MANITOBA CLEAN ENVIRONMENT COMMISSION

HEARING

VIVIAN SILICA SAND EXTRACTION PROJECT

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Transcript of Proceedings
Held at Mennonite Heritage Village
Steinbach, Manitoba
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WEDNESDAY, MARCH 1, 2023
UPON COMMENCING AT 9:30 A.M.

THE CHAIRMAN: Well, good morning everyone, and welcome. I trust everyone had a good evening and here we are, ready to reconvene again. Roughly, I expect the more -- roughly I expect the day, so, we have six-hour days, three hours in the morning, three hours in the afternoon, and that will allow us, based on the sort of time management we've done, about an hour and a half for each of the people that have status to question, with a little bit of time left over because we started with 20 minutes yesterday. So, Dennis, I will turn it back over to you and I will remind you, as I have been reminded, that this is really not the time for opinions or particularly long opening soliloquies, but for questions.

MR. LENEVEU: Good morning. It's Dennis LeNeveu. I have a question regarding (inaudible). And you see from that picture, the water on the outer annulus can return, and in, I think it's 110 there, it formed sort of a curtain around the outer side of the well and gets sucked up again. And the patent says -- well, yes, that that can inhibit sand uptake, and I think they mentioned some strategies around that. Because what can happen if water -- returned water is simply running down along the -- in your -- outer annulus and gets sucked up, so, your water's just going around, around, around, around and that can prevent the sand from uptake. So, this is what it says in the patent, and I'm just wondering what is the hydrogeological perspective or insights on -- on this issue?

MR. BULLEN: It's Brent Bullen from Sio Silica. Cany you identify by number, Mr. LeNeveu, which spacing you were asking about? I mean they're referenced on there. You know, 100, 130, are you talking about the area of 68, 140? I just need to understand your question with some clarity, please.

MR. LENEVEU: Unfortunately, I can't see this slide that well, but it's -- oh, 140, yes, at the -- at the bottom, 140.

MR. MILLS: Ryan Mills with AECOM. Thanks for the question. And yes, I believe I understand what you're referencing. So, you're referencing downward flow of reinjected groundwater that has been treated and the subsequent uptake of some of that water through the drill string as -- as a result of the airlifting process, that would then be entrained in the slurry once again. So, from a hydrogeological perspective, this is a near field well hydraulics kind of phenomenon. You know, in -- in the normal operation of wells, there is -- this can happen as well, and -- and it would be a -- a local scale, sort of centimetre to metre scale phenomenon that would be local to the extraction well string and -- and occur within that void, and -- and that water would be kind of captured in the overall mass balance of the extracted water, and then reinjected water. What that might mean is that some of that -- or more of that water, if you're you -- you're creating a bit of a -- a localized flow phenomenon, it might mean that there's less water being pulled in from the aquifer, and so, you're setting up a cyclic recycling of the water locally to the well.

MR. LENEVEU: Thank you for the answer. I'm just wondering what that local cycling would do to your sand uptake?

MR. BULLEN: Brent Bullen with Sio Silica. With respect of the enhancement, or as it affects the sand lift, it's really not material in the production of it. It just allows the -- the replacement of the water into the aquifer. Sand is still produced with or without the water going down the annulus space.

MR. LENEVEU: Thank you for your answer. Just as a clarification then. Is there any interference of the sand update of that circulating water where it kind of prevents a barrier from the sand of getting into the intake pipe?

MR. BULLEN: Brent Bullen. No.

MR. LENEVEU: Thank you. Now, my next question pertaining to that same diagram, I think it's 110 -- 120, let me just see. Okay, the -- whoops, I've lost my -- there we go. The patent states "Water may be added to the well from an external source to establish the water level 130 at sufficient height to increase the water pressure in the sandstone formation 110 to facilitate the extraction of the sandstone slurry". So, does this mean in the -- when you have the reinjected water at 110 -- raising the level at 130, a column of water entering, and maybe even from an external tank that is even higher, that this creates a pressure at the end point -- intake point of the sandstone, at the top of the sandstone due to that column of water? I -- I think I'm -- that's what the patent says, so, is that column of water in the annulus, which is shown only partially way up on the figure, if it's all the way up, and even outside in a -- in a tank, would that create an extra head and therefore a pressure at the top of the sandstone aquifer, right next to the well? That's a hydrogeological question.

MR. MILLS: Thank you for the question. Ryan Mills with AECOM. In -- it's important to remember that in this well configuration, that there is an overall removal of -- of more mass from the void in the form of sand and water, which is an approximate 50-50 blend. So, you're removing more mass from the -- the aquifer system, than you are returning, and so, that mass must be made-up by -- from flow of groundwater into the system and reinjection of some water from above. And that small volume of water that is removed, right, will need to be made-up by water supplied from the aquifer, so, that small 15 percent. So, you have a -- a small excess of water that is being withdrawn from the aquifer, just like a water supply well. And that net negative coming out of the aquifer is -- would be resupplied by that reinjected water. So, there is a depressurization in that local area during pumping or -- and sand extraction that allows for that reinjected water to flow under gravity drainage conditions into the -- into the well.

MR. LENEVEU: Thank you for your answer. It's Dennis LeNeveu. So, I understand there'll be a lower pressure in the sandstone generally, but with respect to the bottom of the injection pipe, and where the water is returning to the aquifer at the top, is there a local net pressure difference there where there's a higher, with respect to the bottom, there's a higher pressure at the entry where the water is coming down on the outer annulus, and locally in that spot, and with respect to the region around it, and so, a higher pressure there, where the water is to enter, and a lower pressure down at the bottom? The net pressure throughout the system may be negative but is there a local pressure difference with little bit higher at the top due to water entering the resistance to that water moving around and -- and where the water is being pulled in at the bottom, where you'd get a more suction. So, the question is, is there a lower pressure here with respect to up here, a little bit higher, and the pressure up here is a little bit higher than the water around it? Is that an accurate description or am I misinterpreting something?

MR. MILLS: Ryan Mills with AECOM. First, it's important to remember that the entire borehole will be cased, so there will not be allowed to -- there will not be provision or allowance for any interaction between that reinjected water and the limestone aquifer. As you can see on the figure you have, the casing extends into the sandstone formation, and that is an -- an impermeable casing, much like a water well, in fact, it may be the same as -- as all of the water wells here, and it will prevent interaction between that reinjected water and the surrounding aquifer. Our field scale pumping tests demonstrate that the zone of influence where groundwater levels are reduced, in other words the pressure as you're referring to it, is -- is lowered for some distance around the extraction well and -- and therefore, the pressure within that entire -- or the total head within that entire zone of influence will be lower than it was prior to testing, during operations until those water levels recovered to static conditions. And this is the same as what would occur in a water supply well within the system now.

MR. LENEVEU: Thank you for your answer. I wasn't concerned about the pressure in the carbonate, I was concerned about just the local higher pressure in the sandstone where the water is entering from the outer annulus with respect to the pressure at the bottom of the well and the water around it. And I appreciate that they're sealing around the outer casing, or the casing, but in the course of the extraction we saw the -- from the side scan sonar, the aquitard eventually disappeared. And so, then if there is a higher pressure locally, very locally, where the water is coming in from the annulus at the top of the aquifer and the aquitard is gone, except for a small little region where there's still some grout, is there a potential for that return water -- because there's a local -- could be a local higher pressure difference, to enter up into the carbonate?

MR. MILLS: Ryan Mills with AECOM. I'll respond to that question first and then I'll -- I'll let you carry on. So, as a direct response, in order for water to move, it moves from high head to lower head. And so, the tank on the surface will flow under gravity to the base of that casing, and it typically takes the path of least resistance. And so, during operations, the -- the most negative hydraulic head, or -- or elevation equivalent would be within the extraction pipe. So, that water would tend to re-enter the extraction pipe or -- or move in that direction, in favour of moving upward into the carbonate because the heads in the carbonate are higher than what they would be in the sandstone.

MR. LENEVEU: Thank you. Yes, I do understand and appreciate that the water will move from a higher pressure zone to a lower pressure zone. And I appreciate, and as indicated, that the water can recirculate -- water that's entering, down and be sucked up to in the lower pipe. But if there is a small higher pressure difference from the water coming in and it's a little bit higher where it's coming in, than in the carbonate above it, so, there's a high pressure here and a little bit lower in the carbonate, with respect to the pressure and the water coming down because of the big column of water pushing it, then yes, most of it will probably move down into the bottom. But because there's a high head here and a lower -- slightly lower head, maybe, in the carbonate, and it moves from high to low, if there's a higher head locally right next to the well where it's being injected, and a slightly lower head in the carbonate, would it not then, according to your principles, move from higher head here at the top to lower head into the carbonate, if that situation exists -- high head to low head, water moves now upwards a little bit into the carbonate? Maybe most of it moves downward, but high head here, low head in the -- lower head in the carbonate, so, I would think the principles would say that you would get some movement up into the carbonate. Am I misconstruing this or is there -- is this a possibility?

MR. MILLS: Ryan Mills with AECOM. This is, I believe, an opinion that you -- you're kind of providing but it -- in nature and in reality, the water levels in the carbonate are much higher than they are in the sandstone during operations. And so, the -- this hypothetical reversal of gradients and flow from low within the sandstone to the overlying carbonate, it -- it's not supported by the -- the water levels in the carbonate aquifer prior to operation and during operation. They always remain lower in the sandstone than they are in the overlying carbonate.

MR. LENEVEU: Thank you for your question -- or answer. Yes, I could see that, but because there is a higher pressure at the injection point, I don't know that it's definitive that it won't be slightly higher in the carbonate.

But I'll move on from there and ask another question regarding the return of water down that outer annulus. In an artesian situation, there won't be a lowering of the water in the outer annulus, it'll actually and you should actually be coming out at the top. And then in that situation, how do you get water to return down the outer annulus? If there is an upward pressure from the sandstone being higher, because it's in the flowing well zone, how do you get water to enter by gravity feed only down that annulus? This is actually flowing out of the -- out of the top of the well. How -- how do you handle that situation from a hydrogeological perspective?

MR. MILLS: Ryan Mills with AECOM. So, initially the artesian conditions in the sandstone aquifer typically exist further to the west of the project site. It is acknowledged that there are artesian conditions observed in the sandstone, but those do not appear to be prevalent or persistent within the project footprint. And the intention is to not produce sand, or extract sand, in areas where artesian conditions are an issue and -- and are are known to be present. In spite of that, the project would be removing more than the -- the total volume of slurry that would be removed, 50 percent of that is sand and 50 percent of that is water, and so, that would leave room for some reinjection of water at the time of extraction.

MR. LENEVEU: Thank you for your answer. Do you have any data or information on the region of the artesian area that you would not now, as I hear you stated, be extracting sand from, and how would that artesian area reduce your 24-year project area? Would it reduce it at all? Are there no areas of flowing wells within your 24-year project area, at all? If there are, how much would your actual area be reduced so that it's not actually what is shown on your figures? It -- would it be something smaller?

MR. MILLS: Ryan Mills with AECOM. It's important to remember that we're here to talk about the first four to five years of operations, and so, those areas are -- are more well understood than the areas within the overall footprint of the project, that -- that may be approved in the future.

MR. LENEVEU: Thank you for your ---

MR. MILLS: sorry I was not finished. Ryan Mills, again. The exploration to date has not found artesian conditions. Artesian conditions typically onset in the -- you know, in -- in the summer months, they're the highest but they are lower in the spring and the fall. So, there are operational kind of efficiencies or approaches that could be operated to mitigate against that risk, avoid the artesian periods of the year where individual areas may be artesian, and complete the work under conditions that are not artesian.

MR. LENEVEU: Thank you. I'd like to move on to slide 13, please. Now this is -- shows from a response to a CEC IR request, the rate of -- this is respect to the return -- or reinjected water, and it shows the rate of water that's reinjected, and the rate of the sand coming -- or sorry, the rate of the water withdrawn with the sand, and the rate of the sand withdrawal. And it shows separately, with blue dots there, the rate of reinjected water, although there -- there's just discrete measurements, whereas the rate of the sand and water withdrawal are -- and there's another line there for the total rate of withdrawal of the slurry, those are almost continuous readings except where there was a pause for side scan sonar. So, my question is, and another participant asked it earlier, how were those measurements made, and especially the measurement of the returned water flow rate, since it's discontinuous dots, rather than continuous lines of other one? So, how were these water flow rates of withdrawal and reinjection measured?

MR. BULLEN: We just need a second. We're having a slow internet connection -- to pull up some files here. One sec.

MS. WEEDEN: This is Laura Weeden from Sio Silica. So, the water reinjection rate is measured in a straight section of pipe using an ultrasonic flow meter, and it's -- the data is recorded, and we take manual measurements in addition to the recordings. And then we also record the volume of sand as it's extracted.

MR. LENEVEU: Thank you. How do you record the volume of sound that's extracted?

MR. BULLEN: It's Brent Bullen with Sio. The volume of sand is calculated based on a volumetric calculation, so we actually measure it in cubic metres. And then on the cubic metre, convert it back to its mass per cubic metre, and that gives us the tonnage.

MR. LENEVEU: Okay, I -- I'm sorry, I'm -- I'm not understanding your answer. It's -- the sand is measured with a volumetric calculation -- is this wet sand or dry sand, and how is that volumetric calculation made? Do you pull the sand out somehow and dry it, and -- and measure it weight, or I'm not I'm just not clear on --on that, I'm sorry.

MR. BULLEN: During the extraction phase of these test wells, the discharges is contained in the large tanks, and then the sand is actually scooped out of the tank using an excavator track hoe. The calculated level of volume of a bucket on the ones we're using is 2.3 tonnes, working back to the volumetric capacity. The buckets are actually holed to drain, so there's not water with it, and that's how we take the measurement of material based on a volumetric basis, which is easily mathematically translated into volumetric cubic weight.

MR. LENEVEU: Thank you for the clarification. So, the sand that you pull out with a, I think, a track hoe bucket, is it not wet, and if you measure a volumetric calculation, there's some water there and -- and you're -- you're measuring just the sand rate? So, how do you differentiate the sand from the water in it, without drying it?

MR. BULLEN: Brent Bullen. The sand is

wet, so we estimate the volumetric water containment still on the sand at 15 percent by volume, and which is -- which is in there, in the calculations.

MR. LENEVEU: Oh, thank you. So, what is the uncertainty in these measurements, since this is just an estimate?

MR. MILLS: Ryan Mills with AECOM. Wet sand would at -- at most, typically hold sort of approximately 25 or 30 percent moisture content the -- the porosity of -- of the materials. So, the -- a pile of sand would be partially the sand grains and then partially the water, and -- and typically when sand is allowed to free drain it -- it would, you know, at most have 30 percent moisture content, and -- and that would, you know, rapidly deplete as it is a fairly porous material, and it is a fairly, you know, quick drainage process.

MR. LENEVEU: Thank you for the answer. So, I heard 50 percent from Mr. Bullen and now I hear 30 percent draining somewhat, so it sounds like there's some uncertainty there. And when you have a pile of sand X removed with a track hoe, I mean there might be some still in the tank and you -- I don't know how you do a volumetric calculation of your sand. Do you just measure the geometry of the sand pile? Or do you have an actual standard volume you put it in, and spread it out, so you can measure it accurately if you have a pile of sand? I'm having trouble understanding how you measure the volume.

MR. BULLEN: Brent Bullen. A couple of clarifications. Mr. LeNeveu, I think you -- did, you say 50 percent, I said -- or 15, because I said 15.

MR. LENEVEU: I'm sorry, I heard 50. Maybe you said 15. Could you clarify, please?

MR. BULLEN: Yeah, I'll clarify that I said ---

MR. LENEVEU: Whoops.

MR. BULLEN: My course. I said 15 percent -- one-five. Sorry I wasn't done.

MR. LENEVEU: Thank you. So, now I hear 15 and I heard another answer over here, 30. So, I'm still having a -- A discrepancy. Well, I mean, there's uncertainty. And so the volume calculation of your pile of sand, I'm just wondering how you do that.

MR. BULLEN: You know, Mr. LeNeveu, I'll -- I'll answer the questions if you can try to not cut us off with your mic, sometimes.

With the volumetric calculations, they're done based on the volumetric capacity of the bucket on the track hoe. These are test wells, it's testing programs, where we're trying to prove up the methodology of extraction. I think you're familiar with it because I've seen pictures you posted of our equipment on site, but a track hoe bucket has a maximum capacity of sand that it can actually take volumetrically. And so, we will work based on that volume, and then estimate it. And there's your slight variance, is the water capacity in that as we move it.

MR. LENEVEU: Thank you for that clarification. Now, I haven't yet heard how you measure the rate of return water and why it's discrete points rather than a continuous line. Could you please clarify that?

MS. WEEDEN: This is Laura Weeden. I

believe I already mentioned that we used an ultrasonic flow meter in a straight line of pipe to measure the gravity feed of water for reinjection.

MR. LENEVEU: Thank you. Why are there discrete points rather than a continuous flow?

THE CHAIRMAN: Chair. Can I remind people that the transcribers on the other end have no idea who is talking unless you identify yourself before you talk. Thank you.

MS. WEEDEN: This is Laura Weeden. They're manual readings. We're not able to install a data logger for continuous measurements.

MR. LENEVEU: It's Dennis LeNeveu, thank you for your answer. In the EAP it says that when it's talking about return of water flow rate, you must get initially 70 percent sand, 30 percent water, and as time goes on you'll get down to around 30 percent sand, 70 percent water, or even down to 20 percent. I don't see that happening with these numbers. It seems to be blue numbers are fairly constant. Is there some reason why you, as your excavation gets deeper, and the -- you're drawing from a larger area with more intervening water in between, why the returned water doesn't -- or the withdrawal -- withdrawn water doesn't have a -- a decrease with respect to the -- the sand rate of flow? So, why isn't there a smaller sand rate and a larger water rate towards the end of the extraction, than the beginning. I'm sorry, I'm not meaning the blue dots, I mean the other red and blue lines. It doesn't seem to show the water rate increasing and the sand rate decreasing towards the end of the -- as you -- as time goes on in the extraction. Is there some -- okay, is there an explanation for why that differs from what it says in the EAP?

MR. BULLEN: Brent Bullen with Sio. The EAP takes a broad-based approach of all parameters that we've seen, and we've seen production of sand ratios as high as 90 percent, typically 70, we'll go as low as 20. We'll make adjustments during the production phase to adjust those ratios.

One of the things you have to take into consideration, Mr. LeNeveu, is the tankage on site that we have, that we -- we discharge the sand slurry into, to extract the sand from, has a capacity of roughly 110 cubic metres. So, you're looking at moving averages of water.

So, we can actually take high-rate water at 20 percent sand, low-rate water at 90 percent sand, but when we look at putting sand back to the wellbore, we have the ability to average those production irregularities through the volumetric capacity of holding tanks on surface during these -- these test wells. It's not -- it's not instantaneously linear for the water going back in and the water coming out because there is a capacity to hold and give you a storage and -- and average capacity.

MR. LENEVEU: It's Dennis LeNeveu. Thank you for your answer. I see continuous rates here rather than overall average, so, I'm a bit confused how if -- if you put it in a big tank and you're measuring an overall average over time, I -- I'm seeing a continuous lines here that are measuring, at particular -- you know, or continuously with time. So, I -- I'm having trouble understanding overall averages versus a continuous plot that you see here.

MR. BULLEN: Brent Bullen. Maybe, Mr. LeNeveu, I don't -- I'm trying not to give examples, but if you took a 208 litre drum and put a hose on the bottom of it, and you put water into that drum with a five-gallon bucket, and so you could put 5 gallons in at a time, but the hose is going to give you a withdrawal rate of a gallon a minute. You'd only have to recharge that tank every five minutes with a five-gallon bucket. When we're on location, we do have continuous movement of water back into the wellbore and we have discharge coming into those tanks, and so, although the -- the operations are live, you have an -- you have a buffering capacity in the tanks to take the irregularities of water when it comes up high and low in the sand concentrations, and still give you a continuous availability of water back to the wellbore.

