend.
A Former professor.
Q Okay.
A Yes. It was a typo.
Q Okay. So tell me what your -- what your modeling -- what you tried to do with your modeling and how you plan to do it?
A Okay. Again the modeling is trying to address questions and try to run some analysis under given bounds to really answer those questions well. And the general strategy, somewhat like the mounding analysis, is to use a conservative loading condition, the harder to flow at the standards and then to use, in this case, in order to apply the analytical solution, we're using a one-dimensional flow field, which means that the groundwater is all traveling in one direction towards the seeps.
Q In reality, will the groundwater discharged by the TWIS travel in one direction?
A No.
Q How will it travel other than that?
A Well, we know the mounding is going to cause a bell shape somewhat -- a bell shape where the mound -- water is going to be highest near the TWIS. Water will actually flow in all directions from the TWIS and then eventually work its way to the northeast. So it's -- initially it's a divergent

flow path, and then we have somewhat of a wide flow net that comes out towards the northeast.
Q But the model you used had one direction assumed?
A Right, as a simplifying measure.
Q Is that a conservative or not conservative?
A It's conservative in that we're directing all the mass that we're discharging directly towards the seeps instead of having it mix more with the groundwater. So it would end up yielding higher concentrations at the seeps.
Q Okay. Were there any other measures you took or assumptions you made to make it a conservative analysis?
A The solution allows one to take into account absorption onto the aquifer solids or decay or other processes. And we ignored any sort of losses or absorption onto the system.
Q Okay. "Absorption" meaning what?
A Well, attachment of constituents from the discharge onto the sands that would delay their movement towards the seeps.
Q Okay. Well, they're attached to minerals that are already there on the sands, so they wouldn't get to the seeps in a shorter period of time as if they're directing it there?
A Yes.
Q But you ignored that in this model?
A Yes.
Q And did you come to a final conclusion as to what would happen with contaminants that were discharged into the

system and how they would go to the seep?
A Yes. Appendix M deals with mercury. And for Appendix M we saw that the discharge at the standard was 2.1 nanograms per liter, parts per trillion. And the standard at the -- the GSI standard or the standard for mercury at the surface water was 1.3 nanograms per liter. Our outcomes were generally about .8 nanograms per liter, underneath the standard. We did this further analysis in a September 2006 memo from Foth to John Cherry with the full range of constituents that we expected to see in the discharge.
Q Okay. So Appendix M is up on the screen right now.
A Yeah.
Q Is that an appendix to the groundwater discharge permit application?
A Yes.
Q Is that something that you authored?
A Yes.
Q And that has to do -- it says the advection dispersion model. Is that the same as contaminant transfer?
A Yes. The advection dispersion model is the analytical -- it's shorthand for the analytical solution for the horizontal plane source model, which is expressed in the memo.
Q Okay. And with respect to Appendix M, did you model or calculate for every constituent?

A Appendix M just dealt with mercury.
Q And was that as an example?
A Yes. Well, of a constituent of concern.
Q Okay. And then subsequently I understand that you provided those calculations for the other constituents, the other major constituents?
A Yes; yes.
MR. BRACKEN: I'd move for the admission of Appendix M.
MR. REICHEL: No objection. I would note that this appears in the DEQ exhibit list as DEQ Exhibit 158.

VOIR DIRE EXAMINATION

BY MR. EGGAN:
Q Same question, sir, did you create this document yourself?
A Yes.
MR. EGGAN: Okay. I have no objection.
MS. HALLEY: No objection.
JUDGE PATTERSON: Being no objection, it will be entered.
(Respondent's Exhibit 158, Appendix M received)

DIRECT EXAMINATION

BY MR. BRACKEN: (continued)
Q And the calculations as to all the constituents come in under the standards at the seeps based on your modeling?
A Yes.

Q Sir, can we conclude then from your work that none of the -- based on the quality of water that comes into the TWIS from the wastewater treatment plant, that none of them -- none of that will exceed the discharge standards at the seeps?
A That would be correct.
Q Do you know if those are surface water standards or are they groundwater standards? Do you know?
A At the seeps?
Q At the seeps.
A It's the applicable surface water standards or the standards applied for a groundwater vent.
Q Okay.
A I think they're generally surface water quality standards.
Q Okay. Now, with respect to your analysis, this contaminant transportation -- or transport, is there anything you didn't take into consideration in this analysis that would have made the numbers even lower and it would have been more conservative?
A Well, yes. I think there would be several factors that would generally decrease the concentration I would expect to see at the seeps.
Q Okay. And what are they?
A First of all, the divergent flow field is probably the most significant. When we sort of fixed the flow in one dimension towards the seeps and the seeps see highest

concentrations, essentially the center of the plume, that will generally lead to the highest concentrations we'd expect to see in any condition. The concentrations should drop, I think, fairly significantly based on level of dispersion, the source spreading due to the mounding.
Q   Okay. So instead of going in one direction, it's spreading around the --
A   Correct. I think another factor is a lot of the constituents are metals -- heavy metals that are known to absorb onto aquifer solids. And not taking any credit for absorption will lead to an upper bound estimate for concentrations.
Q   Okay. Worst case scenario?
A   Yes. The other thing that we ignore or -- I don't know if we so much ignore but we don't consider in terms of the solution is that a lot of the Yellow Dog Plains and surrounding land will receive -- continually receive recharge. And that water comes down essentially on top of our groundwater surface. And so all of the water that reaches the seeps is actually the top part of the groundwater regime which is generally -- more directly results from the precipitation so not necessarily directly linked to the discharge.
Q   So recharge is precipitation?
A   Yes, and snow melt.

Q And snow melt. Okay. And what are the characteristics of that with respect to the concentrations of what's been discharged by the TWIS?
A I'm not sure. I mean, we're dealing with very low levels in the groundwater discharge. But I would generally say that concentrations are lower in precipitation. There may be -- there may be some elements which are higher in the precipitation such as mercury.
Q But when that precipitation gets into the groundwater, it has some effect on the discharge from the TWIS as well?
A Right.
Q It mixes?
A Yeah. It should mix with the water we're discharging and the natural gradient water.
Q Now, is there any issue about the discharge water and its hardness that you've looked at?
A Yes.
Q Okay. What is that issue?
A The issue is that the standards for -- the GSI standards for the water quality at the seeps will depend on the hardness of the receding stream, in this case, the east branch of the Salmon Trout River.
Q Okay. And what is hardness?
A The hardness is formally defined as the sum of divalent metals dissolved in the water. Primarily in most natural

water systems, we're dealing with calcium and magnesium as the dominant hard metals. But it could include iron and cadmium and other trace metals as well.

