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. XVIII

BEFORE RICHARD A. PATTERSON, ADMINISTRATIVE LAW JUDGE

Constitution Hall, 525 West Allegan, Lansing, Michigan

Wednesday, May 21, 2008, 8:30 a.m.

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Lansing, Michigan

Wednesday, May 21, 2008 - 8:35 a.m.

JUDGE PATTERSON: You ready?

MS. LINDSEY: We are.

JUDGE PATTERSON: Good.

MS. LINDSEY: Your Honor, Intervenor calls Tracey Arlaud.

MS. HALLEY: Petitioners object to this witness testifying based on the grounds that there is no report provided and that the expected testimony is again very vague and very short.

MS. LINDSEY: Your Honor, first of all, I thought that this was brought as a motion in limine. I really thought you had denied the motion, for one. But --

JUDGE PATTERSON: Well, I denied the motion to exclude their testimony, I think, was the essence of it.

MS. LINDSEY: Okay. So I guess I'm not really understanding why we're continuing to get this. But her testimony and her description was -- and I guess I'll just read it. She is going to talk about mine engineering and design, use of drilling and blasting in mining, blasting against backfill, rebuttal as appropriate to Petitioners' experts' opinions regarding design, stability of mine backfill and blasting effects. And this is really rebuttal testimony. And we could not have anticipated what testimony would come in. And so it's kind of -- it doesn't make any sense to think we should have more accurately predicted what the testimony was going to be and more accurately describe the rebuttal that she was going to give to that testimony.

MS. HALLEY: Well, just to be clear, I believe that your ruling indicated that you would consider this on a case-by-case basis. That's why we continued to raise the objection. And we continue to believe that we are prejudiced by the fact that we are encountering witnesses daily now for whom we have no idea what their testimony would contain.

JUDGE PATTERSON: Well, I think, Ms. Halley, there was considerable testimony under Petitioners' case regarding all these considerations; the effect of blasting on the stopes and so forth. So I think the parameters of those considerations that are outlined in the description of this witness' proposed testimony have been established. So I'm going to deny the motion and let her testify.

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

MS. ARLAUD: I do.

TRACEY JANE ARLAUD

having been called by the Intervenor and sworn:

DIRECT EXAMINATION

BY MS. LINDSEY:

Q Good morning. Will you please state your full name and spell your last name for the record, please?
A Tracey Jane Arlaud, A-r-l-a-u-d.
Q Thank you. Can you give us just a general overview of your educational background?
A Certainly.
Q And actually you have prepared some slides in this case; is that right?
A Yes, I have.
Q Why don't we put the first slide up.
A Okay. I completed a bachelor of science in 1992 in geology, geophysics and geochemistry. Our system in Australia works slightly differently. We have a program called an honors program, which you're invited back based on academic merit. That's a postgraduate program very similar to doing a master's degree where you do additional course work and research thesis. I was invited to do that and completed that in mid 1994. I then went on to do a graduate diploma in mining and mining engineering from the University of Ballarat, which is the oldest mining school in Australia. And then in 2006, I completed a master's of mining engineering from the University also of Ballarat, which key areas were advanced rock breakage, drill and blast, advanced mine planning, advanced rock mechanics and mine planning and scheduling.

MR. HAYNES: May I -- I'd just like to request to have a hard copy of this presentation before we go any further?

Q And there's some gaps in there. Were you also working in between those?

A Yes. From 1992 to 1994 being a student I was studying, but I also worked as a demonstrator at the university, which is essentially teaching the undergraduates, helping out in the field and teaching seismic, magnetics and those sorts of things. So you go out with a lecture and help demonstrate those fields. I also worked for a geophysical consultant doing some field work in the field in those areas.

Q What areas were you doing the work in the fields?

A Seismic remote sensing using seismology and seismic, using magnetics, gravity surveying, induced polarization. These are all geophysical methods to find orebodies or to decipher what's actually in the ground. Then on the completion of my honors' degree, I went straight out into industry. And I've worked full time in industry ever since. I took a couple of months off in 2000 when I was looking at my mom who had cancer. But apart from that, I've been in the industry ever since.

Q So in the mining industry?

A In the mining industry since early 1994.

Q Okay. So why don't you start with, in 1994, where did you start working?

A Okay. I started working for Great Central Mines which then became Normandy. And I started off as an exploration geologist at one of their sites called Jundee, which became a open pit and underground mine. Then I moved to Bronzewing operation.

Q How long were you at Jundee?

A I was there approximately a year.

Q Okay.

A Then I moved to Bronzewing in '95 and was there through to 2001. And I had a series of roles there, because I don't like to get bored. I started off initially as a exploration -- a mine exploration geologist and then I moved to an underground geologist geotechnical engineer underground. And I did that from '96 through to the end of '98. In '99, I moved underground and worked as an underground miner for a year.

Q What did you do as an underground miner?

A Basically I did all the jobs in the mine. So principally I did loading blast holes and charging them and initiating them. I also drilled the various blast holes and the different types of activities we do. I installed ground support. And I got to drive trucks and load loaders and also install mine services.

Q And we'll get back into talking in more detail about loading

and charging the blast holes and what that means. But generally how much of your time was spent doing that?
A Probably ten months. I pretty much did blasting the whole time I was -- the whole 12 months I was underground, because I enjoyed it. But pretty much ten months solid was, you know, in there.
Q Do you have any way to estimate sort of how many, you know, blast holes you loaded and charged?
A Oh, we talk in development rounds, which is -- we have two types of blasting. We have development blasting, which is creating the tunnel that we access the ore with. And then we have production blasting. And I worked in both areas. And in the development ore, we talk in what we would call a cut, which is a 3- to 4-meter section of the drive that we blast. I would have done in the vicinity of, I'd say, 580 to 800 blasts of that type physically loading them myself and charging them and initiating them. And I would have probably done in the order of 200 blasts in production of varying sizes.
Q Okay. I'm sorry. And I interrupted you. You talked that you were an underground miner.
A Yeah.
Q And that was in 1999?
A Yes. On the completion of my year underground, I then moved -- came back to the office and took up the role of

drill and blast engineer. And that job involves designing the actual blasts, designing the amount of explosives you put in the blast, designing the timing of the blasts and working out the tonnage and the amount of grade that you have on the blast. That's -- although we do still help out on the development, it's more on the production blasting primarily.
Q And you've told us the production blasting is where we're actually blasting in the ore?
A We're blasting in the stope, in the longhole open stope.
Q Okay. And did you tell us what kind of mine is -- was the Bronzewing Mine?
A Bronzewing is essentially exactly the same type of mine as we're proposing here. It's a longhole open stope mine. It's also very similar geology as here. It is in the Precambrian greenstone belt in west Australia. As you're aware, geology doesn't have any borders in terms of, you know, countries or states or what have you. So we have similar geology repeated all the over the world. And the geology at Bronzewing is greenstone, Precambrian, the same as -- similar to Eagle.
Q Okay. And you said the mining was longhole open stope?
A Longhole open stope much larger than what we're doing at Eagle. The stope sizes at Bronzewing were in the order of 60 meters wide, 60 meters long up to 120 meters high.

Q And in those, did you use any type of backfill?
A Yes. We had several types of backfill. The primary stopes were backfilled with cemented aggregate fill, CRF. We used igneous aggregate similar to what is proposed here at Eagle, which was crushed and screened again similar to Eagle to sub 3-inch material. And --
Q Remind us what sub 3-inch material is?
A So the material is -- size is less than 3 inches -- 3 inches or less.
Q Okay.
A Okay. And the cement -- that was bonded with 3 percent cement and no flyash.
Q Okay. So in general, would that be stronger -- how would that compare to the backfill at the proposed mine?
A It would be the same as Eagle. However, we were exposing much bigger stopes to that obviously, you know, from 90 to 120 meters high exposures at one time before we actually backfilled.
Q What did you use in the secondary stopes?
A The secondary stopes we did a series of different things. We used cemented hydraulic fill which Dr. Stone talked about before, which is the mine tailings mixed with -- the mine tailings screened for a certain size parameter and mixed with cement. We also used straight hydraulic fill, which was just the mine tailings again screened for a certain size

range, which then is put in a stope. And the water from the tailings is allowed to drain out, and it's hydraulic fill. And that then over time just settles. And then the third type was run of mine backfill similar to what is proposed at Eagle for the secondary stopes.
Q Okay. And you told us you were the drill blast engineer in 2000. Did you have another position after that?
A All of 2000 through to 2001 I was drill blast engineer. I also was involved -- you know, we have to do sometimes dual roles because of the number of people. I also was involved in stope design there. And also I was involved in ventilation. And from '96 onwards, I kept a foot in the door in ground support as well.
Q And when did you do ground support generally?
A In -- from 1996 to '99. I designed the ground support -- I designed the ground support standards for the mine. I designed all the ground support for the development as well as any ground support designs required in the stope to support the stopes. I also mapped the entire mine from where we started in the portal down to the non-level and looked at, you know, what type -- if the ground changes in different areas and whether that's consistent. And if we see that, we can predict it, and then we apply certain ground supports depending on what ground type we see there.
Q So after 2001 where did you work?

A 2001 I took a little bit of time off to look after my mom. And then I went to Western Mining Long shaft -- Victor Long shaft, which is a open stope end cut and fill mine also in western Australia.
Q How long were you there?
A Several months through to July.
Q And what did you do there?
A I was involved again in mine design, some stope design and also services designs like designing the pumping -- checking the pumping system, designing the pumping system and compressed air. And I was ventilation officer again. Western Australia has pretty strict regulations on regulatory positions like the ventilation officer.
Q Okay. Where did you work after that?
A Then I went overseas to Freeport, Indonesia, which is one of the world's largest copper mines. And I was technical expert for drill and blast.
Q So generally what were your -- were your duties the same there as what you described with Bronzewing?
A Yeah; yes. Freeport has several different mines. It's a huge complex, so it has several different mines. My first role was essentially improving the drill and blast procedures in the production area. Unlike -- the first area was in DOZ, deep ore zone, which is a block cave mine. As I think you heard testimony earlier, a block cave mine is

where you're drawing down -- drawing the ore down essentially and purposely causing subsidence. And you do this by taking out a whole level basically, blasting and letting it collapse on top. So my thing there was to improve the drill and blast. We kind of changed mining methods which made the drill and blasting far more important. And it's also essentially a teaching job. As an expatriate, as an expert, you're there to teach the -- the national mining engineers how to drill and blast with modern methods. And part of my thing was to -- what I did there was introduce electronic detonators, which improved safety, productivity and some other issues specific to that mining method.

Following that I moved into mine planning role. And I worked at the Big Gossan Mine. Big Gossan is a different style deposit. And the mining method there again longhole open stoping. And I was working on an engineering cost study to design the entire mine and cost it and schedule it. I did that for another six months or so. And then I moved back to the DOZ to work on a study to expand the production rate of that mine and did four life of mine plans, different levels of plans with different options for production rates.

Q And how long were you at that mine?

A I was there from -- three years essentially 'til 2004.

Q Okay. So what did you do in 2004?
A 2004 I joined McIntosh Engineering in Tempe, which is an engineering consulting firm. And I've been a senior engineer there. And again my role there is designing mines and costing them. I tend to do all the drill and blast designs in the company given my extensive drilling and blasting background. And I've worked on more longhole open stoping mine projects, block caving projects, sub-level caving projects, room and pillar projects and sub-level caving projects. So I've covered the whole gamut of mining methods. And again this is designing the entire mine, scheduling, costing them. And pretty much on every project I get called into drill and blast design at some point.
Q Do you do drill and blast design consulting on projects that you may not otherwise be working on?
A Yes.
Q So other engineers in your firm consult you?
A Come to me, yes.
Q All right. And that's where you still are; is that not correct?
A That is currently where I am, yes.
Q Have you also taken some professional courses in addition to your formal education?
A Yes; yes.
Q If we could see slide 2, please. Why don't you tell us

about the ones that relate to sort of -- well, why don't you tell us about the ones that are on this list?

A Okay. This is probably a snapshot of the courses that I've done that are relative to my testimony I'm giving here today. Excavation in engineering for underground mines, the Australian Centre for Geomechanics, this is a group of researchers that sit out just on the side of the University of Western Australia, world leaders. Yves Vitton (sic) -- Yves Vitton, who is foremost in the geophysics -- I'm sorry -- geotechnical field, he runs this group. So when I got into geotechnical engineering in '96, my company sent me on, you know, what were the latest and greatest peer reviewed and peer attended courses. So two courses at the Australian Centre for Geomechanics, underground mine design and support. I went to another excellent course that they -- a very practical course they teach at the Australian Mineral Foundation, which is another professional body, ground support in mining. That was ground support in both open pit and underground and then another -- ground control in underground mining and then blasting courses, advance drill and blast with Orica Explosives and I-kon Underground Shotfiring certification. I-kon is electronic detonators. They were -- they came out commercially in 2000. And I've been using them since 2000.

Q So how long would these courses be generally?

A They're anywhere from three days to a week, fairly intensive stuff.

Q We've heard some reference in this case to TNT and dynamite. Have you reviewed that testimony?

A Yes, I have.

Q Are those the explosives that will be used?

A No, they aren't.

Q All right. Why don't you tell us a little bit about the kinds of explosives that will be used in the Kennecott Mine?

A Okay.

Q And I think, if we turn to slide 3, this might help.

A I think I must preface this with underground blasting is extremely different from open pit blasting. Okay. And as such, Orica Explosives and other companies in the early 90's designed explosives particularly for underground. And they came up with a product called Power Bulk VE. VE stands for variable density explosive. And this stuff is a bit like -- if you can imagine construction glue, I think you call it over here, when you're a kid, it's sort of like that. It's -- or another friend of mine refers to it as elephant snot. But it's sort an emulsified material. It's got oils in it. And you pump it into the hole. Now, this stuff is kind of sticky, so you can pump in holes up to 4 inches -- actually now up to 4.5 inches, and it stays there. It doesn't go anywhere. You can blast against it. At Freeport we pumped this into the ground six months ahead and blasted right next to the stuff, and it still works six to eight months later. It's fantastic. It's specially designed for underground.

Now, one of the benefits of this is -- this material is, one, you can change the density of it. So if you want to protect anything, you can use lower density explosives next to that structure or that material that you want to protect and you get less over break. Generally the over break on this material is -- it either breaks right on the hole limit or you get maybe half a meter of over break.
Q What does "over break" mean?
A Over break is -- if I may draw -- okay.
(Witness draws diagram)
Q Say this is your blasting here. And this is the design limit of your blast. And we put blast holes here (indicating). If we have over break, what we do -- what you would see is, instead of it breaking straight in the middle of these holes, which you can do, it may break half a meter here.
Q Okay. So over break generally is just -- is getting more than you --
A Yeah. Additional -- it breaks further than you design. However, when you do design, sometimes -- you generally take over break into account. So you say -- okay -- if I put my

holes here (indicating), I may get half a meter. So you actually -- essentially, you know, most of the time you'll actually want this to be your limit. So you can move your holes in.
Q Okay.
A It depends on what exactly you're blasting and the aims of your blast.
Q Okay. So emulsion -- is it your understanding that emulsion is what will be used by Kennecott?
A My understanding is emulsion is what's going to be used for here at Kennecott. The benefits of emulsion are several. It is per unit more expensive than Anfo.
Q And what is Anfo?
A Anfo is ammonium nitrate fuel oil, which is essentially a mixture of diesel and fertilizer. But please don't go out and start making it. And that's primarily used in open pits still. Generally the industries particularly in longhole open stoping have all moved to emulsion underground. Anfo has different characteristics. It has what we call a slower VOD.
Q And what is VOD?
A VOD stands for velocity of detonation. And what happens there is, Anfo creates more heave, more -- the explosive column ignites more slowly, more gas is extruded and therefore you get more movement and more damage. This is

important in open pit blasting. You want the ground to move. In underground, we don't. We want to smash the rock against each other and drop it generally where it is. So again these two are very different.

And the benefit of the -- of not over breaking to the industry is the fact that, one, you're not taking waste that you don't want, so you're not knocking out material and processing it and hauling it and all that sort of stuff that you don't want. And the other thing is that you can not do damage to other infrastructure and you have less bolting to do because you've damaged the rock a lot less. So generally speaking, we're finding in studies around the world that, you know, you are getting less rock damage than Anfo.

Q You talk here in this slide also about electronic detonators?

A Yes.

Q Can you tell us a little bit about electronic detonators and whether they have -- there's any benefit to those?

A All right. Electronic detonators are fun. Basically you can create the timing you want in the blast. So conventional detonators which came in probably 25 years ago are called nonelectric dets. And they have in-hole timing. And generally what happens is these dets are essentially in a cord. You have some explosives in there. These are initiated by detonator cord. They go off at a certain time.

One of the problems with -- not problems but they start off -- the increments of time between them start off shorter. And then as you get later in the number sequence, you get more time difference. So you're restricted to that timing. And sometimes you're restricted to the number of dets you can fire at one time. Electronic dets aren't like that. You can put from zero to 1600 milliseconds. You pick whatever time you want, and you can change the delay that you have between those holes. So in underground blasting, it's different to open pit. In open pit blasting, you have what we call a free face to blast to. So there's always room. When you blast, you need a void. In underground, if you don't have a void already, you have to create it in the blast. And you do this by drilling some holes that you don't charge. And then you -- you initiate the timing so that you have a couple of holes going off. And the rock explodes in and explodes out. But what you need to do there is you need to give that rock time to move out of the way. So you start off the blast slow, and then you speed it up.

Now, nonelectric dets work in the opposite way. So what you have to is you have to actually drop out numbers in the sequence that you would use to be able to do this. Electronic dets, you don't have to do that at all. So you can just dial up whatever number you want. And that means that we can less number of holes on the one delay. So we

end up with less peak particle velocity, which can affect the ground. So these things are very exciting for us blasting engineers.
Q Do you just have -- when you are using emulsion, do you have emulsion in a detonator to initiate a blast?
A No. Emulsion is non-explosive. And it's nonsensitive to a detonator. So what you need to do is you have a blast hole. This is the bottom of the hole in solid rock. And what you do is you put a higher energy explosive -- small package of it, which is also emulsion. But this one is more like clay or putty, if you'd like to put it that way. My pronunciation cab be bad. So you put a detonator, which is a cap, in here. And then you pump this up with emulsion. And you leave a section of the hole uncharged. Okay. So what has to happen is this detonator has to be initiated. So the explosive in this detonator cord in this case or if it was a nonelectric det, that would burn down. And then this cap in here explodes blasting the primer -- this (indicating) is what we call the primer -- which then initiates the emulsion to explode or burn. So emulsion is not like you can't heat it. Like if you remember your reference to dynamite, one of the reasons dynamite isn't used anymore is it has nitroglycerine in it, from my understanding. And if you actually hit dynamite, you can get an explosion. This stuff is inert without a detonator

or a cap. So that's -- so with I-kon one of the other benefits of I-kon is you get less -- you can get less damage to the rock over and above using low density emusion here. So, you know -- and areas that we may have used that in is if we're doing construction -- blasting near construction or, for example, the portal. If we use I-kon dets, say, in the portal area, we would get less -- far less noise, far less vibration. And you almost -- it's almost like slicing it out with a knife.
Q And I think the next slide maybe has an illustration of a detonator and a primer.
A Right. Yes. So here as I'm pointing out, the bottom of the hole, the primer, the primer initiates and reacts back up the hole initiating the emulsion.
Q And this is a hole that you first drill and then put the emulsion in?
A Yes.
Q Okay.
A And this one on the side there, you can see the cap being threaded around. And so it initiates back out the hole. It's a directional product. So most of the energy is going back up the hole, not into the rock. Because you want to initiate the explosive itself, not -- you're not trying to -- the primer doesn't -- isn't involved in blasting the rock. It's just to initiate the explosive.

Q And I think -- could you sort of give us an overview. You already kind of have. But in rock when you have -- when you initiate a blast in rock, can you give us a little bit of an overview of what happens? And I think maybe the next slide will have. You have, I think, a laser pointer there if that --
A Oh, is that what it is? Okay. So firstly and foremost, explosives are just a mass expansion of gases basically. And gases are people; they're lazy. They like to exploit existing cracks and joints. So what happens here is you initiate the explosion and you get this mass expansion of gases and we end up with a crushed zone around here. And obviously this mass expansion of gases causes the rock to fracture. And you create shock waves. But in underground rock, these are minute as Dr. Stone testified last week. These are small waves. And basically what happens here is that, when you have a free face, is the gases expand. Most of the energy is going in this direction toward the free face. And the rock starts to break up and swell. So -- and then what happens here also is, when you have a joint or something in the rock, the wave -- vibration waves which are in underground confined conditions are P waves, the energy is going this way. And then it hits a little crack. Some of it, you know, will continue. But a percentage of it, you know, will be reflected back in this way. And then what

happens is it comes back. And when it hits a crack as we've heard testimony from Dr. Stone, these waves cannot be transmitted through air. So, you know, you're losing energy when you've got reflection and you're losing energy from the gases going through -- being lazy and going through the existing cracks or the cracks that it's actually created.
Q There's been some testimony in this case about blasting against backfill?
A Yes.
Q You told us that, in the Bronzewing Mine you did blasting; is that right?
A Yes.
Q And that that was an open stope mine with backfill?
A Yes.
Q Okay. So do you have any idea as to how many -- you did actually do blasting against backfill then?
A Yes, I did.
Q Do you have any idea how many times you might have blasted against backfill?
A Sure. In my underground time when I was actually physically loading the explosives and blasting them myself, I would have initiated over 120 blasts against backfill in varying sizes and dimensions ranging from a 25-meter high blast up to 120-meter blast. When I worked as drill and blast engineer, I designed in excess of 300 blasts against

backfill.

Q When you designed the blast, did you inspect -- did you do any inspection of the blast afterwards?

A Yes; absolutely. Blasting is an intuitive process. Engineering and mining is an intuitive process. So what we would do is we -- after we blast, it's actually pretty much mandatory that the drill and blast engineer goes and inspects the blast afterwards. Obviously we wait for your dust to settle. But we go in afterwards, and we physically inspect from the stope. So we have --

(Witness draws diagram)

A Now, remembering in Eagle Mine, we're only doing a tiny stope. So we're only looking at one level. Here at the Bronzewing Mine we have done much bigger stopes, orders of magnitude bigger than the tiny stopes at Eagle. Okay. So this is the stope. This is now a void. And you've got rock sitting down here. And we will come in up the top -- on the top level. And from supported ground where we've got nice rock bolts, because we like to be safe, we will come in and inspect the stope looking at the wall at the top. Then we'll come to the next -- basically from each level we will inspect the stope and look at the walls on all sides to see how the stope has performed. Then what we will do is we will also generally send a CMS in. I believe Dr. Stone testified about what a CMS is on Friday.

Q What does that stand for, first of all?
A Cavity monitoring system. Now, this takes a very accurate 3-D model of the stope. And what we can do is we can load that in our software and look at it and compare how the stope performed -- how the blast performed against design. So we can adjust our drilling and blasting according to what we see in the stope. Now, we do that generally as we're developing the stope sometimes after every blast. But we definitely always do it at the end of the stoping before we start backfilling. And we do that for several reasons. One, we want to use it, as Dr. Stone testified about -- we want to use it so we have an accurate design to design against when we come to design the drilling and blasting of the adjacent stope. We also want to do it to calculate what ore in tons have gone through the mill so we can look at what did we design, what have we actually mined. And what do what we call a reconciliation between the two. So we do it for those reasons as well. And we also -- we'll do it also if we want to test out different procedures. I personally have -- we've purposely drilled into backfill and blasted it to see what happens.
Q Why would you do that?
A Just to see how it performs and holds up to see what to expect if someone was to over-drill.
Q And what was the result?

A The result was we had very minimal dropoff dilution.
(Witness draws diagram)
A Okay. So what we did is we purposely drilled into the backfill. On the left here, we have the backfilled stope with CRF. And here we have the secondary stope. And we stabbed the holes into the backfill. And we found that we only had very localized, maybe 5 diameters, of backfill around where the actual explosive in the hole was that would break out and drop off.
Q And what does 5 diameters mean?
A Five times the drillhole diameter. So the drill hole diameter in this case is 4 inches. So it'd be five times 4 or, you know, 102 mill times 4, so we're looking at 400 millimeters of material in a sort of cylindrical shape would drop off and go -- drop off down the bottom. And as Dr. Stone testified, that's called dilution -- backfill dilution. And we did not see the hole massive backfill collapsing and falling down or anything like that. As Dr. Stone testified earlier, backfill is more plastic than the hard rock that we're actual blasting here. And it actually absorbs energy. So it's like -- if you've got a sheet of glass and a piece of clay and you hit the sheet of glass with a hammer, it breaks and shatters. That's how this rock behaves. If you hit the clay with a hammer, it just goes "thud" and absorbs the energy. You don't see the clay

shattering or anything like that. So this is how the two behave.

Q Okay. So in your experience, blasting against backfill -- it's stable does not -- I mean, it's --

A Yeah. Backfill is extremely stable. You know, there's mines all around the world that blast against backfill. I have also blasted against unconsolidated hydraulic fill where we have actually -- where, you know, basically instead of backfill here, we blasted against hydraulic fill, which is just the tailings that have been pumped back into the mine, have dewatered themselves. We've designed special walls for the water to come out. And this material has just sat there for six months. It's consolidated. And we've actually blasted against that. And in some cases we've blasted into that. I've also -- we had a case at Bronzewing where we had backfilled a particular stope and then we discovered there was ore on the other side of it. And the geologist wanted to go out and drill it. So we actually have mined through CRF fill.

Now, this took a lot more explosives to blast out the tunnel than we would normally use in development again for this same reason; one, the fact that there's voids as Dr. Stone testified about and, secondly, it absorbs energy. So softer ground actually takes more explosives to blast than hard ground does. And also the fact that you've got,

you know, gases -- the fact that these gases will dissipate in the voids that we've already heard testimony about that are in backfill. And so rather than drilling, you know, small holes, we had to drill quite big holes and pump an awful lot of explosives to be able to get through this material. And it stood up in a nice -- a nice arch and formed a stable arch and obviously we went in and put some split -- some steel righters to -- for the long term. But we mined through this stuff. Obviously we don't plan to do this all time.
Q All right. And you talked a moment ago about the hole diameters and the blast damage and how far it went. And I want to read you a little bit of testimony from Mr. Parker. Did you read his testimony?
A Yes, I have.
Q Okay. And he's testified at page 409 of the transcript. He said:

"If we go with the original application, we're going to have 4-inch holes with a standard explosive, which would probably be ammonium nitrate because it's cheap -- relatively cheap. Some damage would be done to the rock to s distance. Rule of thumb, some hole would be done to the rock to a distance of about 30 hole diameters. Most of the damage would be close to the hole, of course, and then it would diminish to

about 30 diameters. That would be not much."
What I just heard you say, do you agree with that, that the damage will be to 30 hole diameters?
A No, I do not.
Q Okay. What in your experience and understanding would the extent of the damage be?
A Well, with Anfo, which we are not using here -- Anfo as I testified earlier is -- does more damage because it has more heave energy. According to the U.S. Bureau of Mines from some work in 1972, the maximum damage -- and remembering that this damage where you first blast here (indicating), you know, this material is crushed. And the damage diminishes as you -- regularly as you get away from it. According to the U.S. Bureau of Mines, it is 8 to 14 holes diameters using Anfo, and Anfo being a more damaging explosives, which in our case 4 inches would be 56 inches or 1.4 meters. However in emulsion, we're seeing much less than that, below 7 diameters of damage or less. And my experience is we're looking at, you know, half a meter at worst case having looked at hundreds and hundreds of blasts. So, no, I don't agree with his testimony.
Q Okay. Now, we talked a little bit -- you talked about the cavity monitoring system. Is that -- is that used to -- or what's the purpose of using that?
A Okay.