MR. LENEVEU: Thank you for your answer. Can we move on to slide -- It's the slide with the sandpiles. I'm just trying to find where it is. Oh, Slide 15, please. Yeah, this is a simpler question. Here we have the sandpiles at your processing facility, they're 15 percent water and that represents a total withdrawal, permanent withdrawal of water from the aquifer, and there are other withdrawals for your waste streams, for instance, your overs and unders have some water in them, and that would be a permanent withdrawal. And a question -- response to an IR said, "All the vessels containing water at the extraction site, the -- at your end, will be taken to a disposal facility and that water will be disposed of". So, that's another permanent withdrawal of water from the aquifer. So, what is the permanent withdrawal of water from that aquifer per year, based on all these losses?

MR. MILLS: Ryan Mills with AECOM. Thank you Mr. LeNeveu. The primary loss from the system is that 15 percent residual moisture content in the sand as it's transferred to the slurry loop. There will be, at the end of each year, a very small volume of -- of water entrained in solids that have settled in the bottom of the operational tanks that will be extracted and disposed of. It will be, you know, I'm envisioning, you know, an inch or two of water on the bottom of a -- of an operational tank that would be residual and -- and disposed of. So, very small to negligible in the context of the overall water balance and losses in -- to the sand, which is the primary loss that has been tracked.

MR. LENEVEU: Thank you for your answer. It's Dennis LeNeveu. At 1.36 million tonnes of sand per year, I don't know what the density of dry sand is, but the volume may be determined by dividing that by dry density and -- and then taking 15 percent of that, you're going to come up with roughly 800,000 cubic metres of water withdrawn from that aquifer per year from the -- the sand, and I didn't hear how much you'd get from the waste streams, but so, in addition to -- so, that number, 800,000 cubic metres, which may not be right, I -- I wanna hear what the real number is, what is the total amount in cubic metres of permanent water loss from the aquifer per year?

MR. MILLS: Ryan Mills with AECOM. I'm just -- appreciate your patience. We're just looking up numbers that are reported in the -- in our hydrogeological assessment. Ryan Mills, again, with AECOM. As shown in Table 7B of the Hydrogeological and Geochemical Assessment Report, we present two columns of -- of information. One for the zero percent highly conservative reinjection -- zero percent reinjection case, and one for an assumed 50 percent reinjection case. And in fact, since this report was completed, there's an intention to reinject even more water. So, these numbers are higher than what we would expect based on the revised extraction plan. And with that, under the zero percent reinjection case, over the five-year operating life, 2,500,000 cubic metres would be extracted and approximately 169,000 cubic metres in the initial year to 595,000 cubic metres in the remaining four years. With 50 percent reinjection, that would drop to 47,000 cubic metres in total over the five year life and

3,000 to 10,000 or 11,000 cubic metres each year with that 50 percent reinjection case. And again, I apologize, I don't have the updated numbers from the revised extraction plan, but that would be dramatically less. And for -- sorry just to finish for context, this is approximately the volume that has been -- licensed for -- for use on a typical golf course, for instance.

MR. LENEVEU: Thank you for your answer. It's Dennis LeNeveu. I'm talking about not a 50 percent injection rate in a modelling study, I'm talking about your production, when you withdraw 1.36 million tonnes of sand per year at 15 percent water. I don't think this has anything to do with your 50 percent scenario. All you need to do to calculate the amount of water withdrawn per year is know the density of the sand to get the total volume of sand and then multiply by 0.15 and you come up with a number somewhere around 800,000 cubic metres. I don't hear such a number. So, let me ask you again during production when you withdraw 1.36 million tonnes of sand per year at 15 percent water, how much water is that in cubic metres?

MR. BULLEN: Brent Bullen, Sio Silica. Mr. LeNeveu, in the scenario you just laid out 1.32 million tonnes a year, volumetrically and density equates to roughly 800,000 cubic metres at a 15 percent retention rate, you're looking at about 120,000 cubes of water when you look at that -- that ratio.

MR. LENEVEU: It's Dennis LeNeveu. Thank you for that answer. And there was another statement that the water residual in your tanks at the end of the year is just a small amount of water, but that water is -- has to be returned to the aquifer by gravity flow during the operation and -- of your sand. So, once you stop operating your sand the -- the tanks are full. If you keep trying to drain the tank by airlift, then you're putting more water into the tank. And so, the response to the IR was there won't be a -- just a residual water in the tank at the end of the year, it would be full, and the only way to get it emptied because airlifting to create the suction would just put more water in the tank, and you're not going to reinject it by a separate reinjection by pressurizing, was to take it to a facility for disposal, and that's a full tank, not a residual tank. That was the response to the IR. So, at the year end, with all the tanks full in your extraction zone, how much water is taken to this facility for disposal?

MR. MILLS: Ryan Mills with AECOM. It's important to remember that it does take days to weeks for the water levels in the sandstone to recover after completion of extraction, so there is an opportunity to drain tanks under gravity to aid in -- in speeding up the recovery of those water levels at the end of each year, because the -- the drawdown cone or zone of influence has not yet fully recovered to static conditions. So, that -- that water can drain. And as stated, you know, there -- there will be some residual solids with some entrained water at the bottom of the tanks that will -- will not be reinjected. It's expected to be a small volume of water, and that will be taken away for disposal.

MR. LENEVEU: Thank you for that response. It's Dennis LeNeveu. So, you're just saying that the recovery drawdown -- there's a -- after you finish extracting, there's still a drawdown cone that will have enough pressure, suction pressure, as that drawdown cone goes back up again to pull all the remaining water from these tanks. And I think I saw in the EAP that recovery is quite quick -- I heard days, but I -- I thought I saw hours in the EAP. So, you're just saying the recovery from the drawdown is enough suction to empty all your vessels except the residual amount of water at year end.

Am I -- am I hearing this correctly?

THE CHAIRMAN: Chair, I'll just -- a little time management here. I'll let you know you have about 20 minutes left. If you can allocate your time accordingly.

MR. LENEVEU: Thank you. Okay, I won't ask that question. I have a lot of hydrogeochemical questions. Will I have time to answer them?

THE CHAIRMAN: Chair. So, my plan is to give each of the four people on the list roughly an hour and a half today. We got 20 minutes in yesterday, we might have some time left over. We -- people were estimating between one and two hours, so I'm using an hour and hour as a -- as an average. If there's time leftover, I'm happy to cycle back. And others may ask your question.

MR. LENEVEU: Well, I have a whole series of geochemical questions. How much time do I have now?

THE CHAIRMAN: Chair. You have 20 minutes.

MR. LENEVEU: Can we go to the geochemical questions, Slide 1, please. Thank you. Now this is an air quality study from the processing facility plant by Sio Silica. It shows the NO2 contours from exhaust and equipment in the facility, and it's for a certain GHG total for that plant. Now, in the extraction zone, there'll be about six times the total GHG than in the processing plant. So, you would -- based on analogy, you would get six times' the contours of NO2 which would result, based on those contours there, maybe a maximum of 600 cubic metre -- 600 micrograms per cubic metre. And the contours go over big area for this -- at 70, contour covers much of the area that would be for extraction up to 420 micrograms per cubic meter. The allowed limit is 200. Now, there's a compressors in that extraction site that would draw in the air, and they would draw in that nitrogen dioxide because it's over a big area, and they would draw in sulfur dioxide and benzene in the exhaust fumes and oil vapours, and that would end up in the aquifer. And nitrous oxide and SO2 are dissolved very easily deformed nitric acid and sulfuric acid. And the carbon dioxide as well, will dissolve -- some of it form carbonic acid. And the benzene is sparingly soluble, and some will dissolve, and so that's introduced into the aquifer. From a geochemical perspective, is scrubbing of the air a requirement for those compressors?

MR. MILLS: Ryan Mills with AECOM. I think it's important, just for context, to -- to recognize that pretty well -- well every drill rig that involves drilling with compressed air, so most air rotary drill rigs and dual rotary drill rigs, have compressors on them that do operate in this manner to airlift cuttings. That is actually the drilling technology, is to airlift cuttings so the -- the subsurface materials and bring them to surface to create a -- a void that becomes the well after it is cased. And so, I've practiced for 20 years in this field. I have -- have -- have never heard reports of any impacts on water quality as a result of airlifting. That -- part of that is that the -- the compounds that you're referring to are relatively inert. Second, the quantities are very limited. Exhaust from compressors is open to the atmosphere and it is diluted by the atmosphere. There are equilibrium reactions that govern the -- the conversion of those compounds, and there is abundant buffering capacity in the subsurface. So, you know, I -- I just -- I don't see this being an issue. Every well in this area, or -- or the majority or a large proportion of wells have been advanced with air rotary or dual rotary drilling techniques, for portions of the borehole and -- and the air injection pipe, I would add, will be hosted within the production string, so that -- that will create a buoyancy effect that would create up-hole flow, not push it out into the formation. So, it's -- it's more of a, I think you used the word suction effect, that pulls water toward, and gases toward, the borehole and up to the atmosphere to allow for venting rather than reinjecting it into the aquifer.

MR. LENEVEU: Thank you for your answer. It's Dennis LeNeveu. The compressor for the extraction of sand is operating -- this isn't just for well drilling, this is continuous up to seven injection sites per year, operating -- or operating at a time for -- and this is continuing for 220 days. And at -- so, there's a huge input of air directly into the production pipe, and yes, maybe most of it -- and there's definitely nitric acid and sulfuric acid from the NO2 form. This is -- and yes, some of that acid and benzene will come up with the water, but this is in solution, and that water is returned. Your process for filtration only removes particulate, it does not remove dissolved material. So, it'll come back. And so, now your benzene, nitric acid, sulfuric acid, on a continuous basis for 220 days a year of your extraction year, is being sent back into the aquifer in this -- each extraction zone is quite small -- each cavity, and you're having up to five wells pushing water back, and I don't think you can guarantee that some of the acid formed, and benzene, and other toxins, will not leak directly from the pipe into the aquifer. But even with return water, they're coming back into this small volume, and this is happening. I think you -- the scale is far different than you're suggesting for individual domestic wells. This is a massive difference. And I would suggest that the potential for contamination benzene is five parts per billion is the limit.

THE CHAIRMAN: Chair. I'm going to caution you that this is not a question, this is an opinion that's being presented at this time.

MR. LENEVEU: The question was, in the light of that argument, is it not necessary to scrub the air?

MR. MILLS: Ryan Mills with AECOM. It is not necessary to scrub the air.

MR. LENEVEU: Thank you. Can we go to Slide 2, please? Well, I'm running out of time, but this is a typical filter for removing microbial contamination -- to remove it from compressed air. So, there's also a potential for microbial contamination, but I hear that you're not going to filter the air, so I'll just pass by that.

I want to go on now to ---

MR. MILLS: I'll correct you. There will be filtration of the air.

MR. LENEVEU: Thank you. But what I was told in the IR is it's around five microns, which isn't enough size to remove microbial contamination of around 0.2 microns, and you also have to dry the air for microbial contamination. The normal filtration, not for microbes, is just to remove dust so -- and that's what there's quite a bit of literature on that, including Eva Pip's submission that is online now, that you need these much stringer -- smaller filters and drying of the air. And so, is not more required, like I'm showing up here, a big process and a simple filter?

MR. BULLEN: Brent Bullen, Sio Silica. Mr. LeNeveu, you're bringing in other materials and references that are not based upon the work that has been conducted. I -- I think, graciously, we've -- we've answered many of these questions and you're going circular on them, and they've been answered in the IRs, they've been answered in materials to you, and so, you're asking us to validate your work. And I -- I would just ask if you could try and focus your questions on the work that we've presented.

MR. LENEVEU: Thank you. It's, in this case, Eva Pip's work, but -- and I don't think the questions were adequately answered.

So, I just want to go on to Slide 3, please. This is from the MBEN guidelines of what to do with your sample preparation, and to prevent oxidation of your samples. And some of the procedures dry the samples at less than 40 degrees, keep them cool prior and after drying, minimize delay after drying, maintain anaerobic conditions by storing under nitrogen, freeze your samples. This is particularly concerning for sulphide in the samples that can oxidize very readily. Which of these guidelines were -- or all them -- were these guidelines followed in your sample storage and preparation before analysis for all your geochemical samples?

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. This guideline, that MEND present -- is meant to address the sampling and the preservation of the sample for wide range of application, that include tailings, that include waste rock, that include material that could be stored in open pit. So, it's -- it's overarching method. But what the guideline also said is that the preservation need to be made based on the objective of the study. When we drill core, when that core is brought up to the surface, it's left to dry at room temperature. And after that, it's sealed in core boxes, and stored in warehouses where the humidity is maintained, or it's generally very, very low. So, in case of our sample, there is no issue with organic carbon or nitrogen. So, freezing the samples or maintaining in -- in cold temperature is generally not required. Second, when this sample arrive at the lab, and if they might contain some humidity, the lab dries the sample in an oven and stores them before putting in queue for analysis. And we are very confident that materials we sent to the -- the lab were -- were appropriately collected, stored, and sent to the lab in a condition where it didn't -- it was not weathered between the collection and the delivery to the lab.

MR. LENEVEU: Thank you for your answer. I want to go on to Slide 5, please. I want to now -- to particularly talk about your sand samples, only three of them. One of them was taken from 95.3, the sandpiles in Vivian, that Woodbury reports as was unacceptable because these -- they're exposed to the weather. In response to an IR, Sil Silica replied that those sandpiles were covered with a tarp. Now they weren't -- they were extracted in June of 2019, the cover went on in June 2020, as you see by these pictures, so they were uncovered for a year. The reason they were covered is because there were some complaints about silica dust from the piles, and Workplace Health and Safety required them to be covered. So, in the light of the fact that, is not sample 95.3 unacceptable, according to Hollander and Woodbury report, and not valid?

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. So, for this assessment, we collected three different samples. And with respect to this sample in particular, let me backtrack a little bit. When we do our assessment, we are looking at characterizing all the materials that -- the project will mobilize, and those include fresh material, as well as weathered material. It's -- it doesn't say that we only have to test weathered material. And the reason for that -- sorry, we -- we don't only have to test fresh material. The reason for that, analyzing what -- what may be weathered, gives you an indication of those products that may exist after the oxidation. So, you have real evidence of how the fresh material will be if it's subjected to oxidation.

And one more thing, as our analysis shows, the sand is almost 98 percent sand, and the remaining is carbonate with some minor iron oxide -- iron oxide. There is no sulphur in the sand.

MR. LENEVEU: Thank you for your answer.

THE CHAIRMAN: Chair. You have three minutes.

MR. LENEVEU: Oh my goodness. I'd like to go on to Slide 6. The other two sand samples, Bru 121 and Bru 146, were outside the project area, well outside, and they were sampled in 2018 and stored for two years, which according to the -- sampling guidelines, the hold time is much too long. So, those samples are suspect as well. So, I would suggest you have no valid sand samples. And as well, the sand is reported as having up to 15 -- five percent oolite and -- or concretions and interbedded shale that are known to have pyrite in them. So, your sample volume, your -- your sand volume that requires sampling is huge, about five percent of 1.36 million tonnes, which suggests over 80 samples are required per year in order to -- because of these other materials that come up with a sign that are pyritic, and so, not three sand samples, one of which was from a weathering thing, the other two outside the project area, you need probably 80 samples or more because of all the other entrained interbedded shale concretions and oolite that are known -- that weren't sampled that -- but are known to cause a -- be pyritic, and within the sand and be drawn up. So, in the light of those facts, is not three samples completely insufficient, and you must go out and resample the sand over the entire area for somewhat up to 80 samples? And ---

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. I will start by saying that's an opinion, and I cannot address that at this point. However, the guideline that the MEND provide is for the characterization of the waste rock. The sand is the commodity in this case. Let's replace the sand by gold, for example. Is it reasonable to -- to send to the lab six kilograms of ore for testing (inaudible). The same procedure was done for this, and we collected samples to make sure that we have a spatial distribution in order to -- to capture the -- the geochemical features, and that's why we used those two cores. And for the record, two years old core is very, very young. Mining companies use core that's ten years old for assessment, and two years I -- I think you can consider it fresh. A core stored in a warehouse for two years, I'm confident it's -- it still has the same characteristics as when taken.

THE CHAIRMAN: Chair. So, that will conclude this line of questioning. MSSAC, you are up next. May I assume that Jason is in the chair again? Thank you, Krista. Thank you, Dennis, for your questions, and panel for your answers. So, Jason, will let you go for about 20 minutes and then we'll take a brief break and you'll get the remainder of your time on the other side of the break. Sound like a plan?

MR. MANN: Sure. Thank you, Chair. Jason Mann representing MSSAC. Thank you everyone for allowing these questions today. My first question relates to page three of your slide presentation yesterday. You had a list of individuals who were directly involved in the work, who did review of the work. It's quite an extensive list. My recollection in reviewing the peer review by Dr. Ferguson was that Jeff Bell, P.Eng. Friesen Drillers, was also part of that review. I didn't see his name on Page 3. Was his name just missed in that list of reviewers or participants?

MR. MILLS: Ryan Mills with AECOM. Yes, that's correct. Jeff did provide comments and feedback on -- on some of this -- this work.

MR. MANN: Thank you. On your numerical model calibration, was there a verification step there as well, you know, even as a steady state case, to check your calibration against a different set of base conditions? So, in other words, as an example, even in the steady state case, pick a set of conditions at the end of a dry year or dry summer to see if that model still maintained an acceptable calibration? Was there a verification step like that done as part of the the work? Sorry, that was Jason Mann.

MR. HARVEY: Miln Harvey, AECOM. No, we used all of the historical data to do a calibration. A verification step is possible, but not commonly done. We did not do it.

MR. MANN: Okay, thank you for that answer. Related question, I guess. Why would you suggest it's not commonly done when it could be just an extra fairly easy step to check your calibration state?

MR. HARVEY: Miln Harvey, AECOM. Yeah, although it could be done, lack of data means that it's very hard to do. We typically take all of the historical data and -- and do a calibration, and at the end of the project, to do the verification you would require more data, and often that takes years to gather. So, there isn't any data that -- or there doesn't appear to be any data that we could use to do a verification.

MR. MANN: So, there was a very extensive plot of calibration data demonstrated when you -- you achieved your calibration. What I'm asking is you could simply pick a set of data from a different period of time. And there are long-term provincial well records here in the province where a choice like that could be made, where you may not have the same number of calibration points, but you would have a reasonable amount of calibration points to check your calibration. So, again, I'm asking, why -- why wouldn't you take that approach, because -- well, I don't wanna render my opinion, but I wouldn't agree that you wouldn't be able to do it because of data.

MR. MILLS: So, Ryan Mills with AECOM. I think it's a fair comment that there is -- there's no end to the number of -- of kind of time slices that you could undertake to look at the data for an individual year, going back over the approximately 100-year record of -- of well construction and water level measurements in the province. There are sort of a couple of classes of -- of data. There's the long record of borehole well construction reports, that typically have a water level reported on them, that cover the full model domain typically, but as you might expect, the -- the progression of the installation of those wells sort of moved from a centre of population likely, and moved generally east and further away from, for example, Winnipeg. And perhaps Steinbach. And so, the -- you're making decisions to -- to try to, in an attempt to capture the full geographic extent of the model domain, and -- and also pick a representative timestamp for -- for, you know, current conditions. Those water levels do vary over time. There is also a -- actually a fairly good water -- or monitoring well network that has been established by the province and -- and sampled from time to time, and with that, water level measurements were -- were recorded. Many of those records are in -- in paper format, as you're probably well aware, and it -- it does require some time on behalf of the -- the province to provide that data in a digital format that's usable in the modelling context. And also, you know, some time to -- to select a -- a timestamp. Even that monitoring well network has slowly expanded overtime.

MR. MANN: Jason Mann. Thank you for your answer. All of those things are -- are correct, but to answer the original question, a verification wasn't done.

I'll move on to my next question, and please correct me if I'm wrong in -- in my recollection along the way on -- on this one. If I recall correctly, the permeability conditions in the model were assigned generally within the geologic units and may not necessarily vary spatially. Is that correct?

MR. HARVEY: Miln Harvey, AECOM. In the overburden, we have variable hydraulic connectivity. In the sedimentary bedrock and the -- the Paleozoic bedrock, there's -- or sorry, Precambrian bedrock, we have constant properties by layer.