Q So what's the issue with respect to the water coming from the TWIS running towards the seep?

A Well, the treatment system produces a very low hardness water. The RO process removes quite a bit of hardness, for instance. So the hardness is expected to be very low coming out, less than 5 milligrams per liter is calcium carbonate. In the TWIS model we assume that it's zero coming out as a conservative input. Then we apply our analytical solution, the advection dispersion equations, to estimate using background information, background water chemistry, what the concentrations would be the seeps from that discharge.

Q Okay. And have you done that?

A Yes.

Q And what conclusions did you draw and how did you draw them?

A Well, applying the solutions just like we apply any other constituent looking at the background and the discharge of zero, we found that the discharge -- I'm sorry -- the TWIS -- I'm sorry -- the seeps concentrations for hardness were going to be, in general, 40 to 46 milligrams per liter as calcium carbonate based on the analytical solutions.

Q Okay. And is that -- what impact does that have at the seeps?

A Well, our standards are based on -- the GSI standards are based on a hardness of 50 milligrams per liter.
Q Okay.
A And so we're not quite there with the analytical solution alone other than to say that the standards are based on a receding water quality which can involve other sources of hardness of water into the seeps. We also claim that there will probably be some increase of hardness in the water we discharge due to exposure to the solids -- the aquifer solids that are there. It contains some trace levels of hardness.
Q Okay. So let's see if I can put this together. We have a low hardness effluent that comes out of the treatment plant; correct?
A Yes.
Q And we have --
MR. EGGAN: Well, your Honor, I guess I would like this to not be by leading question.
MR. BRACKEN: Okay. Well, that's not going to be the question. I'll rephrase it. Fair enough.
Q You've testified, I think, that there's low hardness coming out of the TWIS; right?
A Yes.
Q And we want to see -- you've also testified, I think, that we want to see for our standards around 50 MGL's --

milligrams at the seeps?
A Yes, 50 milligrams per liter as calcium carbonate.
Q Okay. So do I understand there has to be hardness added along the way to get there? Is that what --
A Potentially. From the straight application of our analytical solutions, we get between 40 and 46 milligrams per liter.
Q Okay. So -- and is there another way to explain how you might get a little bit more so it will be up to 50?
A Yes.
Q And what's that way?
A It would be dissolution of minerals that are already present on the sands, especially the sands that are not currently saturated but it will be exposed to the mound. We expect that there will be an increase of hardness from that. There will also be an increase of hardness potentially from the other sources of water that feed the Salmon Trout River.
Q What other sources are there that feed the Salmon Trout River?
A Well it would be runoff. So we know there's runoff that helps supply those streams as well. The other issue is that we're using kind of the low end for the background for the hardness -- the background hardness. And if that background was increased to more of an average condition, we'd expect to see some increase there. So a variety of all those

different sources of additional hardness, we believe that getting to 50 is a reasonable expectation.
Q And that's in your professional experience?
A Yes.
Q Let me ask you. Is there anything about the natural conditions in this area that would also lead you to believe that?
A Yes.
Q And what's that?
A Well, rainwater comes in and snow melt comes in with very little hardness. And it's been raining and snowing in this area for millennia, I mean, very long periods of time. This is -- these systems are heavily fed by precipitation water. And so when the water comes in at low hardness, it'll contact the sands and other minerals that are in the unsaturated zone, work it's way to the groundwater. In the groundwater there may be other mineral processes that sort of buffer the harness and other water quality characteristics to yield our background water condition. And that it's at 50, there's no reason for me to believe that that's a recent event rather than a very long-term process. And because we're dealing with a very well known low hardness input and 50 milligrams per liter background would indicate to me that the same processes would continue during the application period.

Q Okay. I think I get it. The background hardness is what in this area in the groundwater? Around 50? Is that what you testified to?
A 50 and maybe a little higher; 60, 70 maybe.
Q Okay.
A Different wells have different readings.
Q And that's not the hardness of the rainwater?
A No. Rainwater is close to zero; less than 5 like our discharge.
Q There's something natural happening out here that puts hardness in this rainwater and it ends up in the groundwater here?
A Sure. Dissolved minerals or minerals that are on the sands and other aquifer materials.
Q And you're saying that that's part of how you're concluding that you'll get to the 50 at least?
A Yes.
Q Now, when you did the contaminant analysis, based on these peer reviewed exhibits that we've shown up here, did you check the solutions against them?
A Yes.
Q Okay. And what was the result of your checking the solutions against these authoritative peer-reviewed articles?
A They checked out exactly. I found the error in Charbeneau's

text by checking his solution, it worked to make sure I had that right even though there's a typo. The other thing I did is what we called a mass balance analysis. Once you know how much mass you're entering in the system and you know how much mass you're going to be collecting, you can sum up the two, do an integration and make sure you're closing a mass balance so you're correctly applying -- you're not losing mass somewhere in the process.
Q Okay. And based on that, you made the conclusion what?
A I'm very satisfied with the accuracy of the analytical solution as applied.
Q Both for the mounding and the contaminant transport?
A Yes.
Q Did you have the opportunity to review an analysis or analyses done by Golder and Associates?
A Golder and Associates?
Q Yeah.
A Yes.
Q Mr. Stephen Thomas?
A Yes.
Q Did he also do a groundwater mounding analysis?
A Yes.
Q Okay. And did he use the same analytical tools that you did?
A No. He knew of the solution. He had reference to the

solution I had. The memo was had is in draft form at least.
Q Did he use the United States Geological source of MODFLOW code and --
A Yes.
Q -- and MODBACK mode?
A Yes; yes.
Q That's not what you used?
A No.
Q Okay. And do you know what his results were?
A Yes.
MR. EGGAN: I guess I would object to whatever his results were, your Honor, unless he's coming in to testify. That would be hearsay.
MR. BRACKEN: I'll withdraw the question.
JUDGE PATTERSON: All right.
Q You reviewed his results?
A Yes.
Q Is there anything inconsistent with your results?
MR. EGGAN: Well, that's the other way of trying to skin the cat. But it also results in a hearsay response.
MR. BRACKEN: I think I can ask this question and be and that is, is there anything that would lead him to believe based on Mr. Thomas' results that his results were wrong. That doesn't put Mr. Thomas' in. But it would say that there's nothing, you know, that would lead him to

believe in his opinion, which he's already given, that there's something wrong with it. I think he can do that.