Q And actually if we could -- and maybe if we could get through the next slide.
A Okay. Yeah. The cavity monitoring survey has -- you know, we use it for several reasons, as I said. We use it to see how the blast actually performed. Because sometimes we can actually underbreak the rock. So we want to adjust our drilling if we're seeing those results. We also use it primarily so when we come to design a second stope, one, we know how our design is performing but also most importantly that we know where the boundary is between the actual design and the actual void. Because you can have -- you can have a structure that a little block will move out on. So it may go over design. Or, you know, you can quite often leave ground behind. And obviously we want to get it next time. We don't want to leave it sitting there or we don't want it to fall down in the stope in a big chunk. You know, we want it to be nice and small so our loader can pick it up and the guys can get bonus. So here on this slide it shows a primary stope, which is a designed nice square. And this green, which is possible hard to see, is a cross-section through a CMS takeoff. And it shows -- okay. Here on the left corner, we -- and I just made this up. This is just for demonstration purposes only. Okay. We've left a bit of ground up here, so we've under broken here, so we haven't broken as far back as we designed. And then on this

boundary we can see where a little bit under in some parts and maybe a little bit over in others. So what we do with that is we load that in a computer program that we use to design in three dimensions. And we have the actual drift pick up as well. And we do is we adjust our drill holes so that we can -- particularly for blasting against backfill, we can pull those holes back, move them back. And generally we move them back 1.5 meters so that, you know, the energy again is staying in the hard rock and is staying away from the backfill.
Q Okay. And let's look at the next slide. We talked about moving away. Is this what you're talking about?
A Yes.
Q Okay.
A So in open stoping we use two different -- we have two different types of drilling. We can either just drill straight vertical holes or we can fan drill. And here -- okay. You know, this hole, we can either -- you know, we have the ability once we get the pick up, we could either -- this first hole because we're getting close to the backfill here. We may want to stop this hole at this point or only load the explosives to this point. And obviously we'd stop drilling, because we don't want to waste drill when we're not getting any benefit from it. And then on the second hole here, we can just load, you know, that section of the

hole leaving the first section. So we can adjust not only our drilling, but we can adjust our explosive loading to suit the situation to protect the fill. Okay.
Q So -- sorry. When you're drilling this, how is it that the CMS helps you understand where that -- where the backfill is?
A Okay. The CMS is a three-dimensional survey that we load into the computer. And, you know, basically we take sections through the stope on the planes that we're going to drill on. And we can slice the CMS and therefore we get a profile like that so we know exactly where that void is in space and we can adjust our drilling and our charging to limit damage to the backfill.
Q Are there any other methods that you can use to avoid damaging your backfill?
A Yeah; absolutely.
Q And the next slide maybe.
A Okay. Before we get to the next slide, we have an arsenal of things that we can do here. Okay. First and foremost --
(Witness draws diagram)
A So the top of the board here I'm showing is, say -- this is in plane view. So if you were looking down on the stope when we're drilling vertical holes, so the pattern of holes we would see on the floor, we have the backfill at the top here. So first of all, we have moved our holes 1.5 meters

off. So even -- you know, that's more than 30 times our hole diameter. Now, what we can do is, in this first row, number one, we can load these holes with lower density explosives. That's why we use the Power Bulk VE. That's why it's such a great product is because we can use less density explosives, less energy in those holes.

Secondly, what we can do here also is we can drill what we call easer holes. These are holes in between our planned holes that we don't charge with explosives at all. And if you remember earlier, I talked about how explosives are lazy. So rather than our -- if free face, you know, is here, because we've already blasted these things, what happens is, you know, this is a longer distance between our existing free face and our easer hole. So explosives being good and lazy will break to here straight through the holes. And we end up with what we call half barrels. And us mining engineers get pretty excited about half barrels. So again the energy breaks to here, less energy going in this direction.

Okay. We can also -- a method they use in an open pit is, you can actually do something similar to this and you can actually blast this ahead of the other one. So you've actually just performed a -- you use smaller explosives again and you just create a small crack. So when the main blast comes back this (indicating) way, it breaks to here and stops. And the other way we do it is, we control it in the timing of the blasting. So what we do is -- what we do is, you know, we time a blast --

(Witness draws diagram)

A -- so we initiate somewhere in the middle of a stope. And it's probably better demonstrated -- I'll demonstrate it also on the other slide, mining method. But what we do is, the perimeter -- these holes, we have maybe -- we aim for eight to nine milliseconds between these holes and close to 100 milliseconds to the next row. So we're starting here (indicating). This hole goes off first in the center of the stope.

Q Okay. And so when you're describing this for the record, you're talking about sort of holes in the same row?

A Yeah. We've got -- we've basically got a grid pattern of holes here, and we're starting with the hole nearest -- in the center of the stope nearest to the free face. And we start in the middle. And then the adjacent holes, one after another we blase into that void. So the explosive gases are working toward the void, towards the center of the stope, away from the backfill. And then what we do is -- we are fairly consistent with the timing on these, about eight milliseconds apart. But the last perimeter holes we fire more slowly. And that -- it's like folding them in together. So again, these -- the cracks and voids here

(indicating) have had longer to propagate, and so again more of the energy is going to go into the center and away from the backfill. Now, if we look probably at the next slide -- so here again we would initiate the center vertical hole on the fan. And this is going to form cracks and what have you. So again what happens is, the energy is moving away from the backfill as you blast, 'cause, like, why am I going to go into the hard stuff when I can go into the cracks and fissures? So it moves inwards. And what we tend to see in fan drilling, if you're unaware of this concept, is, actually we tend to leave ore behind as you drag up the side of the walls. Fanning up the walls we tend to leave ground behind. So what we actually have to do to ensure we do that is actually shorten up the distance between the holes on the side here. So the initiation itself, the fact that we start in the center, we start away from the backfill, we can use timing, we can use low-density explosives, we can use easer holes, we can use pre-splitting, we can move our holes, we can not charge parts of the holes -- I mean, it's just a plethora of things that we can do. And that's also why we see them here, so we can see how well it's working for us and what we need to adjust.
Q And you talked a minute ago about half barrels.
A Ah, yes.
Q Could we look at the next slide and could you tell us what

this is?

A Okay. Now, this actually comes from a textbook. It's purely for demonstrative purposes. Unfortunately, taking photographs underground is somewhat challenging, given the lighting situation. So I use this chart to show you. This is an open pit mine. These (indicating) are what we call half barrels.

(Witness draws diagram)

A So going back to our vertical holes in a row, basically what has happened here is, these half barrels are fully loaded with explosives pretty much the whole way up the hole with maybe a meter at the top or two not charged. And when we fire it, what has happened is, as I just described, all the energy in the blast has gone into the face that you no longer see, that's not mined and gone to the mill and no longer there. And basically a half barrel is that the ground has broken back smack into the middle of the hole. So you're not seeing massive destruction of the rock or anything like that. You can see it has broken back exactly on design where you want it to be.

Now, this is done and achieved often underground. I've done it and achieved it often underground. I did a blast with -- just to give you some idea of blasting sizes, I've done a blast that was -- well, starting off, at Bronzewing where we're blasting three levels at a time in

60-by-60-by-150-meter-high stopes, we would use in the order of five tons of explosives for a blast like that; much, much bigger than what we are proposing at Eagle. However, I did a large blast where we blasted 150 tons in the one blast. And it was partly in an open pit; part of it was underground. And we got half barrels like that, and we used the lower-density explosives on those holes. So it's done underground. We see half barrels in development. In the development we use lower-density explosives around the perimeter for safety, first and foremost, and for also economics; that the less damage you do to the rock, the less ground support you have to put in and the less waste you have to haul. So it's in the mine's best interest to always blast the best possible way they can.
Q There was some testimony in this case -- Mr. Parker testified with regard to some calculations he had done of blasting and the potential effects on the fish in the stream. Did you review that testimony?
A Yes, I did.
Q Did you agree with his analysis?
A No, I did not.
Q Why not?
A First and foremost, I did a literature search, going back. These calculations are based on seismology -- seismic. And obviously having studied geophysics and taught at

university, I'm familiar with the equations and the calculations. I did extensive literature research. And these calculations are for unconfined surface environments. They -- unconfined surface environments. So first and foremost, the wrong equation has been applied in these things. These standards principally came about by blasting seismic in streams. So you're actually detonating explosive in the stream with the fish, or you're blasting the explosive in the bottom sediments of a stream. Also, you may be blasting underwater for construction purposes for building a bridge. So this is where these standards have been derived from. Or you might be open -- doing a road cutting. So the literature is actually referring to near-surface blasting; it's not related to underground blasting.
Q Why is underground blasting different, then?
A Okay. So near-surface blasting is -- you know, we have two reasons. The geophysical wave behaves differently. So we have confinement underground. And an analogy is probably the best I can do to explain this without sounding like I'm doing a Ph.D. If you're on a pool table and you've got your pool balls in the triangle and you leave your triangle over the pool balls and you hit it with the white ball, you get sudden movement and it stops. So that's confined. That's like we're in underground. The particles are close together; they've got really nowhere to go, apart from into

the void you've just created.

In surface blasting it's analogous to when you take the triangle off and you hit it with a pool ball. The balls move everywhere in every direction and a slower -- somewhat slower moving, so you don't get that sudden rapid movement and stopping; you get bigger movement. And in seismology we have obviously different mathematics to describe those different environments. And the mathematics that have been applied here are for the unconfined, sedimentary material. Then it doesn't take into account geology. Firstly and foremost, sediments and -- as we've already testimony about with regard to the backfill, sediments and materials like that behave differently. They absorb more energy than hard rock with a higher density that we see underground.

Thirdly, you need to take into consideration the geology of where we are. We've got the stream off some distance away from the stope. We've got --

(Witness draws diagram)

A So here on the board -- so in gross terms I've got, like, the intrusive material in gross terms here. Now, the standard from my reading of the literature is actually based on five -- you know, one of the recommendations that is out there is two psi in the water. So that's the over-pressure in the water, not in the ground. And water obviously behaves differently than rock. And one of the early guidelines was -- you know, which again comes from blasting in water, is less than 500 pounds 100 feet away from the mine. But here what we're doing is -- firstly, we're at some considerable distance. Actually, the closest point that we will blast to the stream is 110 meters, or 360 feet away, which is a considerable distance. Now, when we blast -- monitor blasting vibrations underground, you know, we're interested just very close, because they dissipate. Like the pool -- I'm liking the pool queue. Again, when you hit a ball on the table -- you know, when you hit the white ball, as you get away from when you hit it, obviously it's losing energy and it's dropping off. But what it doesn't take into consideration is, when we blast -- this is a hole on the very edge, last hole. Okay. We've already heard testimony that most of the energy is going into the void. Now, we also have a void above it, so the energy can't go above -- the particle wave cannot go above this because there's a void there. So it's also going out in other directions. It's going down, but we've got a void underneath. So what happens here is, we haven't -- these calculations haven't taken that into consideration. Then what happens is, as we get up to a different type of material, a softer, less dense material, we lose energy -- comes -- is reflected. So it's like when you hit two pool queues together; the white ball rebounds back. So some of the energy is lost in rebounding back. A small amount of it is transmitted into the next media.

Now, remembering that this next media, being sediments, is also absorbing energy, so the energy is dissipating in all directions from this point into the media as well. Then we're going from igneous rock into sediments. Then we're presumably going into gravels or -- like, these sediments have been cooked, you know, from the metamorphism, from the intrusion. So these sediments have been cooked. Then we're going into more sediments that are later on and unconsolidated. And again, you know, we've got reflection back of the energy in this (indicating) one, and we're seeing energy losses in all directions absorbing the energy. And then we go into the sand in the bottom of the river and we're finally going into water. So at all these points we're losing energy and we're reflecting energy back, and all of that has not been taken into consideration in those calculations.

Q Okay.

A The other thing is, the only actually standard that has been adopted that I'm aware of is a Canadian standard, which is actually ten kilopascals -- megapascals -- sorry -- or 14.5 psi, which is almost six times the one in the early literature.

Q Okay. We're going to change topics a little bit here from blasting. And you also talked earlier about your experience in mine design and ground support?
A Yes.
Q Do you have experience designing portals?
A Yes, I do.
Q How many times have you done that?
A I've designed five, and I've physically been there while we have developed and ground-supported and installed three of those in the same type of rock, in igneous, Precambrian rock.
Q And have you reviewed the mine permit and application with respect to the portal design?
A Yes, I have.
Q And do you have an understanding of how that is going to be constructed or planned?
A Yes, I do.
Q Can you tell us a little bit about -- and let's turn to the next slide. If you could, tell us a little bit about your own understanding of the portal design.
A My understanding of the portal design is, the portal is going to be underneath the current soil position, so in the order of two meters below the current soil position. And that's going to be the top of the portal. It can be deeper. And firstly one of the reasons we like to mine into a

portal, into solid rock, is safety. Foremost is absolute safety. Obviously the sediments to the east of -- sorry -- to the west of the eastern trees is sedimentary. It's unconsolidated as we were talking about before. And so it is subject to reeling in, sliding, if you like. So we like for safety reasons to portal into solid rock, which the intrusive is.

So what we will do is, we will come back ask distance of 36 meters or so, and we would do a box cut, which is a ground excavation using an excavator; not blasting, but actually just using a bulldozer or an excavator to dig out the soil, and we create a box cut so that --

Q I'm sorry. Where is the -- and I think you have it on here, but where is the portal going to be located?

A My understanding is that the portal is going to be located below the ground on the west side of the eastern intrusive.

Q So this is the outcrop or what we've referred to as -- heard referred to as Eagle Rock?

A Yes.

Q Okay. All right. I'm sorry. You can continue.

A Okay. So we exit -- we come to the face of the outcrop below the current soil position. And then we ground-support the face, where -- the principle of ground supporting is to actually clamp the rock together so that it can't move on any joints or structures and fall off. So we do some preparation there where we put mesh --you know, we bolt the face and we mesh the face. We may even Shock-Crete it, where we spray on Shock-Crete like you would have seen in road cuttings. In some road cuttings you'll see bolts and Shock-Crete in the road cuttings as you drive past and if you're a geeky engineer like me.

And we do this, and then what we do is, we also support around the perimeter. So we put longer bolts in, a meter to a half a meter, outside what is going to be the shape, to clamp it in further into the ground. And then standard practice when you are doing a portal is to take much shorter rounds. So instead of developing -- blasting three meters, you'll probably blast one and a half meters. You'll do a shorter round. You'll blast that; you'll ground-support that. Then you'll do another one and a half meters, and you'll keep going.

Now, as I spoke earlier, when we do the perimeter holes, the outside of the holes, we use lower-density explosives. In this case, given the sensitive nature of this outcrop, we will probably be using I-kon as well to limit any damage to the rock.

Q An I-kon is the type of detonator?

A The electronic detonators, which create less explosives -- less vibrations. So everything is clamped together at the face. As we start developing, we put in ground support as we go. So we blast; we mark out the dirt; and then we put in mesh and bolts. Now, this is safety. This is the most important thing. We want to make sure our people are safe. We do this regardless of what rock we're going into. We don't like people working under unsupported ground. So everywhere in the mine is going to be bolted on a pattern and meshed on a pattern, clamping the ground together and supporting the ground. Okay.

And now we have several levels of doing that. We have an initial pattern, and then the engineers on site or the operational guys can look at the ground. And if they see something they don't like when they're in there, they can put in additional stronger support if they think it is required. So it is a sequence: blasting, supporting, blasting. So in this case we've got down to the face; we supported the face; we start in developing; we support the ground as we go. Then we get a certain distance in, and we come in, and we construct the steel arches or the can. Okay? So we construct those. And once all that's -- and then they're backfilled in, so we've got a nice can coming out of the sediments in front of the eastern outcrop. And that's hitched into the face only about 400 mil. And then away we go; we're mining.

And then at the end of the mine life we take the

can out and we put a plug, is my understanding.
Q Are you saying "can"?
A The steel arches; the steel arches. My understanding is, we put a concrete plug made out of some of the waste material of the eastern outcrop. We put that into a concrete plug, and we plug the initial -- I'm not sure -- a couple of meters is the portal, to support it. And then we take out the steel arches and we backfill it, so at the end of the mine life it's going to look like it does today, probably a bit neater.
Q And if you could, I think if we turn to the next slide, I believe you've talked about all of these points as well?
A Yes. You know, pattern bolting -- as I said, as we go we pattern bolt as a minimum for safety first and foremost, and for the stability of the ground. But the stability of the ground is what affects our safety. We can put in additional longer bolts if we feel it's warranted. And then some of the bolts that we put in already, we can do other treatments to them to make them stiffer and stronger. We are using welded wire mesh.
Now, with mesh it's a surface treatment, so it's clamping any loose material that may be there. And that itself forms, like, a support mechanism. So basically --you know, something the size of my fist is not going to drop through the welded wire mesh. Now, the welded wire mesh on

any one connection can hold in excess of five tons. So this is quite -- you know, this is quite strong stuff, and it's a surface -- surface treatment to keep the loose stuff from dropping on anybody's head. And in addition to that, we can then go to Shot-Crete -- sprayed-on Shot-Crete. Now, we can use just plain Shot-Crete or we can use Shot-Crete with metal or plastic fibers which have different effects. And then we can use different cable bolts, very strong -- there's a myriad of different cable bolts we can use. All these things are aimed at stopping the joints from dilating or opening up, clamping them back together.

Now, some -- there's going to be some clamping effect anyhow from the stresses, as I believe you've probably heard yesterday from my geotechnical group of friends. And pretty much this material is extremely hot. I mean, we can if you needed to -- we don't need to, based on the outcrop. You know, we can put in concrete. We can essentially do a concrete tunnel like you see in Denver or wherever, where you have lots of tunnels through much, much weaker material than we've got here. I mean, this material was developed at extremely high pressures and temperatures. So they have tunnels through -- civil tunnels through sediments where you've got concrete, reinforcement, all this type thing. This is not normal. We can pretty much mine through some really bad ground. But, yeah, so that's my

understanding of it.
Q And did you prepare a video or an animation to kind of help illustrate how this would work?
A Yes; yes, I did. Because these are fairly abstract sort of concepts. So because I'm not a computer genius, I had one of my guys at work create a nice video under my supervision and instruction. And like I said, this is the video.
Q And this is going to show us essentially the creation of the portal that you've just described?
A Yes. And it's going to show the creation of the portal and then it's going to show after mining; you know, at the end of mining when we're leaving the area.
Q Well, let's play it once, because I believe this is fairly short. And then maybe we could play it again and you could narrate it for us after -- on the second time. While we're getting that up, you've talked about the --
A Okay. So this is -- let's let her play it.
Q Go ahead. Let's let it play once and then --
(Playing of video)
Q Can we replay that? And this time, why don't you tell us what's happening? And if the want the video to stop, just say that.
A Okay. Well, just one point I probably didn't mention is, when we start the box cut we actually -- at the very start of the box cut we actually grade up slightly, so that any

surface water is not going to go down into the pool. I think that's -- I don't think that shows it well. So here we've created the box cut, which is below the current soil position, so we're at least two meters below the current soil position. We put in Shot-Crete here (indicating). These are the spiling cable bolts, about half meter to a meter off the final shape of the thing. And this is clamping the ground together, what we're going to blast into in a moment.

These (indicating) are a bolting pattern to again clamp that face together so those joints can't fall forward. Here we're putting in the foundations for the steel stilts and the road material. Then we blast and support; and then we blast again.

Q Is this the mesh support that you described?

A This is the mesh support, so this is the minimum we will be putting in, because we don't like people working under unsupported ground. This is industry standard. And then this is the steel arches or the steel can coming in. And we're backfilling around it to support it.

Then at the end of the mine life we take the backfill out; we take the steel cans out. We remove the road base, the foundations. We put the plug in the portal and we fill it back up to the current surveyed positions.

Q In your experience is this support going to be -- what's

going to be proposed, is this going to be sufficient to support the rock above?
A From my study of the rock, the rock more than supports what is there. The rock would be stable with absolutely no support, but we do it because it's industry standard practice and we like to make sure that the ground is supported and our people are safe from any small material.
Q Thank you.
MS. LINDSEY: I have nothing further.
MR. REICHEL: No questions at this time.
JUDGE PATTERSON: We'll take a break.
(Off the record)
JUDGE PATTERSON: Whenever you're ready.

CROSS-EXAMINATION

BY MS. HALLEY:
Q Ms. Arlaud, when did you start working on this project?
A June, July 2006.
Q And were you involved in actually designing the mine?
A No.
Q What was your involvement then in 2006?
A Updating, essentially, the cost estimate for the mine, for accuracy in terms of -- to get the mine approved by the company's board of directors to invest in the project.
Q So part of the feasibility work?
A Yes.

Q So you weren't involved in designing the mine?
A No.
Q Were you involved in designing the blasting that would go on in the mine?
A No.
Q Okay. Have you read the application?
A I've read parts of the application that pertain to what I've testified about.
Q Have you read the permit that was issued by the DEQ?
A Again, I've read the sections of the permit that pertain to the portal and to blasting.
Q Now, have you ever worked in Michigan before?
A No, I have not.
Q Now, are you familiar with Michigan's laws, then, about what's required here in Michigan under the new statute; that this is the first mine trying to get permitted?
A I understand it's the first mine trying to get permitted under these new regs. But apart from that I have no knowledge of the -- I'm not a lawyer, so I have no knowledge, really of the law.
Q But being a lawyer or not aside, as a blasting engineer are you familiar with any parts of the statute or the rules that relate to blasting?
A I'm familiar with the ATF requirements for the storage and handling.

Q I'm sorry? What's ATF?
A Alcohol, tobacco and firearms.
Q Okay. That's a federal agency?
A A federal thing.
Q Okay.
A And I'm familiar with their requirements for the handling and storage of explosives. And I'm aware of what's in the actual permit. But apart from that I have not done any further study.
Q So you're not telling us that the mine -- anything about it, really? Since you weren't involved in the design or designing of blasting, you're not telling us that the mine as proposed complies with Michigan's laws?
A I'm unaware that there are any laws pertaining to how you blast underground in Michigan.
Q Okay. How about mining laws in general in Michigan? Are you telling us that the mine complies with those laws?
A I haven't reviewed those laws.
Q All right. Could you tell me what the pounds of explosive per yard of rock is that's proposed to be used at the Eagle site? And I understand it may be -- there may be a range, some different for different types of rock. And I'm interested in hearing what the range is for the different areas.
A In the development we're looking at 2.2 pounds of explosives

per ton -- per -- 2.2 -- sorry. I'm a metric girl. Our scientific community works in metric, so I'm sorry. I'll have to convert this in my head. We're looking at one kilogram per ton in metric or 2.2 pounds per 2,200 short tons, approximately. That's in development. Now, in production that drops down significantly, and we're looking at approximately half of that in production. And the reason for that is, in production we have a free face to blast to, whereas in development we actually have to blast into the rock and get the rock to move out of the way. So it's different.
Q We're going to put up DEQ Exhibit 26, which is Appendix C-2, Figure 31. You've probably seen it before. Have you seen this picture before?
A Yes, I have.
Q Could you tell me -- let's just pick a -- do we have a pointer? Sorry. All right. Let's just pick a stope. Let's just pick this (indicating) one right here for example. Okay?
A Uh-huh (affirmative).
Q Now, if you're blasting in this stope, --
A Yes.
Q -- that's a primary -- sorry -- secondary stope?
A Uh-huh (affirmative).
Q How long would the cemented backfill in this -- the

neighboring stopes -- how long do those have to cure?
A 28 days.
Q 28 days. Okay. So if you've just backfilled, not with the development rock but with the cemented backfill -- okay? -- this stope and it takes 28 days to cure, could you go ahead and blast in this (indicating) stope during those 28 days?
A No, you wouldn't.
Q No, you wouldn't. What would you do during those 28 days if you were --
A Well, the mining sequence isn't as you're portraying it here.
Q Well, why don't you explain it to us then?
A Okay. Sure. The mining sequence is that you take this part -- well, say we start at the end. Say the blue is the primary stope.
Q Uh-huh (affirmative).
A So we take primary stope; then we take a primary stope; then we take a primary stope; then we take a primary stope. While you're taking this primary stope here (indicating), you're backfilling here. And it doesn't -- we don't instantly take the whole stope. It takes, you know, months to mine out a primary stope. So you've backfilled your -- it's curing. Then what we do --
Q Just a minute. I have another question. So let me just -- I just want to make sure I understand what you're saying.

And that is that during the 28 days when, say, this (indicating) stope is curing, --

A Yeah.

Q -- you would be blasting again over here (indicating)?

A Potentially, yes.

Q And how far away are those from each other?

A They're -- well, the stopes are ten meters wide, so there's ten meters between the two.

Q Now, are you aware of any problems related to blasting your green concrete?

A I don't know what green concrete is. I know what concrete is.

Q Well, green concrete is concrete that's not fully set; in this case "concrete" isn't exactly the right word, but the cemented backfill. Are you familiar with problems related to blasting near -- in the vicinity of cemented backfill that's not fully cured?

A Yes. I'm familiar with blasting a stope away from cemented backfill that's not fully cured, but there's no problem with it. As we heard from Dr. Stone, you know, it's starting to get hard within 24 hours.

Q Right. But it takes 28 days to cure, which is what you just said; right?

A Yes. But it's a -- as Dr. Stone testified, the strength is exponentially -- you know, it gains strength rapidly and

then at the end it gets its maximum strength. It's only incrementally stronger than what it is after 24 hours.
Q Okay. Now, is it true that the cemented backfill will shrink somewhat as it cures?
A No. As Dr. Stone testified, this material does not shrink.
Q Do you know what the UCS of the backfill would be at the Eagle Mine?
A My understanding is that it is 1.5 MPa or 218 psi, I believe.
Q That's my understanding too.
A Yeah. Which is far -- you know, far stronger than a lot of mines with much, much bigger stopes used.
Q Now, what is the UCS of the intact rock; do you know?
A I believe it's above 120 Mpa, anywhere up to 280, based on the geology.
Q Could I take just a minute and find that figure, so that we're in agreement about it?
A Okay.
Q Just a minute.
(Counsel reviews documents)
MS. HALLEY: Sorry about the delay.
Q Now, the last column on the right-hand side seems to tell us that the range of UCS strength for the intact rocks -- different types of rocks, but generally speaking; right?
MS. LINDSEY: I'm sorry. Can you identify what

document this is?