MR. MANN: I'm sorry, I was writing notes. Respectfully, could you just restate the layers again that have consistent K properties within them?

MR. HARVEY: Miln Harvey, AECOM. Layers four, five, six, and seven, which are the sedimentary and Precambrian bedrock.

MR. MANN: Jason Mann. Thank you for that answer. So, related question, is it possible then, based on the configuration of the model with these strata having consistent permeability conditions in the fractured rock, you know an equivalent porous media type permeability that was chosen, is it possible that the calibration condition isn't unique? In other words, could you apply a different uniform permeability condition to those strata and maybe tweak your boundary conditions and still achieve a reasonable calibration result?

MR. HARVEY: Miln Harvey, AECOM. So, first of all, the -- the model was well calibrated, but there are other possibilities that could provide a reasonable calibration. To encompass those, we did a sensitivity analysis by adjusting input parameters and coming up with an understanding of the impact on output. And that's a common part of the -- the modelling process. So, it was calibrated, and then sensitive analysis was done to try to capture some of that uncertainty.

MR. MANN: Jason Mann. Thank you for that answer. My next question is related to sensitivity analysis because I agree with what you stated there. Slide 19 had a -- a plot or a table of -- of the sensitivity analyses that were done. Sensitivity analysis were discussed yesterday with the geotech group because sensitivity analysis are important in any modelling study. It tells you the end members of results that may be possible as you vary input parameters or combinations of input parameters. Allows you to choose the most probable configuration or configurations from which design is based and assessment of risk comes. Would you agree with that perspective?

MR. HARVEY: Miln Harvey, AECOM. Yes.

MR. MANN: Thank you for that answer. related question then would be, and apologies, I didn't look through the table in detail, even at a high level, what were the parameters in your groundwater model that resulted in the largest variability on your model results? Jason Mann, if I didn't mention that, sorry.

MR. HARVEY: Miln Harvey, AECOM. Hydraulic conductivity, horizontal hydraulic connectivity with the carbonate and the Winnipeg Sandstone.

MR. MANN: Thank you for that answer. Jason Mann. Slide 20 discusses simulations that were done and as -- as described on that slide with "degradation of the shale aquitard". We've seen yesterday in the geotechnical data collection and sonar scans, the shale, in some cases, completely collapses into the void space that's created in the sand below. So, my question is, in the model, how was that shale condition modelled in the groundwater model and in those simulation cases?

MR. HARVEY: Miln Harvey, AECOM. We adjusted the hydraulic conductivity of the shale to be equivalent to the hydraulic conductivity of the sandstone. So, we're equilibrating essentially the -- the shale -- the degradation of the shale with the equivalent connectivity of the sandstone to connect the two aquifers.

MR. MANN: Thank you for that

clarification in your answer. Related question would be then, because that's a logical approach, what kind of an area would you apply that adjustment to? Was it on a -- sort of a cluster size basis, or a single node, or a single well point, or what did that look like in your model?

MR. HARVEY: Miln Harvey, AECOM. We used a 200 metre radius around the well -- the operating well.

MR. MANN: Thank you very much for that answer. Related question and it -- I can ask it now because it comes into play with some of my questions later. So, with those changes in simulations, which make good sense to me, did you check what the vertical gradient changes might be between those aquifer systems, first and foremost? And then kind of related and second question, did you check for a flux change vertically between the aquifer systems when you impose that change in permeability and a 200 metre radius, which would simulate the -- the loss of the shale? I'm wondering about if you, in the model, looked at gradient changes that might happen and related flux changes vertically that might happen. That was Jason Mann.

MR. MILLS: Ryan Mills with AECOM. I -- there are continuous hydrographs plotted that show the -- the transient response of water levels at several observation points within the study area, to those -- the operation of the extraction well clusters over time. We do plot the water level responses in both the carbonate and the sandstone aquifer at several locations, representing in some cases real water supply wells and in some cases -- or monitoring wells, and in some cases hypothetical monitoring well locations. But we did not explicitly calculate the -- the -- the change in gradient overtime, or plot that information. It would be fairly simple to do that, and -- and just by -- by reviewing the hydrographs. But that was not directly completed here.

MR. MANN: Thank you for that answer. Jason Mann. And so, apologies I didn't go through the minutiae of a bunch of hydrographs and things, but what you're saying is correct. Would that be something that this panel would be interested to do or commit to do just to do those checks on whether gradients change in the model or if any flux changes vertically in the model?

MR. MILLS: Ryan Mills here with AECOM. Yeah. That -- that -- that's fine. We could -- we could undertake that.

MR. MANN: Thank you. I appreciate that answer.

MR. MILLS: Just -- just for clarity. Ryan Mills here. Primarily interested in -- in -- and plotting the -- or the gradient difference.

MR. MANN: So, Jason Mann. Gradient would be important, but I would be interested in flux too with the -- with the loss of the shale if that's -- you know, it should be -- should be something that's capable to be done, but that would be the two pieces that I would ask for a request.

MR. MILLS: Ryan Mills with AECOM. The -- the gradient portion we can probably accomplish within the timeframe covered by the -- this hearing. The -- the rest of the information does require more time to process. It probably exists in the existing simulations, but those simulations do take several days to run each, and we may not be able to process that if it's not already contained in the output files.

MR. MANN: Jason Mann. 100 percent understand the answer that it would take time to pull the flux from the model. Again -- and appreciate that it -- it's not coming in 10 minutes or maybe in a couple of days, but would there be a commitment to share that information?

MR. HARVEY: Miln Harvey, AECOM. Yes.

MR. MANN: Thank you for that answer. The new model results that you have run recently start being discussed on page 23 in your slide deck yesterday. And my understanding is those new model runs were initiated from a change in well cluster layout from the geotech side that -- that happened recently. And there was discussion there about adding new observation points in the model to assess the model results. That's all good stuff. So, my question is -- and again, I apologize. I didn't go through all of the hydrographs or all of the results and cross-reference these, but were there coincident model observation points from that old model to the new one? And you know, what does that change -- what did that change look like, if just even at a high level?

MR. HARVEY: Miln Harvey from AECOM. So,

we kept the previous model observation points and we added new ones.

MR. MILLS: And Ryan Mills here. Just to, I think, directly address the -- the kind of tag on question there. There were very few to no changes. So, really the -- the behaviour of the aquifer remained similar in -- according to the model outputs. And -- and really, the spatial footprint of those -- the drawdown and recovery is -- is what changed.

THE CHAIRMAN: Chair. Let's break for 10.

(OFF RECORD)

(ON RECORD)

THE CHAIRMAN: Chair. Okay. Folks, let's get back to our seats, please. We have lots of ground to cover today. All right. Jason, the floor is yours.

MR. MANN: Thank you. Thank you, Chair. Jason Mann with MSSAC. Just before we -- we broke there, I had a related question on the back end of what we were talking about, and just to revisit, there was the dialogue around there were coincident model observation points within the old and new models. I think that's -- that's important. And so, I also appreciate -- and so, and part of that dialogue was that the lion's share of the differences in the model behaviours between new and old were related to the part of the drawdown area, I think is what I heard, versus the model behaviour broader, which makes sense. And so, more of a maybe comment or -- or question, and I appreciate there were drawn contours shown in the slide deck yesterday, I -- I will say my eyes aren't as good as they used to be and it -- it was challenging to see them. But you did have them there, thank you. I was just wondering if there was -- again, and maybe this exists, or maybe it's something you're planning to do, an overlay of, like, the drawdown conditions of the old model to news, so it would be very easy to see in a -- in a diagram what the differences are? So, just asking that question, you know how -- how would you plan to show the differences in those key areas between the old to new models, I guess maybe is the question?

MR. MILLS: Ryan Mills here, with AECOM. So, I -- I think there are -- there are two -- two components to this, one is the spatial footprint of the drawdown cones and those have been presented on separate figures. There are some common landmarking points on those figures, so, they can be easily compared by sort of having them both on -- on a screen or -- or in printed copy, and they are presented in our presentation that's available to everybody, both -- both on subsequent figures. The -- the second part of the question is -- is there are a number of those observation points in -- in the transient or the -- the plots of groundwater level changes over time in both the carbonate and sandstone aquifers, that don't show much response to pumping. And so, those are sort of outside, or at the margins, of -- of the impacts to water levels and -- and the impacts of sand and water extraction. So, they provide a bit of context. There are some wells that were impacted before, that are no longer impacted, because they're not close enough to -- to the extraction wells to be affected by that pumping.

MR. MANN: Jason Mann. Yep, understood. Thank you. Related to the new model, I believe in the slide deck, there was mention of one model run that's still being done, I believe it was the 100 percent reinjection case of the 85 percent of water that's available to be reinjected. Is there an idea or timeline when that might be available for review, and is there a commitment to provide that for evaluation and assessment along with perhaps, is there a plan for a deliverable of the new model work? And related question to what we just talked about on the drawdown contours, fully appreciate that they're in the deck and the two could be printed and looked at, and compared, I would agree. I just found it really hard to see the ones that were in the deck, so if there was some other deliverable, or a set of maps, or other things that are planned and -- I'm just asking the question if that's part of the plan.

MR. MILLS: Ryan Mills with AECOM. The results that have been completed to date, so the model runs that have been completed to date are the most conservative cases from the perspective of the -- the groundwater users in the carbonate aquifer, and -- and they are the most comparable to the previous modelling runs. The new model will be sort of -- is an updated model that benefits from the input and learnings from the geotechnical program. It takes some time for that information flow to work through all of the -- the interdependent assessments. The work that we have done so far, we used the most conservative case of zero percent reinjection for the -- as a basis for our impact assessment that was presented in the EAP, and that remains the most conservative case, and those results have been presented, in addition to the 50 percent reinjection case, which is the most comparable with the previously simulated 50 percent reinjection case. So, this 85 percent reinjection case is -- is, you know, kind of a -- would result in less impact than we have used in the assessment in the EAP. And you know, it will take, you know, time for that to be documented.

The methods of assessment and the approaches in the modelling are identical to what was done previously. We've essentially moved the extraction points to a new footprint. We have not adjusted any aquifer properties, we have not adjusted any other parameters, and -- and those results are -- are presented. So, there -- they will be documented at some point, but there's -- there's no value to the current -- current, you know, kind of discussion, I -- I don't believe.

MR. MANN: Jason Mann, thank you for that answer. I wouldn't agree that there's no value. I think all results are important to take a look at. I do appreciate your answer referring to the fact that the assessment was done on a -- the most conservative case, and that the run we're discussing, that hasn't been presented, would be as of less impact. And I would take that answer from you as -- at face value. I -- I guess I would just highlight to the Chair perhaps that there's work being done that hasn't necessarily been evaluated as part of the process, and I'm not sure how that would be handled. And so, I'll just leave that at that.

And I'm not sure -- so, next question -- I'm Jason Mann -- I'm not sure if it's the model, or field work, or both, it could be both, there was a discussion or an indication that groundwater recovery at the wells, to about an 80 percent recovery, occurs in short timeframes and probably that's a combination of the actual pumping tests done potentially looking at what the model simulates, as well. So, what are those timeframes for that 80 percent recovery occurring, and could you clarify, is that based on pump test model, both, or one or the other?

MR. MILLS: Thanks for the lead in. Ryan Mills at AECOM, and -- and the recovery times are based on direct observations from the pumping tests, and because there is good agreement between real-world observation during the pumping test and the model, those behaviours are -- are also simulated in -- by the model.

MR. MANN: Thank you for that answer. A related question, then. The field tests were based on single well pump tests and that's okay. The extraction of a cluster of wells will be done by a number of wells that may, and I'm not certain you can, correct me if I'm wrong, may operate concurrently, or may operate independently, but follow one after another, perhaps. So, the single well test is important, to have the model reflect that is important. The model presumably, then this is my question, would reflect also, or would have been assessed against full production status, let's say, full production of a cluster. Is that correct?

MR. MILLS: Ryan Mills of AECOM. Yes, that's correct. We have assessed the operation of a full well cluster.

MR. MANN: Okay. Thank you. So, 80 percent recovery occurs in a short timeframe. Do you know when does practically 100 percent, or close to 100 percent, recovery occur? What kind of timeframe does that -- does that look like? High level. I'm not looking for, you know, minutes. Oh.

MR. MILLS: Ryan Mills. Over a period of -- of weeks.

MR. MANN: Thank you. Jason Mann. Related question, and I believe it was in some of the plots you showed yesterday on the new model side and -- and the X-axis was in days, it wasn't by date, but it showed when the -- when the pumping activity was going on. If we took those days and put them on top of a calendar, what is the season of operation like? When might it end, plus or minus?

MS. WEEDEN: This is Laura Weeden. We are intending to operate between mid-April and mid-November, weather permitting.

MR. MANN: Jason Mann. Thank you for that answer. So, operations going into -- or call it early winter or late fall.

So, related question. There's -- there's some work been done in the province that demonstrates in this region and in other major aquifer systems in the province the lag time between the aquifer showing its pattern of response to a prior years wetter than average condition, or on the other side, a drier than average condition. In this area of the province that lag time can be eight months. So, my question is, then if you operate to mid-November and presumably 100 percent recovery occurs within weeks, which is what you're saying, and then you start up operation again the following summer, if there was a drier than normal year that natural condition would be reflected in a lower than normal aquifer level -- or trending downward aquifer level that following summer. Does that complicate or change how you might approach the work for this project?

MR. MILLS: Brian Mills with AECOM. I think it's important to recognize that the calibration data set captured several decades and -- and information collected over a range of meteoric conditions that, you know, based on my review of the observation well data from -- from the local monitoring well network included droughts and -- and very wet periods. So, implicit in the modelling to date has been consideration of -- of -- of wet and dry periods. And -- and so, the answer is, you know, no. It would not necessarily change the -- the modelling approach.

MR. MANN: Jason Mann. Thank you for

that answer and -- and confirming there's quite a bit of data for calibration and model verification that's available in the province.

Some geochemical questions. My understanding from the geochemical perspective, probably by isotopes, is that the aquifer systems are all demonstrative of meteoric water. I would interpret that that would be the case. I believe that was the statement made, and I just was looking for verification. Please, yes or no on that.

MR. OULD ELEMINE: I would say yes, except the shale.

MR. MANN: Good. Thank you for that answer. Appreciate that. Jason Mann.

On slide 44, there's the oxygenated simulations done where excess oxygen was modelled into the water quality conditions, and I believe the outcome of that work demonstrated that metals like iron will precipitate from solution, which happens. I -- and so, it sounded like that simulation was, I believe, an excess of oxygen applied. I was wondering what a simulation along the lines of what the production process will look like. So, we know the water will be aerated. To some extent it's agitated. It's being pumped to surface. Was there a simulation done to reflect what would be the best estimate of the process itself in terms of oxygenation and perhaps metals precipitation versus what I think I read was simulated where an excess of oxygen was modelled? And please correct me along the way if I'm misinterpreting something.

MR. OULD ELEMINE: Cheibany Ould Elemine. The simulation was done assuming an equilibrium of water with atmospheric partial pressure, not excess of oxygen.

MR. MANN: Jason Mann. Thank you for that answer. So, maybe it wasn't written that way, but I thought I heard that in the discussion, so apologies if I was incorrect there. So, have I -- I heard you correctly, in equilibrium with atmospheric conditions?

MR. OULD ELEMINE: That -- that's -- Cheibany Ould Elemine, AECOM -- that's correct. And it's described in the hydrogeology assessment report.

MR. MANN: Thank you for that answer.

Related question, just to close this one out, does aeration make a difference, or agitation -- that would occur with the process?

MR. MILLS: Ryan Mills with AECOM. I think that this -- this simulation was intended to be the -- the most conservative. What we heard from -- from reviewers and -- and participants was that there was an interest in the effect of -- of air and its interaction with water, and the materials in the aquifers. So, we undertook a highly conservative kind of simulation to look at what the end member condition might look like and -- and so, there -- there would be a -- this condition could persist if that water remained at surface in perpetuity. But as soon as it goes back into the aquifer, we would not expect this condition to prevail because there is not an abundance of -- of air or oxygen in aquifers, and it would likely return to equilibrium with the minerals in the aquifer as it currently exists.

MR. MANN: Thank you. Jason Mann. I guess what I was wondering is, and I know the water quality in the sandstone is quite good, but in places where water can be hard or there's a high -- higher dissolved mineral content, metals content, I mean quite simply, it'll come out of solution in -- in household plumbing, right? I mean, we -- we've all seen that. I'm not suggesting that's the case here, but these things happen. So, again, just wondering with the process that's planned, and -- and yes, aquifers and groundwater have relatively low dissolved oxygen content, there's no doubt, but that water is being airlifted to surface, run through a process, it's agitated. Should something come out of solution, is there a plan to manage that, because so far treatment plan is only UV relative to bacteriological or other concerns? If -- if something comes from solution as part of process, precipitates from solution, is there a plan for that to be handled? Or I'll ask the question in a different way, based on your analysis, is it a non-issue?

MR. MEUZELAAR: Tom Meuzelaar, Life Cycle Geo. Just our models show that we do not expect any significant precipitates coming out of solution.

MR. MANN: Thank you for that answer. So, there's discussion of -- Jason Mann -- discussion of aquifer mixing, as part of the slide deck from yesterday. And please, again, I'll -- I'll paraphrase what I thought I read and heard, and if I don't have it right, please --

please correct me. With upward mixing from the sandstone aquifer and proportionally more than 80 percent sandstone waters coming to the carbonate aquifer, I believe the statement was iron would be predicted to be below guideline. With proportionally more than about 70 percent sandstone waters coming up to the carbonate, manganese would be below guideline as measured in the resultant prediction of carbonate water quality. So, the allowable proportional balances then on the carbonate side are 20 to 30 percent of carbonate waters in that -- in that mix, as round numbers. There's a statement "Other water quality parameters improved as well with mixing from the sandstone aquifer below. So, with 70 or 80 percent of sandstone water quality mixing to the carbonate aquifer, chloride, calcium, magnesium, arsenic, iron, uranium, strontium, improved as well." So, would this then -- and again, apologies, I didn't go back to all of the reams of data, this would imply that the parameters are proportionally elevated within the carbonate aquifer versus the sandstone aquifer under currently naturally conditions. Is that correct?

MR. MILLS: Ryan Mills with AECOM. I -- I think this is when it's difficult to make blanket statements over general -- generalities of -- of all parameters, because there are differences in water quality between the two aquifers -- very subtle differences. One that you've noted with slightly higher manganese concentrations in the sandstone relative to the overlying Red River carbonate, and the opposite is true with respect to iron. So, that's one example of subtle, you know, differences.

MR. MANN: Jason Mann. Thank you for that answer. You're correct, this is a -- is a complicated question because it has to do with proportions of quantity of waters that are mixing, and the concentrations of the parameters that are within those waters, because in some cases, mixing of one aquifer water quality to the other will result in an improvement of parameters. But depending on what that route water quality is, it may also, at the same time,, and mixing in the same proportions results in a degradation of other parameters because it depends on what metals or solutes are in the water quality, and this is where -- where I was sort of going. So, you know, based on the analysis I saw talking about the sandstone upwelling or upward mixing to the carbonate aquifer, the -- the dialogue that I saw there was it improves the carbonate aquifer water quality, and that makes sense to me because basically the sandstone water quality is -- is better than the carbonate -- overlying carbonate aquifer water quality. So -- and at 70, 80 percent proportion you get an improvement in the carbonate. So, if we looked at it simply, if -- if we did the opposite, so, if -- if water flowing from below to the carbonate improves water quality, and you need 70, 80 percent as a proportion, would the opposite be true where carbonate water mixing downward to the sandstone could degrade the sandstone water quality? And again, key pieces here is proportions of mixing as -- as volumes or quantity, but also the parameters that are being looked at, and their concentrations, because again, a source water quality with low concentrations of something lower than the water it's mixing with, will result in an improvement, but the same proportion of mixing of that source water quality that has a different parameter that's higher than the receiving waters, maybe that receiving water can handle some of that, but at some point, you'll hit a tipping point where it degrades water quality. So, am I interpreting that correct? And -- am I interpreting that correctly?