JUDGE PATTERSON: Yeah. I think that's okay.

A I reviewed the Golder reports regarding mounding analysis with interest to see how they agreed or disagreed with my estimate.

MR. EGGAN: Again, your Honor, I don't think he's answering the question. I think what he's about to do is say what that analysis provided.

Q Without saying what the analysis is, you understand the question is is there anything inconsistent that leads you to be concerned about your results?

A No.

Q Did you look at similarly Mr. Thomas' analysis of the contaminant transport issue?

A I believe it's a particle tracking analysis.

Q Particle tracking.

A It's a little different.

Q So that's different than what you did?

A Yes.

Q And how is it different?

A Well, the particle tracking analysis makes an estimate of movement of water along potential paths from the mound to the TWIS -- or to the down gradient locations. And I did not address that, though.

MR. BRACKEN: Your Honor, it's ten to 4:00. I wonder if we could take a short break now and then come back?

JUDGE PATTERSON: Sure.

MR. BRACKEN: I think we can finish up then. I have about 10 or 15 minutes left.

JUDGE PATTERSON: Okay.

(Off the record)

Q Dr. Eykholt, we've talked about the TWIS and the movement of water and your analysis for the seeps. And I've put up on the screen an attachment to Appendix E-and to the Application for Groundwater Permit **4:00:45 permit. Have you seen this before?

A Yes.

Q What I want you to use this is for demonstrative purposes so you better explain where the water's starting from and where it's going. Okay?

A Yes.

Q And if I point here (indicating) -- I do have a pointer here. I'm low tech.

A So right here (indicating) on this line?

Q Yes. What is that?

A This is the TWIS. It's about 150 feet by 1,050 feet.

Q Okay. And there are lines that are shown in this. And think this is for particle tracking, but could you kind of

show the judge generally how your analysis shows the water will go from the TWIS towards the seeps?
A Well, the mounding analysis would essentially draw circles around this in terms of different water level elevations that are increasing above the natural water elevations. For the groundwater contaminant transport analysis we're assuming that these paths are all straight towards the seeps which is generally 4500 by 5500 feet away. So --
Q In actuality -- you assume that they're straight, but in actuality, that's not how it's going to look; right? I mean the flow of water towards the seeps; is that --
A Right. There will be some diversions away from that straight path.
Q And where are the seeps in this?
A They're sort of hard to pick out here, and I'm not an expert at locating them. I've been told the distance. I believe we're looking at bluffs along this zone. So where you see the greatest contours, the elevation drops and along those slopes, you see springs emanating out of the slopes. That's what we're calling the seeps.
Q So this shows us just in general how the water is going to go from the TWIS down towards the seeps; is that right?
A Yes.
Q Okay. Now, do you know if -- have an opinion as to how long it's going to take for the water to go from the TWIS to the

seeps in general, rough approximation?

A Well, if we take an estimate for groundwater velocity that we expect to see, from my groundwater contaminant transport analysis, kind of looking at velocity something like a foot and a half, two feet per day of velocity towards the seeps, and if that were, say, 4500 feet, it would be 3,000 days or maybe, rough approximation, about 7 years, or less if we go to the higher velocities; so 5, 7 -- 4 to 7 years or so depending on just which part and how close it is. So it's kind of a broad range, but there's a broad space there and different velocities.

MR. BRACKEN: Your Honor, we had a couple things I wanted to deal with respect to the exhibits. For some reason we don't show that those two exhibits, 147 and 150, have been admitted. There wasn't any objection to their admission from either side. And I checked with the court reporter and it's true that they haven't been admitted. So we would like them admitted as Intervenor's Exhibits 15, Appendix E-2, and Intervenor's Exhibit 15, Appendix M, if that's okay with -- this is housekeeping matter.

JUDGE PATTERSON: I thought we did admit those.

MR. EGGAN: I'm not sure what we're talking about here.

MR. BRACKEN: These are the two appendices that we had.

MR. EGGAN: Are you talking Appendix M and E-2?

MR. BRACKEN: Yeah.

MR. EGGAN: He's admitted them.

MR. BRACKEN: For some reason they don't show up with the reporter as having been admitted as Exhibits 147 and 158 from DEQ.

MR. EGGAN: Well, they haven't been --

MR. BRACKEN: They haven't been admitted?

MR. EGGAN: They wouldn't have been yet 'cause he hasn't put his case yet.

MR. BRACKEN: Okay. So they're being admitted today under those numbers. That's the --

MR. EGGAN: And I'm okay with that. Is that --

MR. BRACKEN: That's okay.

MR. REICHEL: Whatever number. I was simply noting for the record because we don't --

MR. BRACKEN: I see.

MR. REICHEL: The point is, we have no objection to those however you want to denominate them.

MR. BRACKEN: Well, they can be denominated as previously set in the record. We wondered whether they were already in. That was what was --

MR. REICHEL: No, and I didn't mean to imply that they had been.

JUDGE PATTERSON: Oh, you mean in through -- as a

DEQ exhibit?

MR. BRACKEN: Yeah, as a DEQ already. They haven't been.

JUDGE PATTERSON: Oh, okay. All right.

MR. BRACKEN: But we'll keep those two numbers in.

MR. EGGAN: I'm fine with that.

JUDGE PATTERSON: Intervenor? Going in as an Intervenor?

MR. BRACKEN: No, they're going in -- we'll keep with what we this before, your Honor, as a DEQ exhibit. That makes more sense. I was just told that we weren't sure they were in yet. If they're now in -- so that's okay.