MS. HALLEY: I'm sorry. This is DEQ 26, Appendix 2, Table 3.

Q So if the UCS of the backfill is approximately 1.5 megapascals and we have some numbers on the right-hand column there up to 146, we're looking at strength in the intact rock that are approximately 100 times the strength of the backfill; is that right?

A I suppose so.

Q Okay. Now, do you think it poses any challenge at all to be blasting rock that's 100 times stronger than the backfill right next to it, without damaging the backfill?

A It poses no concern at all. It's done in hundreds of mines around the world.

Q All right. And you don't expect there to be any back break of that backfill next to the blasting of the rock?

A No. The only time that would be any minor dilution from the backfill, as testified by Dr. Stone and myself, would be if we drilled into it. However, we have precautions not to do that. Or if there were some minor segregation issues which -- in the backfill, we would maybe see a small amount of dilution coming into the stope. But the entire mass of backfill would behave, as Dr. Stone has said and I have witnessed, not only all the times I've blasted but over five or six years or so or inspecting this type of thing.

Q Now, have you worked in mines where the orebody is bordered by dikes?
A Yes.
Q In sediment at the host rock?
A Yes.
Q Sedimentary rock as the host rock?
A Yes.
Q Yes? And you haven't seen any problems because of the geology of those sites?
A In reference to what?
Q In reference to the strength of the backfill and in the host rock.
A No.
Q No? Okay. Do you happen to know what the probability of failure of the cemented aggregate fill is?
A I would say zero.
Q You would say zero?
A Or close to. If the quality controls that are mandatory, as we've heard testimony about, are in place.
Q What quality controls that are mandatory?
A As Dr. Stone testified, taking samples -- creating core samples of the -- each batch, or at least two times a shift.
Q Did you see that reflected in the permit; that that's a mandatory requirement of this permit?
A It's an operating procedure.

Q No, my question is, did you see that reflected in the permit?
A No.
Q Now, you testified that the Power Bulk VE is the type of explosive intended to be used here?
A Uh-huh (affirmative).
JUDGE PATTERSON: You have to say "yes" or "no."
A "Yes." Sorry.
Q Is that reflected in the application or the permit?
A It does mention emulsion in the permit, I believe. Either the permit or the application it does discuss emulsion.
Q I believe it's mentioned in the application, but it's also mentioned along with a variety of other types of explosives; right?
A Yes.
Q Does the permit limit Kennecott to using this Power Bulk VE material?
A I haven't memorized the permit, but I don't believe so.
Q I would agree with you. I don't believe so either. Now, does the permit or the application include any kind of detailed blast plan?
A Well, it's not the purpose of the permit. It's an operational procedure, the blasting plan -- detailed blasting plan. It does talk about how they're planning to blast, I believe, somewhere.

Q Does it, for example, require that the blasting happen in the middle of the stope, to minimize danger to the backfill?
A No; no. That's a principle of --
Q No, just answer the question. Does it require that?
A I am unaware, but I don't think so.
Q Well, you said you read it?
A I read it, but I haven't memorized it.
Q But you would have noticed -- right? -- if it was related to blasting? That's your area?
A No, I don't think it said anything about that.
Q Okay. All right. Now, at one point when you were describing the benefits of using the Power Bulk VE material, you said that one of the benefits of that material is that it resulted in less damage to the rock?
A Yes.
Q So "less" compared to what?
A Anfo.
Q Okay. But "less" doesn't mean no damage to the rock. So I'm wondering what kind of damage you would expect to the neighboring rock.
A Okay. Close to the -- close to the hole you are going to see crushing on a centimeter -- you know, a couple of centimeters around the hole. And then you're going to have fracturing. And then as you move out from that, you're going to have minute cracking of the rock.

Q Just so my question is clear, I'm not talking about the rock in the stope necessarily. I'm talking about in the neighboring stopes.
A No. I mean -- no. Because we are less -- our holes are further away than the distance that you would see damage.
Q Well, maybe I misunderstood what you said. Because you're not trying to limit damage to the stope; in fact, you're trying to blast the stope; right?
A Yes, we're trying to blast the stope.
Q Right. So you wouldn't be concerned about less damage to the stope; you'd be concerned about less damage to the neighboring --
A Stuff.
Q -- the backfill, presumably?
A Yes.
Q So I'm trying to understand what you just said just now; that you would expect no damage to the neighboring backfill. So I'm trying to understand.
A Because we moved the holes in so that our holes are further in than any document damage to rock that distance away. So, you know, we've seen -- you know, we've got from the Mines Bureau that maximum damage to the rock is 14 diameters. Now, we move our holes so we're greater -- we're actually greater than 14 diameters, which is based on Anfo. So we would actually see even less damage using the emulsion. So

the boundary --you know, the boundary of the stope is 1.5 meters away. You know, using Anfo we see damage only up to 1.4 meters. So therefore you're not going to see, you know, damage into the backfill. We also talked about the fact that those shock waves come back and are not absorbed into the backfill. And even if they are absorbed, we've already given testimony that even if you drill into the backfill, it is only very localized damage around the drill hole. The whole massive backfill does not collapse or come down; it is solid.
Q Okay. Thank you. Now, are you familiar with the fracturing that's present at this site?
A The -- no.
Q The fracturing in the ore? Has anybody talked to you about that?
A I've seen some of the cores but I haven't been involved in looking at the -- in detail of the fracturing.
Q Well, would fracturing be an important thing to take into account when you're designing blasting protocols?
A No.
Q No? Why not?
A Because one, you're hoping that there's fracturing there, at which --
Q But wouldn't you use less explosive if the area was already fractured, if you were trying to minimize damage to the

backfill right next door?
A No.
Q No?
A No. Because if --
Q do you know if any fracturing has been taken into account in the development of the blast plan, even though you, yourself, weren't involved in developing the blast plan? Let me back up. Is there even a blast plan developed yet, that you're aware of?
A I believe there is a blast plan that led to the mine -- you know, in the mine plan, yeah. It was detailed, you know, of how they were going to blast. It states that they're going to use 4-inch holes.
Q Right.
A It states that they're going to -- it states that they're using emulsion. I mean, that is their blast plan.
Q Right. But it doesn't state any of the sort of safety measures that you've outlined today?
A Well, they're standard industry practice. They're assumed.
Q Well, I don't know about that, but --
A Well, I do. You know, they're standard practice around the world in hundreds of mines.
Q But you've testified that there are a lot of different methods and a lot of different ways that you believe you can minimize damage; right?

A Yes.
Q And you don't think it's important to -- a regulator, for example, to understand the mitigation measures before the blasting begins?
A No.
Q The agency that's responsible for the safety of the mine and other agencies that are responsible for the safety of the workers?
A I think it's demonstrated that, you know --
Q That's not my question. Do you think it's important?
A For a regulator to understand it? No.
Q You don't think it's important for them to understand the measures that would be taken to protect the workers?
A No. They have agencies for that.
Q That's my point; they do have agencies for that. And you just said to me you don't think it's important for those agencies to understand the safety measures that are being proposed before the blasting begins.
A Okay. I think they need to understand the safety procedures in dealing with explosives and using explosives underground; however, I don't think they need to know exactly how each individual blast is going to be initiated or timed.
Q Okay. Now, you talked a lot about this CMS --
A Yeah.
Q It's a machine and then it -- the machine inputs images into

software. And it sounds like a very useful thing. Is it used routinely in the industry?
A Yes.
Q And it's sounds like it's a very important piece of equipment to gather information so that people like you and others can figure out if your blasting plan really is safe and effective; is that right?
A Yes. However, we -- lots of mines have done this type of mining without using CMS, before they were invented, obviously.
Q Well, sure; right. Now, did you see whether the application or the permit requires the use of this CMS system?
A No. It's a procedural, operational issue again.
Q That's not my question.
A "No" was my answer.
Q It's important to safety. You said that; right?
A Uh-huh (affirmative).
Q Does the permit require that it be used here?
A No.
Q Do you know what the plasticity of the backfill here would be?
A No. That would be a question for Dr. Stone.
Q Now, on one of your slides you showed a -- sort of a diagram, I think from a CMS image, and you said that in some spots there would be a little under -- I think under

blasting and a little over blasting?
A Yeah.
Q Is that right?
A That's correct.
Q So that happens commonly; that it's a little under or a little over?
A Yes.
Q And you also testified, I think, that using a fan drilling technique, --
A Uh-huh (affirmative).
Q -- that some ore is left on the walls routinely; is that correct?
A There can be. But that's -- again, you -- well, the standard thing is, if you don't adjust your spacing between your holes, this can happen as you drag up the holes. But standard practice is actually on the wall holes to change the spacing between the holes -- adjust the spacing between the holes to 80 percent of the spacing that we would use down the bottom to account for this.
Q And so my question still is, would there be some ore left on the walls?
A No, not by the time we've taken out the secondary stopes; no.
Q Absolutely no ore left on the walls of the mine?
A In the stope? Are we talking adjacent to the stope or -- I

mean, what is your definition of "ore"?
Q Well, let's look at the picture again and it will help us, I think. This is DEQ Exhibit 26, Appendix C-2, Figure 31. Okay. So my question is, along the walls of the mine; you know, the perimeter here; would there be any ore left along the edges?
A There could be, yes.
Q Could be, yes. Okay. Now, your slide 9 was the picture of the big wall. Do you remember that? I think the point you were illustrating was the half -- what's it called? Half --
A Half barrel.
Q Half barrels. Thank you. Now, the purpose of that slide -- that was in an open pit mine; right?
A Yes, it was.
Q Now, this is Petitioner's Exhibit 36, and this is page 3. Now, this is one of the documents I think you were discussing, having to do with blasting and the impacts of fish. But you said that your understanding of this document was that it only addressed surface blasting. But this illustration is directly out of the document, and it clearly illustrates, if you see up there, the blast there underneath the ground and seismic waves traveling around. I think that represents a river. Is that what this picture depicts? Just "yes" or "no."
A It depicts sub-surface blasting.

Q Now I want to read you a portion of this , just one paragraph. It says:

"Explosives detonated underground produce pressure or seismic waves within the earth. Two modes of seismic waves have been identified: body waves and surface waves. Two types of body waves are propagated through the earth: compressional waves and shear waves."

Do you disagree with that statement?

A No.

Q At one point you -- I think after your movie -- by the way, when did you make your movie, or have someone make your movie I think you said?

A A week or so ago, two weeks ago.

Q Now, I think when -- at the close of your movie when we were talking about, you said that sort of the opening -- the portal was designed to encompass the sensitive nature of the outcrop. I'm wondering what you mean by "sensitive."

A I believe from -- that some people have expressed that, you know, the outcrop is important to them. And, you know, we don't like to disturb things that are on the surface that people enjoy looking at or whatever.

Q Okay. Now, you understand that the secondary stopes would be filled with development rock?

A Yes, that's correct.

Q Okay. Now, do you agree that the development rock is acid-

generating rock?
A No, not all of it.
Q Not all of it?
A Well, a lot of the development rock is sedimentary.
Q That is true.
A And the development rock is going to be created -- my understanding, is with limestone as well.
Q Well, that's my understanding as well. But do you agree or disagree that the rock is acid-generating -- that the majority of the development rock is acid-generating?
A From what I've seen, the majority of the development rock is actually in sediment down the decline.
Q That's not my question. Do you believe that it's acid-generating or not?
A I don't have enough knowledge in that area to say either way.
Q Okay. You don't know if the development rock is acid-generating or not?
A No. I'm not a -- you know, I'm not involved in -- I haven't reviewed it.
Q Okay. But you haven't read about that? You don't understand that from reading the reports?
A I haven't read the reports pertaining to acid generation of the rocks. It's not in my scope.
Q Would you agree or disagree with me that if the development

rock were significantly acid-generating, that that would be an important factor to take into account when designing the backfill plan?
A Again, I don't design the backfill plan. Dr. --
Q But you testified about backfill quite a bit.
A I testified about blasting against backfill, not the design or the mix or anything like that.
Q Well, are you able to answer the question?
A Could you repeat the --
Q Would it be important to consider whether or not -- well, let me back up. Assuming that the development rock is acid-generating, would that be an important factor to consider in designing the backfill plan and the backfill itself -- the makeup of the backfill itself?
A From my understanding of the literature and my understanding of Dr. Stone's testimony, no, as he's worked in highly -- there's backfill in highly acidic environments. I think Dr. Stone testified 1.5 pH.
Q He did testify about that; you're right.
A And I think he's even got photographs of that.
Q Okay. So you've never seen cemented aggregate fill impacted by sulfide oxidation or acid-generating -- acidic conditions?
A No, I have not.
Q Now, would you agree with me that the cemented aggregate

fill is permeable; in other words, that water can flow through it?
A If it has voids in it. But again, Dr. Stone would be more -- better for this question.
Q I think also when you were talking about your movie near the end of it you said something like, "This is not normal, the quality of the rock mass." I think you were saying that the rock was really hard from what I --
A I don't think I said that.
Q "No"? Okay. Well, maybe I misunderstood. Now, related to the portal, the entry, you know, some of the things you showed in your movie, and your testimony is that, you know, safety is your top priority -- okay? -- and that there are many options, many different combinations of tools that you can use to try to achieve safety for the workers.
A Yes.
Q That's true. Okay. Now, does the application or the permit provide any details about those safety mechanisms that should or would be required to be used at this site?
A I don't -- I haven't -- I'm unfamiliar with the whole permit, so I can't answer that accurately, whether it's in there or not.
Q Isn't that a section you would have read?
A I read particularly about the portal area itself.
Q Right. That's what I'm talking about.

A And in the portal area it doesn't -- it does not state what ground support should be used.
Q Does it require ground support -- any particular type of ground support?
A The section I read did not pertain to that. Again, it's an operational issue.
Q Okay. So you testified about blasting, but you weren't involved in developing the blast plan for this mine?
A No. I have reviewed it, and it is within industry standards. And there's no fundamental flaw or problem with the blasting design. And it would work, so, yeah.
Q Well, it would work for the development of the mine, but you have no idea if it meets the standards in Michigan's laws; is that correct?
A I have no understanding that there is any standards in Michigan. I haven't investigated that. I can't imagine any state that would actually get into this amount of detail. But it does comply with -- you know, who's going to handle the explosives and how they're going to be stored will comply with the federal requirements.
Q I understand that.
A Yeah.
MS. HALLEY: No further questions at this time. Thank you.
MR. WALLACE: Mr. Arlaud, my name is Bruce

Wallace. I represent the Huron Mountain Club.

CROSS-EXAMINATION

BY MR. WALLACE:

Q The U.S. Bureau of Mines has promulgated some standards regarding surface damage from subsurface blasting, has it not?

A I don't -- I don't know if they have or not.

Q You're not familiar with such standards if they exist?

A No.

Q We'll get back to that in a minute, but let me ask you this: What is the chemical composition of this emulsion?

A It has -- it has a gas -- I'm not -- I'm not a chemist, so -- but it has oil, emulsifiers, gas and it has nitrates.

Q It has nitrates?

A Yes.

Q Does it leave the nitrate deposit or residue after explosion?

A It may do. I'm -- I don't -- you know, unaware of the quantity and the -- to those effects.

Q It sounded like you were testifying that you could vary the density of the emulsion to vary the power of the blast; is that right?

A Yeah.

Q What's the range of variability that would be used in this mining operation from the least powerful to the most

powerful density?
A I think .8 to 1.2.
Q And what do those numbers represent?
A The grams per -- grams per cubic centimeter of explosive, I think.
Q So the chemical composition stays the same, but you may dilute it or make it more --
A Yeah. And we do that by adding extra gas into it.
Q And when you're blasting at the portal at Eagle Rock to start with, you use twice as much explosive as you're going to use later to mine; is that right?
A Yes.
Q And that's 1 kilogram per tonne of rock from the very beginning?
A Approximately, yes.
Q Have you ever mined under a surface body of water like the one that's involved in this case?
A Well, firstly the -- my understanding from the topography is that the Salmon Trout Creek is actually off to the side of the orebody. So it's not directly underneath. I have mined underneath a body of water in a bottom of an open pit, but I haven't mined in one adjacent, you know, some 360 feet away.
Q Do you have an understanding coming into your testimony today that the orebody is offset from a vertical line below the Salmon Trout River some distance; is that what you're

saying?
A Yes. It's --
Q And how far off of being under the Salmon Trout River do you believe this orebody is?
A It's -- well, in the permit we're permitted to mine up to the 327.50 level is my understanding, and it's over 110 meters on a diagonal. From the furthest point of the stope it's 360 feet or 110 meters away, would be the bottom of the Salmon Trout Creek.
Q Salmon Trout River actually. And what I'm asking you is not up to what level you're permitted to mine but how far your understanding is that the orebody is offset from being directly vertically beneath the Salmon Trout River.
A Well, it's not really directly underneath, so --
Q How far off of being directly underneath is your understanding in giving this testimony today?
A I haven't --
Q 100 meters? 500 meters? Roughly.
A Oh, about 104 meters -- like, if you were to take -- if you were to take the creek which is off to the side and the, oh -- well, where we're blasting up to is 104 meters below that. I haven't actually measured where the top of the intrusive rock is, if that's where you're going.
Q But somebody has told you or you believe you've read that the orebody is not directly beneath the Salmon Trout River;

is that correct?
A Yes. I've actually looked at in 3 dimensions the way the creek is in relation to the orebody, and it is -- from the topography, is off to the side.
Q You talked about seismological studies when you were purporting to refute Dr. -- Mr. Parker's testimony; correct?
A Yes.
Q Okay. Are you a certified seismographer yourself?
A No. I have a -- I have degrees in geophysics which is the study of seismic in the earth.
Q Have you ever conducted seismographic studies of the effect of underground mining on surface damage or on waterbodies?
A Surface damage? On waterbodies, no. I -- on surface we have measured in a surface blast situation, but we have not -- we don't -- I've measured underground.
Q What's the device called that you use to measure seismic waves?
A A seismometer and it uses geophones.
Q And you're not familiar with the use of a seismometer or geophones to measure the peak particle velocity of the surface from underground blasting?
A I've read some of -- there's very little literature in that -- in the literature. All the literature pertaining to seismology is near surface or subsurface effects like this one. There are some where there's lots of mines in the

world that actually operate and work underneath towns. The Stawell gold mine in Victoria is one, where they blast under towns, and they do measure the vibrations on the surface for the buildings. But myself I've not been involved in one from the surface as such.
Q Okay. You mentioned the 1972 Bureau of Mines Report?
A Yes.
Q Do you recall that it sets standards for high frequency and low frequency blasting in terms of limitations on damage to surface structures?
A Now, the 1972 report I was referring to was the U.S. Bureau of Mines in reference to the number of diameters of damage in the rock, not --
Q But are you familiar with U.S. Bureau of Mines standards indicating that at higher frequencies the maximum of half an inch of peak particle velocity per second would or could damage surface structures?
A Yes.
Q Does that ring a bell with you?
A I have read that.
Q Okay. And actually I said that wrong. It's at lower frequencies that the damage is greater; correct?
A I'm not -- I haven't really dealt with the damage to structures as we've had testimony from I believe even your witness that blasting in rock and rock masses do not behave

the same as concrete and structures and steel. And therefore I haven't really been involved in looking at the effects on buildings.

Q Okay. And are you aware then that they maximum permissible peak particle blasts set by the U.S. Bureau of Mines for subsurface blasting in terms of damage to surface structures is two inches per second?

A I, again, have not looked into that.

Q And do you have any idea what significant effect on the bed of a stream above an underground mining operation would be measured in inches per second which is the peak particle velocity measurement; correct?

A I have looked at papers, firstly I think we need to -- this paper that's up here now actually talks about the equation being based on the Rayleigh wave, which is the surface wave. There's been two studies in the literature where they have calculated not only what they think, based on the Rayleigh wave, blasting again, as we said, near surface or subsurface less than 100 feet away at much higher peak particle velocities as is in some of the early literature. And they have discovered that -- they put geophones in the ground and then geophones in the water, and the peak particle velocity in the rock was higher in this study than what some of the suggested guidelines are. But when they actually managed -- measured it in a hydrophone it was one tenth of what was

actually in the rock.
Q One tenth measured in what value scale?
A In psi. So we are looking at, I believe it was a pressure -- an S pressure wave of 3.4, and I believe the pressure wave in the actual water was -- which what's what these standards, from my understanding of the literature, is about, was .4/psi.
Q Well, let's see if we can agree on a couple of principles here. First of all, conveniently enough, we still have the diagram on the screen. Subsurface blasting propagates particle waves to the surface; correct?
A Yes.
Q And when those waves reach the surface, they are propagated out along the surface; correct?
A Yes.
Q And that will happen through rock and will happen through glacial till. It will happen through water.
A Uh-huh (affirmative).
Q It will happen over voids.
A No, it won't happen over voids.
Q It won't happen over voids?
A It won't happen over a void. To propagate a pressure wave, you have to have particles in contact with each other. In a gas situation the particles are not in contact; therefore, it cannot propagate over a void.

Q So if there's a void -- so the infinite void, it's not going to propagate beyond that, but it can propagate around voids through solid media; right?
A Okay. It --
Q I mean, is that accurate?
A In solid media it will propagate a P-wave, which is what we're talking about from underground, will propagate in a straight line in the direction of the energy. A surface wave propagates transversely and has very different behavior.
Q Okay. But this is -- what's on the screen, the February 15th, 1991 Figure 1 drawing from Petitioner's Exhibit 36, you know it's a fair depiction of what does happen when you blast underground in terms of propagation of vibration; correct?
A It's a illustration of what happens when you blast in a subsurface environment, but there's no scale on this diagram and it --
Q There's no numbers on it, but it tells us what happens.
A Yeah, and it doesn't reflect -- does show reflection of the waves back. It doesn't show the waves weakening as it gets further away from the blast. It also -- remembering that all these calculations are based on homogeneous rock. As your own witnesses have testified, the rock is not homogeneous. So it doesn't take into account all the

factors I spoke about earlier.
Q Well, the Bureau of Mine Studies were studies done empirically; right? They took seismometers on the surface and measured from underground blasting what damage was done to structures on the surface.
A Again, there's no --
Q Do you recall that?
A I haven't read the Bureau of Mines about structures because, again, it's not relevant here.
Q Okay. But you do because this is an area of your specialization, that when blasting is done near cities, for example, buildings some distance away from the blasting can be affected by the blasting some distance away vertically and horizontally; correct?
A Is that blasting -- yes. I mean, there can be effects, but it depends on a whole lot of factors.
Q All right. And that's why the Bureau of Mines has set standards and said above certain peak particle velocities, half an inch at low frequency, two inches at higher frequencies, damage can occur to buildings on the surface; correct?
A Yes.
Q And the same waves that will affect -- from some distance away through rock, through soil, through glacial till or whatever, will affect surface structures will affect

waterbodies; correct? It will propagate to the water in the bed or a surface body of water; is that accurate? It's the same -- we'll look at it right here; right? It will propagate to the bottom of the stream or river.
A Depending on the distance, it may do; depending on the distance, it may not; depending on the structure there.
Q It depends on a lot of things?
A Yeah. It's not -- it's --
Q All we know for sure from the U.S. Bureau of Mines is that buildings and houses can be damaged from subsurface blasting from some considerable distance away. We do know that.
A Okay. Subsurface blasting, firstly, is open-pit blasting. Now, the principles of open-pit blasting are extremely different. The principles of blasting open pit is generally we don't use in-hole detonators, so they have -- they don't use in-hole timed detonators. So what happens in in-hole -- in open pits, if I may --
Q Well, you know, you don't really need to do that if we can agree on a point here, which is that the U.S. Bureau of Mines was not only studying open-pit mining, was it, ma'am?
A Again, I haven't read the U.S. Bureau of Mines report particularly.
Q They did considerable studies on subsurface hole mining in Pennsylvania, for example. Do you remember that?
MS. LINDSEY: Objection. Your Honor, she's

already testified that she's not familiar with this. I don't know how far he's going to go with this, but --
A Yeah, I --
Q You don't know about that? I can switch subjects. If you don't know about the U.S. Bureau of Mines studies of the effect on the surface of subsurface blasting, I will move on.
A I don't know about the effects -- the Bureau of Mines has done in relation to the effects on buildings and structures, no.
Q Thank you. And you haven't conducted any experiments on your own to determine seismographically what effect of a certain level of this powerful VE explosives subsurface will have on the surface; right? You haven't gone out there with this --
A All right. I think we need to define "subsurface" and "underground." Subsurface is not -- you know, is not what we're talking about in underground.
Q Well, I'm talking about something similar to what you're planning to do at --
A Again, you know, these pictures refer to, you know, less than 100 feet down. We're talking 3 times that distance or more.
Q But you know full well that blasting 300 feet down, 400 feet down will propagate to the surface and propagate against

the -- across the surface.
A Yes.
Q You must know that from your own experience.
A Yes. You have a --
Q And it can be measured. It can be measured with a seismograph.
A It can be measured, yes.
Q Okay. But you never read any literature about that or experimented with it yourself?
A No. We've blasted under ground and we've microseismic equipment underground. And as we get away from the blast, the vibrations dissipate.
Q The farther away --
A The further away --
Q -- the weaker the wave.
A -- the weaker the wave and for all the reasons I've stated. And we tend not to measure anything further out than 30 meters because we get really no appreciable reading.
Q You're saying you get no appreciable reading from 30 --
A Bits of -- you know, that, you know, of value to us in underground mining, what's going to damage to us in an underground.
Q Have you experienced with -- seismographically with the effect of blasting on backfill?
A No.

Q Have you ever taken a seismometer and put it on top of a filled stope and measured in inches per second the peak particle velocity of the wave coming through that backfill?
A No, because there's been no cause to do that.
Q Okay. And have you ever done that with the kind of secondary backfill that we're going to have here, put a seismometer on top of it and measured what the effect would be from the amount of blasting you're going to do here?
A Okay. The secondary backfill is confined. It can't move anywhere.
Q But it propagates the wave, doesn't it?
A Well, again, you have voids in the secondary backfill between it. So the wave will come to a void and can't propagate any further. So you only have propagation of waves where you've got rock-on-rock contact with the rock next to it. So when it comes to avoiding the backfill, it can't propagate any further.
Q But it could propagate around it where there's content between rock; correct?
A Yeah, where you happen to have rock on rock on rock, you know, a continuous thing, but that's -- you know, there's going to be voids throughout it, so, you know, at some point it's going to -- the wave is going to hit a void.
Q The wave propagates through glacial till which is full of voids or can be; correct?

A It's compacted where the point that -- you know, joining each other.
Q But in any event your company nor, to your knowledge, Kennecott or Rio Tinto, has not done any actual testing of the seismographic effect at surface or at the bottom of a body of water or at the top of a backfilled stope of blasting at the level you're going to be conducting this blasting here. Is that fair to say?
A No.
MR. WALLACE: Okay. Thank you.
MR. EGGAN: Your Honor, may I ask a quick question or two just for clarification?
JUDGE PATTERSON: Sure.