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. I think degrade is a strong word because both aquifers are very fresh and our analysis shows that the parameters that exceed the guidelines are generally iron, manganese, and turbidity, and iron and manganese only exceed the aesthetic. The other parameters we are indicating here do not exceed any guideline and we do not anticipate that a conservative mixing will result in an increase, for example, of chloride in the sand to the point that it will exceed applicable guidelines.

MR. MANN: Jason Mann. Thank you for that answer. And you're right, guidelines matter too, because you can approach the threshold and be below a guideline, and that's important. But let me ask the question in a different way and -- and degrade maybe as a strong word. I'll step back from that. Would you agree that with an exchange of waters between these aquifer systems there will be changes in water quality, and in some cases a parameter may reduce in its concentration because of the source water quality, the proportion of mixing, and the result, and in some cases parameters might increase. We still might be below guidelines but there will be those changes. Am I correct?

MR. MILLS: Ryan Mills with AECOM. It's important to remember that both of the -- the aquifers here contain potable water, and they are used for drinking water purposes as they sit now. One is slightly softer and the other is slightly harder. The exchange of waters occurs in response to driving forces in the form of hydraulic gradients, so differences in groundwater elevations between the two aquifers. Within the project study area, we found, based on the provincial groundwater level monitoring network, that those groundwater elevations in the carbonate and the sandstone are fairly similar. It's because just 10 kilometres east of here, they're both supplied by the same overburden aquifer, right, the Sandilands recharge area that equilibrates those heads, and there have been some historical interconnections. There are -- the magnitude of this impact surely has been noted much further west, near the Red River, where that deep, you know sandstone aquifer is saline, or brackish at least, and -- and the overlying carbonate aquifer is -- is you know, fresh. And so, here, the exchange of those waters is -- they're not too far from their origin in the Sandilands and they're not, you know, they're not -- to kind of -- it changes as you move further west in -- in the aquifer. And so here, where the heads are equilibrated, that exchange would be a very short-term phenomenon and until the -- the heads and the aquifers have returned to static conditions. So, we're talking about periods of days to weeks, and -- and they would not persist because the heads would likely equilibrate, as they are nearly equilibrated now.

MR. MANN: Jason Man. Thank you for that answer. The things you're saying are -- are right. They will equilibrate, but they'll equilibrate because there'll be an exchange of water, and an equilibration of pressures. So, I'll ask the question in a different way. Is there an opportunity, recognizing both of these aquifers are in a reasonable water quality, however, is there an opportunity for water qualities to change because of these exchanges, because of these reequilibrations? I guess I'm answering my own question because you've modelled it and you have shown that parameters will change, but I'll ask the question, is there an opportunity -- is there potential for aquifer water qualities to change in one or both of these aquifers?

MR. MEUZELAAR: Tom Meuzelaar, Life Cycle Geo. So, fundamentally, yes. We're talking about two waters that are very clean, TDS 300 to 400, so their chemistries are not all that different. So, you know, are -- are there some mass-balance changes? Absolutely. Are they significant? In our opinion, absolutely not.

MR. MANN: Jason Mann. Thank you for your answer.

MR. MILLS: Apologies. Ryan Mills with AECOM. I'll just maybe add an analogy to help kind of frame this. You know, we've all had bottled water, it reports the concentrations of -- of minerals on the label and you might have a -- one bottle from one manufacturer, let's say Evian, and you might have another bottle of water from another manufacturer, let's say Dasani. They have slightly different chemistry. You could pour half a bottle of one into the other, and it may take on the flavor of one versus the other. It may be undistinguishable. And we think it's going to be undistinguishable.

MR. MANN: Thank you for your answer. Jason Mann. I'll -- I'll leave that there. I don't know if I have another question on that. I think we'd be straying into opinion and so, I'll respect the panel and I'll respect the process, and I was warned yesterday.

There's a statement made in the assessment of impacts, Slide 49, that the groundwater impacts are short-term and reversible. Please correct me if I have that language incorrect, but I believe that's what -- what the statement was. Based on observations of pumping tests and modelling results at least -- and at least when looking at 80 percent aquifer recovery from pumping stresses, there was an acknowledgement in that discussion there's variable vertical gradients in the region that tend to show, I believe, and correct me if I have this wrong, upward flows, at least in places, from sandstone to carbonate, as well as the opposite downward flows from the carbonate to the sandstone. The geotech team yesterday demonstrated clearly, at least in some areas, there's complete failure of the shale aquitard that will occur with the development of the void spaces within the sand, with the loss of the shale, aquitard and at least some of the project area. And this whole question about geochem that we were in, and exchanges of water and mixing, it's why I asked about the model, it's why I asked about did you measure vertical gradients in the model, it's why I asked about vertical flux in the model. The loss of that shale aquitard, at least in some of the project area, would it be reasonable to believe there would be a change in vertical exchanges of water between the aquifers? And secondly, is that outcome reversible?

MR. MILLS: Ryan Mills with AECOM. First, it's important to note that there -- we have not observed upward gradients from the sandstone to the overlying carbonate locally. It's primarily downward gradients that we've observed or near -- near neutral, so approximately zero. The -- and apologies, there were a bunch of questions embedded in there, or maybe some comments, so, maybe I'll just ask you to repeat the question?

MR. MANN: Sure. Sorry. Jason Mann. Thank you for that clarification. With the dialogue of upward mixing I made the interpretation that those gradients might be variable. So, thank you for -- for clarifying that.

So, really the question is -- so -- so, the -- the dialogue here was that, based on the assessment of impacts, the groundwater impacts are short-term and reversible. This is what I heard. We've also heard -- or we've -- we've seen that there will be a loss of the shale aquitard in at least some of the project area. And again, it ties back to why I asked about some of the model results and how that was resolved in the model. So -- so, the -- really the question is this. With the degradation or loss of shale aquitard, at least in places, would it be reasonable to interpret that there would be a change in the vertical exchanges of water between the two aquifers? That's the first question.

MR. MILLS: Thank you -- thank you for that. Ryan Mills with AECOM. The -- the response is, yes. There will be a short-term change in the exchange between the aquifers until groundwater elevations equilibrated.

MR. MANN: Thank you for that answer. And then -- and the extension of that question is, is that outcome reversible?

MR. MILLS: Ryan Mills with AECOM. So, the -- the changes in -- you know, with removal of -- of shale, the model simulates what those changes will look like. The groundwater elevations were simulated to restore themselves similar to those present when we accounted for the degradation of the shale in the aquitard. As we discussed earlier, you know, the gradient plots will be provided. And we can more directly respond to that, if you like.

MR. MANN: Jason Mann. Thank you for your answer. I think what's important here is, I would agree with you in saying that there's a re-equilibration of -- of heads that will occur because it will. And I agree with you with that assessment. And I asked if that was reversible. I think I -- I have my own opinion of what that answer is. I think it's not. And -- and I -- I didn't hear an answer from you specifically on that and that's okay. I have no further questions. And I thank you for your time and the opportunity to ask the questions.

MR. MILLS: Ryan Mills with AECOM. Apologies. I don't think I did respond directly to your question. So, if the shale does in fact collapse, that is not reversible. And that is, yeah, understood to locally change the aquitard. The -- the flow of water in aquifers is as a tenant of the field of hydrogeology, typically thought to be horizontal primarily within high permeability or moderately permeable aquifers, and vertically, you know, across aquitards. It's all driven by head differences. If there are no head differences, there will not be any exchange of water. There may be diffusion dominated processes, which are very slow and of limited magnitude when the water qualities are similar because they're driven by concentration gradients.

MR. MANN: Thank you for that answer. I would agree with what you're saying, but that occurs in a natural system that hasn't been drilled through or otherwise altered. So, I'll leave my questions and comments there and appreciate your time. Thank you.

THE CHAIRMAN: Chair. Thank you very much, Jason, for your questions, and panels, for your answer. We're going to take a brief unscheduled pause as we appear to have lost our internet connection with Toronto, so transcription services are currently down. And I will wait for Cal to give me a thumbs up when they return. MBEN, you are up next. Is that correct? Chair. Okay. The emphasis was -- was on a brief pause. We -- we are reconnected with the outside world. So, I've just kind of clarified the process here. I did understand that Our Line in the Sand was asking for -- or would be questioning tomorrow, but I think Our Line in the Sand doesn't have any questions, it's MB Net that will have -- MBEN that will have questions tomorrow morning when Byron is back with us. He's currently in King's Court. And I should point out that Kelly is here for -- as Bill is in King's Court today, so Kelly, maybe raise your hand just to note on the record that we have a change in CEC lawyer.

So, with that questioning will revert, uncharacteristically not last, but to the panel, since Byron will be last tomorrow morning and on behalf of the panel, I will turn it over to Hartmut Hollander.

MR. HOLLANDER: My first question -- Hartmut Hollander -- is in the regard, what is the size of your model domain?

MR. HARVEY: Miln Harvey, AECOM. The square area is 3,200 square kilometres. The length and width -- that's approximately 80 kilometres by 40 kilometres.

MR. HOLLANDER: Hartmut Hollander. Thank you very much. The answer which you gave to Jason Mann just before, was that you used a homogeneous system for the sandstone and for the carbonate aquifers throughout the whole domain, which is, as you said, just 80 kilometres wide -- long and the 40 kilometres wide. How appropriate is this to describe the groundwater flow in such a big area?

MR. HARVEY: Miln Harvey, AECOM. So, in the model development and calibration process, there's a principle called the principle of parsimony, and if you want to Google it, you can look up Mary Hill at the USGS. And in that -- that principle says that you should start modelling -- start your model with simple assumptions. So that -- so you start with uniform properties and simple boundaries and compare the model results using calibration. If you achieve a reasonable level of calibration, there -- there is little need to increase the complexity in the numerical model to describe something that you're already describing well. So, we assigned heterogeneous hydraulic connectivity to the overburden and uniform properties, hydraulic connectivity, to the -- the bedrock, because that simple -- more simplistic assumption was validated through the calibration process. We got -- we got a good calibration from that.

MR. HOLLANDER: Hartmut Hollander. Thank you very much. So, in order to start this process, to come to this point which you just explained, you were carried out pump test, is that correct?

MR. HARVEY: That's correct.

MR. HOLLANDER: So, you used a single pump test, and I don't want to forget the five slack tests, to identify the hydraulic parameters in that area of interest. Is that correct?

MR. MILLS: Ryan Mills of AECOM. As you know, we conducted a local scale pumping -- or slug tests associated with individual monitoring wells, which are also a form of aquifer testing, more localized tests, and complemented that with a -- a constant rate pumping -- a step test and a constant rate pumping test that encapsulated approximately a 1.5-kilometre radius of influence from -- from memory.

MR. HOLLANDER: Hartmut Hollander. Thank you very much for this explanation. So, you built a well inside the sandstone and there are advice from the -- from the province, published by Betcher, 95, to screen wells when you bring them into the Winnipeg sandstone. Did you screen the well?

MR. MILLS: That's correct. Ryan -- sorry, Ryan Mills of AECOM. That is correct.

MR. HOLLANDER: After screenings -- Hartmut Hollander, thank you. After screening those wells, there should be a procedure of well development.

Your data, which you published inside your hydrogeological part show that this well has a very poor well efficiency. Was the well development to -- to code?

MR. MILLS: Ryan Mills with AECOM. During the process of drilling any water supply well for the purposes of water supply, wells are typically developed to improve the efficiency. That is not a requirement for hydraulic testing when you have observation wells. And pump -- because we had an extensive observation well network that was spread out laterally, and with depth within each aquifer, we were able to reduce the need for development to allow for use and reliance on that observation well data in place of the pumping well data, which is known to be fraught with perturbations related to pumping and -- and poor well efficiency, as you pointed out.

MR. HOLLANDER: Hartmut Hollander. Thank you very much. You said there was a lot of observation wells which you created. How many created -- were created by you for this pump test and how many residential-owned observation wells did you use?

MR. MILLS: Ryan Mills with AECOM.

Apologies, I'll be slow here because I need to consult and count along the way. From Table 3B in our Hydrogeology and Geochemistry Assessment, we had one pumping well in the Winnipeg sandstone, a vibrating wire piezometer nest with completions in the Red River carbonate, there were two vibrating wire piezometers in the Red River carbonate at a distance of 89 metres from the pumping well, one vibrating wire piezometer installed in the shale unit, and one vibrating wire piezometer installed in a sandstone unit. In addition to that, we had three additional monitoring wells installed in those units at a distance of 338 metres from the pumping well, one in the carbonate, and one in the sandstone at a distance of 1.2 kilometres. And three private water supply wells that allowed us to instrument their -- their wells during the pumping test. So, those last three were not installed by us, but were monitored by us, and the remaining -- of the remainder, four were installed in the Red River carbonate, three observation wells were installed in the sandstone, and two monitoring wells and/or vibrating wire piezometers were installed in the shale.

MR. HOLLANDER: Hartmut Hollander. Thank you very much for this clarification. The guidelines which are laid out for pumping test by Cruseman

Derida (ph) show that you should have a minimum of three observation wells, formation. In this case you showed that you have three formation, three observations in the sandstone, and four in the carbonate. That makes just the minimum. Can you repeat your judgments that you have an extensive observation well network, or do you see that you met just the industry standard?

MR. MILLS: Ryan Mills with AECOM. As you've pointed out, we did meet industry standard with the observation well network. And I will also point out that this work was conducted on -- following an extensive literature review that had conducted several other pumping tests in the area, and -- and also utilized observation wells and -- and pumping wells. So, we -- we began with a point of knowledge. We're not starting from a point of -- of no knowledge.

MR. HOLLANDER: Thank you for putting your choice into place. Hartmut Hollander, again. Now, I would like to move to the evaluation of the pumping test. Can you explain which methods did you use and why you chose this method to evaluate the pumping test?

MR. MILLS: Ryan Mills with AECOM. A

Bouwer and Rice method and it's a -- a method that's widely applied to aquifers that -- and hydrostratigraphic units that meet the -- the basic assumptions of -- that are often employed in analytical solutions. For the pumping tests, we utilized the Theis method. And the Cooper-Jacob method. And with -- and the Theis method allowed -- was employed in -- in three different ways. So, there was an analysis of the -- the pumping data using the Theis 1935 solution analysis of the recover -- sorry, drawdown and recovery data using that same solution, and employment of the distance drawdown method for analysis of of -- of the drawdown data, stabilized drawdown data, at various distances, and the Cooper-Jacob method, which is a -- a fairly routinely employed straight line method. The ---

MR. HOLLANDER: Oh, sorry, I thought that you were ready.

MR. MILLS: Thank you. They were all kind of judged to be acceptable for use in an application to these aquifers because they meet the basic assumptions of those methods, you know, homogeneous, infinite acting aquifers, primarily horizontal flow, et cetera. There's a -- a long list of of the assumptions.

MR. HOLLANDER: Thank you. Hartmut Hollander. So, if I just conclude this shortly, you use different methods which are created for confined aquifer. Is that correct?

MR. MILLS: Yes, that's correct.

MR. HOLLANDER: Hartmut Hollander. A method for confined aquifer is not able to identify the Doric properties of a shale layer which is in between two aquifers. The measurements which you did showed that the carbonate aquifer experienced, at least at one observation well, about 1.5 metre -- the observation well is BRU 95-9, vibrating via two. So, we have already some connection, hydraulic connection in the current state between both aquifer. It's -- and why didn't you use this knowledge in your groundwater model later on?

MR. MILLS: Ryan Mills with AECOM. Two parts to that question, or two questions, I guess, there. The first was why did we not utilize a -- and I'll use industry terminology, a leaky solution, to evaluate the pumping test data. It is acknowledged that there are other, many in fact, hundreds, of -- of different analytical solutions that can be utilized to evaluate pumping test data. At the time, we looked at the data and the relative magnitude of drawdown in the -- in the pumped aquifer and we made the decision to focus on that for the analysis of the pumping test data. When it came to the numerical model, that information was considered and -- and the pumping test data in both aquifers was utilized to inform the transient groundwater model calibration. So, we calibrated, but first in steady state, and then in transient, in an attempt to simulate the behaviours of the aquifer over time based on the data collected from that pumping test.

MR. HOLLANDER: Thank you for this clarification. Maybe just one more question in this direction. maybe I didn't fully get it. So, you used this information later in the modelling, but you didn't calculate it, the -- the value based on your measurements. Is that correct?

MR. MILLS: Yes, that is correct.

MR. HOLLANDER: Thank you. I would like to move from the pump test evaluation to the local slug and bail tests which you did. Can you explain shortly to the panel, the difference between a slug and bail test, and the impacted area towards -- against a pump test?

MR. MILLS: Ryan Mills with AECOM. You know, slug and bail tests for the -- for the participants, typically remove a -- a fairly small volume of water, or insert a fairly small volume of water, into a well and measure the response or the recovery of water levels to that -- that stress. And they typically, you know, big, round numbers influence, you know, on the scale of metres around, you know, the -- the well.

MR. HOLLANDER: Yes, so they are just in the -- Hartmut Hollander, sorry -- just in the way of metres. So, why did you carry them out to characterise the aquifer? What was your intention in this direction?

MR. MILLS: Ryan Mills with AECOM. The intention of the -- the slug and bail tests was -- was to understand, collect some -- some simple basic data to understand the spatial distribution of hydraulic properties with -- at a very fine scale within the study area. And then that was going to inform broadly the approach to conducting a step test and pumping test and --

and so, that was the -- the purpose of it, was to characterize local scale hydraulic properties.

MR. HOLLANDER: Hartmut Hollander. Thank you very much. So, you did total five slugs tests, is that correct? Two of them should be in the sandstone, two in the carbonate, and one in the -- in the shale?

MR. MILLS: Ryan Mills with AECOM. Table 3A shows that we have two tests in the carbonate, one in the shale, and one in the -- or sorry, two in the sandstone.

MR. HOLLANDER: So, this -- Hartmut Hollander -- this -- this limited amount of tests will inform you for the -- for the well tests. Can you let us know what were the information which you received from them, and how did you use them in the design of the pump test?

MR. MILLS: Ryan Mills from AECOM. The information we received or we -- we obtained from -- from those tests, was essentially the transmissivity and hydraulic conductivity of -- of the aquifer within the vicinity of those wells.

MR. HOLLANDER: Yeah. The question is -- Harman Hollander -- whether in this moment when you do a slug test over such a large thickness, you would get an estimate which is reasonable to prepare the design of a pump test. And I'd like to come back to the pump test because you talked -- you said yesterday, and also in the report, that you did a step pump test in the beginning. So, the step pump test used intervals from 412 US gallons per metre, to 402, to 421, and then finally, you got confident 372. This is not the industry standard for pump tests. So, what did you try to -- to identify with this step down -- step down pump test which you -- which, I don't know what that was exactly, maybe you can explain that a bit better.

MR. MILLS: Ryan Mills from AECOM. As I kind of noted earlier, the -- the objectives of the pumping test were not to -- were primarily to obtain aquifer properties. And so, the step test was -- was used to guide or understand what that well would be capable of producing to establish a -- a pumping rate that -- that could be employed for the long term constant rate pumping tests that we -- we conducted.

MR. HOLLANDER: Yeah, I think -- Hartmut Hollander -- I think exactly that was not done because you changed your -- your pumping rate, if I calculate that in person by five percent -- a five change would not give you the answer which you just -- had just mentioned. Maybe you can comment on that.

MR. MILLS: Ryan Mills from AECOM. Shortly after installation of the well, we had a target pumping rate that was essentially -- our target was to maximize the pumping rate, to test as large a volume of the aquifer as we possibly could with -- within the, you know, constraints of something that was reasonably replicating the operational situation. And so, we wanted to see simply how much that well could produce after a period of development and -- and then conducted a long-term pumping test.

MR. HOLLANDER: Hartmut Hollander. That means you started this pump test -- you tried to pump as much as possible, but you were not able to pump more because this -- as I said, this variation of five percent? I still have not fully understood that.

MR. MILLS: Ryan Mills with AECOM. The

variability in the -- that portion of the test, as I understand you're speaking of, was partly due to some equipment, you know kind, kind of measurement techniques. You know, it's common to use an orifice plate, and there are some -- there's some subjectivity to those measurements, and so, those measurements were recorded as they were observed. It was not the intention to vary it simply by five percent, but that -- that is what came out of those direct measurements. All -- many pumping tests have subtle variations over their duration.