JUDGE PATTERSON: All right.

MR. BRACKEN: I also move for the admission of the treatises and reports that Dr. Eykholt relied upon and identified here, Intervenor's 126, 127 and 128.

MR. REICHEL: No objection.

MR. EGGAN: Say that again. I'm sorry.

MR. BRACKEN: Intervenor's 126, 127 and 128, I believe.

MR. EGGAN: And those are?

MR. BRACKEN: Those were the treatises and articles that we put up on the --

MR. EGGAN: I don't -- I do object to those. I don't see how they can come in. They are treatises that are not generally admissible; in fact, by court rule are not admissible.

MR. BRACKEN: Well, I think under the rules here, under the rules of this administrative body, the basis of this report, we're allowed to admit those as the basis of his report and it's support for his expert report in this case. I think that's what the court wants, make sure that he's -- the bases for his report are in the record and they were relied upon.

JUDGE PATTERSON: If he relied upon them, I think they're admissible. So I'll overrule the objection. And again those were what?

MR. BRACKEN: 126, 127 and 128, your Honor.

JUDGE PATTERSON: Okay.

MS. HALLEY: For the record, we join Mr. Eggan's objection.

JUDGE PATTERSON: Okay.

(Intervenor's Exhibits 126, 127 and 128 received)

Q Okay. I just want to make sure we have your conclusions here today, Dr. Eykholt, first as a result of the mounding. Is the mounding -- it's likely from this -- the infiltration of water to discharge the water into the groundwater likely to cause any concerns or problems with respect to the groundwater table at the site?

A No.

Q And it's your testimony that the maximum mound will be 30 to 33 feet?
A What I would consider an upper bound estimate, yes.
Q And so what does that mean by an "upper bound estimate"?
A Well, with conservative assumptions on the inputs larger than what we're allowed to discharge, that would be one reason that I would say it was a upper bound --
Q It's not likely to exceed that? It might be less?
A It has to be less or the permit would be violated.
Q And second of all, with respect to the contamination transport analysis that you did, your conclusion is?
A The concentrations at the seeps will comply with the applicable standards.

MR. BRACKEN: With that, I have no further questions, your Honor.

MR. REICHEL: Just to follow up, Dr. Eykholt, my name is Bob Reichel. I represent the DEQ.

CROSS-EXAMINATION

BY MR. REICHEL:

Q Just to follow up briefly on one of the last points you were asked about, this mounding analysis, just so the record is clear, what -- I believe you alluded to some limitation in the groundwater discharge permit -- is that correct? -- as to the rate at which water can be discharged from the treated water infiltration system?

A Yes.
Q And what is your understanding of what volumetric limitation is established in this permit?
A My understanding is the applicants show -- run a test, an infiltration test, and that the maximum infiltration rate has to be less than 3 percent of the measured infiltration rate from that test.
Q And do you recall whether or not the groundwater discharge permit as issued states a maximum amount or volume of groundwater that may be discharged?
A The ultimate volume that may be discharged?
Q Yes.
A I am not aware of the specific total quantity of volume.
Q Leaving that aside, are you aware -- if you know, does the permit establish a limitation on the rate at which groundwater may be discharged that could be converted to gallons per minute?
A Yes. The maximum discharge is 350 gpm, I believe.
Q So any discharge in excess of that would not be -- is it your understanding as to -- in your understanding, would any discharge in excess of that be allowed or not allowed under the permit?
A My understanding it wouldn't be allowed.
MR. REICHEL: No further questions at this time. Thank you.

MR. EGGAN: I have a few questions, your Honor.

CROSS-EXAMINATION

BY MR. EGGAN:

Q Dr. Eykholt, I just want to ask you a question or two initially about your resume. First of all, you are not -- you're a professional engineer, but you are not a hydrogeologist, I take it?

A No.

Q Or a hydrologist?

A No.

Q Nor are you a geochemist?

A No.

Q Okay. And you don't profess to have any particular expertise in those three fields that would give you an opportunity to offer an expert opinion?

A My sense of the environmental engineering profession is that it is --

Q Sir, do you have an expert opinion to offer as a hydrogeologist?

A Yes.

Q You do? Okay. Well, go ahead and tell us your credentials, then, for testifying as a hydrogeologist. You told us you are not one, but tell us how it is you have the ability to offer expert opinions based on a reasonable degree of scientific certainty as a hydrogeologist.

A I don't claim to be a hydrogeologist. You asked whether I had expertise in hydrogeology.

Q Did you stay at a Holiday Inn Express last night?

MR. BRACKEN: Objection, your Honor.

MR. EGGAN: Oh, just kidding.

A What I'm trying to explain is that the environmental engineering field is interdisciplinary. It always has been, dealing with multiple aspects. And I've taken courses. I've trained for many years understanding, working with hydrogeologists to understand these features. I've written papers, accepted, peer-reviewed papers in hydrogeology journals. So it's -- I would -- I wouldn't say that I don't have things to offer to the hydrogeology field or practice.

Q Are you a hydrogeologist?

A No.

Q Are you a hydrologist?

A No.

Q Okay. And you're not a geochemist?

A No.

Q Okay. And would you suggest that somehow you have the ability because of your experience to offer scientific opinions on geochemistry?

A Yes.

Q As a professional engineer?

A Yes.

Q Okay. Looking at your relevant experience in your resume, do you have other mine-related experience other than the Kennecott Project? I think you mentioned one or two other projects?
A Yes. For the Flambeau Project, I have some experience running what was called the **4:14:28 Biolytic Liggen Model for the Stream C question. Better understand the applicable -- to better understand the or estimate the concentrations that would be toxic to fish and indicate organisms for Stream C.
Q It sounds like you didn't have anything to do at least at Flambeau with groundwater mounding or modeling?
A No; no.
Q Okay. What was the other project?
A I've worked on water quality modeling projects that are mining related.
Q For -- what projects were those? What projects?
A There's a question about the impacts of the water treatment and water quality at pit lakes, and our company is generally interested in understanding the subaqueous disposal of tailings and trying to understand their interactions. So we're doing water quality modeling to understand those interactions.
Q Okay. And where are those pit lakes?
A There are several pit lakes.