CROSS-EXAMINATION

BY MR. EGGAN:
Q Ms. Arlaud, I just want to -- I just want to clarify something with you to make sure that we're all on the same page about where this mining is going to occur. Okay?
A Uh-huh (affirmative).
Q And maybe you were wrong, and if you were you can just say so. But this is a -- this is Figure 7.3 of the post-reclamation groundwater quality monitoring plan that was submitted for the Kennecott Minerals Company by Foth & Van Dyke which is a company that has been working with Kennecott.

A Uh-huh (affirmative).
Q And I want to show you an area that is here by the Salmon Trout that is circled here in black.
A Uh-huh (affirmative).
Q Do you have an understanding that that is the area to be mined? In fact, really the circle in red may be even more important. Don't you have an understanding that that's the area to be mined here?
A No. My understanding is that that is the outline of all the workings. So, yeah, I mean, that -- but that's not on every level. You know, like it -- as you saw from the diagrams, you know, if it's smaller at the top and, you know, changes shape, it's -- type thing?
Q I did see the diagrams.
A Yeah.
Q And so maybe we're just miscommunicating. There's going to be underground activity down here.
A Yes, there is.
Q And there's going to be blasting underneath, isn't there?
A Yes.
Q Okay. Good. That's the point I was trying to make. So when you said that you didn't think that blasting was going to occur underneath the river, mistaken?
A Well, I don't know if that's a, you know, accurate representation, but what I looked at was the closest

possible blasting on the opposite -- upper limits, 360 feet away, and then that was what I looked at.
Q But if we used -- if we used this document created by Foth & Van Dyke, this Figure 7.3, it certainly shows that there's going to be activity underneath the river, and you've indicated that there's actually going to be blasting under the river.
A Well, you know, I -- you would have to show me the actual development to tell you, you know, exactly if it's directly underneath there. But the major stope -- production stopes from -- you know, there's a *PHD (11:11:34) further in. So at the highest point I looked at it, and -- you know, where -- at the highest point where we would generate a peak -- you know, a P-wave, you know, we are translated away from the creek.
Q I'm trying to get an idea here. Are you saying there will or will not be blasting underneath the river?
A I can't tell you from that diagram.
Q Have you seen any diagram that describes this more accurately?
A Not that I can recall. I looked at --
Q Let me ask you this: If you could get up and show us, where do you understand the orebody to be here?
A More in this (indicating) area at the top.
Q Okay. And what do you understand this blue area to be

through here (indicating)?
A I understand that to be wetlands.
Q Okay. And what about this dark blue area down here (indicating)?
A I believe that is part of the creek.
Q Okay. Very good. So from what I understand of your testimony, your testimony would be that you understand that there will not be blasting under the river?
A My understanding, my testimony is that the closest blasting to the river is not directly underneath the creek.
Q But mining will occur underneath the river or the creek?
A Again I haven't really looked at anything other than the worst-case scenario in terms of closeness to the creek. So I can't tell you accurately.
Q I understand.
MR. EGGAN: All right. Thank you very much. That's all I have, Judge.

REDIRECT EXAMINATION

BY MS. LINDSEY:
Q If I can just real quick, the picture that was up there that showed the underground blasting, is that -- do you understand that to be a diagram of blasting in mining?
A No. My understanding of that diagram is that it was an illustration from subsurface mining as pertaining to that document which relates directly to near surface blasting or

subsurface blasting either blasting in row cuttings or seismic blasting into the subsurface. It's not a deep underground example. And it -- the equations that are used there are based on the Rayleigh wave which is the -- again, the surface wave which behaves differently to the underground wave.
Q And you were asked a series of questions by Ms. Halley about the -- what's in the mine permit or mine permit application. I believe she asked you just about the mine permit itself as to what might be in there about the portal.
A Uh-huh (affirmative).
Q Are you familiar with what's in the mine permit application with respect to the construction of a portal?
A Yes, I read that section of the application.
Q And are there -- some of what you talked about, the features that would be used for safety and for support, are some of those in this mine permit application, to your understanding?
A I don't believe so.
Q Well, in -- okay. If we looked at -- I mean, is this -- do you remember or do you just --
A I just can't remember at this point.
Q All right. Do you think that if you saw the permit or the permit application, you might remember?
A Yes.

Q All right. Why don't we put up the -- actually let's put up the permit.

MS. LINDSEY: And for the record, this is Intervenor Exhibit 385, the mine permit. If we could turn to the special conditions, page 6, I believe, of the special conditions? If we could look at condition number 4, highlight that so it's a little bigger.

Q Okay. Could you just read that into the record?

A "The portal shall be constructed of prefabricated steel arch socketed into the bedrock below the surface expression of the outcrop as detailed in Figure 4.7 of the permit application."

Q Okay. So does that refresh your recollection about the -- some of what's in this permit about --

A Yes.

MS. LINDSEY: Okay. And could we also look at condition number 7 which is just below this?

Q Could you read that as well, please?

A "The permittee shall utilize roof bolting or rock support mechanisms as necessary to stabilize the roof of the decline and ramps at discrete locations."

Q Is this what you had testified about, the roof bolts and the other support mechanisms?

A Yes. Not only are we -- we are not only doing that, but we are surpassing that by having all the underground tunnels supported and rock bolted. So we are going far beyond what is actually required there, and we do that because of safety.

MS. LINDSEY: And I have no further questions, but, your Honor, for demonstrative purposes only, I would move for the admission of both the slides and the video that we used today for demonstrative purposes.

MS. HALLEY: I don't have an objection to that, but we don't have a copy of the video and we'd like to have a copy.

JUDGE PATTERSON: That could be done; right?

MS. LINDSEY: I'm sure we can make that.

JUDGE PATTERSON: Okay.

MR. WALLACE: No objection.

MR. EGGAN: I do, your Honor, wonder what it is the court is going to do with exhibits that are offered for demonstrative purposes only.

JUDGE PATTERSON: My intention was to only use as, essentially, an outline of the testimony to help me refresh my recollection.

MR. EGGAN: Understood. My concern is that to the extent that they're going to be used by a trier of fact, they're either exhibits or not exhibits. And so I would express that concern. They really cannot be used as substantive evidence.

JUDGE PATTERSON: Well, yeah, that's true.

MS. LINDSEY: Sure. And that's not what we're moving them for. I think we've had a series of demonstrative exhibits moved on the Petitioners' side, and this is just similarly for, you know, the court's assistance, demonstrative only, not for substantive evidence.

MR. EGGAN: Okay. I understand.

JUDGE PATTERSON: I guess you need to trust me to make that differentiation.

MR. EGGAN: We do, Judge.

JUDGE PATTERSON: Okay.

MR. EGGAN: If there's anybody here that we trust, it's you.

MS. LINDSEY: And those would be Intervenor Exhibits 627 and 628.

MR. REICHEL: I have no objection.

(Intervenor's Exhibits 627 and 628 received)

JUDGE PATTERSON: Any questions?

MR. REICHEL: Yes, I just a couple. I just want to follow up briefly on some questions. My name is Bob Reichel and I represent the DEQ.

CROSS-EXAMINATION

BY MR. REICHEL:

Q With respect to some of the questions that Ms. Halley asked

you on cross-examination -- I'm not going to go through all them, mercifully, but she asked you a series of questions about whether certain things were specified in the permit as requirements.
A Uh-huh (affirmative).
Q And let me just touch on a few of those. One of them had to do with quality control measures regarding backfill, cemented rock backfill.
A Uh-huh (affirmative).
Q Based upon your experience in the industry that you've testified to in this type of mine, do you have any understanding as to whether or not the type of routine quality control of cemented rock backfill is or is not an industry standard practice?
A In all the mines that I'm aware of and in the mine that I worked in, it is an industry standard, and it is always done.
Q Similarly with regard to the -- one of the questions had to do with blasting -- a blasting pattern within a stope. I believe you testified, among other things, that it's typical to begin the detonations more in the middle of the stope as opposed to on the periphery of it.
A Uh-huh (affirmative).
Q Again, whether or not that type of blasting pattern is specified in the permit, to your knowledge, is that or is

that not an industry standard practice in a mine of this type?
A It's an industry standard practice, and it also -- you have to do it that way -- well, essentially physics 'cause you want to create the maximum void you can in the initial stages of the blast, so that would be by being able to blast in two directions rather than just one direction, because if we're blasting next to the fill, we're only blasting in one direction. So you're getting less void for every detonation. So physics is that you need to blast -- in the middle create a big enough void for the material to blast into 'cause you need -- as we break the rock, it expands in size, so, you know, you could blast next to the fill, but, you know -- and only go and propagate in one direction. But, you know, you're wanting to create as much void as you can in blasting the center so that basically the blast doesn't choke because if you -- when you blast, if you don't create enough void and open it up big enough, what happens is this -- your blasted material has filled up the void, and the rest of your blast can't propagate into it.
Q So in other words, it would be fair to say that to serve its intended purpose of mining out the rock, --
A Yes.
Q -- you would need to -- that your seeking -- that the mine operator is seeking to recover for economic value, they

would need to do it that way?
A Yeah. But, you know, it's -- the most bang for your buck is to start in the middle and work your way out.
Q And you've also testified, I believe, about a series of measures or techniques that can be used to control the extent of blasting as it relates to the edge of a stope -- a backfill nearby. Excuse me. Again, based upon your understanding of industry practice in this area, is there or is there not an economic incentive for the mine operator to use these types of controls measures where necessary to limit the extent of the blast of the backfill?
A Yes, absolutely. I mean, you know, backfill costs us money, so we don't want to waste it. Also if you do get some amounts of dilution in the stope, then you're having to take that backfill with your ore, and then say you have got the cost of mucking it out or taking it out of the stope. You've got the cost of trucking it to the surface. Then you've got the cost of transporting it, crushing it. You've got the cost of milling it. These are all added costs that make no sense for the mine to do, and, you know, hence why we try to limit any backfill dilution as much as possible by using these techniques. I mean, we don't want to put it there to blast it. We want to put it there for it to stay there.
Q One of the other questions that was raised on

cross-examination had to do with the techniques that you've described that are used, I believe with this -- as an example, the CMS system, --
A Uh-huh (affirmative).
Q -- techniques to usually map in 3 dimensions the openings that are created -- is that correct? --
A Yes.
Q -- the surface of the openings?
A Yes.
Q And again, based upon your experience in the mining industry and particularly in the mining technique that is proposed for the Eagle mine, is some type of similar mapping practice -- is that or is that not an industry standard?
A It's an industry standard we're -- yeah.
Q Do you have any reason to believe that if this mine is developed and proceeds, that a system like that, whether or not that particular brand or whatever, a system like that would, as a matter of mine operations, be used?
A It's my understanding is that, you know, they are planning to use a CMS. However, you know, my experience is also that, you know, even if you -- worst case scenario you didn't have that system and you were to blast into the fill, you know, stab your holes into the fill, that we only have very localized damage around the fill, that the backfill mass as a whole does not collapse and fail. So it's only

localized, you know, and then you take that waste and fill it up. So, you know, standard industry practice is that we use it. My understanding is that Kennecott is going to use it. However, if you don't have it, you know, we have successfully used this mining method for many years before this technology is available, and it does not create a fatal flaw.

MR. REICHEL: Nothing further. Thank you.

MS. HALLEY: I have one more question.

RECROSS-EXAMINATION

BY MS. HALLEY:

Q You testified that many of these mitigation measures we've talked about are industry standards; is that right?

A Uh-huh (affirmative).

JUDGE PATTERSON: "Yes" or "no"?

THE WITNESS: Yes. Sorry.

Q Industry standards, if they are not reflected in the permit, are merely voluntary; is that correct? "Yes" or "no"?

A Yes.

MS. HALLEY: Thank you. No further questions.

MS. LINDSEY: Nothing further, your Honor.

MR. REICHEL: Nothing further.

JUDGE PATTERSON: Thank you.

(Off the record)

MR. KOHL: Good morning, your Honor.

JUDGE PATTERSON: Welcome back, Mr. Kohl.
MR. KOHL: Intervenors would call Andrea Martin.
REPORTER: Do you solemnly swear or affirm the testimony you're about to give will be the whole truth?
MS. MARTIN: I do.

ANDREA MARTIN

having been called by the Intervenor and sworn:

DIRECT EXAMINATION

BY MR. KOHL:

Q Could you state your name for the record?
A My name is Andrea Martin. It is spelled M-a-r-t-i-n.
Q And by whom are you currently employed?
A I'm employed by Foth Infrastructure and Environment.
Q And where are you employed?
A In Green Bay, Wisconsin.
Q How long have you been employed -- can I just call it Foth?
A Foth.
Q Okay. That's F-o-t-h?
A Yes.
Q How long have you been employed at Foth?
A I joined the company about five years ago.
Q And what is your position at Foth?
A My title is lead environmental engineer.
Q What does that mean?
A It's a combination of staff work and leading others to

perform preparation of documents to serve our clients.
Q When you say "leading others," do you sometimes perform tasks in a team approach?
A Yes, definitely.
Q So would you be a team leader then when you're leading others?
A Yes. And then I would also interact with the person above me then who might be coordinating several documents for a project.
Q Since your title includes the term "engineer," I assume you've had some training as an engineer.
A I do.
Q Can you briefly go over your formal education?
A Sure. Actually I have a -- I graduated from high school from Marquette, Michigan. I went on to Michigan Technological University and received a bachelor of science in chemical engineering. Fairly recently I completed a master's degree in environmental science and policy from University of Wisconsin in Green Bay.
Q And I believe your CV has been identified as an exhibit. It's Exhibit 189.
MR. KOHL: I would move for its admission.
MR. STAPLETON: No objection, your Honor.
MR. REICHEL: No objection.
JUDGE PATTERSON: Okay. It will be admitted.

(Intervenor's Exhibit 189 received)
Q Are you a licensed professional engineer in any states?
A I have professional engineer's license in Michigan, Wisconsin and Illinois.
Q And does your current engineering practice at Foth have any particular focus?
A I have been in the air permitting arena for most of the five years that I have been with them. So we have served many of our clients, Wisconsin, Michigan, Illinois, Missouri and I think we had activity in California, mostly on air permit compliance and associated compliance work.
Q When you say air permitting, what generally are you talking about --
A Well, many of our clients -- oh, I'm sorry.
Q -- from the standpoint of your day-to-day functions?
A Many of our clients had ongoing needs for construction permit applications. That's when they want to modify their facility, also renewal of operation permits and even, you know, originating new facilities' operation permits.
Q And when you say a "construction permit," when would a client of Foth need a construction permit in the air arena?
A A construction permit is needed prior to any construction activity on a new facility or to embark on modifying an existing facility. The construction permitting programs are usually delegated from the EPA to the particular states.

And it's the agency's opportunity to review and set up the permit limits to make sure that the air emissions that are coming from the new facility or the new modification are still within the regulation thresholds and criteria for protecting human health and the environment.
Q All right. Now, you also mentioned operational or operating permits. What are those as opposed to construction permits?
A Once construction has taken place and you have an operating facility, generally an operating permit then combines all permit limitations for the entire facility and just maintains the parameters of operation of what's allowed and what's not, what record keeping needs to take place, what maintenance needs to take place.
Q Now, you indicated that you obtained a master's. Did you write a thesis for your master's?
A I did.
Q And what topic was that on?
A My thesis was on an analysis of the Wisconsin regulations to reduce mercury emissions from coal-fire utility boilers.
Q As a result of your master's work did you become generally familiar with the types of emissions that can be expected from coal-fire utility boilers?
A I did. Coal is -- has quite a few trace metals. Recently there's been quite a lot of focus on mercury emissions, and coal does have a small amount of mercury in it. But because

we burn so much of it, it ends up being a bit of a problem in the environment. A lot of the reason behind that is because of its toxicity, and it's by a cumulative nature.
Q And when you say "coal fire utility boilers," would that be inclusive of boilers that are used in power plants to generate steam to turn turbines?
A Yes.
Q Now, are you familiar with the Kennecott Eagle Mine Project in the Upper Peninsula of Michigan?
A Yes, I am.
Q And when did you first become aware of this project?
A I began work on it in the summer of 2005.
Q While at Foth?
A Yes.
Q And who brought the project to you?
A I was working at that time for the project manager, Steve Donohue.
Q And what was your -- in general terms, what was your assignment relative to the project when you first became involved?
A It was to begin preparation of the air permit application.
Q Would this be -- in the parlance that we've already covered would this be the construction permit?
A Correct.
Q And prior to getting involved in this project, did you have

any experience in doing construction permitting -- air construction permitting in Michigan?
A I do not have -- I did not at the time have experience on preparing a permit to install application; however, I have clients who operate under their permit to install in Michigan.
Q So you were familiar with Michigan's air permit to install context but had not prepared an actual air permit to install previously?
A Yes.
Q And when we talk about permit to install, is that the equivalent to what other states would call an air construction permit?
A Yes.
Q Can you conceptually tell us what's involved from your perspective in beginning the development of a permit to install application for a project such as the Eagle Mine?
A Sure. The approach is quite generic. We need to receive the design of the facility. Sometimes that might be a conceptual design but it does have to have information on equipment -- emitting equipment. So, you know, someone other than Foth would have prepared the design of the facility and even go so far to have perhaps preliminary specifications on equipment, process through-puts information on how the facility is going to operate. And we

do a preliminary tabulation to at least identify where we think it might lie as far as whether it might be a major permit or a minor source of permit needs.
Q Okay. Let's break that down. When you got involved in the Eagle Project do you recall what stage the design of the mine, if you will, was at?
A I think the term used was "pre-feasibility study."
Q And did the design get any more definitive prior to your actually submitting a permit application?
A I think it remained as a pre-feasibility study based design, and we always knew that as the project progressed, that equipment and, you know, design of the facility would also progress and become polished.
Q Now, when you talk about developing an air permit application, you outlined a couple of steps. Let's break those down. Do you need to have an understanding at least generically as to the types of equipment that would be involved in a permit that may emit an air pollutant or contaminant?
A Yes.
Q So for instance would you need to know if there was going to be a boiler?
A Yes.
Q Would you need to know if there were going to be generators?
A Yes.

Q Or any combustion device; correct?
A Yes.
Q With regard to particulate emissions, would you need to know -- in the context of the Eagle Mine, would you need to know if there were going to be crushers?
A Yes.
Q Would you need to know if there were going to be storage bins?
A Yes.
Q Would you need to know the relative or expected size of those units?
A Yes.
Q Would you need to know fundamentals with regard to plant layout?
A Absolutely, yes.
Q Would you need to know the anticipated capacity of any equipment?
A Yes.
Q Process capacity?
A Yes.
Q Would you need to understand the general mining processes that would be involved?
A Yes.
Q And were you provided all that information in order to prepare the air permit application?

A Yes, we were.
MR. KOHL: Can we bring up Exhibit 462? Will you bring up the first page?
Q Now, do you recognize this document?
A Yes, I do.
Q What is that?
A This is the application form that the State of Michigan requires to be filled out with its permit to install applications.
JUDGE PATTERSON: Mr. Kohl, what's the number of that exhibit? I'm sorry.
MR. KOHL: Hm?
JUDGE PATTERSON: What's the number of that exhibit?
MR. KOHL: 462.
JUDGE PATTERSON: 462. Thank you.
MR. KOHL: It's the first page of 462.
Q Is this a standardized form?
A Yes, it is.
Q And is this application form then supported by material?
A Yes, it is.
Q And what would you call that material?
A Well, there's a lot of instructions on not only filling this form out but also what needs to go into a permit to install application.

Q So this form is supplemented by a substantial document?
A Yes, it is.
Q All right. Then why don't we page through this? Do you recognize this document?
A I do.
Q And what do you recognize that as being?
A This is a follow-up submittal to the original submittal. You know, in processing an application we iterate through questions and answers and sometimes provide additional material to the MDEQ to review our application.
Q Do you recognize this page?
A Yes, I do.
Q And what do you recognize that as being?
A This looks like the original cover letter that went with our Kennecott submittal of the air permit application.
Q Do you recognize what this page is?
A Yes. This is the cover page, the stamping page of the application.
Q And cover page to what?
A Of the entire application.
Q And what was contained generally in the application?
A Well, in many ways these applications are really a presentation of all the information that the DEQ needs to have in front of it to evaluate whether they approve of issuing a permit to this facility. So in accordance with

their instructions, we provide them a description of the facility really from the perspective of what's being emitted through stacks and other sources on site. We give them equipment specifications. We present to them through-puts, whether that be the maximum through-put that could go through the plant and what we actually plan to do on a regular basis. Substantial documents that go with that may be material composition describes and, you know, references to standard materials that were used to prepare calculations.

Q So there's a body of -- a report body in essence?

A Yes.

Q And would it be then accompanied by appendices, if appropriate, to provide supporting and back up information?

A Yes.

Q And was that done in this case?

A Yes, it was.

Q And is this a cover page to that reporting body and its accompanying appendices?

A Yes, it is.

Q And did you personally prepare this application?

A I prepared a lot -- or a large portion of it and oversaw other portions that were prepared by others.

Q And you reviewed it before it was submitted by Kennecott to the MDEQ Air Quality Division?

A Yes, I did.

MR. KOHL: Your Honor, I would offer the admission of Exhibit 462.

MR. STAPLETON: No objection, your Honor.

MR. REICHEL: No objection.

JUDGE PATTERSON: No objection, it will be entered.

(Intervenor's Exhibit 462 received)

Q Is it typical in one of these air permit applications to provide a location map of the project?

A Yes. Everybody wants to know where it is.

Q Okay. And does this indicate how far the project is from Marquette?

A Yes, it does.

Q How far is it?

A About 25 miles.

Q Do you recognize what this is?

A Yes, I do.

Q What is this?

A The Table of Contents, first page of our document.

Q And this would be -- would it be fair to say this Table of Contents in essence walks through the MDEQ's requirements for an air permit application?

A Yes, time does. The application reflects really what the MDEQ wants to see.

Q With company tables; correct?
A Tables, figures, appendices.
Q Now, do you have to in the body and did you in the body of this air permit application discuss the role of regulatory criteria that this project would have to meet from an air perspective?
A Yes, I did. That would be a requirement of the application. There are many federal and state regulations that pertain to facilities. And it can be -- really one of the up-front tasks are to identify which of those regulations might pertain to your facility. Many of the regulations have certain thresholds or perhaps it might even have to do with where the facility is located, and that can impact whether a particular regulation will apply or not. So we do need to address those up front.
Q So when you talk about certain thresholds, you're talking about emission thresholds?
A Yes.
Q And are those typically or sometimes expressed in terms of tons per year?
A Yes. That's the term used.
Q Now, earlier on I think you mentioned major source or minor source?
A Yes.
Q Is it important for you to know when preparing an air permit

application if your source is going to be a major source or a minor source?
A Yes, it is.
Q Can you explain to us what major source, at least to your understanding, means in the context of air permitting?
A Yes. First a facility is identified as far as location goes and whether it is in an attainment area or a non-attainment area. The EPA has segregated the country into areas. And depending on what pollutant you're examining, you may be in an attainment area or not. Typically non-attainment areas are in heavily industrialized portions of the country, and so in our case for the Eagle Project, it is in a completely attainment area for all pollutants, all criteria pollutants.
Q Okay. What are criteria pollutants?
A Those would be nitrous oxide, sulfur dioxides, PM10, VOC's, volatile organic compounds, and I think lead is a fifth one, lead emissions.
Q And what is the significance of a major source or a minor source relative to areas of attainment or non-attainment for --
A Well, if you are in an attainment area, then a major source threshold would be if any of the criteria pollutants are at 100 tons per year or above.
Q And was this site a major source -- this project a major source for any pollutants?

A Yes, actually it is. Our generators do emit over 100 tons per year of nitrous oxides.
Q But is it a PSD source?
A It is not a PSD source because in this area one would have to emit 250 tons per year to reach the threshold of PSD source.
Q And PSD means what?
A Prevention of significant deterioration. So if there's a background of a particular contaminant and you propose to come in and build a new facility that will increase that particular contaminant, then you have less flexibility as far as how much you can add to your immediate area from your facilities, so --
Q So these are the thresholds you were talking about, 100 tons, 250 tons, et cetera?
A They are per criteria of pollutants. Also looked at are what's termed as hazardous air pollutants. Those originate from an EPA list of what's called HAPs or hazardous air pollutants. And if an individual HAP is emitted at 10 tons or above per year, then that would also put it into a major source category. If there are several HAPs on site and in -- or cumulatively that they reach 25 tons per year, then that also would put it into a major source category.
There's one more part to this which is if one of the new source performance standards which is federal regulation,

one of those standards apply, then that too would also make it into a major source even if their emissions were below the thresholds that we just talked about.

Q So these thresholds and these regulatory programs, be it PSD or HAPs or NSPS, all have to be addressed in the air permit application; correct?

A Yes, they do.

Q And were they?

A Yes, they were.

Q And for the Kennecott Mine, was the Kennecott -- is this mine a major source for HAPs, hazardous air pollutants?

A It is not. The HAPs that are emitted from this facility are generally metals, and they are not at a major source level.

JUDGE PATTERSON: Mr. Kohl, it's noon. Can we break for lunch?

MR. KOHL: Sure. We do that.

(Off the record)

Ms. Martin, I think when we took the break we were talking about the development of the permit application for the Eagle Mine; correct?

A Yes.

Q But at break you pulled me aside and wanted to correct one of your answers with regard to a major versus minor source?

A Right. In Michigan a major source would require a ROP, a Registration Operation Permit, so that's really the

delegated task for -- under Title V of the EPA authority.
Q Okay. What's the threshold for a major source for a Title V Permit?
A That would be the criteria pollutant of 100 tons per year.
Q Okay. And this -- the mine would be a major source for a Title V permit because of its potential nitrogen oxide emissions from generators; is that correct?
A Yes. Is over 100 tons per -- yes.
Q And a major source for purposes of whether you are a PSD source the threshold for that is 250 tons?
A It is for attainment areas which Eagle is in one.
Q Okay. So this is not a major source for PSD purposes?
A Correct.
Q Okay. Thank you. Going back to the development of the mine air permit application. I think you already testified that there was a need to identify the processes and the equipment that would be in place associated with the mine; is that correct?
A Yes.
Q And did you compile -- do you have available to you a layout of the mine and the equipment that was anticipated for the mine?
A We did. The largest equipment on site, of course, are the three generators and we received specifications on those from the engineer. The equipment included mine air heaters,

we have crushing --
Q Let me ask that. Mine air heaters; where are these heaters?
A Well, the permit application actually has the option for them to be placed in two different places -- or actually, I don't know if the heaters are placed, but the exhaust can either be routed through the mine as part of the ventilation air flow, or we had the option to have dedicated stacks.
Q Okay. And these are heaters that heat the air inside the underground portion of the mine; is that correct?
A That's correct. During the wintertime especially when the air is cold you're actually drawing from ambient air through the mine, so in the effort to keep the mine temperatures above 32 degrees you would want to heat inflow.
Q What other equipment was associated with the mine that you needed to concern yourself with in developing the air permit application?
A Well, the ore handling process includes transportation of the ore from the underground mine up into actually a -- what's termed a course ore storage area. It's just a little covered building that the trucks dump this ore into and then it goes into the crushing process. That ore then is transported over to the crushing building which includes the grizzly and crusher conveyors into the bins and then loaded onto trucks and shipped offsite.
Q Now, the crusher building; would the crusher -- and you

described a grizzly. What's a grizzly?