MR. HOLLANDER: Hartmut Hollander. Thank you very much for this clarification. So, after you finished the pump -- the step test, it is advised that you wait until the water level have recovered. Why didn't you do this in your procedure? Why did you directly move on to the constant pump -- concentrate pump test?

MR. MILLS: Ryan Mills with AECOM. It is an option to let the wells recover to static condition between a step test and a constant rate test. It is not a requirement. And in the industry, there are decisions that are taken by professionals to wait for that, or not. When you have a -- a measured static water level prior to the pumping test, you do have some understanding of what that initial point would be, and -- and that allows for decisions to be made in the field. Frankly, this -- in this case, the decision was made because it was quite cold at the time of -- of the pumping test, and leaving equipment full of water was going to require considerable effort for zero benefit at the time.

MR. HOLLANDER: Thank you for this explanation. Hartmut Hollander. So, there were, as we discussed, a couple of issues with this pump test. And also, one pump test, you probably agree, is not able to define the heterogeneity of such an aquifer, especially the plan which you showed, showed that about -- that's mining -- mined area -- will be about 168,000 hectare. The coverage which you had with your pump test is about 460 hectare, so,, just marginal amount, less than one percent. Is Sio Silica interested or willing to do more investigations to understand what is locally going on in this area before you start mining, so that this can be tested and proven after your mining impacts to -- to look at these impacts of that -- what will happen there?

MR. MILLS: Ryan Mills with AECOM. First, many other pumping tests have already been conducted in this area. You know there's an EAP submitted for -- for

Dugald, and Oak Bank, and -- and many other wells in the area. So, there is a -- a regional understanding that provides a -- a useful starting point where pumping tests have been conducted, that we benefit from through published and peer reviewed literature. Second, yes, we acknowledge that this specific pumping test did not test the entire footprint of -- of the proposed extraction. When -- when we compare the results of this pumping test to those observed regionally, and -- and documented regionally, they are similar, and within the range of reported values. So, it's a -- it's a reasonable understanding. Pumping tests, the entire purpose of a pumping test, is to test a large -- a larger volume of the aquifer that encapsulates, by definition, more heterogeneity than individual slug tests. And so, you start to understand the -- the regional aquifer properties, and because you've overcome what's known as the scale effect to some degree, there -- we can't test the entire study area. The third part of this, and -- and the reason for conferring with -- with Sio, is that the groundwater monitoring and mitigation plan and -- and recognizing that that has only been provided a couple of weeks ago, it acknowledges that there will be an expanded monitoring well network for the -- for many purposes, including geological confirmation, water level measurements, groundwater quality monitoring, and hydraulic testing that would be completed in advance of -- of extraction within any given new area, to provide, you know, really additional data to validate the information that we're already very comfortable with, for the reasons that I just mentioned. And I'll maybe pass it to -- to Sio to comment further.

MS. WEEDEN: This is Laura Weeden. So, Sio has reviewed and agrees with the approach that's recommended by AECOM in this case.

MR. HOLLANDER: Hartmut Hollander. Thank you very much for the clarification and the ongoing field investigation in this area.

I would like to move to the conceptual model, which you have shown on Slide 11 yesterday, and also in the report. And one question which came up in the geotechnical discussion is such a shale layer was identified between zero and five metres, and I asked the question to the geotechnical panel, where are these areas with zero metres, and they moved this question to you, so, I'd like to ask this question in the beginning again.

MR. MILLS: Ryan Mills with AECOM. Based on our review of the -- the well database, the majority of those wells with no reported shale thickness, or a reported thickness of zero, are, you know, at a distance of approximately 10 kilometres to the east of -- of the study area, where the -- those bedrock aquifers and the shale, so the -- the Red River Carbonate, the -- the shale, and the Winnipeg sandstone terminate and at what's called a -- a subcrop. So, it's covered by the -- the glacial sediments, but those units terminate there at the edge of the -- the sedimentary basin. And -- and I will maybe add that it's also possible, and we did observe some wells, that we think were either mapped to an incorrect location, or historical wells that utilized drilling technology where it's not easily -- or easy to capture, or maybe perhaps the intention of the drilling was not to capture the presence of the shale. So, going back to the early days of water well drilling, and the methods that were being used, you -- you may not have been focused on capturing the low permeability materials because the entire focus of those investigations would have been to find aquifers that produce water. And so, we find this in many jurisdictions that the -- the old well records don't always capture those low permeability units, but they do quite often do a good job of capturing the -- the aquifer information.

MR. HOLLANDER: Thank you for explaining where did you -- when this was found. Hartmut Hollander. My question is can you maybe explain to the -- the panel what is the meaning that the shale is missing 10 kilometres east of your site, towards the -- the Sandilands area? What would be the hydraulic implications? Sorry, what are the hydraulic implications?

MR. MILLS: Ryan Mills from AECOM. The shale terminates there, so essentially the -- the aquifer and the -- the bedrock aquifers and the aquitard or -- disappear at that location, they terminate, and so, there is no bedrock -- there are no bedrock aquifers above the Precambrian Canadian Shield. And -- and therefore, there is -- it's essentially an overburden -- you know, the Sandiland complex is an overburden aquifer that overlies lower permeability Precambrian rock.

MR. HOLLANDER: Yes, thank you. Hartmut Hollander. So, that means you can have an exchange of water, in this case of recharged water, fresh recharged water which dries in the end -- the whole stretch of your 80 kilometres down to the Red River, is that correct?

MR. MILLS: Ryan Mills from AECOM. The Sandilands area is the primary source of -- of recharge to the bedrock systems that occurs in the east. There is also spatially distributed recharge across the the -- the full model domain that -- to represent precipitation less evapotranspiration and runoff. So, there are, sort of, multiple inputs to the aquifer system, but the primary one is thought to be from the Sandilands Glaciofluvial complex in the east.

MR. HOLLANDER: Sorry that I forgot, for simplicity, the overall recharge over the whole stretch, but yeah, thank you very much for this answer. So, when you -- when we now know that the water is mainly driven by the recharge in the Sandiland and it flows, in your model, mainly towards the Red River, and there's a small impact of the -- the Birds Hill which we probably don't want to discuss at this point, then you come up with two boundary conditions, in this case, one is the recharge boundary at the beginning of the aquifer at the Sandilands, and you have a boundary condition at the Red River. Can you explain the boundary condition which you chose for your conceptual model for the Red River carbonate at the Red River and for the sandstone aquifer?

MR. HARVEY: Miln Harvey with AECOM. So, the boundary that we chose to the southeast was the Sandilands recharge area, and that's based on research that was done by Cherry 20 years ago. The -- that recharge is not the only recharge. There is distributed recharge across the entire model domain based on the mapping of surficial geology and -- and coarse, medium, and fine-grained sediments. And to the northwest, we chose the Red River and Red River Floodway as the -- the boundary to the northwest because of -- and that's in both the -- the surficial geology and in the -- in the Winnipeg sandstone because of mapped groundwater levels, and -- and because of previous research which indicates that there is a meeting of two flow systems and upward gradients from the Winnipeg sandstone into the -- the carbonate.

MR. HOLLANDER: Thank you for this explanation. There are maps created by Betcher, 95, which clearly indicate that the sandstone aquifer is not effluent to the Red River. Why didn't you look at that? Why didn't you integrate that?

MR. MILLS: Ryan Mills with AECOM. Could

you just clarify the question? The -- yep.

MR. HOLLANDER: Sorry. So, we have you explained, well, the boundary condition why you chose this for the carbonate aquifer. Well, the carbonate aquifer is definitely dewatering. The sandstone aquifer, there's no indication that the sandstone aquifer dewaters into the Red River.

MR. MILLS: Ryan Mills from AECOM. There are conceptualizations presented in the academic literature, I think the 1995 Betcher work. There have been many more publications since then, including, I believe, Graham Phipps of the Water Sustainability Division presented at the CGS in Edmonton. There was a companion paper to the work of -- I don't wanna be misquoted, but perhaps Ferguson or Jianrong Wang at the time. I believe it's a Jiron Wang paper, and a Phipps paper, on the flow and and chemistry components. And there is sort of some evidence of upwelling of -- in his water typing work, they looked at the chemistry of the carbonate aquifer, and I believe there's some evidence of elevated constituents that may indicate upwelling of basinal brines in that area.

MR. HOLLANDER: I expect -- Hartmut Hollander -- but you refer to your Slide 12 in the presentation yesterday. And I'd like to ask you what is the direction of this cross section which was shown in this publication?

MR. MILLS: Ryan Mills from AECOM. I believe, from memory, that it is an east-west cross-section that shows sort of it's parallel to the maximum dip of the -- the basin.

MR. HOLLANDER: Yes, that is correct. That is from east -- east to west, or west to east. It is not in the direction of the length of your model, it's not in the direction of the Red River, and therefore, this cross-section is misleading, and most likely came to the solution that your boundary condition for the Red -- for the Winnipeg sandstone next to this area might not be correct, and that should be something which you maybe want to revisit.

MR. HARVEY: Miln Harvey for AECOM. The boundary wasn't set specifically based on this cross-section. The -- this cross-section conceptualized that there's likely upwelling occurring there and a boundary is is -- can be set there. A constant head was set in the Winnipeg sandstone using groundwater mapping. So, the boundary itself is based on mapping of groundwater heads in the Winnipeg sandstone, which is an appropriate approach to setting a boundary. And whether or not that boundary is -- is actually a discharge boundary directly, or whether or not groundwater flows even farther to the west, using a constant head, that location is appropriate because it's far enough away from the project area where it's not going to impact any of the results that we predict. So, the location of the boundary was based on mapping -- mapping of groundwater heads.

MR. HOLLANDER: Hartmut Hollander. Thank you for this clarification. You did -- you mentioned the topic which I wanted to move next, groundwater mapping. Where did you present your -- your map groundwater tables for the -- for the carbonate and for the Winnipeg Shale? I have not found it in the appendix.

MR. MILLS: Ryan Mills from AECOM. I believe that information is presented in Figures 5-10 and 5-11 of the Hydrogeology and Geochemistry Assessment.

MR. HOLLANDER: The information which you gave on that one does not indicate the -- whether this is based on data, and it does (inaudible) not show contour lines. You used a screen, which is in the end, a colour-coded version so that it is very difficult to read any of the contours.

MR. MILLS: Ryan Mills with AECOM. I am in agreement that it is this method of presenting that -- that same information. I think it would be useful to present it -- with contours as well. It is -- the information that it is based on is -- is the data from the -- the well database and -- and so, it's -- it's a matter of presentation, and it is acknowledged that this information could be contoured to avoid looking on the legend to interpret the information.

THE CHAIRMAN: Chair. And with that, we will break for lunch. We'll regroup in one hour, please.

(OFF RECORD)

(ON RECORD)

THE CHAIRMAN: So, we'll resume in

three minutes.

(LONG PAUSE)

THE CHAIRMAN: Chair, good afternoon. We will resume. I see we have all the members of the panel, so that's a good thing for a start. And Hartmut is in his seat, so that means we have a complete set. So we are good to go. Hartmut, you have about an hour, not quite left, and you've asked me to give you a 30 minute warning, so I will do that. Following Hartmut, we -- I understand the RM of Springfield would like to ask a few questions, so happy to do that. Someone at the table looks surprised, but I think we're okay with that. Is that -- yeah, all right. So, Hartmut, over to you.

MR. HOLLANDER: Mr. Chairman, thank you very much. Just want to connect to where we left before the lunchtime. So, we discussed about the Winnipeg Sandstone formation, the northern boundary, and the question was you -- you mentioned that you created the water -- the water table map Figure 5-10, and my question now would be we see, based on Betcher, and also the newer investigations by the groundwater section here from the province that we will have salinity, their TDS concentrations in the range based from Betcher, about 20, 30, 40 grams per litre. Is this a reason for you to do density driven modelling or do you stay with your attempt to do single phase modelling?

MR. HARVEY: Miln Harvey, AECOM. The measured values of -- of salinity in the area of the northwestern boundary underneath the Red River are approximately -- are less than 3,000 milligrams per litre, and those, you know, in the sort of the 500 to -- to 1,500 milligrams per litre, those concentrations don't impact density enough to do density dependent modelling. All of the -- the denser water, which is affected by high TDS levels are west of the study -- or west of the model boundary, essentially. So no, we don't feel it's needed to do density driven modelling.

MR. HOLLANDER: Thank you very much for your point of view. I'd just like to highlight the governmental documents show that there's concentration of 30 grams per litre, that means 30,000 milligrams per litre, which indicates that there is a density driven floor system and that this needs to be taken into consideration.

MR. MILLS: Ryan Mills from AECOM. I acknowledge that there are localized -- there's localized -- or documentation of localized elevated concentrations of TDS, in areas that it's my understanding based on the -- the publication that I referenced earlier, indicate evidence of historical upwelling of saline water from the underlying sandstone in those areas. There are also publications that show that the -- the TDS, high TDS boundary, and saline water is -- is sort of 3,000 milligrams per litre or 3,500 milligrams per litre. So, there's a zone below that that's called brackish. And saline water is -- does not occur in the overlying carbonate aquifer on a -- a typical basis. But there are localized zones where interconnected wells historically have allowed for upwelling of water from the sandstone into the overlying carbonate and caused impacts to that water quality in that area.

MR. HOLLANDER: Thank you very much for this clarification. Hartmut Hollander. The point maybe we talk here about two different things written -- maybe I want to step back. And so, I'm not talking about the carbonate aquifer, I'm still talking about the Winnipeg Sandstone aquifer. And so, this is -- and the boundary condition which you have chosen below the Red

River -- the Red River, as mentioned before, both of which you have shown inside your presentation yesterday, that the shale seems to thicken towards the Red River formation. So, there is no water flowing from that position, that this water is obviously, based on governmental documentation, saline as a threat, 30,000 milligrams per liter TDS. The question would be, did you correct the water level -- water level measurements for this aquifer in that region, because your flow direction -- that direction looks different than that what the governmental documents show. So, yours show towards the Red River, while the direction from Betcher is a 90 degrees tilt.

MR. MILLS: In looking at the publication that I ---

MR. HOLLANDER: Yes, I look at the publication and HRI contribution #CS-93017, March 95, Page 13, Figure 8 and 9.

MR. MILLS: Ryan Mills with AECOM. In looking at Figure 9 of the publication, you reference the contouring is largely focused on the area to the west of the Red River, which is not included in our groundwater model domain or assessment. On the boundary that approximately coincides with the Red River, there is a contour that -- a concentration of total dissolved solids control -- contour, that is approximately two grams per litre. Apology.

MR. HOLLANDER: Sorry.

MR. MILLS: Ryan Mills with AECOM. Which is below the threshold where we believe density dependent flow becomes highly important.

MR. HOLLANDER: Yes, two grams per litre, I would agree, is that correct, but I don't know whether you look at the same version of the document. There's a river clearly shown, and the river lies between 10 and 50 and this is grams per litre that it is not in my IS too. So we have one, two, ten, 50, 100, these are the isolines and the area lies between 10 and 50. And for reference, the groundwater branch currently (inaudible) from the province is creating a new map which is not published yet or where you could get latest references about salinity concentrations in the sandstone aquifer.

MR. HARVEY: Miln Harvey, AECOM. Can you

give us the reference to the figure that you're looking at so that we can confirm we're looking at the same thing?

MR. HOLLANDER: Yeah, so it's Figure 9, "Total dissolved solids of Winnipeg formation groundwater (grams per litre)".

MR. MILLS: Ryan Mills with AECOM. This, you know, we're talking about the width of a line or two. It's a very small scale figure. The accuracy and the -- the data source of these interpreted isoclines -- or isocons is not clear based on this figure, so it's very difficult to judge, you know, within the error of a line, on -- on these small scale figures.

MR. HOLLANDER: Yeah, certainly I see this limitation -- Hartmut Hollander -- but this is a provincial wide -- or let me say the part of the Western Canadian basin here in -- in Manitoba, and that this one is certainly rough estimates, that's why I gave the additional information that currently the province is producing a new map. The person in the province for Manitoba agriculture and reforest development is (inaudible) who is working on this topic, with recent data.

MR. MILLS: Ryan Mills, from AECOM. That's useful information. I think that could be part of future considerations, but it's not, was not, and is not available to us, and unfortunately we cannot comment on it at this point.

MR. HOLLANDER: The next area which I would like to discuss, or to question, is the spatial discretization, which was also asked yesterday by Mr. Dennis LeNeveu. You mentioned yesterday that there is a refinement in the area of interest, which you identified as the red area. Can you give me the nodal distance which you have used in this -- in this area?

MR. HARVEY: Miln Harvey, AECOM. Approximately five metres.

MR. HOLLANDER: Thank you very much. Hartmut Hollander. Did you use the five metre constantly over this area or did you do this next to the wells and then further out in a different nodal distance?

MR. HARVEY: Could you repeat -- repeat the question? Miln Harvey.

MR. HOLLANDER: So, the -- the five metres, are there only next to the wells which you modelled, the pump tests, or are they are throughout the whole areas of interest?

MR. HARVEY: Miln Harvey, AECOM. We -- we used the entire area and refined if necessary as we added new information. So, it was initially -- we initially just tried to mesh -- to take into account wells but if observation points or other wells were added, we refined the -- the mesh. But it is for the whole area where exploration has been done.

MR. HOLLANDER: Hartman Hollander. Thank you very much. Did you use a different mesh or a refined mesh for the transient simulation compared to the steady state simulation?

MR. HARVEY: Miln Harvey, AECOM. We used the same model for both the steady state and transient simulation, so it -- it has the same mesh.

MR. HOLLANDER: Thank you very much. Hartmut Hollander. The final question to this direction is the appearances in -- of sinkholes in the northern part of your area. Next to Beausejour, there is evidence of several sinkholes. How did you involve, or how do you edit this -- this information into your model?

MR. MILLS: Ryan Mills. The sinkholes are a local scale feature that would typically be below the resolution of a grid cell in a regional model, and they were not incorporated into the -- this model. They probably do not have much bearing.

MR. HOLLANDER: Sinkholes have the opportunity to collect water, surface water, and bring them a relatively fast to the groundwater table so that we have next to the areas which are in the Sandilands and next to the -- to the Hill area, the Birds Hill area, next to Winnipeg, we have a potentially area where we have higher recharge and potentially also faster pathways to the groundwater. Can you comment on the view of your answer?

MR. MILLS: Ryan Mills. I'm not familiar with the exact locations of all of the sinkholes that you've mentioned. The Birds Hill complex is -- is tens of kilometres from the project area and -- and that's sort of the -- the primary reference I picked up. And I think you're -- I believe you're referring to sort of some depression focused recharge that may or may not occur, depending on where those sinkholes terminate, and the texture, and -- and hydraulic conductivity of those surficial materials. So, it would need to be a -- a site specific kind of understanding that would govern the behaviour of those local features.

MR. HOLLANDER: Hartmut Hollander. Thank you very much for this clarification. You used a lot of wells, or you added a lot of wells to this model. Have you evidence -- do you know where they are screened, whether they are screened in one aquifer, the other aquifer, or in both aquifers?

MR. MILLS: Ryan Mills. The wells were imported into a three-dimensional geological model. They include information on geology, and -- and you know, a wide range of information is typically collected during drilling. The well database is -- is typically associated with water wells and we, as you may appreciate, presented some figures that -- presented the results of our interpretation of where those wells may be screened. Understanding that the -- the source of the data, you know is disparate, it was collected by many different people over many different decades, and so, there is some uncertainty, and so, we applied some professional judgment and -- and based on discussions with local drilling companies and -- and others that have experience in the area, we made some professional judgments, and assigned them -- assigned the wells to, you know, either the carbonate aquifer, or the -- the sandstone, or the quaternary glacial sediments. Some were even assigned to the shale, which would be atypical, but we did follow a logic in assigning those -- those completion intervals to each borehole and -- and presented it as such.

MR. HOLLANDER: Thank you for the clarification. Hartmut Hollander. Does this mean that you did not yet assign any well to both formations, although there's a knowledge based on Kennedy and Woodbury that there are about 500 wells in that area at least connected to both aquifers at the same time?