Q I know there are lots, but I just -- I guess I'm assuming that you must have gone to one of these locations and have done a study or something or --
A Yes. We have done some looking at specific tailings facilities.
Q I'm just wondering where.
A One would be the -- there's a Groveland Mine. That's just a very ancillary look at things. There's the Humboldt pit, which is in -- near Humboldt Township.
Q Right there in -- right there near our mine site?
A Yes.
Q Any other mine projects that you can think of? Did you work at Crandon at all, do any work related to Crandon?
A I did not.
Q I asked you a few questions initially about Appendix M, and as I look through Appendix M, it looks to me like a major component of your analysis is that the flow field is both -- it's -- one of the assumptions you apply is that the flow field is constant and one-dimensional. That's kind of one of the basic assumptions of Appendix M; am I right?
A Yes.
Q Okay. But we can agree, can't we, that the hydraulic properties will probably vary over that flow path in reality, can't we?
A Yes.

Q Okay. And we can probably agree that the gradient will also vary in that flow path, can't we?
A Yes.
Q So in reality, while your -- while Exhibit M is based on the assumption that the flow field is constant and one-dimensional, it really isn't in real life. It isn't constant. It will vary, --
A Yes.
Q -- both in terms of gradient and in hydraulic properties?
A Yes.
Q I think you also assume in Exhibit M that there is going to be a slightly increased gradient because of the mounding; am I right? A slightly increased gradient --
A Yes.
Q -- as a result of the mounding?
A Yes.
Q Now, again, looking at Exhibit M, it looks like you assume that the saturated aquifer has -- what? -- a 25-foot thickness in Exhibit M?
A Yes.
Q And I think you call this a conservative assumption.
A Yes.
Q Okay. What evidence do you have to support the conclusion that that aquifer is, in fact, 25 feet in thickness?
A We have well data from nearby the TWIS which gives us water

levels of that order of magnitude. On top of that width amount itself we'd expect addition as well. And when evaluating the hydrogeologic reports from North Jackson which are used to develop the conceptual model in reading their reports of the saturated thicknesses near the area I felt that was a reasonable estimate for the saturated thickness.

Q Now, my guess is that what -- and based on what you said, I think you said that you have well data from nearby the TWIS. But you don't have that well data from, say, out northeast of the TWIS, do you, to establish that it is actually 25 feet?

A We have interpolations based on wells between -- essentially there's wells between --

Q The TWIS and the seeps?

A Yes.

Q Really there are wells at the seeps and there are wells at the TWIS, but there really aren't any wells between the seeps and the TWIS, are there?

A Not to my knowledge.

Q Okay. And you've indicated that the flow direction is off to the northeast, but you really don't have any wells between the TWIS and the seeps to really help you establish that conclusively, do you, because there aren't any wells in that area.

A One would not need wells necessarily --
Q Sir, just answer my question.
A Yes.
Q I don't mean to --
A I understand.
Q I do mean to stop you, but I don't mean to be rude. There aren't any -- there really aren't any wells between the TWIS and the seeps; am I right?
A I have no -- nothing to add to that 'cause I don't know if there are any other --
Q You don't know whether there are or there aren't?
A I have no knowledge of any well between the TWIS and the seeps.
Q No, no. And --
A And I've never used information from -- you know, I have no knowledge of a well between the TWIS and the seeps.
Q All right. You don't have any knowledge because -- is it because you've looked and you don't think they're there, or you've looked and you know they're not there? Just let me know. Which is it?
A I have not become aware of a well between the TWIS and the seeps. I -- sorry to --
Q All right. And the seeps themselves, they're like 4500 feet; right? So you know that there are wells here, which is where the TWIS is; right?

A Yes.
Q And we know that there are a few wells at the seeps, don't we?
A Yes.
Q But we also know -- you and I know because you looked at the permit application and so did I -- that there are no wells in between that would help you to determine the actual direction of the flow of the water.
A First of all, it's --
Q Sir?
A Yes.
Q Am I right? Am I right?
A I think you're wrong in that --
Q Well, very simple question: Are there wells between here (indicating) and the seeps?
A No.
Q Okay. Perfect. And one of the ways that you as an engineer or a hydrologist or whatever would be able to confirm that flow direction would be a series of wells in through this area. One of the ways to do that; am I right?
A Yes.
Q But there are none.
A There are wells.
Q Well, there are wells here (indicating) and there are wells at the seep.

A And there are wells laterally.
Q And there are wells laterally, meaning in the sideways direction?
A Yes.
Q Okay. But I'm talking about the direction that you have come here and testified that the water is going, to the northeast. Is that, by the way, your conclusion, that it's going to the northeast?
A Upon reading other reports and looking at the data, conceptual models of the site.
Q Well, I'm asking for your opinion.
A Yes, I believe that is a reasonable expectation given the characteristics of the site.
Q Wouldn't it be nice though -- given the consequences involved here, wouldn't it be nice to just have some wells here to tell us and to be certain about this issue? I'm asking you as an engineer or a hydrologist or someone who has experience in this area. As a scientist, wouldn't it make sense to have that?
A I think it's useful to have more information. I'm not sure --
Q Well, but in this instance --
A We have to ask --
Q -- it's actually not more information; it's actually some information, isn't it?

A No, because we already have some information.
Q All right. From wells that are lateral?
A And the topography of the site. We know that the seeps are there. They are taking plenty of water from the surrounding areas.
Q Did I ask you if you -- if I did, I apologize.
A Yeah.
Q Did I ask you if you've been to this site?
A No.
Q I didn't ask you have you been?
A No.
Q You've never been to this site?
A No.
Q So you're relying on what others have told you about the topography and the geology, et cetera? Haven't held a rock in your hand; right?
A Yes, I've held a rock in my hand.
Q Have you held a rock in your hand at this site?
A No.
Q Now, your analysis -- and again we're kind of focusing on Appendix M at this point -- assumes an 81- to 290-gallon-per-minute inflow?
A Can you describe what "inflow" means?
Q Well, frankly, I'm using your language -- let's take a look at it real quick -- from Exhibit M.