A A grizzly is actually a passive device. It is a screen, a very large screen and I don't quite recall the openings, but essentially because you're bringing in ore which can be a variety of sizes you would want to have this grizzly then just take out the oversized particles -- that wouldn't be particles; I guess rocks -- that would be too large for the crusher. So I think that our calculations are based on perhaps five percent of the ore coming into this crusher building would be in the form of oversized rocks. Those rocks would be taken aside and broken by the rock breaker and then transferred back into the grizzly to continue on with the crushing operation.

Q The grizzly and the crusher itself would be enclosed in the building?

A Yes. In fact, all of those ore handling processes are enclosed. There's a curtain that the vehicles can come into the building and when the ore is dumped onto the grizzly there are some water sprays and then as they move through the crusher there is a wet scrubber on the crusher. The covered -- the conveyor goes out of the building via a covered conveyor and then transfers into the ore bins.

Q I want to show you -- it's identified as Intervenor Exhibit 465.

(Pause in dialogue)

Q This is a cover page, is not, and it's labeled Appendix C, "Emission Calculations and Stack Summaries"?
A Yes.
Q And you recognize this cover page?
A Yes, I do.
Q And this is part of the appendices to the air permit application?
A Yes, it is.
Q And did you put this together?
A I did.
MR. KOHL: Your Honor, there were in addition to Exhibit 462, which was the body of the air permit application -- there were Appendices A through I to the air permit application and those have been identified as Intervenor Exhibits 463 through 472 and I would offer those into evidence.
MR. STAPLETON: No objection, your Honor.
MR. REICHEL: No objection.
JUDGE PATTERSON: With no objection they'll be entered.
(Intervenor's Exhibits 463 through 472 received)
Q And, Ms. Martin, can you tell us what this page represents in Appendix C?
A It is a table of contents to the calculations. I think we ended up at 43 pages of calculations, so this helps a reader

navigate through the pages.

Q And is Appendix C where in the body or within the appendix to the air permit application you developed for purposes of the application, the MDEQ review estimates of the emissions that could be given off of the type of emissions from the various mining operations and the equipment, and then provided the MDEQ with support with regard to how you reached those calculations?

A Yes.

(Pause in dialogue)

Q Now, this appears to be a listing of equipment; is that correct?

A Well, it's a listing of emissions, whether they be stack or fugitive.

Q All right. Why don't we go through these from top to bottom so we -- can you provide us with a general description of each? The first line item is "SVGEN1/SVGEN3." What does that stand for?

A Yes. Those are the three generator stacks. The nomenclature is per the DEQ's preferences. So right; we started with the three generators. And underneath that is -- are the mine heaters.

Q Okay. Then I see several lines that are labeled "SVMVAR"?

A Correct. The stack we're talking about is the main ventilation air raise and each of those entries are the different activities that go into the emissions that exit that stack.

Q All right. Now, when we talk -- so there's no lack of clarity with regard to what we're talking about, when you talk about the main ventilation air raise, what air is coming out of that?

A Well, for an underground mine we have ventilation needs, especially since people are working underground, so there is an elaborate design that takes place -- not done by Foth -- that maintains the air quality under the mine. They look at both activities -- you know, emitting activities and protect the workers as well as vehicle traffic in there, so --

Q Did you have an understanding at the time that you developed the air permit as to the design criteria at least that were considered with regard to a mine ventilation system?

A I didn't need to have an understanding, with the exception of how much air was flowing through the mine, and I wanted to have approximate dimensions of the underground workings.

Q Then the next item, as I review this exhibit, is SV crusher building?

A Yes. And that is the building which is ventilated through a bag house, and within the building there are the crushing operations, the grizzly, and several transfer points that take place before the product exits the building.

Q This would be the area where -- I guess in my sense this

would be the primary area where ore is handled?
A That's correct.
Q And when you say "bag house," what's a bag house?
A It's actually a fabric filter. They're very commonly used. And they're mounted, you know, on a exhaust feature. And there are many different types and sizes. They are filled with cartridges that can be changed out. They have maintenance and you can monitor their performance. And they're actually very effective pollutant control equipment, especially with particulate matter.
Q And that's why a bag house is put on, to control the emission of particulate from a source?
A Yes, it is.
Q So other than putting them on a building would you put them on other kinds of equipment, just generally speaking?
A Yes. When you move dry material, solid material -- and generally there will be some particulate matter and many systems, whether they be pneumatic or just open to the air, will have draw-off points where they can be filtered through the bag house and then as that exhaust exits into ambient air it's cleaned.
Q So would I expect to see bag houses, let's say, in quarries?
A Yes, I would expect there would be some.
Q In silo operations where you're storing fine particulate material like cement or grain?

A Yes; that's another application.
Q Would you say based on your experience that they're very common pollution control devices?
A Yes. It's a very mature technology.
Q Thank you. Going down to the next item I'm talking -- I see a line item, SVCOB1, SVCOB2. What does that stand for?
A Yes, those are the two crushed ore bins that are in the "crushed ore bin building," I think was the term. So as the crushed ore exits the crusher building by a covered conveyor it's actually ramped up to the top of these two bins. It enters the building and then drops into one of the two bins such that when a truck comes along it can pull into the building and the product is just dropped into the truck bed and loaded and then the truck can move the ore offsite.
Q Now, if we go back up the list we're looking at the generators and there we're talking about the exhaust of a combustion engine; correct?
A Yes.
Q And when we look at the MVAR we're talking about a fan system driving the ventilation of the mine and blowing air out; correct?
A Yes, it is. The fan actually draws the air from the mine out.
Q Well, we look at the crusher building there we're talking about again, in essence, a ventilation system through a bag

house as drawing or blowing air out from the crusher building; correct?
A Yes.
Q When we get to these bins do we have any fan airflow --
A No, those are --
Q -- driving emissions from these sources?
A Those are actually passive devices. When you have a bin, you know, the operation on a bin is to fill it or empty it. So when you fill the bin you're going to displace air that's in the bin and it will be pushed out and via the bag house -- or the "bin vent" sometimes we term it -- so that exiting air will be cleaned and you'll have a cleaner point source. When the bin is empty you will be drawing air into the bin to -- just to make up for the, you know, volume of ore that's being emptied. And then you would not have an emission from the storage bin.
Q Okay. So these are vented -- to draw an analogy -- like a gasoline can?
A Yes.
Q Put gasoline into it, the air has to come out; or you want to take gasoline out, air has to come in?
A That's right.
Q That's all that this vent does on these bins?
A Yes.
Q Thank you. Now, the next items are cement silo and ask --

flyash silo; is that correct?
A Yes. Those two silos are in the backfill facility, which is that little facility that is actually in the location where the main ventilation air raise is. And there's a borehole that goes down into the mine workings and at the base of that borehole is our backfill plant. So we can bring in cement and flyash from offsite and then, you know, transport it down to the mine by this borehole and do the mixing for the backfill process.
Q And why are these silos air emission sources?
A Only because of what we just talked about. You know, as you empty them and fill them you would have air incoming to the bin and air outgoing that you would want to clean of particulate matter.
Q So are there controls on these sources?
A Well, the bin vents would be the controls, yes.
Q And then items further down you have several line items which are fugitive; correct?
A That's correct.
Q What does "fugitive" mean in the context of air permitting?
A Well, fugitive sources are any source of emissions that cannot -- or that will not be going through a stack. So for example, if you had a pile of rock, you know, there might be some particulate matter that would -- emitted when wind comes along and blows it. Or for example, a vehicle

traveling down a dirt road would also have some dust kick up from the wheels. So those would be termed fugitive sources; they aren't coming into a stack and you don't have the opportunity per se to put a bag house on them.
Q Would another way -- at least with regard to some fugitive sources, would another way of referring to them be area source?
A Yes. Some of them do become area sources and that's in the perspective of modeling.
Q They have to be handled differently than a source where you have an identified stack as the source of your emission?
A That's correct.
MR. KOHL: Now, if we can expand our view of this exhibit.
(Pause in dialogue)
Q Can you explain going from -- now we've covered the left-hand column -- going left to right what these various columns represent in general?
A Yes. This is the summary of criteria pollutant emissions in tons per year. As you can see, across the top there are the criteria pollutants and then as you read down the left-hand column you can see where the emitter sources are.
Q Now, for purposes of this proceeding I want to focus in on just two columns, which are labeled "P.M." and "PM10." Do you see those?

A Yes.
Q "P.M."; what does that represent?
A Particulate matter is anything that's a solid. It could include aerosols. And so typically P.M., particulate matter, ranges in size from less than 2.5 perhaps all the way up to 30 microns. P.M. 10 is that particulate matter which is ten microns or less in size.
Q And for regulatory purposes in Michigan does it make a difference whether you have P.M. or PM10?
A Well, some of the evaluations for modeling are done on the P.M. basis and others are on a PM10 basis, so you'd want to track both.
Q And that's why did so in this exhibit?
A Yes.
Q And as we go down the column, let's say, with regard to generators; you have an estimate there with regard to P.M. and/or PM10; is that correct?
A Yes.
Q And what would be the P.M. or PM10 from a generator?
A Well, generally combustion sources will include soot and especially with diesel fuel, so there will be some soot which I think is made up some -- of carbon sources; some sulfur also contributes to diesel particulate matter.
Q Would the same be true then of the mine heaters; are those also a combustion source?

A Yes, they are. Propane is relatively clean burning, so those two numbers for particulate matter are quite low.
Q And then as we go down through the rest of the sources relative to P.M. or PM10, none of those are combustion sources; correct?
A That's correct. So those would be more of the solid types of particulate matter from ore handling, development rock handling and backfill handling. I do have to point out that this application was based on not having any control on the main ventilation areas.
Q So let's talk about in general, how generally the process was for you to develop -- this is labeled, "Potential to Emit Summary"?
A Yes.
Q And I take it that's an estimate then of the potential that each of these sources could emit on an annual basis?
A That's correct.
Q Given what you understood with regard to the mine and its processes?
A That's correct.
Q Let's talk a little bit in general about how you then went about developing these estimates for P.M. or PM10 for each of these sources.
A Sure.
Q With regard to the generator; in general how did you develop

that estimate?
A Well, since I had a specification and emissions are quite a focal point for any manufacturer, I did have specific emission factors from -- in this case it was Caterpillar Generators and those factors are what I used to prepare the emissions.
Q Now, when we get to the MVAR I see that you've broken it out into I guess six different categories of activities?
A Yes.
Q Is that correct?
A Yes, it is.
Q And for instance, with regard to blasting, how did you -- what assumptions did you have to make with regard to blasting to generate those numbers?
A Well, here's where the EPA AP-42 emission factor referenced is come into play. AP-42 is the -- sort of a living document that air emissions are based on. It's got a variety of chapters in the total document, you know, that pertain to this -- this first part of AP-42 has to do with stationary sources. There's another chapter for mobile sources. But for the stationary sources there are multiple chapters and details as far as focus on industrial activities and what one could expect a certain activity to emit. So generally you can go to AP-42 and develop or just pick out emissions factors that you think fit your activity

and, therefore, begin to tabulate your emissions for your facility.
Q In developing these emission estimates did you have to assume any rate of or level of mine activity --
A Yes, because --
Q -- on an annual basis?
A Yes. In fact, the factors are typically sort of an emissions per through-put kind of a term, so therefore, once you had the factor you would need to multiply it by the through-put to come up with your pounds per year or pounds per hour of emissions.
Q And so with regard to the through-put, what -- did you use an average level of through-put or some other measure to develop these potentials to emit?
A Well, you know, with an air permit application you want to have an upper bound level of emissions, so we are asking the DEQ to allow us to emit up to a certain emission level. So we want to, you know, make sure we have asked for as high a level that we could possibly anticipate. And especially in the context of, you know, real time operations there may be some hours or some days that you would have a high through-put but in general you would probably be not operating at that high, high rate all the time. But we do ask for permission to operate at a very high rate and that's really what the potential to emit represents.

Q So when you calculate potential to emit, I can see that you can calculate a potential to emit for, let's say, a highest hour rate; when you do an annual basis, did you utilize the highest rate possible and then assume that was sustained for a year period?
A Yes. Generally the activities are calculated on an hourly rate and then the potential to emit assumes that you're operating at that high hourly rate for all the hours of a year. So it really is an upper bound, perhaps in some cases unrealistic high level of emissions.
Q So you don't take into account and develop -- you didn't take into account and develop in these potential to emits the mine being shut down on weekends?
A Correct.
Q The mine being shut down on Christmas Day?
A That's right.
Q The mine operating two shifts instead of three shifts?
A Correct.
Q You assumed 24/7, 52 weeks a year?
A Yes.
Q And did you have an understanding with regard to the mine plan as to whether or not the peak rate of production and were using whether or not that could even be achieved in the early years of mine development?
A Well, in the pre-feasibility study we did have information

as far as the years went on what year was the maximum year of production. I think it ended up being 2012 based on that study. So as they begin developing the mine, of course, they, you know, would have a lower level of production and it would ramp up to a maximum and then ramp back down to the end of the mine life.
Q All right. So if you wanted to you could have done a potential to emit for the mine that would have been different for each year depending upon how much it had developed even assuming it was running around the clock?
A Right.
Q But you didn't; you just took the peak assumed year and the peak level of production and applied that?
A Yes.
(Pause in dialogue)
Q Can you read that, Ms. Martin, from where you're sitting?
A Yes; yes.
Q Okay. What does it say?
A "These are the potential to emit for the hazardous air pollutants per stack."
Q All right. So what are you accomplishing in this chart?
A Well, besides the criteria pollutants we do need to look at the hazardous air pollutants and in the mine we've identified these metals as being potential hazardous pollutants. So that top row has the particular metals and

right below that are three different materials that we handle. You know, the ore is handled obviously, and that has some higher composition of copper and nickel. We also handle development rock and it has some lower levels of some of those metals. And then native soils also, you know, have some emissions based on them and then you can see the composition there.
Q Now, did you have analytic data from which you could determine how much arsenic or barium or cadmium or chromium, et cetera, could be expected to be contained within the ore, the development rock, the native soils, the flyash, et cetera?
A Yes, we did.
Q Was that contained as part of the air application?
A It was. I think it is in Appendix G and it has several memos developed from a variety of sources that cover each of those main materials.
Q When the -- when you used values for the metal content of these various materials, did you take an average value or a different value?
A Well, you know, it's a statistical exercise and I think that the memos address the details of what happened, but we did use the -- let's see if I can get this right, because I'm not a statistician. It's the 95 percent confidence level that the means are -- is it below? -- below the level that

we use. So that number then -- like, for example, copper -- for the ore is at 3.11 percent. That means that we are at a 95 percent confident level that the ore would have at most that level of copper in it.
Q And employing a 95 percent confidence interval, is that in your experience a conservative means of estimating a value?
A Yes, it is.
Q So in practice would you expect the values you used here to overestimate the amount of copper or cadmium that might be in any one of these materials?
A Yes; yes, it's a conservative estimate.
Q Now, did these -- would it be fair to say that this chart then lays out emission factors on an annual basis?
A Well, not factors, but the results of the calculations, so we actually, you know, begin this calculation set with a summary. This then -- you can come to this table and see, you know, what are the totals of any particular metal and then as you move up the column you can see which stacks or which sources are the -- you know, contribute the most or least to that particular total.
Q Okay. Did you in this chart come up with a total potential to emit of copper that could be emitted by the mining operations to the air?
A Yes. It appears that total facility wide the number is 395 pounds per year and that is on the assumption that there's

no control equipment on the main ventilation air raise.
Q And did you also come up with an estimate for nickel?
A Yes. That number is 402 pounds per year.
Q Okay. And did you break down the total mass potential to emit by source?
A Yes.
Q And what was the largest source of the copper and nickel?
A The largest source does come from the underground mine and exhausts through the main ventilation air raise.
Q Okay. And what do you -- what did you compute as the value of the copper that -- the potential to emit from the mine ventilation air raise was?
A The copper is 342 pounds per year that exhausts from the main ventilation air raise, and that is uncontrolled.
Q And the nickel?
A Nickel is 347 pounds per year.
Q Now, is there a detail sheet -- let's back up. To develop this computation you applied the appropriate copper concentrations, which you've just testified were derived from Appendix G?
A Yes.
Q And applied that to the particulate mass that you assumed was going to be emitted from the source, in this case the mine ventilation stack; correct?
A Yes.

Q Now, is there a detail sheet within Appendix C that details how you developed your calculations for the mass that could be emitted uncontrolled from the mine ventilation stack?
A Yes, there are. In fact, all of those activities have detail sheets to describe how those numbers were arrived at.
(Pause in dialogue)
Q Would this be one of the detail sheets?
A Well, this is actually the data sheet.
Q Oh, okay.
A And I like to have -- you know, many times we're using the same piece of data in several calculations, so with spreadsheets it's nice to have a lot of common data in one place and then you can go back and grab that number and have confidence that you would grab -- be grabbing the same number for similar calculations. So I've got all of the -- well, hopefully, most of the data then used. And this really describes a lot of the operational numbers that we received from McIntosh Engineering who had prepared the pre-feasibility study.
(Pause in dialogue)
Q Can you tell us what this page is in Appendix C?
A This appears to be one of the later pages. I think there's five pages of data and, you know, it's -- you can see this happens to cover the mine air heaters, so I -- you know, in one place showing that there's four of them and what the

capacity of each heater is, and then, you know, as I moved down through the various pieces of equipment -- you know, this information just comes from the specifications. Now, this part that's entitled "Ore Data"; that's a summary of the chemistry of the ore. So it -- the full memorandum appears in the appendix to this -- one of the appendixes to the document, but here I've got it loaded into my spreadsheet so I can go grab the number and, you know, use it to calculate emissions rates if needed.

(Pause in dialogue)

Q Can you tell us what this page represents?

A Well, this is an explanation of how the blasting emissions are estimated and --

Q Now, let's back up. The blasting emissions are a component of the estimate of a mass of emissions from the mine ventilation stack; correct?

A Yes. And if I'm not mistaken, there's actually two parts to blasting emissions. This is the particulate matter part. So the closest chapter from AP-42 then is this Chapter 11.9 which is Western Surface Coal Mining. You know, again, we need to use references and do the best we can if they don't exactly match the activities that we're doing. So as you can see then, I've just stepped through in narrative form as to how the numbers are arrived at and once an emission factor is developed, as you can see EPM-10 equals 1.68

pounds of particulate matter per blast, then I can apply the particulars to my blasting activities and estimate then the, you know, annual emissions then from that activity.
Q And from looking at the sheet I see in the middle there is from McIntosh Engineering "number of hours blast, number of hours day, number of blasts per day," so you were provided the information from McIntosh with regard to how much blasting activity would be expected at peak production?
A That's correct.
Q And then as you work your through -- your way through the formulas then you wind up with estimates of maximum P.M. emissions expected from blasting on an annual basis and estimates of PM10 emissions?
A Yes. And you'll see throughout these details calculations that those are the two results, the estimates that you're trying to achieve. It's the P.M. total emissions and the PM10 emissions. And generally the AP-42 factors -- or chapters have emission factors for both of those two types of P.M.
Q Now, here we have -- on one side you have maximum emissions and then on the other side you have actual emissions. Can you explain the difference between those two numbers in concept?
A Yes, because that gets back to that concept of potentials to emit. You know, it may be possible to have -- you know, do

I think it's two blasts per day and if we extrapolate that to an annual basis then we could get the potential to emit. But in routine operations and even just to achieve our goals at the facility, we really only will be doing 1.4 blasts per day. You can't -- you only have the incentive to blast as much as you can pull out of your stopes. So this isn't really a unlimited activity; you only have certain amounts of blasting that you really need to do. So up to the -- I think it's two blasts per day we produce our potential to emits or maximum emissions and then on giving the routine emissions, what I expect to happen on a given year, and that's reflected in the actual emissions.
Q Would it be -- could you view your column "actual emissions" as being a projection of actual maximum emissions?
A Well, I'm thinking -- I guess the way I like to think of actual emissions are on routine years, especially over the course of a year I would expect actual emissions to be close to the reality estimate of what is coming out of the facility. And again, back to that potential to emit; that's the amount of emissions we're asking the DEQ do we have permission to emit on a given day.
Q Which number represents the maximum production in 2012?
A That would be the maximum emissions.
Q Do you recognize this page?
A I do.

Q And what is this page -- what are you doing on this page?
A Well, this is the explanation of the settling chamber that we have in the underground mine. I think this section covers three pages and it's a multiple-step process. And I have taken a credit for the activities that happen underground. Because they are happening underground in a chamber, you'll have some of the particles settle and this represents then the credits that I'm taking because not all of it's going to come out of the exhaust, the main ventilation air raise.
Q And was there a recognized methodology that you used for taking these credits?
A There was. I used the <u>Perry and Chilton Chemical Engineering Handbook</u>. That is a reference book that's been around for decades. This theory of gravitational settling is actually one of the first methods of air pollution control. And you know, Perry's handbook really is a great reference that just provides empirical formulas or relationships for particle dynamics, fluid flow, and it's just one of the staples for engineering predications of how matter is going to behave.
Q And as we go down to the upper portion of this document there's a box there?
A Yes.
Q And it's -- you have columns labeled "settling efficiency"

and "settling emission factor"?
A Right.
Q What do those represent?
A Well, you know, there's two ways you can look at a settling chamber. You'll notice that the settling efficiency matches the settling factor in that they both add up to one. So if I have an efficiency, for example, in the stope for the drilling activity -- the chamber is 57 percent efficient, I turned that around and said, therefore, 43 percent of the activity emissions will be exhausting.
Q And I notice going down through this exhibit you have developed settling velocity for PM10?
A That's correct.
Q To apply these settling factors to recognize some of the particulate will settle out inside the mine as opposed to being exhausted, did you have to make any assumptions with regard to the size of the particles as you were doing that?
A I did.
Q And what assumption did you make?
A Well, I wanted to choose a representation particle size for all of the particulate matter, so if we say the particulate matter ranges in size from less than two up to about 30, --
Q Thirty; and that's microns?
A Microns across and then I would want to select a conservative size that, you know, I could use to go through

the calculations and then apply to the total particulate matter. So I determined that PM10 really is a great selection, because if you think about it, I mean, between two and 30 just a straight average would be around 15. So I wanted to stay away from that. PM10 I think is just a conservative size selection and it can be applied to total P.M. and in a conservative way then you can, you know, estimate then, you know, what your settling chamber is going to do for you.
Q All right. When you apply these formulas if you assume that all of the particle size was P.M. 30 microns, would you then be recognizing a higher settling efficiency inside the mine?
A Yes. Really larger particle sizes will settle more effectively than the smaller particle sizes.
Q So by utilizing size of PM10 to apply to all particle, that was in your judgment a conservative estimation of the settling efficiency?
A Yes, it was.
(Pause in dialogue)
Q And what are you doing on this page?
A Well, this is where the dimensions of the chamber are incorporated and you end up with your efficiency, that end value with the boxed equation then. So the UT, which is the particle velocity, which was determined in the page we just looked at, is put into this formula with the length of the

chamber, LS, the height and the velocity of the gas moving through and then it's just a straight calculation to end up with an efficiency.

Q Now, I would assume that if you used this methodology and you assumed, let's say, five settling chambers, you'd be able to recognize more settling efficiency than if you assumed one settling chamber; correct?

A Yes.

Q How many settling chambers did you assume?

A Well, you know, we do have a series of chambers and you can see that in the mine section, the lower box there. However, as a layer of conservative strategy we really only applied the settling factor of what -- where that activity was occurring; we did not take additional credits for the settling which will continue to occur as that air moves through the rest of the mine.

Q So, for instance, if I'm in the lowest levels of the mine blasting, you're assuming settling within that stope of the mine?

A Yes.

Q And applying your efficiency factors within that settling chamber; correct?

A That's correct.

Q But you're not assuming any further settlement on up through the mine?

A That's correct.
Q And by not assuming or recognizing any further settling through other chambers of the mine does that result in effect overestimating the emissions?
A Yes, it does.
(Pause in dialogue)
Q Now, there would be vehicle traffic within the mine; correct?
A Yes.
Q The various trucks, conveying devices within the mine?
A Yes.
Q And these would be driven so there's in essence roadway within the mine?
A Yes, there is.
Q Did you have to address particulate being stirred up by road traffic within the mine?
A Oh, yes. Yes.
Q And how do you go about doing that?
A Well, vehicle travel calculations appear on page 30 of Appendix C and it's development of the emission factor for the activity. Again, that's out of AP-42. And the vehicle roadway traffic is influenced by the weight of the truck, by the silt content of the roadway. Let's go to the page and I can remember more. There we go. That looks like it.
Q There we go.

THE WITNESS: Go up to the top there. Let's see. At the beginning of this section is where the emission factors are developed. So if you go one page up I think. If you could go another page up, please. And one more. There we go.

MR. KOHL: Can you blow that up?

A Let's see here. You know, I want -- I'm looking for a different page here. It's two -- a couple multi-step -- a multi-step process, because you're obviously taking into account how long their trip is and you're applying an emission factor which is in pounds of particulate matter per vehicle mile traveled. So I am looking for the page that has the development of that emission factor. You know what? I'm sorry. I think it would be page 25. There we go. Okay. So out of AP-42 we apply per equation 1-A, there's a variety of variables in there. The "W" is the vehicle weight, the "S" is the silt content. Exponents to those terms are A and B and they vary depending on whether you're talking P.M. or PM10, and they are straight out of the table from that chapter. The "K" is also from the table. So there's a rather straightforward math involved on that one. You can apply a -- it's called "factor of precipitation factor" here and it has to do with the wetness of the road, and then multiply that together you will end up with your, you know, effective emission factor for the vehicle miles traveled in your situation.

Q Now, what -- do you recall what silt factor you used for the roadways?

A We used a one percent silt factor.

Q Now, what does "silt factor" mean?

A It is the amount of finer material that would be present in a soil surface.

Q Okay. And that affects on how much dust you would expect to be picked up by a truck?

A That's right. So if you had very silty roadway, then you would have more dust than if you had very little silt.

Q Okay. Now, I think there has been reference previous in -- previously in this hearing to a silt factor of three percent?

A Yes.

Q And was there a silt factor of three percent ever identified or associated with the mine?

A Yes, there is. On the data page of this calculation set there is a silt factor of three percent that appears on that page and it was in reference to the native soils in the area.

Q That would be on the surface?