MR. MILLS: Ryan Mills. It is fair to say that they were -- there were wells that were not assigned to both aquifers. There were, however, some wells that were censored from the data set based on professional judgment. In other words, we -- we judged them to be mapped to an incorrect location or exhibited geology that, you know, was not found or representative of any of the materials that are -- that are found in the area. And you know, I think, that -- that was the basis for -- for our approach.

MR. HOLLANDER: Hartmut Hollander. Thank you very much. I would like to come back to a question from Jason Mann this morning. He asked, and you agreed to provide a map with gradients or an information about gradients, between the sandstone formation and the carbonate formation based on the groundwater table maps Figure 5-10 and 11. Would you be able to provide a before map -- the hydraulic had differences at this point and how they would change based on your simulation?

MR. MILLS: Ryan Mills. Apologies, we're having a difficult time hearing you. We can't hear you when you're speaking, very well, so, if you could repeat that question again?

MR. HOLLANDER: Sorry for that. So, we had this morning, a discussion from Jason Mann. He talked about hydraulic gradients between the sandstone formation and the carbonate. We can do a pre-analysis before the mining starts, you have the maps of both -- both layers, the potential heads. Can you make a comparison how this would change the -- the gradients from pre-mining to post-mining and add this to the documentation?

MR. MILLS: Ryan Mills. In fact, three well pairs -- so, three of those Manitoba government observation well pairs, there is historical information, water levels presented overtime in both of those aquifers and the -- the vertical gradient, it was calculated and presented on those Figures 5-12, 5-13, and 5-14. It is agreed and -- and in one of those cases, at least, I would have to check, we did include one of those well pairs in our model simulations and the -- the water levels were presented, and I believe we agreed this morning to present the gradients in response to the -- the project operations.

MR. HOLLANDER: Hartmut Hollander. Thank you very much for clarification. Yes, there are exactly the three wells, and you gave also this data. I'm not talking here about specific sites which are potentially not directly next to the mined area, but especially in that area which you -- in which Sio Silica intends to mine, to draw a map of this based on your analysis, what would be the gradient prior, or what is the -- the gradient prior to the mining, and what would be the gradient after the mining? This has a lot of implications in terms of the water exchange. Jason Mann mentioned this morning has a lot of implications potentially to geochemistry and probably would be very supportive and easily to do for this process.

MR. MILLS: Ryan Mills. Similar to the response this morning, we have presented the existing conditions, groundwater elevations in some of the figures in the modelling results section. It is possibly something that would require additional data processing. We have presented, I believe, the results that are broadly indicative. We have those transient time series plots that do show water levels in both aquifers overtime at the monitoring locations that we've inserted, or the observation points that we've included in the model, at various distances from the project operations and so you -- you see that the -- the response at various distances from operations, and at various time steps through the project development and operation, that essentially convey that information. And I -- I think some of the follow up would be to -- to present that -- that information and calculate the gradient and present it overtime, and I think that's what we agreed to this morning. Is there something beyond that, that I'm missing?

MR. HOLLANDER: Yeah, a little bit. Hartmut Hollander. Because currently we started the discussion that -- well you mentioned that due to parsimony, you used -- you started with a -- a homogeneous model for the carbonate and for the sandstone. And that will be certainly a bit more discussion we will have on that. And the question is whether this homogeneity which you have assumed is reasonable to use, we will have a few more questions on that. And in this direction, the question afterwards, because when the soil would not be homogeneous then there might be different gradients -- different strengths, at different positions, and spatial analysis of this would be helpful because in the end it would cover the -- the heterogeneity of the system.

MR. MILLS: Ryan Mills. As I understand it, I don't think there was a specific question, but you're looking for gradients to be presented before mining in addition to -- in response to the operations. I see. Yes, that -- that could be provided. It would require some back casting of information.

MR. HOLLANDER: Thank you very much. Hartmut Hollander.

THE CHAIRMAN: Chair. Hartmut, at your request, you have about 30 minutes left.

MR. HOLLANDER: You know, maybe I have to speed a bit up. Last question to the conceptual model is about the well. Which last update of the database, of the GW drill database did you use?

MR. HARVEY: Could you repeat the question again, please?

MR. HOLLANDER: The GW drill database which you used for creating your conceptual model, what is the current, or what was the -- the time -- the last update which you used?

MR. MILLS: Ryan Mills. I don't have the -- the exact date, but I can let you know that it was a -- a fairly recent export. We had requested the information from the latest update. We were told that not all of the wells had been incorporated into that, and there are others, including drilling companies, that do maintain the databases sort of offline and so, we were able to access sort of a combination of a historic drilling database that was supplemented by known recently installed wells in the area.

MR. HOLLANDER: A similar other question. Which date did you use for the steady state -- simulations? What was your your date which you used? What -- what did you find at steady state?

MR. HARVEY: Miln Harvey, AECOM. We used all the available data that was downloaded for developing the conceptual model. So, whatever was available at the time of download.

MR. HOLLANDER: Yes, I understand that certainly that you take that what is available, but when you have all this data, you make the selection, what do you define as quasi-steady state? And that's most likely a month of a certain year or that is what I would like to hear.

MR. HARVEY: Miln Harvey, AECOM. After filtering the data for any anomalies, we used all of the data and assumed long-term steady state average conditions. So, all of the data points are -- they're over different drilling seasons, different drilling years, but it's all the data that was available. And the assumption is, based on all that data we're getting average long-term groundwater conditions.

MR. HOLLANDER: Hartmut Hollander. To my knowledge this is not industry standard. Industry standard is that we analyze the fluctuation curves of the best wells. This would be most likely the wells of the -- by the province, which are observed constantly. We select a mean situation for that. That was also the question which Jason Mann had. From this data set we can also define the times when we have low water tables or high water tables for validation purpose which you have not carried out.

MR. HARVEY: So, Miln Harvey AECOM. Industry standard is to use all the data that's available. We made professional judgment on the data that we used, filtered the database to make sure we had good data, but we used -- in order to -- to look at long-term average impacts, we used all the data to get long-term average groundwater heads. And that, as far as I've been using for the last 30 years, is the standard that I've used in modelling. So, we -- we didn't pick spring, summer, fall, winter, we -- we chose all the data to -- to encompass the available changes that occur over the seasons and over the years.

MR. HOLLANDER: Hartmut Hollander. Thank you for the clarification. Does this mean that you compare a data row which might go from 1960 to 1990 with a data row from 2000 to 2020 ,and that you compare and plot the data into the same -- into the same plan?

MR. HARVEY: Miln Harvey, AECOM. We used all the data. And so, we didn't categorize the data by decade. We developed a database of groundwater elevations for all of the available data, assumed long-term steady state conditions and calibrated to that.

MR. HOLLANDER: Thank you for clarifying. This is Hartmut Hollander. So you used this data which we just discussed with the time that this was selected from all over the whole period, what you -- what what was measured, and you came up with the graph, which you showed yesterday, where you printed on one axis the simulated head versus the -- versus the observed --

observed heads. And what we see is you have done it unfortunately a bit small yesterday that you're data don't follow the one to one line, that there's a bias especially towards the low lying areas. And I would like to hear from you what kind of implications this bias has at lower hydraulic head.

MR. HARVEY: Miln Harvey for AECOM. So, I don't see bias in the data. I see a greater number of data points near the Red River, but near the area of the Red River. I see less data points near the Sandilands. Up and down that 45-degree line I see -- well, first of all, I see that the -- the data follows that 45-degree line. It's the -- the average data points are three metres high. The statistics show that there's a normalized RMS error, which is good. There are some areas where there are a cluster of data points which are both below and above that line. Those areas are near the Red River floodway, and we've plotted those on a graph -- or sorry, on a -- a figure, so a plan view figure, and you can see a cluster of both red wells -- on Figure 6-3, in big and colour, there are a cluster of red wells and a cluster of pink wells. The red wells are simulating greater than 10 metres and the pink wells are simulating less than ten. The reason there are those clusters likely has to do with the timing of -- of when they were drilled and like, the two effects, one being a greater groundwater use in the area of Winnipeg and the construction of the floodway. So, we did use all the data that goes back historically. Some of those wells were installed before the floodway was installed. Some of those wells were installed after greater groundwater use had been completed. And as a result, there -- we can explain the -- the likely reason why they're there, but they do contribute to our calibration and to our understanding of the system.

MR. HOLLANDER: Thanks for the explanation. I revised two Figure 6-2 part 3 of the Appendix A. When you look at your model results, then you will see that for higher hydraulic heads you have a much better fit than for the lower hydraulic heads. For the lower hydraulic heads starting at about 240 metres above sea level, you have a significant over prediction of your simulated error values compared to the observed values. When I would extend this and would put a trend lines through this, then the intersect of this one -- this line, it is not zero as it should be, it is 160 metres for the position at -- sorry not at zero, it should be 150 of your cross-section. But if you draw this through there it would be 160, so ten metre too high. So, that means that this model, which you have created, significantly and constantly, overpredicts the flow of the -- the heads at -- next to the Red River, therefore the -- the gradient inside your aquifer is not correct because it's too -- too small.

MR. HARVEY: Miln Harvey, AECOM. I can't see what you're describing. You've created something that I haven't got access to.

MR. HOLLANDER: I assume that you have access to your Figure 6-2.

MR. HARVEY: So, I'm looking at Figure 6-2.

MR. HOLLANDER: Can you tell me how many points below 225 metres are below the line and how many are above the line? Do you see a significant difference?

MR. HARVEY: It's Miln Harvey, AECOM. So, you've grabbed the data points that are in the red and the data points that are in the pink, and you've connected them. Those are in areas of the -- the model domain where we have other -- sorry, those are in areas of the model domain which are not connected -- or not contributing to flows in the -- like they're -- they're just different sections of the -- of the model domain. We look at those as an amalgam against all of the groundwater heads up and down the 200 to 300 metre observation and simulation point. So, cherry picking that area ---

MR. HOLLANDER: I thought that you were ready, sorry. Thank you very much. The questions which I want to ask or come with this point is the heterogeneity of the assumption inside the aquifer. That's a key question which I wanna go through with. So, we have just shown that -- we have just shown that the gradient inside the -- the aquifer is not perfect, that is okay. And we have seen that there are lots of publications which are coming most likely -- or most of them coming from Kennedy, Ferguson, and Woodbury which have used non-homogeneous conditions for both aquifers. In a publication starting at 2000 to the end of the 2010 -- 2007, 2008. My question is -- the first question is can you explain to the panel what equifinality is?

MR. HARVEY: Miln Harvey. Could you rephrase that last question?

MR. HOLLANDER: Can you explain to the -- to the panel what equifinality is in modelling results?

MR. HARVEY: Miln Harvey, AECOM. Equifinality means that a different set of parameter values can lead to the same result. And so, to address your previous statement, we've used industry standard methodologies for taking all the data that we have available, filtering it using simplified development of the -- of the model to come up with a tool which matches simulated versus observed, to a level of standard that the industry accepts. We had that model reviewed by a number of consultants and -- and peer reviewers, who've indicated that the methodology we used was adequate, was okay, was -- meets industry standard, and that the simulation -- and then therefore is useful, for making the simulations that we're -- we're attempting to make.

The area that you're describing is also quite a distance away from the area where we're trying to predict our impacts. Where we have a -- have a reasonable simulation of gradients -- groundwater heads and groundwater gradients. In summary, there are -- there are possibilities -- there are possible configurations of the model, distribution of parameters, which would give similar calibration results. But we -- we tried to encompass that by doing a sensitivity analysis and a predictive -- predictive uncertainty analysis. And in doing so, we have created a model which can be used to make conservative decisions -- using the sensitivity and uncertainty analysis, to encompass some of the uncertainty that you're alluding to, which leads to equifinality.

MR. HOLLANDER: Thank you very much for explaining your standpoint. Hartmut Hollander. Just want to come back to the term equifinality. Equifinality means when we have oversimplified the systems, that by change of the certain parameters, potentially the recharge in the Sandilands, we would have, for every recharge value, if you just address this by the hydraulic conductivities in the sandstone, in the carbonate, we come to a good solution. By oversimplifying the aquifer, not looking at heterogeneity, not including the information which was published several times by the authors which I mentioned before, Kennedy, Woodbury, Ferguson, you run into a problem that the data which -- which are there, cannot be proven. Additionally, if you look at your hydraulic test, you came up with one times ten to minus five. If you compare this to the calibration of your steady state model you will see that there is a half a magnitude difference between that what you measured and that what you calibrated.

MR. MILLS: Ryan Mills with AECOM. I'd just like to point out that one of the references that you make was to Dr. Grant Ferguson at University of Saskatchewan, who did collaborate and investigate this very aquifer system as part of his PhD studies with Dr. Woodbury. And I will point out that he was one of the peer reviewers who is a practicing -- or a professional that evaluated our work and judged it to be -- meet industry standard, and he has direct and specific experience that we were able to incorporate into our work in response to his review comments prior to finalization of our report. We had specific testing results that were implemented in the model as input parameters and others that were used as fitting parameters. This is a common industry standard practice whereby we don't force the model with too many input parameters, and we recognize that there is some heterogeneity in this system that cannot be captured in a single pumping test. And there is a broad number of tests that have been conducted across the aquifer and the singular value that we utilized in the end falls within those parameters, and therefore, the model is reasonable, and it can, and was, used to simulate the results of our pumping tests with a reasonable result. And -- and therefore, especially in the area of our investigation, the results of the model can be relied upon.

MR. HOLLANDER: Thank you for agreeing to that. What I want to say in my next sentence. The point is that when you finished your steady state calibration and you went to your transient calibration, you had to change your hydraulic conductivity again because you just said a regional derived hydraulic conductivity is not equal to the local hydraulic conductivity. Therefore, your regional model is completely neglecting all site specific features. Means, and other terms, heterogeneity, and that only in the transient model you were able to model what's going on on your site.

THE CHAIRMAN: Chair. So, Hartmut, you have a little -- you have about 10 minutes left and I'm not sure was there a question there?

MR. HOLLANDER: No, it's fine. So, let's -- let's jump to the prognosis shortly, very shortly. When did you know for both sections, hydrogeology and geochemistry, that the shale formation will collapse? At which point in the process?

MR. MILLS: Ryan Mills with AECOM. We did not, you know, have any certainty. We applied our professional judgment very early on in the investigation to characterize the system and -- and simulate, or to allow us, to understand the system and simulate a range of possible configurations of the project. As -- as we work on projects, it is very typical for work to continue through environmental assessment and permitting projects and evolve overtime. So, we like to guard against future change by having a -- a kind of a -- a broader scope of of field investigation, collect information, and of course, you -- you learn and -- and refine your approach as you go. And so, we did not know for certain -- I guess perhaps it could be argued that the sonar surveys that we saw the other day, were -- were the first direct evidence that the shale may collapse. And -- but it was expected throughout the process that the shale was a weak layer, it may change and adopt different properties, and we attempted to capture that in our modelling simulations both in steady state and transient.

MR. HOLLANDER: Thank you for that. Not that you answered exactly my questions, but you admitted that there was certainly knowledge that you had (inaudible) in your knowledge and that the geotechnical sonars, which they got, that you saw the failure and you changed your model from the original submission from just the change in hydraulic conductivity, you call it degradation of the shale, to know a failure of 200 metres. That was discussed with Jason Mann this morning. And unfortunately, I had no time for -- to review this, because this was just presented today, so I cannot ask full amount of question. Just wanted to know when you got to know that the -- the failure will happen.

MR. MILLS: Ryan Mills. I think there's a terminology, kind of maybe a misinterpretation of the term degradation. The term degradation in -- in my mind was always to represent complete removal of the shale from the system, in other words, not relying on the hydraulic properties of the shale. So, for the entire modelling exercise, when we say shale degradation, we are changing the properties of the shale to match, at that time, I believe we made the decision to set them to the underlying sandstone hydraulic properties, which are very similar to the overlying carbonate properties, and so, degradation and removal of the shale should be thought to be the same. And -- and those -- those results have sort of been presented in -- in every one of -- of our modelling deliverables both the -- the original 2021 model and the updated model yesterday. The radius of shale degradation was an assumption that we took on. There was no information available on the -- the cavity design at the time. So, we took a broad assumption that that would potentially extend 200 metres. It turns out, based on the recent information, that we were overly conservative, and we would need to adjust that in the future. We have not updated that assumption in our 2023 model but should at some point. We wanted to provide comparable cases without model adjustments along the way between the 2021 model and the 2023 model, so that people could compare things without making additional changes.

MR. HOLLANDER: Thank you for the clarification. Just maybe a last question on this topic. Is it correct that the new failure of the shale formation is replaced by properties of the sandstone layer so that the shale, which you have in this failed areas becomes the hydraulic properties of the sandstone, or do you go still with a reduction -- or an increase of the hydraulic conductivity?

MR. HARVEY: Miln Harvey, AECOM. We haven't updated the sandstone properties based on our understanding of the -- the collapse of the shale.

MR. HOLLANDER: Thank you. My final question to the hydrogeological part is the review. You mentioned the review by Grant Ferguson, it was also mentioned the review by Jeff Bell. You used an -- an unconventional way to present the comments because you put them into the table. You took them out of -- obviously out of a document. So, normally you write a document with all comments, and you put this into tables. I would like to ask, are there additional comments, which you did not provide in the document's Appendix B?

MR. MILLS: Ryan Mills with AECOM. It's quite common in an environmental assessment process to translate written documents into an information or -- or comment tracking table and dispose of those comments in a table format, just for ease of filtering the comments based on subject area or commenter and -- and respondee. And so, that was the rationale for doing so. And to directly answer your question, no there are no additional comments from either of those reviewers that we did not directly translate into that -- that document.

MR. HOLLANDER: Can I ask one question in this direction? Why didn't -- I was provided with both -- both reviews when I requested this through -- through the CEC panel?

MS. WEEDEN: This is Laura Weeden. This is not a request that I'm aware of, so I'm just going to have to go back and double check.

MR. HOLLANDER: My few last minutes, I want to spend on the geochemistry. Thank you very much for all your answers to help to understand the -- the model and the assumptions. I want to start with your explanation from this morning from Jason Mann, that you certainly wanted to take samples from the pre-mined system and the post-mined system. That means in the end, the sandstone which is inside the aquifer, and the one which is on the hill which you showed there, which was shown this morning, how many samples have you taken from the sandstone aquifer in situ?

MR. MILLS: Ryan Mills. Could you clarify whether or not you're interested in solid phase samples or aqueous phase samples?

MR. HOLLANDER: I'm interested in solid phase samples.

MR. OULD ELEMINE: We -- we collected a total of three sample -- one surface sample from BRU 95.3, and core sample -- sand sample from the aquifer, two.

MR. HOLLANDER: The sample which you got from the aquifer, in which environment did you found -- you mentioned this sub-oxic -- is it this anaerobic or anoxic? Which one did you -- which was the state?

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. It's a sand collected in a bag because we cannot core the sand.

MR. HOLLANDER: You cannot core the (inaudible), but that's not required to get a sample and of the same geochemical soil, you just need to take a sample, close it, take it out, when you don't need to core this for this. That is not needed. You just need a device, which in the end, grabs a sample and seals it towards the environment.

MR. OULD ELEMINE: Well, those samples were put in a double bag in a smaller zip lock and within another zip lock. But I think the point we are missing here is when we do our assessment -- oh, sorry, Cheibany Ould Elemine -- when we do our assessment for -- for solid phase, we are not looking at characterizing the ore, because that's the material that will be processed. Our objective is to focus on that material that will be extracted that may have environmental impact. So, that was the focus of the investigation.

MR. HOLLANDER: Hartmut Hollander. Thank you very much for this clarification. That means you took a sample from the surface deposit, this, which you say, is dewatering very fast which is directly exposed to oxygen. So, you have the change from the reducing conditions to oxidized conditions, and with this, the fast flow of the fluids, you can also remove all other ingredients, solutes which you have, based on that.

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. This is quartz -- this is mostly almost 98 percent quartz. It's essentially inert sand. The remaining of the material is carbonate and some kaolinite.

MR. HOLLANDER: Yes, we heard yesterday that there's one percent kaoline inside. That was the reason for cementing. (inaudible) geotechnical people. And the question is, what is happening to this fine kaoline? It has a very (inaudible) particle. It has the opportunity to absorb a lot of particles. Certainly, when you change the environment, absorption capacity can change. Did you consider this in your sampling?