(Counsel reviews exhibit)
Q You know, I probably misspoke. Here's what you said:
"The discharge from the infiltration area was evaluated at two different levels of discharge, 290 gallons per minute as determined in the water balance for the project, and 81 gallons per minute."
A Yes.
Q So I used the word "inflow." I apologize.
A Okay.
Q I should have said "discharge."
A That's okay.
Q And that I assume is based on studies that were done by others?
A Yes.
Q Your analysis doesn't consider higher rates of discharge?
A For this analysis, no.
Q Okay. Now, just a question or two about the hydraulic conductivity. You specified a rate of 25 feet a day?
A Yes.
Q And again I think I'm going with Appendix M here, 25 feet per day. Where did the data come from to support that?
A I believe we referenced that it from North Jackson's baseline report, the hydrogeological report. The actual reference is in the appendix.
Q Have you seen any other data that might conflict with that

in the mine permit application?
A I'm not sure about the mine permit application. The groundwater discharge permit application I've seen hydraulic conductivities that are lower and higher.
Q Have you seen Figure 21 from the mine permit application, K values?
A I possibly have. I don't recall.
Q Let me show you Figure 21.
MR. EGGAN: And I apologize, your Honor, but the only place I presently have this is on my computer. So I would like to show him this figure on my computer. It's Figure 21 from the mine permit application.
Q Have you seen this (indicating) figure, sir? And if you haven't seen it, then I'll just move on, but --
A No, I haven't seen that figure.
MR. PREDKO: For the record, Mr. Eggan, what figure are we looking at?
MR. EGGAN: We're looking at Figure 21 from the mine permit application.
MR. PREDKO: I'm not aware of any Figure 21 to the mine permit application.
MR. EGGAN: Well, Counsel, I didn't even know you were participating today. I thought the other Kennecott attorney was participating today. So, I mean, are we doing two or three people objecting at a time or --

A If you could possibly put this on the overhead projector.

MR. PREDKO: Just helping to make the record clear.

MR. BRACKEN: Has this been admitted into evidence?

MR. EGGAN: It hasn't been. This is cross-examination, so I'm just asking if he's seen it.

MR. BRACKEN: Well, he's answered the question.

Q You have not seen it?

A No.

Q All right. Well, let's take a quick look at it. It's a relatively short document; in fact, very short. Does this suggest that the hydraulic conductivity may be different than 25 feet per day?

MR. BRACKEN: I'm going to object, your Honor. He doesn't know the figure. We're not sure it's in evidence.

MR. EGGAN: It doesn't have to be in evidence for me to conduct cross-examination on it.

MR. BRACKEN: Well, you have to identify it, who did it and when was it done, under what circumstances was it done. It has to have some reliability even as a cross-examination exhibit.

MR. EGGAN: Well, it is from --

MR. BRACKEN: But it has to be established --

MR. EGGAN: -- the mine permit application that was submitted by Kennecott.

MR. BRACKEN: Who did it?

MR. EGGAN: It's Figure 21.

MR. BRACKEN: Who did it?

MR. EGGAN: Well, that I don't know. I suspect it was -- I suspect it was either Golder or --

MR. BRACKEN: When was it done and what was the purpose of it?

MR. EGGAN: Okay. Well, my question still stands. Is there anything on this exhibit that leads you to believe that the value that you attached may be different, may be incorrect?

A No.

Q "No"?

A No.

Q Why not?

A This figure shows a category for outwash sands and hydraulic conductivities ranging from approximately 5 to 500 feet per day. We used the value of 25 feet per day which is in the range of what you're presenting. It's on the lower end of the range, and I believe that that would be appropriate for conditions of the outwash sand on a broad scale. And we're within that range.

Q 25 is within the range of -- what? -- 500?

A 5 to 500 feet per day.

Q Oh, I see. Okay. All right. Well, I guess I'll move on then. You've not seen this, and you don't agree with me that it may support a different conclusion, so I'll just move on. Okay?
A Okay.
Q All right. Let's do that.
MR. EGGAN: Is that all right with you too, John?
MR. BRACKEN: It is.
MR. EGGAN: All right. Thanks.
MR. BRACKEN: And I didn't sleep at the Holiday Inn Express last night.
MR. REICHEL: Judge, just -- I don't know what nature of the objection, but I'm a little concerned about the clarity of the record. I've reviewed the mine permit application. As we all know, there are multiple appendices to it. I don't know which appendix Counsel is referring to.
MR. EGGAN: Yeah, frankly, that was my concern when I said it was Figure 21. It's to an appendix, and I don't have that number in front of me right now, so I apologize.
MR. REICHEL: Okay. But I just -- having looked at the mine permit application itself, the initial portion has a list of figures. There is no Figure 21 there. presumably you were referring to some appendix.
MR. EGGAN: All right. Well, it must be an

attachment. It must be part of an appendix, so I don't know. Okay?

MR. REICHEL: Okay. Again, I'm just trying to clarify the record here.

MR. EGGAN: Okay. Well, the record should reflect that it was Figure 21 which is a part of the mine permit application, but I don't know what it was attached to. I will look this evening and come back tomorrow with a report. Okay?

MR. REICHEL: That's fine.

Q Now, with respect to the analytical model E-2, just a question or two. You used -- you also -- in terms of flow rate, you used 400 gallons per minute for your analytical model?

A Yes.

Q And you didn't consider inflows that were greater than that?

A No.

Q And that was because?

A The 400 at the time we ran the analysis was considered an upper bound analysis or upper bound amount of flow that we'd be interested in. Since the time of that analysis it's dropped, and the discharge is 350 at max because --

Q Right. The discharge is 350 at max because that corresponds with the maximum of wastewater treatment plant, I take it?

A Yes.