A Yes.

Q And would the roadways in the mine be of material different from the surface soil?

A Well, typically it would be. We would have -- you know, have built a road out of gravel, so if you read that AP-42 chapter it will reference that for a first cut you can use the native soil silt factor and that provides you with a very conservative estimate. But it is recognized that generally on road beds where you have traffic moving over the surface and if you've, you know, made efforts to make it into a surface that is different from the native soils, then you can use a lower silt factor.
Q And that's what you did in this case?
A Yes, it is.
Q And did you believe in your judgment it was appropriate to do so?
A Yes, I did.
(Pause in dialogue)
Q Can you tell us what you're doing on this page of the exhibit?
A Yes. This is the ore handling activity underground and there were two scenarios that are shows here. Depending on what level we're mining, you may have an extra point of handling, so I'm showing here that the -- depending on whether you're below level 293 or above it, you know, which -- what would your emissions be and then I choose the higher level. So it appears that when you have ore being processed from above level 92 -- sorry -- 293, you have slightly more

emissions coming from that operation, so we used that set of emissions estimates as part of our PTE calculation.
Q So in simplest terms, depending upon what level of the mine you're in, you may have an additional material handling process within the mine?
A Yes.
Q That could create additional particulate?
A Yes.
Q That could potentially be emitted through the mine ventilation raise?
A That's correct.
Q So in this page you're trying to take into account and recognize that that additional material handling step could generate additional particulate emissions?
A Yes.
Q Again, in an effort to be conservative?
A Yes.
Q And did you walk through this type of analysis that we've just displayed for each activity occurring within the mine to come up with your estimates of particulate to be emitted through the mine ventilation raise?
A Yes, we did.
Q And did you apply then the copper and nickel values from Appendix G to each particular material being handled or stirred up in the mine?

A Yes, we did.
Q To come up with your mass of copper and nickel that would be emitted from the mine ventilation raise?
A Yes.
(Pause in dialogue)
Q Do you recognize this document?
A Yes, I do.
Q What do you recognize this as?
A This is Mr. Helwig's (phonetic) cover letter to Mr. Jon Cherry notifying him that the permit to install application had been approved.
Q Do you recognize this document?
A Yes, I do.
Q And what is that?
A The cover sheet of the permit.
MR. KOHL: I'd offer Exhibit 586.
MR. STAPLETON: No objection, your Honor.
MR. REICHEL: No objection.
JUDGE PATTERSON: It will be entered.
(Intervenor's Exhibit 586 received)
Q Do you recognize -- this is the table of contents?
A Yes, it is.
Q And within this table of contents does this at least direct you to the conditions within the air permit that apply to the various operations that were permitted under the air

permit?
A Yes, it does.
Q When we talk about mine heater flexible group, in simple terms what does that mean?
A Well, there's -- when you have some similar pieces of equipment or similar activity it becomes streamlining to consider them in a flexible group. So for example, we have the three generators and two of them will be operating at one time, and the third then would be out of service. So instead of regulating each generator and having text in your permit and text in your recordkeeping that addresses each generator, you can form them into a flexible group and handle them as a group and it just becomes, you know, more streamlined as far as documentation goes for both the permittee and the DEQ and it, you know, doesn't change the results of whether you're in or out of compliance with your permit.
Q And does the MDEQ have a standardized format in the way to express the conditions generally that apply to equipment within a flexible group?
A Yes, they do.
(Pause in dialogue)
Q Would this box represent some of that standardized format?
A Yes.
Q Okay. And in the left-hand column there's a label

"pollutant"; here a pollutant of concern with regard to these generators would be nitrogen oxide emissions?
A Yes.
Q The limit there is 188 it's "TPY." What does that stand for?
A "Ton per year."
Q Okay. And when we say -- time period here is 12-month rolling time period. What does a 12-month rolling limit mean?
A Well, each month we will be tracking certain operational parameters on these -- this equipment and each month then we would prepare recordkeeping. So for example, the number of gallons of fuel that you used in a certain month would be documented, and from that fuel usage you would estimate how much emissions are coming out of the stack. So to apply the permit since, you know, facility emissions are not particularly observant of calendar years, we use this 12-month rolling average concept. So every month that you would prepare a monthly record you just take that month and the previous eleven months and evaluate it for permit compliance and then the next month comes and you roll that 12 months to cover your next month and you drop off the month that was one year previous. So it's a very common permitting tool then to demonstrate compliance over the year ending in the month that you are currently preparing your

records for.

Q So at any given point in time the mine is limited to a -- over a 12-month period to no more than 188 tons of nitrogen oxide emissions?

A Yes.

Q Now, the column "testing monitoring method"; what goes into that box?

A Well, there is a stack test needed on these generators and it is detailed in one of the further paragraphs, and that is -- there's many different test methods the EPA generally approves or produces test methods that are recognized to be acceptable. And that column then just pertains to which method is the correct one.

Q and then the far right-hand column is labeled, "Applicable Requirements." Do you see that?

A Yes.

Q What goes into that box?

A Well, the emissions limits that are presented there are tied into the reasons why they need to be that way. So there appears to be several state rules that pertain to that emission limit as well as some federal standards that are, you know, evaluated to arrive at that permit limit.

(Pause in dialogue)

Q Do you recognize what this page represents?

A Yes, I do.

Q What is it?
A These are the conditions that apply to the ventilation air raise.
Q The pollutant is inorganic P.M., and why is it inorganic P.M.?
A Well, because the permit really pertains to stationary source emissions and as we talked before, the activities taking place underground which are ore handling and development rock handling and backfill, those are those particulate matters that are inorganic; there's no organic parts about them because they're made out of rock. There are some particulate matter that will be coming out of the tailpipe of the vehicles down there, and those will be the organic ones, so -- but because they're tailpipe emissions, they're mobile emissions, they are not governed by this permit, therefore, the emissions limits should only pertain to the inorganic part of the main ventilation air raise exhaust.
Q And we have limits expressed for both P.M. and for PM10; is that correct?
A Yes.
Q And why is it broken down for both P.M. and PM10, if you know?
A Well, you can see the applicable requirements are different for the two categories. A PM10 has -- that 40 CFR Part 52

is the PSD increment and when you read that it does use the counts per hour and there's thresholds and evaluations in that analysis. Up at the 9.8 that's expressed as a concentration. It actually is the same number. The thousand pounds of exhaust gasses are based on the ventilation rate, which is 427,000 cubic feet per minute of ventilation. So they are essentially the same number, but you can see from the applicable requirements they are just termed in different ways.

Q   So the top number is a concentration limit in effect; correct?

A   Yes.

Q   For source like the MVAR would that result in basically also limiting your mass because the exhaust rate is constant?

A   Yes, it does.

Q   And the bottom rate is a mass rate over time limitation?

A   That's correct.

Q   Okay. Now, if we go down to condition 9.3 that first paragraph says, "The permittee shall not operate the MVAR unless a malfunction abatement plan as described in Rule 911(2) for the fabric filter system has been submitted within 365 days of the permit issuance." First of all, does the permit require a fabric filter system?

A   It does.

Q   And is that the same as the bag house that we talked about before?

A It's similar. There's a nuance difference but they are essentially the same. Air is passed through fabric and the particulate matter, you know, impinges on the fabric and is collected and can be pushed off so that they are essentially the same thing.

Q And what's a malfunction abatement plan?

A Well, that's a very typical operational requirement. Because you have a piece of air pollution control equipment that enables you to emit emissions that are at acceptable rates, it's very important to maintain the operability of that equipment. So the regulatory agencies require this preparation of this plan and it's really a preventive maintenance plan and the steps that would be taken when a -- if a malfunction is identified. So you would not want to be operating your facility or any of your processes if your air pollution equipment that is required by the permit is not operating properly. So this is the leverage, the operation, the day-to-day routine method of making sure that that takes place.

Q Do the subsequent paragraphs in this section further amplify what's required of the -- in the malfunction abatement plan?

A Yes, they do.

Q And do you see the final paragraph?

A Yes, I do.

Q And what is your understanding of how that paragraph would operate?
A This kind of strategy is quite typical in many plans, operational plans in that if a malfunction abatement plan is prepared and evaluated to be adequate, occasionally something happens that is outside of the scenarios presented in the plan, so you would have then the requirement that you need to amend the plan within 45 days after some event might -- that took place.
Q To address the new contingency that was identified or whatever?
A Yes.
Q So Kennecott on this permit is required to have a fabric filter on the mine ventilation exhaust; correct?
A Yes.
Q It's required to have it operating at all times that the mine ventilation exhaust is operating?
A Yes.
Q It's required to have a malfunction abatement plan with regard to the fabric filter?
A Yes, it is.
Q It's required to modify that malfunction abatement plan if at any time it proves to be inadequate?
A Yes.
Q Testing; is Kennecott required to test the emissions from

the mine ventilation raise?
A Yes, they are.
Q And does Kennecott have recordkeeping obligations with regard to the mine ventilation raise?
A Yes, they do.
Q In fact, does it have to do monthly calculations with regard to the mass and the concentrations emitted?
A Yes; yes, they do.
Q And if they exceeded the stated mass or concentration limits that would be a violation of the permit, would it not?
A Yes.
Q Now, earlier we saw estimates of the mass of particulate on a potential to emit basis from the MVAR in Appendix C. That was done in the original application; correct?
A Yes.
Q The permit required a fabric filter control on the MVAR; correct?
A Yes.
Q Did you happen to have an opportunity to do -- recalculate those mass emissions?
A Yes, I did.
Q Let me show you what we've had identified as Intervenor 625.
(Pause in dialogue)
MR. KOHL: All right. We can't blow it up, so we're going to have to work off the paper copy.

MR. HAYNES: Your Honor, I can't help but observe -- counsel is talking about blowing up exhibits. I thought we were supposed to cover that with the last witness.

(Off the record comments)

Q We're working off a paper copy. Did you have occasion to recalculate the potential to emit a particulate PM10 from the MVAR in light of the permit conditions?
A Yes, I did.
Q And what values did you come up with?
A Appearing in pink I have just applied the 85 percent control efficiency to the MVAR activities and potential to emit for P.M. is 3.02 tons per year, and for PM10 the result is one ton per year.
Q And did you also using the same methodology you utilized for purposes of preparing the permit application recompute the potential to emit of copper and nickel in light of the permit conditions on the MVAR?
A Yes.
Q And that's on the second page?
A Yup. On the second page I have 51 pounds per year of copper, and 52 pounds per year of nickel coming from the main ventilation air raise.

MR. KOHL: I move for the admission of Exhibit 625.

MR. STAPLETON: Can I just get some clarification on -- am I looking at a potential-to-emit summary that's just been color-coded, essentially?

MR. KOHL: Yeah.

MR. STAPLETON: Okay. This was attached as an appendix to the permit to install application?

MR. KOHL: The original version was. But since that didn't contemplate a control, this is just an update to account for the 85-percent control.

MR. STAPLETON: With that clarification I have no objection.

MR. REICHEL: No objection.

JUDGE PATTERSON: With no objection it will be admitted. And that's 625.

(Intervenor's Exhibit 625 received)

Q Ms. Martin, have you seen this exhibit before?
A Yes, I have.
Q And this is a portion -- I believe it's Appendix 1-O of Exhibit -- Petitioner's 632, Exhibit 77?
A Yes.
Q Do you see in the far left-hand column that there is a column labeled "Long-Term Controlled," and it's apparently emission rates?
A Yes.
Q Do you see the emission rate for P.M.?

A Yes.
Q Expressed as pounds per hour?
A Yes.
Q And what do you read that rate as being, as expressed there?
A We are looking at total?
Q Yes.
A Vent raise uncontrolled P.M. long-term emission rate is .819 grams per second.
Q And how about the controlled rate?
A Controlled rate is 0.109 grams per second.
Q And is that also right above it expressed in pounds per hour?
A Yes. That's pounds per hour directly above.
Q That's .86?
A Yes, I think so.
Q And that would be -- and the permitted rate as we've just covered is .7?
A That's correct.
Q So to the extent that this rate was employed by CRA, it would have overstated the allowed rate of the mine ventilation raise?
A Yes.
Q Did you find any errors in your judgment with regard to how CRA appears to have computed in this exhibit the amount of copper or nickel that would be emitted?

A I did find some anomalies.
Q Can you explain what those were from your perspective?
A Over on the left-hand column there are two entries for vehicle traffic. The rock type column indicates that half of the vehicle travel emissions were based on development rock and half on ore. I disagree with that evaluation. Vehicle travel would never be operating on ore. The ore has a higher level of both copper and nickel, so doing this assumption then inflates the amount of copper and nickel coming out of the main ventilation air raise. As well, the backfill is based on development rock, and again that is incorrect. Backfill material is comprised of flyash and cement and aggregate that comes from off site. So that is a -- more of a standard type of composition. I would not expect it to have the same metals content as the development rock. So that, too, would inflate the amount of copper and nickel coming out of the main ventilation air raise.
There are some additional mechanics going on with this density and weight density which -- I don't quite understand why they went there. If you wanted to arrive at a weight percent, which I think is where those two columns, the first entitled "Short-Term Weight Percent" and "Long-Term Weight Percent," you would want to take the amount of copper or nickel or any other contaminant weight basis and then divide it into the total particulate matter, and that

would be a weight percent. So I'm not really sure why the density column appears. So I really wasn't able to figure that out.

But multiplying it, it appears that in multiplying a density value -- which does vary as you can see. If you're talking about ore, you're talking about development rock, it has a higher value than if you talk about the mine air heaters, which I would view as a standard type of material. I mean, it's soot, but it doesn't have high metals. You're going to inflate again your weight percentage for the metals that are coming out of the main ventilation air raise.

Q So to the extent that CRA may have relied upon these calculations in developing a deposition model, would it be your judgment that they overstated the potential to emit of copper and nickel from the mine ventilation raise?

A Yes.

Q And to the extent their numbers disagree with your numbers as summarized in Exhibit 625, you will stand by your numbers?

A I do.

Q Was air modeling conducted in support of the permit-to-install application?

A Yes.

Q What type of air modeling was conducted?

A Well, typically one provides air model that shows that someone standing at the fence line of the facility, meaning it has public access, would not have any health effects, you know, from emissions coming from the plant. So we do perform dispersion modeling. And it translates your emission rates, meteorological conditions in the area, and topography into a concentration. And those concentrations are compared against acceptable concentration levels. Both federal and state have those. And then you determine whether you have a facility that is in compliance with those standards.
Q And the output of an air dispersion model results in a concentration in the air of a pollutant or contaminant?
A Yes, it does.
Q And do you model for where the highest concentration in the ambient air shows outside the fence line of the facility?
A That's correct.
Q And do you model for criteria of pollutants? NOx, SOx, et cetera?
A Yes.
Q And that's federally required as well as state required; correct?
A Yes, it is.
Q And in Michigan do you also have to model against a screening standard for toxics?

A That's right, yes.
Q And the toxics that we've covered -- you've covered in Appendix C are from this plant metals; correct?
A That's correct.
Q And insofar as you're aware, did you model satisfactorily from the standpoint of below, "all applicable standards of the State of Michigan apply relative to ambient concentrations for criteria pollutants or air toxics"?
A Yes, we did.
Q Did you do the modeling yourself?
A I did not.
Q Did you oversee or participate in the inputs in the providing of the modeling to the MDEQ?
A I did.
Q Was Kennecott required, by either state or federal law, to do deposition modeling in support of the air permit application?
A No. I have never seen deposition modeling being required for an air permit application.
Q Now, I want to come back. We already saw and we left it, but there was one point I wanted to cover on the air permit itself. The conditions for the MVAR and the fabric filter in a malfunction abatement plan, in your experience not only with Michigan but in other states, is that a fairly common way of expressing permit conditions for that type of control

device?
A Could you go over that question with me again?
Q Sure. The conditions we covered with regard to requiring a fabric filter on the MVAR or requiring a malfunction abatement plan, is that in your experience a fairly standard way for a state agency to express conditions for a fabric filter control device?
A Oh, yes, it is.
Q In your experience with -- strike that.
(Counsel reviews documents)
Q Do you recognize this table of contents?
A Yes, I do.
Q And what is that remember?
A This is for the mine permit application, volume 2, the environmental impact assessment.
Q And did you participate in the authorship of a section of this document that related to ambient air impacts for meteorology?
A Yes.
Q Have you had occasion recently to review that section?
A Yes, I have.
Q And what is what was represented in this report accurate and true, to the best of your knowledge?
A Yes.
MR. KOHL: Well, I think all of Exhibit 6 ought to

be part of the record, so I'll move for all of Exhibit 6. But certainly she substantiated that portion of Exhibit 6 that related to her work.

MR. STAPLETON: Exhibit 6 is the EIA?

MR. KOHL: Yeah.

MR. STAPLETON: I have no object, your Honor.

MR. HAYNES: Your Honor, I think the EIA has been admitted.

JUDGE PATTERSON: I was just going to say that.

MR. KOHL: Well, I'm admitting it for the truth of the matters stated therein.

MR. HAYNES: Well, I'll object to that, except for the portions that this witness may have identified that she prepared.

MR. STAPLETON: She's only testified as to one small section in this EIA.

JUDGE PATTERSON: Right.

MR. KOHL: Well, I trust you to keep straight which came in substantively and which came in simply for the proof that it was admitted.

JUDGE PATTERSON: Okay.

MR. REICHEL: I have no objection, but just for clarity of the record, I don't know if this appears in the transcript. Counsel, are you referring to Section 3.17 of the EIA?

MR. KOHL: Yes.

MR. REICHEL: With the title "Air Quality and Climatology"?

MR. KOHL: Yes.

JUDGE PATTERSON: I'm sorry? What was that? 3 point --

MR. REICHEL: 3.17, your Honor.

JUDGE PATTERSON: All right. That section will be admitted as proffered for the truth of the matter asserted.

(Intervenor's Exhibit 6, Section 3.17, received)

MR. KOHL: I have no further questions of this witness.

JUDGE PATTERSON: Okay. Let's take a break.

(Off the record)

MR. STAPLETON: Good afternoon, Ms. Martin. My name is Bill Stapleton and I'm an attorney for the Petitioner, Huron Mountain Club. And I have a few questions for you today.

THE WITNESS: How do you do?

CROSS-EXAMINATION

BY MR. STAPLETON:

Q It was not clear to me, from looking at your resume, how much time at Foth you devote to air projects as opposed to other types of projects that you might work on.

A Well, up until about two years ago when I began working on the Eagle Project, I would say at least 80 percent of my time was devoted to air permitting work. Additionally, there were SPCC plan preparations, stormwater plan preparation, hazardous waste, inventory, annual-reporting-type general compliance for medium-size companies that are our client base.

Q And the other 20 percent, what sort of projects do you work on?

A Oh, that would have been the SPCC plan, hazardous waste. That would have made up that --

Q Oh, you were including that in --

A So then when Eagle began, the bulk of the -- I mean, that was preparation of the air permit application for that, so that would be 100 percent there on air.

Q And as I understand it, you -- this was the first permit-to-install application in Michigan that you have worked on; is that correct?

A Prepared, yes.

Q And have you ever prepared a permit-to-install application for a mine?

A I have not prepared a permit-to-install application for a mine. That would just be in Michigan.

Q Pardon?

A That would be Michigan, then?

Q Well, just to be clear, have you ever prepared or been involved in a permit-to-install application for a mine in Michigan, prior to Kennecott?

A No.

Q Have you ever been involved in a permit-to-install application for a mine located outside of Michigan?

A I would say yes, except that it would not be termed as permit to install. I have worked on construction permits for mines, one in particular in Wisconsin.

Q And what type of mine was that?

A That was actually a nonmetallic mine, so -- it happened to be a limestone facility.

Q So you've never done air permitting work for a copper and nickel mine such as the one we're talking about today with Kennecott; is that correct?

A That's correct.

Q Now, as I understand it, you were sort of a leader at Foth for the air permitting issues related to the Kennecott Mine; is that correct?

A Yes.

Q And were there other individuals at Foth who also worked on the air permit?

A Yes.

Q And who were they?

A The gentleman named Curt Dungey performed the modeling and also prepared portions of the text. And we worked together

to assemble this document with peer review and, you know, complementary experience.
Q And so were you and Mr. Dungey then the only ones at Foth who worked on the air permit project?
A Yes, with the assistance of those who prepared appendices.
Q Okay. Were you the direct contact for Foth on air permitting issues, in terms of communicating with Kennecott?
A Yes.
Q And who was your contact at Kennecott?
A At the time of the permit application it would have been Jon Cherry.
Q And did it become someone else at a later date or at an earlier time?
A Well, fairly recently they've had an expansion in staff, so -- I mean, that's post permit approval.
Q And who have you been communicating with at Kennecott recently?
MR. KOHL: Objection; relevance. Go ahead.
A Their new environmental manager. Her name is Vickie Peesey.
Q And are you also the direct contact for communications with Air Quality Division at MDEQ?
A Yes.
Q And who are your contacts at Air Quality Division?
A I have been corresponding on matters pertaining to the Eagle air permit with Mark Mitchell, the permit writer.

Q Okay. Is there anyone else that you communicate with at AQD?
A No.
Q Now, as I understand from your testimony, there was some discussion of the dispersion modeling that had been performed for this project -- performed by Foth?
A Yes.
Q And you did not do that modeling directly; is that correct?
A No.
Q Do you have modeling experience?
A I do not.
Q Have you ever run either a dispersion or a deposition model of any kind?
A No, I have not run those models.
Q Well, I want to touch on one of the subjects that you mentioned last in your testimony, and that was the deposition modeling that was referred to by Mr. Kohl. You're aware that deposition modeling has been done in this case; correct?
A Yes.
Q And are you aware that deposition modeling has been performed not only by Conestoga-Rover & Associates but also by MDEQ?
A Yes.
Q I'm putting on the screen what has been admitted as

Petitioner's Exhibit 83. This one always takes awhile to load. Let me ask you, have you seen any of the deposition maps prepared by CRA in this case?

MR. KOHL: Your Honor, I'm going to object at this point. I mean, CRA, they presented their witnesses on that. This witness was not offered on the topic of deposition modeling. She hasn't testified about deposition modeling on direct. She's testified that she hasn't done deposition modeling. I asked her one question with regard to the exhibits that their expert prepared that solely related to emission rate calculations which she did do for the Kennecott Project. This examining her with regard to CRA is beyond the scope of my direct examination.

MR. STAPLETON: Your Honor, I simply have a few questions about the scope of her air permitting work as it potentially relates to any deposition modeling that was done. I just have a few questions.

MR. KOHL: She's already testified she didn't do any.

MR. STAPLETON: I just have a few follow-up questions.

JUDGE PATTERSON: Go ahead. I'll overrule.

Q Now, this is the deposition map that CRA prepared. And this -- you're familiar with this map; is that correct?

A Yes, I am.

Q And this shows a 40-kilometer by 40-kilometer grid that shows deposition of copper in this case across that area. Do you see that?
A Yes.
Q And here's my question -- well, let me also -- just so we're clear, the red line is the area of deposition -- and I don't know if we see it completely, but -- that was modeled by CRA. And the green line, if it comes up again -- the green box, irregular shape there, was the area modeled by MDEQ. And is that your understanding?
A I thought that the red line, which is in the center, is the outline of the surface and backfill facilities and that the green line is the MDEQ modeling and the purple was the --
Q Oh, I'm sorry. I'm referring to the red box.
A The purple box?
Q The purple box.
A There we go. Okay.
Q Purple, red, yes, I -- yeah, the purple box is the area of the deposition modeling performed by CRA. Okay?
A Okay. Good.
Q And here's my question: First of all, do you know where the Huron Mountain Club is located?
A Vaguely. I know it's north of the facility.
Q And from your air permitting work that you just testified to, are you able to tell us how much copper or nickel or any

other metals that come out of the vent raise are deposited, for instance, on the lands of the Huron Mountain Club?
A No.
Q Are you able, from your air permitting work, to tell us how much particulate matter would be deposited in the Salmon Trout River?
A No.
Q Are you able to tell us anything about particulate matter and the amounts and locations of that particulate matter -- are you able to tell us anything about, based on your work done in connection with air permitting?
A No.
Q I want to turn to -- well, before we leave this subject, you testified that deposition modeling is not part of the air permitting process; is that correct?
A Yes.
Q And what's your understanding as to why that's not typically a part of the process?
A Well, in the states that I've prepared permit applications, there have never been deposition in any of those scopes. Typically states are rather formulaic in their expectations of what an air permit application needs to include. The relationship between emissions and deposition has to be evaluated with a model, and it's an area that is beyond the scope of general state air permitting agencies.

Q And just so I understand this, when you're preparing an air permit and you're doing your emission calculations, I mean, the primary concern is the levels of pollutants in the air in the facility and in the immediate vicinity of the facility to protect human health and the people working there; correct? I mean, is that one of your primary concerns in preparing an air permit application?

A Well, I think that the air permit focuses on public health. That's why the evaluation is done at publicly accessible areas, which would not be inside the fence line; it would be outside. The governing regulations inside the fence line are the OSHA or Mining Safety & Health rules. So it's really outside the arena of environmental protection.

Q Okay. Do any of the calculations that you performed for this project -- do they establish contaminant levels in the air within the facility fence line?

A The dispersion model may include concentrations at the fence line. I would have to check the output for that. It would -- I think it would typically be higher levels of concentration within the fence line; not all the time, but it's generally close to the facility because that's where the emissions are taking place.

Q Okay. I want to talk a little bit about the MVAR stack that you testified about. Now, as I understand it, when the air permit application you originally submitted to MDEQ -- that

application did not contain any filter for the MVAR stack; correct?
A That's correct.
Q It was -- the initial application, it was described as an uncontrolled emission; correct?
A Yes.
Q And in the original application, as I think you've testified, there was -- you calculated a potential to emit of about 20 tons per year?
A From the MVAR, yes.
Q From the MVAR stack; is that correct?
A That's right.
Q And that included over six tons of PM10; is that correct?
A That sounds correct, yes.
Q I think what I wrote down was 6.65 tons of PM10. Does that sound right?
A That does sound right, yes.
Q And these emissions from the MVAR stack include -- I mean, it's particulate matter; correct?
A Yes.
Q And that particulate matter includes copper; right?
A (No verbal response)
Q It includes nickel; is that right?
A Yes.
Q It includes sulfides?

A Yes, it would.
Q It includes arsenic?
A Yes.
Q And it includes cobalt?
A Oh, yes.
Q And manganese?
A Yes.
Q And incidentally, is nickel a carcinogen?
A I think I don't know.
MR. KOHL: I'll object; lack of foundation.
MR. STAPLETON: Well, I'm just asking her if she knows, Judge.
JUDGE PATTERSON: She said she didn't know.
A I don't know.
Q You don't know. In your air permit calculations was nickel -- nickel emissions, were they treated any differently in terms of how you calculated the emissions than any of the other metals that you modeled?
A No.
Q Now, the permit that was finally issued contained emission limits for the MVAR stack; correct?
A Yes, it did.
Q And it also -- the permit contains record-keeping requirements for those stack emissions; correct?
A Yes.