MR. OULD ELEMINE: Can you please repeat your question? I didn't get it.

MR. HOLLANDER: Yesterday it was discussed that there's one percent kaoline inside the soil, which was the reason for cementation. Can this -- this kaoline absorption places where you can put different irons on, by the change of the redox situation, or geochemical environment can the absorption places change? Can you have leaching which you have not covered inside your sampling?

MR. OULD ELEMINE: Cheibany Ould Elemine. Again, I would just repeat what I said. This is entirely 98 percent quartz. The remaining is the mixture of carbonate and -- and kaolinite. The source of metals from this rock are usually contained in the sulphide and the sulphide needs to be oxidized to -- to release these metals. And if there are no sulphides, I don't know what metal will be absorbed within the kaolinite.

MR. HOLLANDER: Thank you very much. Hartmut Hollander. The next question is how many duplicate samples have you taken?

MR. OULD ELEMINE: We collected nine samples.

MR. HOLLANDER: I asked for duplicates.

MR. OULD ELEMINE: Yeah, just let me -- let me get to that, please. We collected nine samples. We did not collect any duplicate in the field but there is a standard procedure when we send our sample to the lab, they create a duplicate based on their -- the number of samples, and they conduct various analysis on this replicate, just to capture the spatial variability within the sample. I would like to go back and explain what happened. When we sent the sample -- we tried to send, for the waste, two kilograms, and this material is crushed, homogenized, but there is an understanding that a spatial variability may exist within the sample and that spatial variability is driving the replicate analysis.

MR. HOLLANDER: Yeah, your replicate is from the same sample. You did not use A second sample.

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. We -- we don't need to use a second sample to capture potential heterogeneity. The replicate from the sample can act as a check of the spatial variability within the sample.

THE CHAIRMAN: Chair. So, we're going to have to leave it there.

MR. HOLLANDER: I would have two questions more only.

THE CHAIRMAN: It's not the number that matters, it's the length. Are they quick questions?

MR. HOLLANDER: Yes Sir, they are towards the trace metals and that was not discussed this morning with Jason Mann. So, he explained, or they discussed nicely, the mixing of the water, but the failure of the shale has some other implications which was not asked yet.

THE CHAIRMAN: Chair. So, given there is no duplication, I'll give you an extra couple of minutes, but let's be quick about it, please.

MR. HOLLANDER: Thank you very much, Chair. My question would be towards the samples which you took from the shale formation, as an example, BRU 102-2 from the depths 36.57 to 37 metres. We see trace metals in this area, uranium up to 30 PPM, that means milligrams per kilogram. Why didn't you investigate what would be the collapse of the shale, the extended surface which you have inside the aquifer? How much of this uranium could go to the -- to the aquifers? This is not only for uranium, for trace metals. Why didn't you neglect trace metal at all?

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. Can you please provide the number of the table you're looking at?

UNIDENTIFIED SPEAKER: (inaudible).

MR. HOLLANDER: It is Page 5 of 10 of Work Order FA20C2029, Amendment 2.

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. So, we did the shake flask extractions test, and that test provided simulation of what would happen if a rock material is exposed to atmosphere and oxidizing conditions in a quite vigorous process. The sample is crushed to about 6.3 millimetres. We add three-to-one water to solid ratio, and we shake it for 24 hours within and -- an oxidizing condition. And we reported that -- we identified that there is a potential for selenium, arsenic, and uranium to leach. Those metals have tendency to leach and at neutral pH and oxidizing conditions. In the current aquifer the -- the condition are sub-oxic and we do not see any of these elevated in the groundwater. So that's means the solubility is being driven by the oxic condition in the lab.

MR. HOLLANDER: Thank you for this clarification. I'd like to address that during the mining process, a lot of oxygen is introduced in the aquifer, that we -- you intend to use air to inject, that means you change the oxidation state from a reduced condition to oxidized condition. And this geochemical assessment is completely different. The same thing is that you did not report for your geochemical analysis the PE state which you used for your analysis, so that I could not follow up with your calculations in that direction.

MR. MILLS: Ryan Mills with AECOM. First off, disagree that the intention of the project is to inject air into the aquifer. The intention of -- of the operation is to utilize air to create a buoyancy effect within a steel casing to create an upward movement of water and draw in water into that -- that borehole and -- and up to surface with some entrained sand. And so, there will be very limited, you know, injection, or no injection of air, into the aquifer. There may, however, be some transfer of oxygen contained within the atmospheric air at surface in that water that flows down under gravity and back to the formation. The partial pressure was set to atmospheric pressure, and that was the basis for the simulation, under the assumption that that water stays at surface and is allowed to become fully oxic under atmospheric conditions, as a conservative assessment of how that water quality may change.

MR. HOLLANDER: Thank you very much for this explanation. That means you don't expect that the redox state in the aquifer is changed due to the mining operation. Is that correct?

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. Yes, we don't expect the -- the air to -- to shift the redox potential subsurface.

MR. HOLLANDER: Thank you very much. My last question would be on the statement that there is meteoric water. You showed in your isotope study that says a source of seawater -- a seawater source. I would like an explanation -- like to hear an explanation where this seawater comes from when you have meteoric water.

MR. MILLS: Ryan Mills with AECOM. So, that -- that information came from core samples and -- and were analyzed in an isotope lab at University of Saskatchewan. And -- and what it interestingly showed, so this is purposefully to understand the behaviour of that -- that shale and -- and how it factors into the conceptual hydrogeological model, that is essentially legacy, sort of call it connate water that was formed, or present at the time of -- of sedimentation. And it's our understanding that that is slowly diffused, or is continuing to diffuse, out into the overlying and underlying aquifers that are largely recharged by meteoric water to the -- from the east.

MR. HOLLANDER: Thank you very much for all your answers and for the time that you spent.

THE CHAIRMAN: Chair. Thank you very much, Hartmut, for your questions, and panels for your -- panel for your answer. Up next is someone from the RM of Springfield. Who's that going to be? Very good. Please come up to the mic in the middle, state your name, and spell it for the transcriber, please. I'll remind you that the purpose at this point is to ask questions. Participants will have their opportunity to state their view and be asked questions later on in the program.

MR. PRYDUN: My name is Mark Prydun, M-A-R-K P-R-Y-D-U-N. I'm with the RM of Springfield. Special Projects Coordinator with the Water and Waste Department. Chair Doering, CEC panel, thanks very much for the opportunity to ask a couple of questions. Only be about five minutes. And -- and the reference documents I have towards the panel is the -- the presentation Hydrogeology and Geochemistry Assessment, specifically Page 57, and also the Groundwater Monitoring and Impact Mitigation Plan Page 25, Section 6.2. First of all, I guess -- and I'll be very brief, I just have one general comment and followed by two quick questions. The general comment is -- is that so we'd like to -- the RM would -- is thanking you for preparing this monitoring plan. We find it to be very informative, well structured and -- and very helpful to us. So, we want to congratulate the authors for -- for producing a very sound document. The first question we have is -- is that, in the RM Springfield's experience, our experience is -- is when its citizens have concerns about their groundwater, they'll reach out to the -- to the rural municipality for guidance and -- and direction. So, the question is can you describe what opportunities might exist for the RM of Springfield to participate in the groundwater monitoring and impact mitigation plan process to ensure that we could support our citizens fairly?

MR. MILLS: Ryan Mills with AECOM. I appreciate the question. It's -- it's an interesting one and I'll admit it's not one that I've fully thought through yet. It's -- it kind of recognizes that this is needs to be -- there needs to be some collaboration and --

and kind of involvement of -- of the -- the local community in -- in the -- these types of projects. As a hydrogeologist working on other similar projects, I've seen this work well where there is sharing of information. There is a -- a panel that can be established, or a working group that can be established, that has a regular cadence of meetings, and an open sharing of information as it relates to groundwater level monitoring, groundwater quality monitoring, the analysis, the results. And so, there would be sort of, perhaps, an opportunity and -- and Sio has just -- I've just floated this idea past them and they're in general agreement, but I think this -- this should be fleshed out, and some of it should come from the RMS -- of Springfield. And -- and we would welcome that input as to how you would like to be involved, because you know, it -- it can be a discussion point, and you know the point of this would be to involve the RMS to the -- the level that they're interested in being involved and -- and at a minimum, commit to open sharing of information and regular presentation of results.

MR. BULLEN: It's Brent Bullen from Sio -- sorry, Brent Bullen from Sio Silica. If I can add to that to Ryan. We've made it openly clear that we intend to -- to fully put in place one of the most robust and fulsome monitoring programs of the aquifer. That's a commitment to the -- the project, and obviously the well-being, and the monitoring of the water. We also have a commitment to have transparency on that and -- and to work. So, I'm -- I'm pleasantly -- I'm quite happy with the question you have because we -- we look forward to working with the RM of Springfield on this.

MR. PRYDUN: Mark Prydun. Thank you very much for the response, and it probably leads in quite nicely into my second and last question. And -- and just strictly for the record, can the panel confirm that the RM of Springfield will have a -- a formal and -- and defined role in the coordination of the groundwater monitoring and impact mitigation plan?

MR. BULLEN: Brent Bullen with Sio Silica. Of course we look, and welcome any involvement from the RM of Springfield, you know, in the monitoring. We have to look at a sharing of data. We have to look at the use of that data. You know, you have a responsibility to your stakeholders and the residents, as -- as does the company, and so, you know, the only way it does work is in partnership and so, it's -- it's a welcoming invitation to work with you.

MR. PRYDUN: Okay, I thank you very much. Mark Prydun. Thank you Board, again. That concludes my questions.

THE CHAIRMAN: Chair, thank you very much, Mark. Thank you, panel, for your answers. We're going to take a brief recess here and then we will go to some public questions. Sander, I think you and Kelly might want to get together. Thank you.

(LONG PAUSE)

THE CHAIRMAN: So, we'll regroup in about two minutes, please.

(LONG PAUSE)

THE CHAIRMAN: Chair. Okay, can we return to our seats please? Get the panel back up to the front. Up comes Ryan, up comes Miln, maybe. Chair. So, when we concluded, I suggested that Kelly and Sander might need to chat. I will retract that, and we'll hold that thought until tomorrow morning. But I understand that Sio would like to make a couple of statements regarding undertakings.

MS. WEEDEN: Hi, this is Laura Weeden. I just want to follow up on one of -- the undertakings yesterday that was asked by, I believe it was Mr. Williams on the behalf of MBEN, on the extraction depth as it relates to the previous Stantec reports, and the new Stantec report which currently states that the extraction depth is based on a 20 metre vertical depth. We reviewed the other reports last night and they were based on the angle of repose of 31 degrees with varying spans, that translates to a depth between 10 and 20 metres.

Laura Weeden again. And as it relates to the questioning from Dr. Hartmut, we -- I cannot find any records of the request to see the original review documents, but we are happy to provide them.

MR. HOLLANDER: Thank you very much. So I asked that via Peter, our secretary. I don't know exactly the process, but it would be great if you can hand it over so that I can review them and that we can close this topic.

MR. DUNCANSON: Mr. Chair, Sander

Duncanson. So, Sio will take that as an undertaking to make sure that that's completed on the record. And just recognizing that Mr. Williams is not in the room, when Ms. Weedon satisfied the undertaking from yesterday, we'll make sure to provide that information to him as well.

THE CHAIRMAN: Chair. Thank you very much. So there is one other participant, as I think you are aware, who has deferred questioning until tomorrow morning regarding the geochemistry and geo hydrology, so that will be Byron Williams. So, that leaves us a little bit of time left today. Are there any members of the public that would like to ask a question? And again I remind that members of the public will have their opportunity on the two evenings, one in Steinbach, one in Beausejour, and the Saturday in Anola to share their feelings and thoughts. But at time, we can take questions of the panel. Please come to the front. I'll ask you to state your name and spell it please and proceed with your questions.

MR. COLE: My name is Ted Cole, spelled C-O-L-E. And I have a question for Sio. Back in October, There was a hearing with the Manitoba Municipal Board AND Sio gave a presentation. In that presentation, it was, like you see here. Same thing we heard. This time around also. Well, it was -- I believe it was the second day that after the presentation, they were talking to planning department of the municipality, and it came up that request had made for a pile, roughly 95 feet, which would equate to close to a ten-storey building. But when I heard that, and I looked at this, and I remembered the presentation, I had no idea that back behind all this there was a big pile. Now, if this is how information is to be presented, I would have expected to have seen a large pile here, as part of the whole deal, but it was nowhere to be seen. Okay. So, I came in to that meeting as newbie baby as you could ever be. I had no idea what was going on. I came there to find out what was going on. By the third day, I was scared, literally, not of Sio, I was scared of what could happen to us, to me, to my family. And like I said, I was scared. And that's the only reason I'm here now, because I'm still scared. When I go to bed, this is still in my head. Now ---

THE CHAIRMAN: Chair. I'm giving you a lot of latitude here with the preamble. Are we getting to a question?

MR. COLE: Question is coming ---

UNIDENTIFIED SPEAKER: Your microphone.

MR. COLE: Oh, sorry. My question is now, did you a request in for a pile, 94 feet, roughly -- 95 feet?

MR. BULLEN: Brent Bullen with Sio. The pile height is 94 feet in the fall. That's the maximum apex of it prior to going through the winter months and it -- it is part of the application.

MR. COLE: Thank you for that. The next question then is, why was it not here, to show us in a presentation?

BRENT BULLEN: Brent Bullen of Sio. That slide that you're referring to is actually a slide on where the sand will go, and there's been numerous materials and open houses that actually show a depiction of the pile, the layouts. It's been -- been disclosed many, many times. Just because it's not on one slide doesn't mean it's not been disclosed.

MR. COLE: Fair enough. Now then, is

there more than one file?

MR. BULLEN: Brent Bullen with Sio. Within the actual facility project which, this is a facility, and you know, with respect I'll answer the question, this is not part of this hearing, or the CEC -- this involvement, but it does talk about two piles, a smaller pile and a larger pile. So, the reference that you're talking about is the larger pile. There's the potential for two piles.

MR. COLE: I thank you for that information. Now if you recall in that hearing that we had with Manitoba Municipal Board, I asked the question. And well, actually, sorry, my apologies, I have to correct that. I didn't ask the question, but another individual asked the question, what about the voids? And if I'm correct, one of your people gave a response as to what happens to the voids? Do you recall what that response was?

MR. BULLEN: Brent Bullen with Sio. I'd like to hear what you heard.

MR. COLE: If I'm right, and correct me if I'm wrong, it did not come from you, did you not give a response to that question?

MR. BULLEN: Brent Bullen with Sio. I don't recall where you're going with the direction. I mean, we -- we spent the whole day yesterday talking about geotechnical stability and void. But if you have a question that would probably help me answer it.

MR. COLE: My question was when the response was made, there was a description of a material to be injected into the voids. But I mean, that sounded good because it's -- it's supposedly going to support that void. But then I believe it was in the paper, would have been in February -- now this -- this hearing was in October and the paper came out with the voids are going to be filled with water. When did that change?

MR. BULLEN: Brent Bullen with Sio. I'm not aware of what you're talking about for injection. We've always said that it's room and pillar, and once the sand is extracted, there's a void left that's filled with water.

MR. COLE: I believe it's on public record at that hearing what that material was.

MR. BULLEN: Brent Bullen. I have no recollection of -- of what you're discussing, and I'd have to have a look at it to see what you're referencing.

MR. COLE: I would ask that your Committee, or apologies for not knowing the correct terminology -- sterilizing every piece of pipe from the well site, or from your facility back to the well site?

MR. BULLEN: I think the -- what I see here, the extraction area where the UV system is, that's regional at the extraction components and that's -- that's separate. You want to take that water out immediately and return it to the well treated. The slurry lines that move the facility -- the sand to the facility, that's a whole separate water system. There's not an interchange. You know, in your -- in your package that you have there, prior to the one slide that you asked me about for sandpiles, there's actually a -- a diagram that shows the facility lines. There's a hard break where sand is moved from the facility extraction to a transportation loop. The transportation loop is commercial water. That -- that is not exposed. It will never, ever come in contact with the extraction and the wellbores. That's where you have a total isolation of water. So, when I talk about an extraction site, you know, fitting into this room with equipment to actually separate, treat the water, put it back, that footprint moves around as you're moving in the extraction. The transportation loop is -- is not a -- a reinjected water source at all.

MR. COLE: Sounds good. But it still comes down to the same thing, water is going back into a well through pipes which could be three miles, or however far you want to go with this, and you're going to tell me that if you sterilize that water before it goes back to the well, that every one of those pipes will be clean so we're not having contaminated water after it being sterilized, because it's now travelled through a pipe going to a well that is where the whole thing was originated from. Now, if a well has given you slurry, but as a precautionary measure, you decide then that the water that came from this slurry, that would be separated at the plant, that water should be cleaned. So, when did it get dirty -- possibly?

MR. BULLEN: Brent Bullen of Sio. Are we -- do you have to keep putting our name in or is it just a discussion here, Mr. Chair?

THE CHAIRMAN: Chair. Sorry I missed that.

MR. BULLEN: I just wasn't sure if we need to identify ourselves by name every time we speak for record.

MR. COLE: My apology ---

THE CHAIRMAN: So, Ted, yes, it would be useful if you could remember. I was kind of letting you go there. Your 15 minutes is almost up, Sir, so, if you want to prioritize your time.

MR. BULLEN: I would like to answer the question Mr. Cole, if that's all right. I think there's a -- a misunderstanding when you talk about three miles of pipe. The water at the extraction site is never going to be subject of the transportation of sand to the facility. It's -- it's separated at the extraction site, treated at the extraction site and put back in. So, even if you're extracting two miles from the facility, you're separating the sand at the -- at the extraction site and putting the water back in. Now the transportation loop that actually moves the slurry, that's a closed system, and that is separate. So, you'll never, ever be in a situation where you're pumping water hundreds of metres or kilometres. You know, the water that we're talking about treating and putting back into the well is near wellbore, with equipment that is at the extraction site. And so, I think there's a misunderstanding in -- with the two components of water here. The slurry itself, when the sand is actually put into the slurry loop, that is a closed system that just deals with moving the sand from the extraction to the facility, but that water is never part of reinjection, ever.

MR. COLE: How much time did he kill?

THE CHAIRMAN: I think "kill" is an unfair word, but ---

MR. COLE: (inaudible). How much time has he wasted?

THE CHAIRMAN: I'm not going to respond to that, but I will let you know that you have a couple of minutes left. I -- I think this is an important point that there are two systems here. There is the withdrawal system and there is a system to move the sand, and they are exclusive systems, and this may be a cue to Sio that perhaps this message is not permeated to the extent that is -- should have.

MR. COLE: Ted Cole. I got that one right that time. Thank you. Now, I understand you've got two different systems, one takes the slurry and then separated and it's not the same system. What I'm talking about is not -- how should I put it? I'm talking about the pipe that goes with this sterilized water. I -- I realize they're not the same. They're two different systems. I understand that. But my question is, when you sterilize water and you have to get it three miles away, it's not going to go through the air. It's not going to go in a tank. It's going to go through a pipe. I am not a professor. I'm not anybody. I'm just the person that has a question. And the question is, how can you get sterilized water from point A to point B through pipes that are not sterile?

THE CHAIRMAN: Chair. So, it is not for me to answer that question, but I will refer it back to Sio, please.

MR. BULLEN: Brent Bullen with Sio. Mr. Cole, I think to put it into perspective, the final treatment phase and the UV -- and UV is used as a precautionary finishing because we don't want to use chlorine or chemicals. So, that distance is about 60 feet, you know, roughly with hosing. So, it would be no different as if you actually had to have potable water delivered to your house and you actually had a water truck show up, they pulled hosing out of contained environment, hooked it up, and put water back in. Because the water is sterile after the UV, arguably it's actually going to be put back in a -- a sterile state compared to the water that's actually coming out of the well. When we look at the -- your analysis of doing surgery with garden gloves on, I prefer to think this is more like surgery with some of the best tactile nitrile gloves that are available because the use of plate press for fines, the use of the systems that will be talked about tomorrow -- and I hope you can attend because a lot of this will be discussed with the other panel. The equipment we put in place is the best of the best available in the world. It's the best technology. It's the best of equipment. So, you know, we've gone into an approach to actually look at what the best applications can be to protect the water.