Q Okay. But if the inflows were actually greater than that, your calculations would change, wouldn't they?
A They would change. I can't comment necessarily how much 'cause I didn't run the analysis.
Q Well, we don't know how much the inflow rate would increase, but if they were greater than that, we do know that there would be a change in your calculations?
MR. BRACKEN: Objection. And this is just a clarification. You used the word "inflow" again. I think you meant discharge.
MR. EGGAN: No, here I'm talking inflow.
MR. BRACKEN: Inflow into?
MR. EGGAN: Inflow into the treated water infiltration system.
A So the TWIS discharge is equivalent to inflow in this case?
Q Yes.
A So the question was? Could you repeat it?
Q Yes. You assumed an inflow of 400 gallons per minute maximum, but you didn't consider inflows any greater than that?
A I did not run the analysis for inflows greater than 400 gpm.
Q Okay. Have you studied the various layers and zones beneath the treated water infiltration system?
A I reviewed the North Jackson report which did describe conceptual models for the stratigraphy of the site, which

includes different hydraulic conductivity and different strata with different hydraulic conductivity, different thicknesses.
Q And you're aware that there are low permeability zones beneath the TWIS, zones that have much lower permeability than the sand that you described earlier?
A Right. Our report includes a cross-section figure from North Jackson that demonstrates that, so, yes.
Q Okay. And some of those low permeability zones could cause perching, couldn't they?
A Cause perching?
Q Could result in perching of water as it comes --
A Yes.
Q -- into the groundwater system?
A Yes.
Q And some of those -- some of those lower permeability zones, they're above the water table, aren't they?
A I have scant evidence. I haven't reviewed thoroughly reports of perching above the --
Q Well, you said you reviewed the North Jackson report.
A Yes.
Q Okay. That shows a low permeability zone above the water table below the TWIS.
A Yes. There's question about lateral extent because we see them intermittently. And there's also a question about

whether the perches that we're seeing are temporary or long term perches.
Q Okay. But it could cause perching of water as it comes down through?
A Yes.
Q And those could affect your calculations, couldn't they?
A I don't believe that there would be a significant effect.
Q What evidence do you have that they would not be signature?
A The basis for my thinking of that is that -- my position on that is that the lateral extent of the mounds or the confining units does seem to be very extensive and that there's plenty of opportunity for other higher conductivity zones to allow the water to flow around the perches if they are there.
Q Do you have any data or any -- what do you have to support that they don't extend laterally?
A That information from the next nearest well would indicate that those units aren't contiguous through the site.
MR. EGGAN: I don't think I have anything else. Michelle, do you have questions?
MS. HALLEY: Just couple. I'm Michelle Halley. I represent the National Wildlife Federation and the Yellow Dog Watershed Preserve.

CROSS-EXAMINATION

BY MS. HALLEY:

Q You testified that you're doing some work at the Groverland pit? Is that what you called that? Correct my pronunciation.
A It's Groveland, G-r-o-v-e-l-a-n-d.
Q Thank you. Where is that located?
A I'm not specifically sure. It's something that we -- it's a mine pit we know that's in the area that's in the Upper Peninsula.
Q Is it in Marquette County?
A No. I'm trying to recall exactly where it is. It's somewhat recent understanding.
Q What do you mean "somewhat recent"?
A Well, it's just recently become -- I became aware of that pit. That's all.
Q And why did you become aware of it?
A It's an iron pit in the Upper Peninsula region, and generally Foth is interested in mining resources including -- including former -- former mines.
Q And what is the extent of your analysis at that mine site?
A Just knowing that it's there, a former iron mine.
Q But you said you were doing some sort of study about subaqueous tailings.
A We are interested in the general strategy of subaqueous disposal and whether that could be a potential -- what the potential water quality effects would be from subaqueous

disposal facility. And tailings have been placed subaqueously in other mines. We were wondering about the water quality impacts from those from a --
Q Who were you performing that work for?
A We -- for Groveland it's -- we have not performed any work on that site. It's simply an internal review. We haven't -- we haven't done any real work on that, just -- we're looking through --
Q Well, who asked you to conduct the review that you've done?
A There's a company called Aquila Resources.
Q So Aquila is interested in the water quality at the Groveland Mine?
MR. BRACKEN: Your Honor, I'm going to object. And I apologize. But it seems to me that the only reason this was brought up was on a request or an answer to a question about his expertise in mines or his -- and now we're kind of getting off -- I think he's already told us he's hardly done anything on it. It was an internal review. And whose mine it is I don't think is very pertinent to the issue of whether he had background in the mine or this issue that was involved in this matter. I don't know where we're going with it.
MR. REICHEL: I would join in that objection on the basis of relevance.
MS. HALLEY: So I don't have any more questions

about the Groveland Mine.
Q The Humboldt Mine site, you said that you were doing some work there?
A Yes.
Q And what kind of work are you doing there, sir?
A We're looking at -- this is for Kennecott.
Q Uh-huh (affirmative).
A We're looking at the existing water quality characteristics of the mine, the bathymetry of the pit.
Q What's that?
A It's the water depths and spatially at the pit. We're looking at existing records, the former NPDS permit for the former placement of tailings of the Ropes tailings from the Ropes Mine into the Humboldt pit and the water quality that's come from that.
Q Why are you -- why is Kennecott interested in these particular questions that you're answering for them?

MR. BRACKEN: Objection, your Honor. Same objection as before.

MS. HALLEY: Well, your Honor, we've already heard testimony about the potential for the beneficiation activities at the Humboldt Mine. I think it's very relevant.

JUDGE PATTERSON: I'll overrule the objection.

A So the question again? Pardon me.

Q The question is, what are the questions to which you are seeking answers through these activities?
A We are trying to estimate what the water quality impacts would be due to placement of tailings as well as the recovery that occurred after the placement of tailings that we can understand from the application of -- the application of tailings from the Ropes Mine was in the Humboldt pit. There's a record of water quality. We're reviewing that water quality. We're doing addition modeling studies to understand what the impacts would be to additional tailings loadings to understand what the -- what the opportunities would be for subaqueous tailings disposal.
Q Tailings from where?
A Tailings from other mines.
Q Like the Eagle Mine?
A Potentially.
Q And when did you start this analysis?
A Explain "this analysis."
Q Well, the work you're doing at the Humboldt Mine, when did you begin working at the Humboldt Mine?
A I think the initial work, to understand the problem and understand the -- to gain access to records from the water quality impacts and what measurements that have already been done may have began in the spring of 2007, April, maybe May of 2007.