Q Now, prior to the final application being issued, there was a draft permit issued by MDEQ; correct?
A Yes.
Q And at the time that the draft permit was issued, Kennecott opposed any permit limits on the MVAR stack; correct?
A I don't remember the details. Having a permit limit on a ventilation stack is unusual.
Q Okay. You don't recall Jon Cherry writing a letter to MDEQ, specifically in opposition to having any permit limits on this MVAR stack whatsoever?
A I don't recall. I wouldn't be surprised if a correspondence like that took place.
Q Would you be surprised if you, yourself, submitted this correspondence to MDEQ?
A I would be surprised, because I don't think I personally corresponded or signed any letters that went in to the MDEQ for Kennecott. I certainly had emails back and forth, but formal submittals were signed by Mr. Cherry.
MR. STAPLETON: For the record I'm putting on the screen -- this is Kennecott Exhibit 401, which is a table of contents of the administrative record for the air permit. And this is tab number 85 from that exhibit.
Q Ms. Martin, can you describe this exhibit for us, please?
A This appears to be an email from me to Mark Mitchell with an attachment on it.

Q All right. And this email is dated June 14, 2006; is that right?
A That appears to be true.
Q And you're attaching comments to the referenced permit-to-install draft?
A That appears to be true.
Q And these are comments from Kennecott; right?
A Correct.
Q Now, the attachment was a letter to Mr. Mitchell from Kennecott; correct?
A Yes.
Q And these were comments that Kennecott had with respect to the draft permit; correct?
A It appears to be so.
Q And does this refresh your recollection that this letter was written by Jon Cherry from Kennecott?
A Yes, probably with some assistance from Foth.
Q Okay. Now, I want to focus on the comments in the letter related to the vent raise. And the first paragraph, do you see that up there?
A Yes.
Q These are comments that relate to the conditions imposed by MDEQ in the draft permit; correct?
A Yes.
Q And I'll just read the first part of paragraph one. "KEMC

notes that the ventilation stack for the mine is not a process stack and should not be permitted as such." Now, that relates to what you were -- your previous testimony that you were saying frequently these types of stacks do not have permit limits; is that right?
A   Can you just read through this letter? Because I vaguely remember there being an issue, but I thought that it was not from the permit limits but from the testing.
Q   Okay. Well, let's just keep reading, then. And I'll read from the last --
MR. KOHL: Well, are you refreshing her recollection with this?
MR. STAPLETON: I'm attempting to.
MR. KOHL: Well, then let her read the letter and then she can refresh her recollection or tell you it's not refreshed.
MR. STAPLETON: I thought she testified that her recollection had been refreshed. But if not, that's fine.
Q   I want you to take your time to read it.
A   Well, you know, I'm -- okay.
MR. KOHL: Your Honor, I think the witness should be afforded the opportunity to read through the whole letter --
JUDGE PATTERSON: Oh, I agree.
MR. STAPLETON: Yeah. And that's fine.

MR. KOHL: -- before having to respond to questions.

MR. STAPLETON: I have a copy, Judge, of the letter, if Ms. Martin would like to read through it.

THE WITNESS: I would.

JUDGE PATTERSON: Would you be more comfortable with that?

THE WITNESS: Yes, thank you. Thank you very much.

MR. STAPLETON: Sure.

(Witness reviews exhibit)

MR. REICHEL: Excuse me, Counsel. Just to clarify something on the record, I believe when you put this up you referred to this as a Kennecott exhibit? Is that -- what number did you say this was?

MR. STAPLETON: 401.

MR. REICHEL: I'm sorry, just so I'm clear on this, I believe you also said something about it being from the administrative record?

MR. STAPLETON: Right.

MR. REICHEL: So I think the record should be clear.

MR. STAPLETON: It's not crystal clear. My understanding is that the table of contents for the air administrative record was identified as an exhibit. And what -- in terms of just trying to identify what we're talking about, in that table of contents it listed several hundred entries. This is tab entry number 85 from that list.

MR. KOHL: But it's not been separately identified as an exhibit by us; correct?

MR. STAPLETON: My understanding is that it was your proposed exhibit 401.

MR. KOHL: Exhibit 401 is the index.

MR. STAPLETON: As an index. And that's essentially what this --

MR. KOHL: No, the index is different than the letter.

MR. STAPLETON: I understand; I understand. And I tried to make that clear; that --

MR. KOHL: You didn't identify this letter as an exhibit?

MR. STAPLETON: No, I did not. I was -- I was attempting to identify the table of contents as an exhibit and that this was one of the entries in the table of contents.

MR. REICHEL: And I think so this record is clear, Counsel, when you're referring to the administrative record, I assume that you're referring to the administrative record that was filed in a separate proceeding in Ingham County

Circuit Court in which the petitioners are challenging the issuance of the air permit itself; is that correct?

MR. STAPLETON: That's correct.

JUDGE PATTERSON: That's what I assumed.

MR. REICHEL: Okay. Just wanted --

JUDGE PATTERSON: Thank you for clarifying that.

MR. STAPLETON: And that's fine, yeah.

MR. KOHL: That's what I assumed too.

MR. STAPLETON: Yes, that's correct.

MR. KOHL: This document has not been identified as an exhibit in this proceeding?

MR. STAPLETON: This document has not been identified as an exhibit in this proceeding, but the table of contents --

JUDGE PATTERSON: I think it's about to be.

MR. KOHL: It may be. And if he's going to do that, then he needs to mark it if he wants to introduce it. On the other hand, if he wants to simply refresh her recollection of the letter and it works, well, that's fine too.

MR. STAPLETON: And just to be clear, Judge, the exhibit reference was to the table of contents, not the actual letter.

Q Ms. Martin have you had a chance to review the letter?

A Yes, I have.

Q And in this first paragraph, I mean, Mr. Cherry is expressing his opposition to having any permit limitations imposed on the MVAR stack?
A Yes.
Q He is?
A Yes.
Q Okay. And so Mr. Cherry, when he first received this draft permit application, he wanted the emissions from the MVAR to be completely uncontrolled and completely unregulated; correct?
A I would not characterize that.
Q Well, there were no -- he's wanting no permit limits whatsoever on this MVAR stack; correct?

MR. KOHL: Well, I'll object. The letter -- I mean, he's trying to refresh the witness' recollection, but on the other hand he's trying to testify as to what the letter says. The letter says "KEMC is not opposed to testing MVAR's," indicated in paragraph 9.3, apparently, of the draft permit. So either he wants to put in the letter as an exhibit and let it speak for itself, or he wants to ask this witness is and see what her recollection is. You can't do both.

MR. STAPLETON: Well, your Honor, I'll move for the admission of the exhibit, which I was intending to do. And I'll move for it as Petitioner's Exhibit. And I don't have -- it would be proposed Petitioner's Exhibit Number 160.

MR. KOHL: And do you have copies for all of us?

Q So, Ms. Martin, returning to Mr. Cherry's objections to any permit limitations on the stack, --

A Yes.

Q -- he didn't want there to be any control or limitation on what Kennecott could emit through the stack?

A The letter does state that it was thought inappropriate to apply an emission limit on this stack.

Q And you calculated a potential to emit of -- I believe it was 20 tons per year?

A Yes.

Q With an estimated P.M. emission of about 8.2 tons per year? Does that sound about right?

A That last part was -- it was 20 tons per year of particulate matter and 6.65 tons of P.M. 10? Is that what you meant to say?

Q It was 6.65 for PM10?

A PM10, yes.

Q And so if the emissions were uncontrolled and unregulated as Mr. Cherry wanted, there would have been tons and tons of particulate matter emitted from the stack and deposited over a wide ranging area of this mine; correct?

A There would; however, the analysis made for allowing a

facility to emit pollutants is not done on that basis; it's done on whether you maintain *(3:41:08) at the fence line and whether you are able to comply with the various other rules of the permit.
Q And that gets back to what you were saying before, which is, when you're doing an air permit, you don't really consider yourself with the deposition of the particulate matter that comes from the stack?
A To obtain an air permit? That's correct.
Q That's correct. Okay. And that apparently wasn't Mr. Cherry's concern?
A Well, he was concerned about obtaining an air permit, so one would think --
Q Right. But he wasn't concerned about the particulate matter that would be deposited on the Huron Mountain Club, in the Salmon Trout River, in the Yellow Dog River over the Yellow Dog Plains? He wasn't concerned about that, was he?
A Whether there was a need for concern is another subject to explore.
Q Well, he certainly didn't seem concerned based on what he wrote in this letter that we're looking at; correct?
A Based on the letter, that may be true.
Q Do you know how far this stack is located from the Salmon Trout River?
A The stack is fairly close. I think some of our maps may

show in feet. I don't remember the number offhand.
Q Does 300 feet sound about right?
A That sounds all right.
Q And when you prepared this application, I'm assuming you knew that this stack was located 300 feet from the Salmon Trout River?
A Yes.
Q Have you ever been to the Salmon Trout River?
A I have not.
Q Do you know anybody about it at all?
A Not beyond it being a body of water that flows.
Q Do you know what kind of trout are found in the stream or anything like that? No?
A No.
Q You testified that the emissions from the MVAR would have a fabric filter device; correct?
A Yes.
Q And I want to talk about that a little bit. First of all, the stack that we're talking about is -- has a 14-foot diameter; correct?
A Yes.
Q Now, I'm just a lawyer; I'm not an air person. That seems to me like a pretty large stack opening.
A It is.
Q It is. Okay. And this -- through this opening there is

427,000 cubic feet per minute of air?
A Yes.
Q Is that correct?
A It is.
Q Now, once again, that seems like a lot of air passing through a stack in a minute. Is it?
A Relatively speaking.
Q Okay. Do you recall when the issue of a filter on the MVAR first came to your attention?
A I certainly don't remember the date. I can approximate it must have been in 2007.
Q Okay. Do you recall having any discussions with MDEQ about a proposed fabric filter on the stack back in 2006?
A I wouldn't preclude that that had happened. I don't particularly recall. I would say that we had proven with our application that a filter was not needed to comply with the air permit regulations.
Q Do you recall a meeting with MDEQ to discuss the air permit application on March 24, 2006?
A That sounds about right.
Q Do you recall at that meeting if there was any discussion of the fabric filter for the MVAR said?
A I don't recall specifically. It seems that that would not have been a topic of discussion, but it certainly may have been. I just don't recall.

Q Do you recall anyone from the MDEQ stating to you anything about whether this MVAR should have a fabric filter?
A No, I don't remember something like that.
Q So your recollection is that the first you learned about this was in 2007?
A I would say when we began seriously discussing it as something to explore, it would have happened in 2007.
Q And who did you begin seriously discussing it with?
A Well, it would have been with Kennecott. It was obviously something that they would have needed to purchase and agree that it was needed. As I said before, the air permit didn't require there to be a filter. At last fall's public comments, it seemed like at that point the public concern about deposition had apparently persuaded Kennecott to seriously consider having the filter, and this is where, you know, apparently we've arrived at.
Q Did it persuade Kennecott or the MDEQ?
A Oh, I -- my understanding was that it was Kennecott. In fact, I think it may have appeared in the public comment letter that was provided to MDEQ last October.
Q Do you recall any discussions with Jon Cherry in which he opposed the installation of a fabric filter on the MVAR stack?
A I don't remember opposition from him. I think it was a serious consideration for him because it does represent

capital and operating cost.
Q And these filters are quite expensive, aren't they?
A I -- it's a large filter, so it costs more money than a small filter.
Q Okay. And this -- once again, this fabric filter covers a 14-foot diameter opening; is that right?
A Yes.
Q And these filters just to purchase them can be over $1 million; do you understand that?
A You know, to tell you the truth, I have not been involved in pursuing specifications of the filter. So I've seen some different options on filters, but I can't speak to, really, the details of construction beyond that.
Q Okay. And are those options that the MDEQ prepared?
A Oh, no. This would be, you know, the owner working with viable vendors.
Q Okay. And have you seen options for this fabric filter on paper somewhere?
A I have seen conceptual designs but nothing detailed only because I haven't -- I am not, you know, part of that process of purchasing.
Q And, I mean, operating expenses for these filters can be in excess of $1 million a year; correct?
A I don't know.
Q Okay. Did you ever submit any specifications for this MVAR

filter with the application?
A No.
Q And you talked before about another fabric filter in connection with -- it might have been the crusher bag house?
A Oh, yes.
Q And did your permit application include specifications for that filter?
A I think we had a manufacturer's specification for that bag house, yes.
Q And is that pretty typical with an air permit application to include specifications for control devices?
A I think it would be for off-the-shelf items. It's easily available. A lot of that is downloadable or when you obtain a quote from a vendor, they'll go ahead and send you specifications because they're all ready to go and, you know, you can pursue purchasing. For the MVAR filter, it's not an off-the-shelf item.
Q It's not an off-the-shelf item?
A Correct.
Q Okay. Is it a filter that would have to be specifically manufactured for this facility?
A I would say "assembled" is a better word. Many of these pieces of equipment are modular, so depending on the needs of the client, you know, many of these manufacturers will just manufacturer modules and then add to them. So you have

sort of a standard kind of an assembly, and then you just put them in series or put them in parallel, and you effectively take care of the capacity that's for your client.
Q Do you have any experience in ever seeing a fabric filter of this size installed in a mine anywhere?
A No, I don't think there's another example like that. However, there are large fabric filters on large air flows in other industries.
Q And I just want to be clear on this point: Do you know whether a particular fabric filter has been chosen by Kennecott for this MVAR stack as of today?
A I don't know.
Q And are you providing any consulting services to Kennecott with respect to identifying that fabric filter for this facility?
A No.
Q Is anyone at Foth providing those consulting services?
A No.
Q Now, you've had -- you testified a little bit about the filter for the crushing building bag house?
A Yes.
Q And this filter for the MVAR would operate similarly to the crusher building bag house filter?
A Only in the sense that air is flowing through fabric which

catches the particulate matter. And beyond that, I don't know.
Q Okay. So you would have fabric covering the opening, the 14-foot diameter opening; correct?
A I don't know whether that would be the case. I can't tell you what the -- what the structure of the stack is. I don't know.
Q Okay. Do you know what the -- what size particulate the filter would be capable of filtering?
A Well, generally they have a fairly efficiencies to rather low -- or rather low diameter sizes. It's, you know, less than PM10. I think typically they'll quote, you know, a percentage efficiency on PM2. I'm really not fluent in those numbers, but I do know it's a fairly small particulate size they filter up to.
Q But you don't know anything specific for this facility?
A I do not, no.
Q And can this fabric rip or tear?
A They have been known to rip and tear, yes.
Q And what happens when that occurs? Does the whole fabric need to be replaced and the facility shut down or how does that work?
A Well, depending on whether you have cartridges or bags, those -- you know, a rip would only happen in one of those. So in accordance with the manufacturer's, you know,

instrumentation if there's any supplied and your own malfunction abatement program, you could identify a malfunction in the filter or the bags or the cartridges, whatever it is. And then you go and inspect and explore to find the, you know, item that's not functioning correctly, and you can go ahead and replace it. That is just one scenario that, you know, could happen.

Q Do you have any sense of how much particulate matter would have to be filtered out per hour for this MVAR stack to achieve 85 percent efficiency?

A Well, the 85 percent efficiency is a rather conservative number. Generally bag houses or bin vents, fabric filters have upward of 95, 99 percent kind of efficiencies. So the way these bag houses work -- and I don't know whether the MVAR filter does too; I assume it could be -- is that you have a pulsing. So you'll have a -- you know, you'll have particulate matter that comes onto the filter, and, in fact, you know, having a buildup of material actually increases your filtering efficiency. And then when those -- that filter media gets a little too full, the instrumentation sense it, and you will get a pulsing so that you would have a shot of air that pushes through and empties some of that particulate matter on the bags that's collected. So you can collect that particulate matter and dispose of it accordingly. And then that maintains the viability of that

bag until it tears or is in need of replacement.
Q And just returning to my question, do you have any sense for this facility, how many pounds of particulate per hour would be filtered by this fabric filter?
A Well, if you look at the uncontrolled calculations, that had an emission rate of about 4.6 pounds per hour. And then when we put the 85 percent control for the filter on, it brought it down to .7 pounds per hour. So I would assume then that approximately 4.6 pounds per hour of particulate matter were coming up to meet the, you know, inlet of this filter.
Q Okay. And how often would you have to maintain a filter like this?
A Well, I think you would be washing it very frequently. It is a permitted piece of equipment; therefore, it's in everybody's best interests to keep it maintained and operable. The way -- certainly in the malfunction abatement plan, which hasn't been written yet, you would attend to that, so you'd want to have preventative maintenance to, you know, maintain its operability to, you know the most efficient level, and then be watching for the opportunity, then, when, you know, more or deeper maintenance is needed.
Q Can these filters clog with too much particulate matter?
A They can.
Q And what happens when a clogging occurs?

A Well, then you would have an indication that there is something wrong, and then you'd go to your malfunction abatement plan and go investigate it and address the issue.
Q And have you been involved at all in preparing the malfunction abatement plan?
A Not for this project. I have done so on other projects.
Q Has a malfunction abatement plan been prepared yet for this mine; do you know?
A No, it has not.
Q And do you know if you will be the one preparing that plan?
A I may.
Q I want to turn to the subject of the modeling, the dispersion modeling that was done for this permit.
A Sure.
Q And as I understand it, you do computer dispersion modeling to predict air contaminant emissions for certain criteria pollutants outside the fence line.
A It would be ambient air concentrations of pollutants.
Q Ambient air. Okay. And what are the criteria pollutants?
A Nitrogen oxide, sulfur dioxide, PM10, volatile organic compounds and lead is -- is lead sometimes -- I don't think lead is part of the criteria pollutants on our project. Sometimes it can be said lead is in there.
Q And when you run the model, that yields a particular concentration of the pollutant; correct?

A Yes.

Q And you, as I understand it, take the highest level of concentration detected by the model, and then you compare that against various standards, one being the national ambient air quality standard; correct?

A Yes.

Q And the other standard being the prevention of significant deterioration standard?

A We compare the increment, allowable increment, whether we've --

Q The increment under the PSD standard?

A Yes; right.

Q And just so I -- and I'm not sure I do, but I think I understand this PSD increment. This is the amount of a criteria pollutant, an incremental amount, that a facility is allowed to emit from its -- from the facility; correct?

A Right. You'd need to compare what you have allowed, so in an area you have allowed an increment, a number, say, 25. And then you're allowed to go up to -- in our case, 80 percent of that number is Michigan's rule.

Q Okay. That's Michigan's rule?

A Yes, that's what I understand.

Q Is that for PM10?

A I assume so, but I don't know offhand. I think so.

Q And what is the purpose of a PSD standard?

A Well, I think it's a way to allow several businesses to locate in an area and, you know, fairly allow them to not impact each other. You know, if someone comes in and they have very high emissions and they eat up all the increment, then the next business, you know, can't come in and plan a facility because somebody else is eating up the increment. So I think it's a way to maintain air quality in an area and still allow for businesses to locate in an area and not compete against each other in this tiny arena.
Q And I think you testified before that you're measuring concentration offsite -- correct? -- or outside the fence line?
A Publically accessible areas, which would be outside the fence line, yes.
Q And so part of the reason for the PSD standard is to protect public health; correct?
A Yes.
Q And does that include protection of national wilderness areas?
A I would say so, yes.
Q You mentioned the Michigan standard for PSD for PM10, and that -- as I understand it, the max increment is 30 micrograms per cubic meter; correct?
A I don't know offhand. It sounds like it's right.
Q And 80 percent -- in Michigan any given facility is not

allowed to emit more than 80 percent of that standard; correct?
A That's my understanding, yes.
Q And 80 percent of the 30 is 24; correct?
A Yes.
Q So when you did your modeling for PM10 emissions, 24 is the standard that you were looking at?
A I think so. I would have to check that that's the case as presented in our air quality impact analysis.
Q Now, assuming that the number is 24, if you run a dispersion model that yields a number that is over 24, you don't get an air permit; right?
A No. I'm not sure you would go down that road. I think you would look at where you can reduce your emissions and iterate into a place that you can demonstrate fulfills that requirement.
Q Okay. But if you couldn't reduce emissions and your fence line stayed the same and you have a PSD number that's over 24 either at the fence line or outside fence line and that doesn't change, you're not going to get a permit from the State of Michigan, are you?
A Well --
MR. KOHL: I'll object. Is he asking her as a matter of legal authority whether or not if you exceed MDEQ's guidance of not consuming more than 80 percent of the

increment wouldn't get a permit from MDEQ? Or is he asking her based upon her experience with MDEQ? I'm not sure what the foundation is for the question.

MR. STAPLETON: Well, I mean, she's testified that she's handled, you know, many air permit applications and has dealt with --

MR. KOHL: But you're asking her Michigan's here.

MR. STAPLETON: And has dealt with -- has dealt with -- has dealt with the MDEQ for this particular permit. And I'm asking her if she knows that if you had a PSD concentration above 24 that was not changed in some way, whether MDEQ would issue an air permit.

MR. KOHL: Let's be very careful of our terminology because we're throwing around different things. We're throwing around national ambient air quality standards which are distinct from PSD increments.

MR. STAPLETON: I'm not talking about that. I'm talking about PSD increment only for PM10.

MR. KOHL: All right.

Q Do you know?

A I would expect that they -- if all those things were true, then one would not expect an air permit because it is outside of the criteria evaluation.

Q It's over the limit; right?

A If it were --

Q Michigan's limit.
A Well, if that were the case, then that's my understanding.
Q Now, when you're going dispersion modeling -- and let's talk specifically about the mine and for PM10 -- you are considering all of the sources for PM10 at the mine; correct?
A Yes.
Q I mean, all of that information is plugged into the model?
A Oh, yes.
Q All of the sources?
A Yes.
Q Okay. And you are trying to create with your modeling a worst-case scenario essentially?
A Yes.
Q For maximum PM10 emissions?
A Right.
Q Do you know what the largest source of PM10 emissions is from the mine?
A PM10 source?
Q Yeah, PM10 source.
A Well, main ventilation air raise has the largest -- well, wait a minute. Let me look at my summary here. Controlled or uncontrolled? What would you like?
Q Controlled.
A So the exhibit that was presented today shows that fugitive

emissions have approximately 3.4 tons per year, and that category appears to be the largest PM10 contributor.
Q Fugitive emissions?
A Yes. That's my reading of this chart.
Q Okay. And does that include PM10 emissions from vehicle traffic aboveground?
A Yes.
Q Okay. And is the vehicle traffic the largest source among the fugitive sources for PM10?
A Well, let's see. By my summary, it appears that storage piles at 1.15 tons per year -- let me see if I've got that -- yeah, that looks like it's the right line here. Storage piles are shown at 1.15 tons per year of PM10, and that appears on the page entitled "Potential to Emit Summary With the Filter Control," yes.
Q Okay. Thank you. Does your sheet there show the PM10 emissions from road surfaces aboveground?
A It -- where is that how? Vehicle travel, yes. Here we go. Aboveground vehicle travel?
Q Right.
A 1.04 tons per year of PM10 is what is shown here.
Q And that is generated as a result of vehicles traveling back and forth over the road?
A Yes.
Q Now, the modeling that you do for PSD includes placing

various receptors at and outside the fence line that fan out for some distance; is that --
A In a grid formation?
Q Am I essentially right about that?
A Yes, in a certain distance away; yes.
Q And is the concentration of PM10 measured at each receptor?
A Yes.
Q And you need all of the receptors to be under 24 -- or at 24 or under to meet the Michigan standard for PM10?
A I think that's the case. Again, I'd want to look at the text in that air quality impact analysis report for further clarification.
Q Okay. Did you -- how many times did you run dispersion modeling for the -- to determine the PSD increment? Do you know how many time Foth ran the modeling?
A Well, in what regard?
Q Well, I guess my question is, you have input data for the model and you enter that data, and then you -- and then that yields results; correct?
A Yes.
Q And I'm wondering how many times did Foth engage in that process of inputting data into the model and having it yield results?
A I could not tell you a number; however, it's an iterative process, so, you know, as you run the model and you identify

a receptor that may be above what you want it to be, you look at the source of that contaminant that could be affecting that receptor and address it, you know, whether that may be an extra spray bar, extra watering, pulling out the fence line, there's a number of methods to address that. So there must have been a number of iterations, and I don't know how many that would be.
Q Okay. You didn't do the modeling directly; right?
A Correct.
Q Were you aware that the first time that Foth performed dispersion modeling for this mine that it yielded a PSD number of around 30?
A I don't particularly recall that event if it took place.
Q Do you know if -- any of the modeling that performed for the PSD increment, do you know if any of those modeling exercises yielded a PSD number over 24 for PM10?
A I don't recall offhand. I think the application, the report speaks to the final results which is really what counts.
Q Do you recall Kennecott having to move its fence line in order to achieve the PSD increment standard for PM10?
A I remember moving the fence line, not in a significant way, but I don't recall the contaminant which motivated us to do so.
Q If you're moving the fence line, it means that you got a hit over 24 -- correct? -- for PM10?

MR. KOHL: Objection.

Q If you're talking about --

MR. KOHL: She just testified that she didn't recall whether it was PM10. Furthermore, are we trying the air permit in here or whether or not this facility meets PSD increment, or are we dealing with issues under 632 and Part 31?

MR. STAPLETON: Judge --

MR. KOHL: I'm not sure what the relevance is of this line of questioning.

MR. STAPLETON: Judge, they completely opened the door on this. I mean, there were questions about PSD increment. There were questions about --

MR. KOHL: I didn't ask her a single question about PSD increment.

MR. STAPLETON: No, that's not true. Yes, you did. And there were questions about PSD modeling. This is all part of their case that they're putting on, and I'm entitled to ask her questions about it.

MR. KOHL: I didn't ask a single question on direct about PSD increment.

MR. STAPLETON: That's just not true.

MR. KOHL: Well, it's true. I asked if it was a major source under PSD.

JUDGE PATTERSON: I frankly don't recall. I'll

overrule the objection, and we'll proceed.
Q Okay. We were talking about moving the fence line back.
A Uh-huh (affirmative).
Q Let me give you an example. Let's say you're modeling for PM10 and it yields a PSD number at the fence line of 28. That's over the 24 standard; right?
A Yes.
Q Okay. So in order to try to meet the standard of 24, you just move the fence line; correct? Because the concentrations decrease as you move away from the facility.
A Well, that's one way you could solve the problem. There may be other ways to do so, and it's -- the modeling -- that's how you do modeling. That's how it's done. That's now I've seen it done in the air permits that I've prepared whether it be modeled by Foth or modeled by the regulatory agency, which sometimes occurs.
Q And is that -- do you know if that was the way it was done in this case, moving the fence line back to meet the 24 number?
A I think -- well, I think that the fence line was moved. I don't recall which contaminant it was moved for, but I think at one point we had some fence line moves.
Q Okay. And moving the fence -- just so we're clear, moving fence line doesn't change the concentrations of PM10 in the air; right?