Q The tailings from the Eagle Mine that may be disposed at the Humboldt site, how would those tailings be created?
A The tailings are produced from milling operations, and so there would have to be a milling operation that would generate tailings. And so would potentially be managed in a tailings management facility.
Q What kind of milling?

MR. BRACKEN: Objection, your Honor. While this may be interesting, it's -- again, the issue is about his expertise. Now we're kind of on a discovery -- far flung discovery request by her as to what may happen in the future apparently with tailings from a mining process -- milling process. Excuse me.

MR. REICHEL: I would also join in the object that nothing in the permit that is the subject of this proceeding authorizes or purports to authorize milling or tailing at any particular location, including the Humboldt -- former Humboldt Mine. I don't think it's relevant.

MS. HALLEY: Your Honor, Part 632 certainly contemplates that the mining area for an EIA is required, for which a mining plan is required and a variety of other things, the definition of a mining area includes lands on which beneficiating or treatment plans and auxiliary facilities are located. Clearly, whatever goes on at the Humboldt Mine is very relevant to this particular case.

Now, the --

MR. BRACKEN: Your Honor, this is an investigation.

JUDGE PATTERSON: But there's nothing going on there.

MR. BRACKEN: There's nothing going on.

MR. REICHEL: No, this mischaracterizes the regulation. Let the record reflect the definition in the rule is approximately as Counsel stated it, but that begs the question, if it were the case that Kennecott had applied to the DEQ under Part 632 to engage in beneficiation at this site, the Eagle site, or some other site, that would be germane, but they have not done so. When and if they do so, that will be the subject of review, permitting, et cetera. But that is not this case.

MR. BRACKEN: This is just an investigation -- a pre-investigation of doing any application if they should ever make an application. So it's certainly not relevant to this case. It might be relevant to another case in the future but certainly not here.

MS. HALLEY: Your Honor, parts of 32 requires that beneficiation in treatment facilities be included in a Part 632 application. While I agree with Mr. Bracken and Mr. Reichel that the company has not yet included any of these plans in this particular application, to the extent that they are considering those options and to the extent that in the future they ask for permits to undertake those activities, Part 632 requires that those things be discussed in an application where the cumulative impacts of all of these things can be looked at as a whole. It seems as if perhaps the bits and pieces of this mining project are being parsed out so that it is impossible for the Petitioners, the public or anybody else to really look at the project as a whole. And to the extent that the Petitioners already have some idea that they're going to be conducting operations that fall under the definition of "the mining area," we should be able to talk about that.

MR. REICHEL: Again, your Honor, the record in this case reflects that as originally applied for, there was no proposal and as of today there is no proposal pending before the DEQ to conduct beneficiation anywhere within the State of Michigan. When and if Kennecott proposes to do that, it is certainly the Department's position that the law would require Kennecott to apply for and do the full analysis required under Part 632. But no such proposal has been made.

MR. BRACKEN: I agree with Mr. Reichel. It's an entirely theoretical issue.

JUDGE PATTERSON: Yeah, I agree. I think there's -- at this point it's preliminary and there's certainly nothing going on there. So I'll sustain the objection.

MS. HALLEY: Thank you. No further questions.

MR. EGGAN: Judge, for the record, I can identify the location of that exhibit that we seem to be questioning.

JUDGE PATTERSON: Okay.

MR. EGGAN: It's Intervenor 0007. It's Figure 21 in Appendix B-1 from the mine permit application.

MR. BRACKEN: Appendix B-1?

MR. EGGAN: Correct. And I apologize for the delay caused by that.

MR. BRACKEN: Actually there was no delay. It didn't delay us at all.

MR. EGGAN: Thanks.

MR. BRACKEN: I have a few questions, your Honor, to follow up on. Thank you.

JUDGE PATTERSON: Okay.

REDIRECT EXAMINATION

BY MR. BRACKEN:

Q In Appendix M, the advection dispersion model appendix, Dr. Eykholt, you agreed with Mr. Eggan that the flow path would vary in gradient and hydraulic properties from what you assumed for your modeling; is that correct?

A Yes.

Q Does the way you did it cause a more conservative view or a

less conservative view of the analysis?
A My opinion, my judgment is that the conditions at the site would lead to less mounding that what the modeling would indicate.
Q So a more conservative view of things?
A Yes.
Q Okay. You indicated in response to some of Mr. Eggan's questions that there was other information besides the location of wells by the TWIS and by the seeps that was germane or relevant to the issue of where the flow was from the TWIS. What was that other information?
A The overall site water balance would indicate that we've got a precipitation fed system that keeps the groundwater table higher, elevated. Otherwise the water would drain out. Okay? So we have a gradient towards the seeps, as I understand it, as other experts have shown in reports. The other information that I think is a very solid piece of evidence is the topography and the actual flow that's observed in the streams themselves indicating that the flow has to come from somewhere. It comes from upgradient. So by the inference that we've got significant flows at the east branch of the Salmon Trout and they're significant flows, that -- and the upgradient condition is the Plains to the southwest of those seeps is fairly strong evidence that we've got a regional gradient towards the seeps.

Q From the southwest to the northeast?
A Right.
Q I think you've acknowledged that the limitation that we can only discharge -- that Kennecott can only discharge 350 gallons per minute through the TWIS; is that correct?
A Yes.
Q If I understand when you doing your volume analysis, you've used the figure 400 gallons per minute.
A Yes.
Q What effect does that have on your mounding that you use 400 gallons per minute rather than 350?
A We would expect potentially less mounding because of the lower flow.
Q I just want to see if heard this right, that there's no information with respect to the confining zones that were referred to by Mr. Eggan that are above the groundwater table as it sits now, that they would -- that are contiguous; is that correct?
A Right.
Q Is there any information that they have mounding there now? Is there water above those perches now?
A I don't know.
Q Okay.
A Yeah.
MR. BRACKEN: I have nothing further, your Honor.

MR. REICHEL: No further questions.
MR. EGGAN: Nothing, your Honor.
MS. HALLEY: Nothing.
JUDGE PATTERSON: Thank you, Doctor.
THE WITNESS: All right. Thank you.
MR. BRACKEN: Thank you, your Honor.
(Proceedings adjourned at 4:56 p.m.)

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