A No, that's correct.
Q You just moving the boundary?
A Public access; that's correct.
Q The public access?
A Right.
Q And do you know how many times the fence line had to be changed in this case to meet the PSD standard?
A I don't recall even the number of times the fence line was moved, much less whether it be for a PSD increment.
Q But do you know if it was more than once?
A I don't know if it was more than once.
Q Mr. Martin, I think you testified previously about preparing -- did you call it an air quality analysis?
A I think this is termed "air quality impact analysis."
Q Air quality impact analysis.
A Uh-huh (affirmative).
Q And is that Appendix E to the application?
A That sounds correct.
Q Okay. And this is -- what I'm putting on the screen is a part of Appendix E, the air quality impact analysis. Do you recognize it?
A I do.
Q Okay. And can you just briefly explain what Table 5.1 indicates?
A Well, we're looking at the criteria pollutants, so PM10,

NO2, SO2 and carbon monoxide -- oh, carbon monoxide's up there too, yup, and lead for criteria pollutants. And we look at -- okay -- maximum predicted ambient concentrations from the modeling studies. So the output of a model then is -- appears in maximum concentration, the column there, the second from the right. Those are the results then the points of where maximum concentration occurs, and those are identified there in the xy receptor coordinates. That looks like 2004 meteorology was used. And you can see the averaging period there, that second column from the left also is called out because the thresholds that you're looking at then pertain to the averaging period. So the very far right column then is the NAAQS standard, and then you can compare those two adjacent columns there for showing whether you meet the NAAQS or not.
Q Okay. And I want to focus on the PM10, and the number that you use as a 24-hour average number, is that applicable result?
A Well, there appears to be two averaging periods for PM10 annual and 24-hour averages.
Q But for the -- to meet the 24 standard, you run the model using the 24 average number; correct?
A Right. Well, I mean, we run them both and we compare them both and --
Q Right. But you use the 24-hour average number?

A Yeah. This is the NAAQS standard, yes.
Q Okay. And the modeling yielded a PSD increment number for PM10 of 22.69; is that right?
A Well, it appears to have produced a maximum concentration of 22.69 micrograms per meter cubed.
Q All right. And do you know which model run yielded this number?
A I don't. I have no idea. The last one, I guess.
Q You would assume it would be the last one?
A Well, that's typically how it happens. You meet the needed, and then you move on.
Q And then you move on. Okay. Now, this PSD increment number is based on certain assumptions of that --
MR. KOHL: Objection. You've mischaracterized that exhibit. It's a NAAQS value, not an increment. It's an ambient air quality standard, not a PSD increment.
Q Okay. The maximum concentration of 22.69 for PM10 that was calculated by the model?
A Yes.
Q Okay. In order to calculate that number you made certain assumptions in terms of the PM10 emissions from the facility; correct?
A Correct.
Q Okay. And I think you state here it reads, "Among the more significant controls assumed for this analysis are the

following." Is that correct?
A That's what it says.
Q Okay. And you list here, as I understand it, various sources of PM10 at the mine; correct?
A Yes. That looks like what that is.
Q And then you also identify a control in percentage terms that you applied for these emissions; correct?
A Yes.
Q And these control rates were part of -- they were all part of the data that you submitted in order to do the modeling; correct?
A They were incorporated into the emissions calculations and produced the emission rates that then were inputted in for modeling.
Q So the emission rates -- like if you assumed a 90 percent control for a particular source, you would input the emission with a 90 percent control -- assuming a 90 percent control?
A Right. And that would be detailed then in the calculations of Appendix C.
Q All right. I want to look at the first one here.

"Certain ore processing volume sources such as the coarse ore bins or the crushed ore bins are partially enclosed. It is assumed these enclosures will result in 90 percent capture of particulate matter emissions."

You might have testified -- I think you touched on this earlier in your testimony -- that, now, these are partially enclosed bins; correct?
A Well, they're in a structure that's partially enclosed.
Q A structure that's partially enclosed. And that structure is -- has four sides to it, does it? I mean, it's rectangular or square?
A Right. And then that fourth side is a curtain or something that a vehicle can move in and out of.
Q Okay. So it's not fully enclosed. There's -- one side of it is open?
A Well, with a curtain.
Q With a curtain. Okay. And you assumed a 90 percent capture; correct?
A Yes.
Q And is that based on any particular standard that you referenced?
A Well, there's not a lot of reference guidance on that, so that, you know, could be a subjective judgment.
Q Okay. And so what you're saying is, when this ore processing occurs for the coarse ore bins and the crushed ore bins, that 90 percent of all the fugitive emissions are going to be controlled and not emitted; right?
A Right.
Q And would you call that a conservative assumption?

A I would say so, yes.
Q Is it possible -- I mean, when you're modeling, you're trying to use worst-case scenario numbers; correct?
A Yes.
Q Okay. Is it possible that in this activity of ore processing that, you know, 75 percent control might be -- might occur on any given day?
A Possible is the key word there. I think that a structure is actually a passive device. It should perform fairly consistently from day to day. So I would say that the efficiency of capture should be fairly consistent.
Q Now, just so we're clear, this is a structure that hasn't been built yet; right?
A Right.
Q So you haven't seen this structure?
A No.
Q You've just seen what -- have you seen a diagram of it? Sketch?
A I've seen structures. I've seen structures before.
Q You've seen structures similar to this?
A Of four sides, roof, door.
Q Have you seen any design for this particular structure for this mine?
A I've seen some conceptual designs, yes.
Q Okay. Now, if you have a, you know, particularly windy day,

you know, is it possible that you wouldn't have 90 percent control in the ore processing?
A Perhaps if the wind was coming at the right angle to the curtain and a vehicle moved in at that time with a wind gust, there could be all sorts of --
Q Okay. And if you're assuming -- if this number 90 percent changed to 75 percent, say, the PM10 concentration yielded by the model would increase; correct? As the controls decrease, the PM10 number increases?
A Yes.
Q Is that correct?
A It could increase, yes.
Q If it's possible that only 75 percent of the particulate -- of the PM10 emissions from these -- from the ore processing would be captured, wouldn't that be the worst-case scenario for this activity?
A If you thought that were the case --
Q It's certainly possible.
A -- then I -- you know, that individual could proceed on that premise. I didn't think that was the case. I thought that 90 percent was a conservative and realistic value, and that's why it appears in here.
Q Okay. And I guess you've testified that it's conservative, and I guess my question is, is it worst-case? Is it the worst-case scenario?

A Well, I'm not sure anybody can answer that question.
Q Now, you've described here a number of other activities that yield fugitive dust; correct?
A Yes.
Q Okay. Now, once again, down here when you talk about the transfer of aggregate to the feed hopper as being partially enclosed and once again, you have a 90 percent control?
A I'm consistent, yes.
Q Okay. And, in fact, let's just go down the list here, 90 percent control for this (indicating), for the underground transfer of ore through the grizzly, 90 percent control for the current fly ash transfer and mixing operations you assume 95 percent control. The cement and fly ash silos with vent controls you assume 99 percent control. Of the unloading of aggregate at the storage pad, you assume 90 percent control. And particulate emissions from the roads you assume 90 percent control?
A Yes.
Q Correct?
A Yes.
Q And, you know, I'm just a lawyer, and I'm not an air person, but these numbers seem highly optimistic to me in a facility that has not yet been built that will have a number of fugitive emissions sources at the surface. Would you not agree that these numbers seem optimistic under that

scenario?

A I don't think "optimistic" is an appropriate term here. I think that the -- certainly the fabric filter vents on the silos at 99 percent is backed up with, you know, thousands of bin vents and specifications. So I don't think that's an optimistic number. The use of spray bars is -- there's a lot of spray bars out there on solids handling processes, and I think that the 90 percent may not appear in a reference, but for air pollution control, in that arena I think a 90 percent is a conservative value. There are spray bars in a lot of places. So we don't have to have the Eagle facility to get a feel for efficiencies on these operations. There's actually not a lot of unique operations at Eagle. It's a very ordinary kind of a permit application and permit. These are very common activities. And I think that the numbers don't need to be characterized as optimistic or not.

Q Let me ask you this: Do you know if the dispersion model was run with control rates less than 90 percent for any of these activities?

A I think that the control efficiencies are detailed in the calculations, and the inputs to the model would be from the calculations or a higher rate. The model may have been run at a higher emission rate than you see presented in the calculations only because of that iterative process.

Because if we show a passing of an evaluation from the model and we continue to adjust emission rates, we don't go back and remodel at a lower rate for the one that passed. We already know it passes. So, you know, in that respect, I think we've named efficiency rates here that we feel confident that we are going to achieve, and I think those rates appear in Appendix C calculations.

Q I want to focus on the road dust for a minute. And you assumed a control rate of 90 percent; correct?

A Yes.

Q And was that based on any particular standard that you reviewed?

A Well, road dust is a difficult emission to estimate sometimes because conditions for road dust just changes by location and conditions. So when you look at AP 42, Unpaved Road chapter, which is 13.2.2, they provide guidance and emission factors. And we walked through the vehicle emission calculations previously. You know, you estimate an emission factor, and then you apply a vehicle mile travel. But you can apply additional factors for your conditions. So for example, if you are, you know, adding a water control or a watering plan, then that provides you less dust, and you can claim a credit. If you have a location that is, you know, rainy, cold -- you know, the Upper Peninsula of Michigan is snow-covered for a large portion of the year, so

I feel quite comfortable in claiming a relatively high emission control efficiency on those vehicle travel. Additionally, this roadway is going to be managed. It's not just some public roadway that gets graded every couple of years. This is going to be a highly regulated surface. And I have confidence that the 90 percent is a conservative control efficiency to apply to those roadway emissions.
Q Now, the roadway is going to be watered; correct?
A Yes.
Q And the dust control -- the level of dust control is dependent on the amount of water put on the road in dusty times of the year?
A That's an influencer, yes.
Q And have you prepared any calculations with respect to the amount of water or the frequency with which water should be applied to these roads?
A Well, I'd point out that if you did a dust plan, which is part of the air permit, it does address roadway watering.
Q Does it have a specific watering schedule?
A It has a frequency mentioned in there. I think the text -- well, we could certainly go look at the text, but just from memory it says something like during dry times of the year the roadways need to be monitored, I'm saying every three hours I think is what it terms for the need for watering. So, you know, and that would be evaluated then on this

three-hour basis. And you would look at how sunny it is, how windy it is, how dry the roadway is now and whether you think the next three-hour period would need to have water applied to get to the next point of evaluation.
Q Are you familiar with the Handbook for Dust Control In Mining that is published by the Department of Health and Human Services and the Centers for Disease Control and Prevention?
A I have looked at that publication in the context of the exhibits.
Q Okay. Is this an authoritative reference?
A Well, you know, there's a lot of references out there, and what was the date on that one? I don't remember offhand.
Q 2003.
A Okay. There was another reference that was rather old. One of the issues about references is that -- you know, what are the data -- where did they draw their insights from? So historically there's been a lot of mines and unpaved roads on mine. And, you know, my judgment would be to look at, does that pertain to our facility. So I'm not familiar with the contents of that document, but on any document I would look at how it pertains to our facility and whether I had a better reference to use.
Q Are you familiar with the study referenced in this handbook as it relates to the frequency of water application and

control of fugitive dust?
A Not in particular, no.
Q Okay. You mentioned AP 42 as a reference that you used in preparing the air permit application; is that correct?
A Yes.
Q Is this handbook referenced in AP 42; do you know?
A I haven't come across it, so I don't know.
Q But AP 42 is a standard reference that you use in preparing air permit applications; correct?
A Yes.
Q Okay. I just want to bring your attention to the study I referenced earlier, and in this part of the report it's entitled "Water and Chemical Suppressants." And I'll just read the first couple sentences.

"Untreated plain water is commonly used for roadway dust control. The study by Rosbury and Zimmer showed that watering once per hour resulted in a control efficiency of about 40 percent. Doubling the application rate increased the control effectiveness by about 15 percent to 55 percent." Did I read that right?
A That's what I read, yes.
Q Okay. In your plan for fugitive dust control at this mine is to check the roads during dusty periods every three hours?

A Yes.
Q And you're not -- you're not stating that water should even be applied every three hours. You're just saying check the roads to see if it needs to be applied?
A Right.
Q Okay. And were you -- I can't recall what you testified to about this study. Did you say that you were aware of it or you're not?
A No, I was not familiar with this document.
Q For your prediction of 90 percent control, did you rely on any study like this in the handbook for dust control in mining?
A Well, we did explore the clearinghouse EPA Website which has facility information with control efficiencies for a large variety of emission sources. So we had -- you know, when you look at that database, you know, which is on the EPA Website, you can find, you know, several examples documented of roadway watering programs and dust suppression programs that obtain 90-plus percent of control efficiency. So we had --
Q Did you reference any of those studies in your air application permit?
A Well, we have -- I don't recall one of the later appendices of the permit to install application has some of those printouts. I don't recall whether vehicle emissions are in

there. We could certainly take a look at that appendix.
Q If you assumed a control efficiency -- and let's be optimistic based on this study -- of 55 percent for the road dust at the mine, do you know what the max concentration for PM10 would be under those circumstances?
A I don't think that's an appropriate control efficiency factor for that location.
Q No, I understand -- I understand you disagree with the control efficiency. What I'm saying is, assuming that you used that control efficiency, you used 55 percent, do you know what the maximum concentration of PM10 would be for this facility?
A I don't know what it would be.
Q Would you surprised to learn that it's 79?
A That could be.
Q Could be. And so the control rate that you assume here and not only for the roads but for all the other emissions, that's a very significant factor when you're calculating PM10 concentrations; correct?
A It would influence your results.
Q Now, when you ran the dispersion modeling --
MR. KOHL: Objection. She testified she didn't run the dispersion model.
MR. STAPLETON: I'm sorry.
Q When Foth ran the dispersion modeling that you reviewed --

correct? --
A Uh-huh; yes.
Q -- do you know what silt content that you assumed for the roadways?
A Yes. We assumed a one percent silt content.
Q Okay. And you had discussed a data sheet earlier that showed road silt content at 3 percent, and I think that was information provided by Golder. Do you recall that?
A Yes. Well, Golder had performed this native soil analysis, and they had determined that an average value of 3 percent silt content of the soils in that area was -- you know, was what they had returned on their data.
Q And why didn't you use 3 percent silt value in your model if that was what was recommended by Golder?
A Well, we are not -- we don't have a roadway of native soil. We have a roadway of prepared gravel with a lower silt content.
Q What's going to be used for the gravel?
A Well, there's a certain offsite aggregate that we would obtain to, you know, construct the roadway.
Q And do you think using 1 percent rather than 3 percent was conservative?
A I think that it was realistic. I mean, conservative as far as -- we could have used 100 percent and we would have called it conservative, but in this instance --

Q Well, I'm just saying, do you think it was conservative?
A I think it was proper. I think it gave me the conservative emissions that I was looking for.
Q Would using the 3 percent value provided by Golder have been more conservative?
A It would have been more conservative.
Q And do you know -- if you'd used the 3 percent value, do you know how much that would increase the PM10 concentration?
A I would expect it to increase. I don't know by how much.
Q Okay. Because the higher the silt content, the more emissions you have; correct?
A That's correct.
Q Okay. Would you be surprised to learn that it increased the emissions by 216 percent?
A That seems like a high number.
Q And that would take you over the 24, wouldn't it?
A If that were the case.
Q I want to touch on a point that you made in your testimony about the level of production and how it will increase as the mine progresses. Is that your understanding?
A Yes.
Q And I think you were testifying about this in connection with the potential to emit calculation.
A Yes.
Q And do you know if there is ever a point that will be

reached by the mine where they will be operating 24/7 in production?

A I don't think that's possible, 24/7. Equipment and shifts I don't think operate that way. I don't know what the maximum value is. I just know that you can't run 24/7.

Q You can't run a mine 24/7?

A Not with all the equipment running.

Q And why is that?

A Well, that's typical for a lot of facilities. There's generally a bottleneck somewhere in process, especially when you're moving material around to different places. So generically there's typically some bottleneck somewhere that you can't run all the equipment 24/7 at full capacity.

MR. STAPLETON: Okay. Thank you, Ms. Martin. I don't have any further questions. Your Honor, at this time Petitioners would move for the admission of the letter that was authored by Jon Cherry dated June 14, 2006 which I had referred to as entry number 85 in the administrative record, Table of Contents. And Petitioners would also move for the admission of the Handbook for Dust Control in Mining published by the Department of Health and Human Services. And I believe all of -- I believe all of their exhibits were previously admitted.

JUDGE PATTERSON: I think so.

MR. KOHL: With respect to Exhibit 160, I fail to see the relevance of it. It was a letter written back in June of 2006. I has nothing to do with the current permit conditions that were issued by the MDEQ. I don't see the relevance of it. I would object on that grounds. I don't contest the authenticity of the letter, but I don't see the relevance of this proceeding of that letter. With respect to the handbook, you know, I offered our peer reviewed that you didn't want in on the grounds of hearsay. I would object to the handbook on the same grounds.

JUDGE PATTERSON: Mr. Riechel, have you something to say?

MR. REICHEL: With respect to 160, I'd join in the relevance objection.

MR. STAPLETON: Your Honor, you know, I think it's completely relevant and it goes to how Kennecott treated and approached the air permit application. This was a process where they were proposing initially, you know, the absolutely minimal controls on this stack. And the only reason we're at the point today of a fabric filter is 'cause it was jammed down their throat by public comment and public opposition. So it's completely relevant as -- to show how the fabric filter came about. And, Judge, there is not reference -- there is no reference to the fabric filter anywhere in the air permit application. And as for the -- as for the Handbook for Dust Control in Mining, I mean, this is a reference that is cited in AP 42 which is the standard reference for preparing an air permit application. And it's put out by the Department of Health and Human Services. I don't know how it could be more authoritative.

MR. KOHL: I don't know if it's been established in evidence that the fabric filter was jammed down Kennecott's throat. Even it was, I still don't know what the relevance to that letter is. With regard to the handbook, I don't know if it's part of AP 42. He hasn't established that with any witness that I'm aware of. And I don't know what context that handbook is published as, if it's published for purposes of mineworker health and safety or it's published for purposes of ambient air issues regulated by EPA. I do note that it's not put out by EPA. It's put out by a different agency of the federal government, and I don't know for what purpose.

MR. REICHEL: And, Judge, following up further, again with respect to this letter and the suggestion that it's relevant, again the issue in this context before this Tribunal is whether or not a mining permit should be issued under Part 632 and under what conditions. Kennecott's communications with Air Quality Division staff about an earlier now superceded draft air permit I don't see as relevant.

JUDGE PATTERSON: I'm going to admit Petitioner's

160 based merely on the fact it was authored by Kennecott during the application process. As far as the handbook, I agree with Mr. Kohl. I don't think there's been a proper foundation for admitting that, so, no, I won't. I'll sustain the objection to that.

(Petitioner's 632-160 received)

STAPLETON: I don't have any questions, your Honor.

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

REDIRECT EXAMINATION

BY MR. KOHL:

Q On cross you were asked about the fabric filter and there was some exploration of the malfunction abatement plan.

A Yes.

Q In your experience, when are definitive malfunction abatement plans actually prepared for a facility?

A Well, they would have to be prepared after the specifics of the filter installation and operation were known. So I would suggest that after the filter has been purchased and we know how it's going to be installed and operated, that's when preparation of the malfunction abatement plan would take place.

Q and in your experience, at this stage of a facility where permits have been issued but construction has not commenced, is it atypical not to have a detailed malfunction abatement

plan for any piece of equipment?
A I don't see how one could be prepared at this point.
Q And is that what the air permit contemplates, that a malfunction abatement plan will be prepared and required under the permit at a later date?
A Yes. I think there's a time frame included on that.
Q And, Ms. Martin, we have admitted Exhibit 467 which is Appendix E to the air permit application.
A Yes.
Q Do you recognize this table? You just saw it a little while ago.
A I do.
Q All right. Let's try to put this table into context. This is the table reporting the modeling results of the maximum predicted ambient concentrations relative to the national ambient air quality standards; is that correct?
A Yes.
Q So over in the far left-hand -- right-hand column, are those the national ambient air quality standard values for those various pollutants?
A They are.
Q Are those expressed in terms of micrograms per cubic meter? Is that correct?
A Yes.
Q These are EPA values?

A They are.
Q These are values that EPA had determined to be protective of the public health when present in the ambient air concentration?
A Yes.
Q And the column next to that then compares the maximum measured impact of modeling against those health-based standards; correct?
A That's true.
Q Now, when we say "maximum" out of a modeling study, are we talking about the value that's modeled generally in the air outside the fence line of the facility?
A Yes.
Q Well, are we talking about that, or are we talking about their maximum value of a particular receptor point?
A Well, it would be at a particular receptor point outside of the fence line.
Q So in other words, you could have a value of, let's say, 3.0 micrograms per cubic meter at one receptor point and all other receptor points could an order magnitude below that?
A That's correct.
Q It's not representative of the general concentration in the air throughout the area around a plant site or a mine site, but of a particular receptor point which is the highest value?

A That's correct.
Q And for regulatory purposes it's that value that's relevant for permitting; correct?
A Yes.
Q So this chart shows that let's say for instance with regard to -- and am I correct in understanding that EPA for different pollutants has generated not only an annual value, let's say, for the public health, but also a 24-hour maximum value that is safe for the public health?
A Yes. That's the case of the PM10, and you can see a variety of averages. For example SO2 has three different averaging periods. So it depends on the pollutant.
Q So for PM10 based on this chart -- and this chart was submitted before the permit issued and before a fabric filter was required on the mine ventilation; correct?
A Yes.
Q So this is assuming the mine ventilation exhaust is uncontrolled; correct?
A Yes.
Q So for instance in rough terms, this shows that on an annual basis the emissions of PM10 from the mine as proposed with an uncontrolled mine ventilation stack would be about 6 percent of the ambient air quality value that EPA has determined is safe for the public health.
A That's correct.

Q And relative to the 24-hour average, it's about 17 percent in round numbers; is that correct?
A Yes.
Q Now, did you also then have to compare the maximum concentrations from the mine against the existing background?
A Yes. There's a table that I think is presented after this that includes what background is and what the mine contributes then beyond background.
Q Right. Then the background would represent what people are living and breathing and animals and flora and fauna are living in every day in this area of the Upper Peninsula; correct?
A Yes.
Q Is this where you're comparing or showing the added effects of the maximum value as modeled at a single receptor point where you had the highest value against the background values and then adding the two to still show that you were meeting national ambient air quality standards? Correct?
A Yes.
Q So looking at this table, the background annualized for PM10 in the Upper Peninsula is 16 micrograms per cubic meter; correct?
A For an annual averaging period, yes.
Q Hm?

A For an annual --
Q On an annualized basis?
A Yes.
Q So that's just how much dust is in the ambient environment already?
A Yes.
Q And again, when you add the mine to that, you're only approaching -- what? -- 20 percent at your highest impact point of the health standard?
A That's correct; yes.
Q And we can do the same extrapolation with regard to PM10 on a 24-hour basis; correct?
A Yes.
Q So the background existing dust in the air in the Upper Peninsula is higher than the maximum concentrations on the 24-hour value of PM10?
A Yes.
Q So based on these charts, there's plenty of margin of error relative to health standards; correct?
A Yes.
Q Now, we talked a little bit about the fugitive dust plan. Does the MDEQ also set standards in that plan with regard to the opacity that can be seen behind a vehicle moving down one of the haul roads on the plant site?
A They do. As detailed in the plan, a 5 percent visual

emission limit is required on roadways and a variety of other fugitive dust sources.
Q So the only means of regulating fugitive dust from the haul roads is not just watering; correct?
A Correct.
Q There's also a requirement that they meet that opacity standard?
A That's correct.
Q And what is the opacity standard? What do you have to do?
A Well, a trained and certified emissions reader takes a reading in accordance with an approved method. I can't quite recall what the method name is, but they do that on a frequent basis and demonstrate compliance with that opacity limit.
Q Now, do other states use opacity limits as a way to control or limit fugitive dust?
A Yes, they do.
Q And what do other states have as a standard?
A Well, I've seen 10 percent as a low limit. So the 5 percent that Michigan requires I think is a rather stringent number.
Q Is it the most stringent standard you've seen for opacity relative to fugitive emissions from roadways?
A Yes, it is.
MR. KOHL: I have no further questions.
MR. STAPLETON: I just have -- real quick, Judge.

JUDGE PATTERSON: Okay.

RECROSS-EXAMINATION

BY MR. STAPLETON:

Q Ms. Martin, just real quick, Mr. Kohl was asking you about a table -- this is a table in your Appendix E; correct?
A Yes.
Q And this shows -- I believe that what we're looking at is a PSD increment concentration table and comparing the results of your modeling with the PSD increment limits set by the State of Michigan; is that right?
A I think that's the case.
Q All right. And Mr. Kohl was asking you about the NAAQS standard which is a different standard; correct?
A Yes.
Q And so the number that we were talking about, the 22.69 from the other table, it's that number -- right? -- the PM10 --
A Yes.
Q -- 24 average? And that's the maximum allowable increment for any -- in the State of Michigan for PM10; correct? The increment?
A Well, I thought that would be the 80 percent number over on the right is Michigan's.
Q Right.
A I think nationally --
Q And Michigan -- Michigan takes 80 percent of this number,

and this ends up being the limit that you cannot exceed -- correct? --
A The increment, yes.
Q -- for the PSD increment for PM10; correct?
A Yes.
Q Okay. And you were talking about opacity. Opacity is the degree to which dust particles obstruct or obscure light; is that correct?
A Yes.
Q Okay. And when you're talking about an opacity limit of 5 percent, this is a visual observation at the site; correct?
A It is.
Q Okay. This isn't -- opacity isn't something that you model for?
A No, that's true.
Q Right. I mean, you start the mine and you create some dust, and you've got a person there visually making a determination as to opacity.
A Correct.
Q Is that correct?
A Yes.

MR. STAPLETON: All right. Thank you. I don't have anything further.

FURTHER DIRECT EXAMINATION

BY MR. KOHL:

Q Just very quickly, PSD increment, that's not directly related to health criteria, is it?
A No, not my understanding.
Q And opacity, if you're meeting a 5 percent opacity standard, that would be a measure that you have very well controlled fugitive dust from a haul road; correct?
A It would on an ongoing basis, yes.
Q And it would be consistent with your assumption of 90 percent control of fugitive dust from haul roads; correct?
A Yes, it would.

MR. REICHEL: Just one last question on this 80 percent increment.

CROSS-EXAMINATION

BY MR. REICHEL:
Q If you know -- I recognize you're not a lawyer, but if you know, is -- that 80 percent increment value, is that actually a promulgated rule, or is that a DEQ policy, if you know?
A I don't know. I don't know.

MR. REICHEL: Fair enough. Nothing further.

MR. STAPLETON: Nothing further, your Honor.

JUDGE PATTERSON: Thank you.

(Proceedings adjourned at 5:06 p.m.)

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