So, I think you have a very good solution. You have the ability to have continuity and containment of those water lines because the last point of treatment is from the UV to the wellhead, and that's close proximity. That's where I thought there may be a misunderstanding thinking they were going to have water going across the countryside and back. That's not the case.

THE CHAIRMAN: Chair. So, Mr. Cole, you are out of time, sir. I'll remind you that there are three sessions. There's next -- next evening here in Steinbach for the public to talk. There's next Saturday. Not this coming Saturday. The Saturday after that in Anola. And there's also an evening session in Beausejour. And the purpose of the sessions is for this panel to hear from the people in the area, to hear their thoughts, their comments. And if Sio has anything they wish to add to -- to that record, they can do so at that time. But those sessions are primarily for the public, sir. So, if you wish to come back again, I encourage you to do so.

MR. COLE: I thank you very much. I appreciate the opportunity. Like I say (sic), I am nobody. I don't belong to anybody. And I do appreciate the fact that I'm allowed to speak here. Thank you.

THE CHAIRMAN: Chair. Everybody here is a somebody.

Are there any members of the public -- other members of the public that would like to ask questions? Please, come forward. State your name and spell it. You have 15 minutes. That's okay. Go ahead. Yeah.

MR. HALKET: Good afternoon, Chair, panel, member -- of Sio, and the panel from AECOM, I suppose, all AECOM.

UNIDENTIFIED SPEAKER: You don't have to hold it. Just push it once -- press it once.

MR. HALKET: Okay. And good afternoon, everyone else. My name is Ian Halket, H-A-L-K-E-T, and I am working with, or an advisor to, Peguis First Nation. I think today the discussion -- the back and forth between the proponent and AECOM's engineers, and the interveners has been very interesting. I've learned a lot about this project that I didn't actually pick out of the environmental assessment or the hydrogeological material that was filed. I think there's a lot of new information here, one of it being, to me anyway, was the collapse of the aquitard -- of the shale aquitard that separates the sands from the limestone aquifer above. I'm interested in, and Peguis is interested in, the structural stability of this, and we heard about -- of the mining extraction and that honeycomb sort of structure, if you will, that will be left over in the Carmen Sands -- or the Black Island sands. I'm not quite sure which formation this is, or what the distinction is between the two, and I would ask -- ask if you have, or can inform me on that?

MR. MILLS: Ryan Mills with AECOM. Happy to kind of clarify that point. The Black Island Sands are located in outcrop, above surface, on Black Island in Lake Winnipeg, and it's -- so you can appreciate that's several hours north of here by car, and this is a different formation. Some of the key differences are that aside from its geologic origin, that there are known to be more metals and sulfidic minerals present in that shale, and there is a -- in fact, there are government reports on that specific area and that specific formation that -- that discuss some of the -- the kind of characteristics of -- of that material that is observable at surface on Black Island, that is not found here.

MR. HALKET: So, again, thank you for that. Ian Halket here. I'm -- the sands were laid down, I think contemporaneously, like the same time, if I'm not mistaken. Is that correct?

MR. MILLS: Ryan Mills with AECOM. I -- I can't comment on the exact temporal timeframe. This was, you know, several millennia ago.

MR. HALKET: Okay. I'm just wondering why, in yesterday's discussion with the -- with the geotechnical people, and also with your geochemical analysis, why there is no information, or shall we say cross-correlation, with those sands -- with those sands, and the ones that you're dealing with, in what you call the Carmen Sands below Vivian. I would suspect, this is a statement on my part, that they'd be fairly similar, and that the sands under Vivian would show quite a lot of different -- that there would be differences in their geochemistry. It wouldn't be as uniform as you're characterizing it, and I wonder -- and here's my question, is your characterization is coming from, what I can see from the hearing today, three samples. Is that correct?

MR. MILLS: Ryan Mills with AECOM. So, number one, the two sand deposits are very different. The Black Island Shale is in a different geographic location with very different material properties. Those are characterized and discussed elsewhere in government documents, and they can be obtained online. The local samples have been characterized both the carbonate, the shale, and the sandstone, with three samples each, and supplemented with some additional characterization data that Sio conducted themselves.

MR. HALKET: So, my question then is do you -- are three samples adequate to characterizing a deposit as large as is under proposal here -- is under ---

MR. MILLS: Ryan Mills, AECOM. The answer is, yes, as we showed in the table this morning. Dr. Elemine, next to me, presented what is considered widely, and in a global sense, to be industry standard for sampling of materials that are encountered during mining -- and of -- of any type of material. And the required number for characterization of the -- the volume and mass of material that works, that Sio is proposing to remove, requires three samples or less.

MR. HALKET: Okay, so we have three samples taken from the silica sands -- from the sand layer, three samples, or core samples shall I say, that are being extracted from the shale, and three samples from the overlying limestone. Am I correct?

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. That's correct.

MR. HALKET: Were these, all nine of these samples, fresh or intact, or did any of them experience weathering before they were given to the lab?

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. These samples were collected following standard practice. When the core was taken, the samples were taken from the core, was -- some of them were examined in the field, and packed in a standard sampling bag that is used for this type of sampling. They were stored in a pail, they were sealed, and they were sent to the laboratory.

THE CHAIRMAN: Chair. Ian, please remember to state your name each time.

MR. HALKET: Excuse me, Ian here. My

understanding is that these samples, one was collected from a stockpile within the proposed mine area, and two were collected from outside the proposed area to be mined. Is that correct?

MR. OULD ELEMINE: That is correct. And the objective of that is to capture the spatial variability that may exist within the unit. If we just collect sample from BRU-95, it's a small area, and the heterogeneity in that small section will likely be low. So, it is very important that we collect sample from different locations, and from different type of weathering status, whether fresh or completely weathered, to understand the overall potential that may occur. Very often, people think that it's only fresh material that generates acid or (inaudible), but it's not -- that's not the case. We commonly found that weathered material contains acidity, and if we're not careful to analyze that material and identify that there is potential for acidity from that material, we may -- estimate that and we probably have an issue with the -- with the leaching.

MR. HALKET: Thank you. But I have a -- a question that probably goes to the constituents within -- within the samples, if the sample is allowed to weather, do we have an accurate -- an accurate composition of the constituents that make up that complete sample?

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. This sample, for example the shale that's the main concern here, as we have shown during our presentation, and -- and indicated in our borehole log, it's already weathered. So, there is only a finite amount of material that the shale can release.

MR. HALKET: So, I'm going to come back to the idea here that the aquitard -- the shale and the aquitard will probably, at least from evidence yesterday and the day before, will collapse into the void after the sand has been extracted. And of concern to us is the release of selenium into the groundwater from that collapse, and also, the possible acidification of that groundwater from the pyrites within the shale.

MR. OULD ELEMINE: Sorry. Cheibany Ould Elemine, AECOM. I'm sorry for cutting you off. As was shown yesterday in our presentation, for ARD to occur, you need three elements -- need the -- the sulphide, the pyrite, you already need oxygen, and you need water. Based on the the way extraction proceeds, we do not anticipate that there will be oxygen to oxidize pyrite in the subsurface. But just for the sake of discussion, let's assume you have all the ingredients needed. The shale has very, very limited amount of sulphide. The highest pyrite content we measured was 1.3. And just let's -- for the sake of discussion, assume that it's 20 percent, for example, if that shale collapses, we also expect that some portion of that limestone would collapse as well. And let's say you have two metre of shale collapse, two metre of limestone collapse, that limestone contains enough buffering capacity to neutralize all that acid that may be generated from even 20 percent of -- of sulphide. And we know from the data we have, that the sulphide content is only -- that the pyrite content is only 1.3 percent.

THE CHAIRMAN: Chair. Ian, you have about one minute left, so maybe one more question.

MR. HALKET: I'm just wondering that if you had taken more samples, if there would be some variability to the amount of sulphide that you are finding in the shale. And the other question that I have is oxygen being introduced by the mining technique -- or air, shall we say, and what evidence do you have that air will not be introduced from the extraction of the sand, and does -- have you evidence that you are not going to be introducing or oxidizing the water. Sorry about that. For some reason I ---

MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. As my colleague indicated earlier, the requirement for the number of samples for characterization at this phase of the project is three samples per 10,000 tonnes of material. The project, in this case, will remove but less than 4,000 tonnes of shale and carbonate together. So, theoretically we only need three samples to cover both, but we went a step ahead. We collected six samples for those. That's one. The second, we indicated in our waste characterization management plan that we will try, and we plan on collecting samples ahead of production during the installation of monitoring wells, will make sure to collect samples to validate what we know already and -- if there is any requirement for improvement that will be done. We also plan on including additional testing that can get -- help us further constrain the ARD and our risk.

THE CHAIRMAN: Chair. Ian, thank you for your time. Thank you for your questions. Thank you, panel. Are there other members of the public that would -

- please, yes. I see. Now I understand my confusion. I didn't see Ian's hand go up earlier, but it's okay, it's okay. It's the person that raised their hand wasn't the person that walked up to the microphone. That's why I was confused. Chair. Welcome. Please state your name and spell it for the transcriber, and then you have 15 minutes for questions. Sorry?

UNIDENTIFIED SPEAKER: (inaudible).

THE CHAIRMAN: Please, please, please.

MR. FORTIN: I'm back. The last time I was here, it was stated that Stantec set it up so that you ---

THE CHAIRMAN: Sorry. Chair. I'm going to intervene. Please state your full name and spell it for the transcriber, and then please proceed to your question.

MR. FORTIN: That's Roland Fortin, F-O-R-T-I-N, R-O-L-A-ND. Last time I was here, Stantec set it all up that they designed the cavities for certain overburden depths. And once they did that, it was free for you guys to set up your configurations for your excavation wells. They stated that -- or it was stated that there would be one to five wells, that the configuration would -- would be, I'd believe, 18 metres apart, 9 metres to the edge, that two -- two excavations could go on at one time, and that there would be a 65-degree outset for the cavity. My question to you is, how is that configured and what are the pumping rates for the various -- I could -- if you would like a specific, there's a one -- one excavation and three in the other -- how do you ---

MR. MILLS: Yeah, thanks for your question. Ryan Mills with AECOM. As a -- a matter of clarity, so, Stantec provided the -- the cavity design to Sio, and Sio developed an extraction plan, and that's occurred sort of twice, once prior to the 2021 groundwater modelling exercise, and then once again in the last couple of months, and that revised extraction plan was brought forward into an updated 2023 groundwater model that -- we presented both of those results cases in our presentation yesterday. The pumping rates and the comparison of the 2021 scenario to the 2023 scenario are provided, I think it's Slide 24, and there's some -- some lines with red, and -- and magenta, and purple -- I'm partially red-green colour blind, so excuse my colours -- but they are presented on that figure. And what we saw was that the -- the zero percent reinjection case, which was what was used previously, the revised zero percent reinjection case is similar to slightly higher than what was previously the zero percent reinjection case. And but the -- the 50 percent case is much lower. And a yet to be completed -- I've just got a note that -- that the results are -- the model's wrapping up, but those -- that 85 percent reinjection rate is -- is going to be even less yet again. So, does that -- I think you were asking specifically about the pumping rates and ---

MR. FORTIN: I didn't explain myself well. You've stepped -- with the new model you've changed from four days, to possibly five to seven days. You've changed as you've gone to one to five wells. You've changed that you're going to be -- and the young lady, I'm sorry I forgot your name, gave a demonstration on -- as the -- on Page 11 of -- of what would five wells would look like in one cluster. And it's giving a top view and a perspective view. Now, when we're looking at the sand extraction, I believe that we're looking at a drawdown cone that is for -- like, there's three things happening here. To isolate one is -- is difficult, but to put all those three is even more difficult, because I'm looking at a five -- so it's virtually across, and you're looking at it -- the drawdown cone being within that cluster. Well, with the configuration you've given, that drawdown cone can expand beyond, for the water. For the sand, it would be an inverse drawdown cone so the bottom -- at the top would be greater than the at the bottom, because you're restricted by that 65 degree angle. You have to stay within that boundary.

MR. MILLS: Ryan Mills with AECOM. I think maybe there's a -- we should make the distinction that the -- the void space will be essentially full of water, with some residual solids that settle to the bottom of it. Whatever configuration that void space takes, essentially from a hydrogeological standpoint, is of little significance in that the water is allowed to freely pass from -- from that water-filled void to and from the surrounding aquifer. And the -- the the reinjected water would go into that void space. And -- and you know, we're -- remember, we're removing some sand, more sand, and that creates a -- more room for water to be held.

MR. FORTIN: (inaudible) -- Roland. The withdrawal of the sand will be an inverted -- it'll end up exactly as you say, but the progression of sand removal will advance that way. When you look at the -- the diagram of the. -- of the removal of this, it goes on an inverted slant contrary to the 65 degrees. If you look at ---

MR. MILL: Ryan Mills of AECOM. Does it -- I've put a graphic on this screen. Is it -- is this the graphic you're referring to? Does this help?

MR. FORTIN: That is correct. But if you look at -- at the simulations of the sonar readings that Stantec put up and that -- the withdrawal is -- is going going at this way, an inverted of that. So, the sand is removed at -- at that percentage, and it's -- it's contrary to the way what you would think, but that's the only way it can happen.

MR. BULLEN: Brent Bullen with Sio. Roland, I think the -- the diagram that we showed -- what we were trying to show when we showed the five well cluster was that when you look at the radial extent of the void at surface, you know, the five well cluster -- the five wells would actually stay within the radial limitations that have been defined by the Stantec model for void creation. On that -- that one that you have in your pamphlet, that's not -- oh yeah, there -- those cones are actually at 60 degrees -- 65-degree angles. We just looked at what the long-term predicted angle would be on the sidewalls. You're correct, in the initial extraction, you can have vertical walls, but what we tried to show is, you know, a visualization of how five wells would work in a pad, and even though there's overlap and there's areas where you would see extraction, you know, only occurring at the bottom of the wellbore, like say, the centre one, you know, it was a conceptualization to show how you get these -- these cones. You know, at the end you're not going to end up with five little spikes, you're going to have a bit of leveling of the sand, you'll have a steepening of the wall. But you know, we had, through the discussions and feedback, people trying to understand how do you put two wells? Do you put them so far apart that the radiuses come together and meet or are they close enough together? And in this scenario, which we wanted to show, it's a cumulative effect, you know.

MR. FORTIN: Undoubtedly, it's a cumulative effect. In fact, the drawdowns should be greater than one well or -- and that's where I'm leading to, is how are you looking at -- because the wells are 18 metres apart or am I -- I believe I'm correct, you're going to get a cumulative drawdown. You've got a steady state drawdown on your -- on your -- and it is a 400, or whatever it is, US gallons a minute. It's steady state. You're not going to get a steady state because you've got all wells pumping. Aare they all pumping at the same rate?

MR. BULLEN: It's Brent Bullen with Sio. The five well model, you would not have five wells producing at one time, you would -- you would produce one to two at a time, and then sequentially move around the pad.

MR. FORTIN: (inaudible) -- have three and the other cluster?

MR. BULLEN: If you have a -- it's Brent Bullen with Sio -- if you have a three well cluster, you may only produce one at a time or two at a time. Even if you were to produce five wells at a time, and I'm not saying that's what we would do, because that's not planned, your total withdrawal is less than the 386 gallons per minute that this formation was stressed to. So, we know that it actually can operate within the parameters of what the modelling projects. But we don't anticipate ever having five wells -- nor do we see a need for it. You would sequentially bring the wells on.

MR. FORTIN: So, in other words, you would have one well -- in that sonic you had it running for six days to equate 3,000 US gallons or 3,000 tonnes of sand. There's a -- there's nothing in the model that equates to two. How much sand do you want to take out from the cluster when you're done?

MR. BULLEN: The sand is dependent entirely on the void calculation capacity as to what it can deliver. So, just because we have a well that's capable of producing 4,200 tonnes and a five well pattern, you may turn off the perimeter wells first after they've only produced two or 3,000 tonnes and you may use the centre well to extract six or 7,000 tonnes out of that well. But you have to stay within the void. And so, it's the actual rotation of the wells to produce from that cluster.

MR. FORTIN: So, how deep are you going then?

MR. BULLEN: Brent Bullen with Sio. You have a formation depth, I think of around 75 feet, on average. Typically, in our results to date, you know, we've produced, you know, down to 40 feet into formation with producible formation below. When the 4,200 tonnes was completed, we turned that well off electively because we wanted to sonar it and we wanted to prove that you could actually have a well reduction in the overall drilling. There was additional material below that well that could have been extracted. We just chose not to do it at that time.

MR. FORTIN: So, how much are you extracting per cluster? It depends on -- I agree on -- on the overburden thickness -- on your thickness of your limestone. So, for the various components that you're looking at, how much are you extracting per cluster? If I look at the 15 metres to 20 metres to 25, those will all obviously have more room to obtain -- and how has that then modelled?

MR. BULLEN: Brent Bullen with Sio. Roland, if -- if you look at the size of the voids that we're allowed to work within, you're typically looking at a range of 4,600 tonnes out of a -- out of a well, that may just be achieved with the single well, up to a maximum that we calculate of 22,000 tonnes out of a multi-well pad configuration. And these, again, are all dictated on the void space. The void space is calculated for stability. How many wells it takes to get the sand out, obviously the fewer, the better for us, but that's your range -- you're looking at range. You know, typically within 4,600 metres to 22,000 metres depending on the modelling of what the allowable void space is.

THE CHAIRMAN: (inaudible) -- Roland. Roland, your time has expired so maybe we can wrap this -- wrap this up. You're allowed 15 minutes, Sir, and you're at the 16-minute mark.

MR. FORTIN: I've got more questions. If -- if ---

THE CHAIRMAN: Chair, before I allow you to proceed, I need to understand that there's no one else in the room that wishes to ask questions.

MR. FORTIN: That's more than fair.

THE CHAIRMAN: I'm just following the rules, Sir. Is there anyone else in the room that wishes to ask questions? Then I will give you another five minutes and we will likely adjourn.

MR. FORTIN: Appendix H gives you a schedule -- a set schedule. Do you have a set schedule for your model?

MR. HARVEY: Miln Harvey for AECOM. Yes, there is a set schedule. We had a schedule for the 2020-2021 model, and we -- it was given to -- provided to us by Sio. The updated schedule, they choose how to operate the wells, put that in a schedule, give it to us and put it in the model. That's how we do the -- the groundwater modelling.

MR. FORTIN: Is that -- can that be provided? Hmm.

MR. MILLS: Ryan Mills with AECOM. The production schedule is essentially in the same form as what was provided previously in Appendix H. The coordinates of the wells are -- were presented and -- and can be put on the screen again now, if desired, but I assume you have a hard copy of -- of the presentation we gave yesterday. And the -- essentially, it -- it shows how the progression of -- of sand extraction moves spatially over -- over space and time and -- and so I -- I think arguably, that that information has been provided, and it has been adjusted, in a -- with a similar kind of manner to be resimulated. So, it's really the coordinates of wells and the start and stop time of individual clusters that -- that has been adjusted.

MR. FORTIN: Thank you. With regard to the shale degradation, has anything been done with the idea that the shale degradation was not to occur? So, the spacing of the wells, everything else would have to have been reduced. Was that ever taken into consideration?

MR. HARVEY: Miln Harvey, AECOM. In the 2021 modelling we chose -- we simulated a specific scenario, it's Scenario 3, in which we had steady state analysis, conservative, no degradation of shale and zero reinjection. And the purpose of that one -- scenario was to -- it was conservative from a Winnipeg sandstone perspective because it -- it places most of the impacts confined within the Winnipeg sandstone. So, yes, we did take into account, and we had attempted to do it in a conservative way to see what the worst possible impacts were.

MR. FORTIN: I understand that. But the

weakest link in this whole picture is the shale. Now if you wanted to keep the shale intact, what is the minimum distance you need to do -- or was that even considered?

MR. DUNCANSON: Sander Duncanson.

MR. FORTIN: The size of the void would have to accommodate that.

MR. DUNCANSON: Sander Duncanson. So, Mr. Chair, unfortunately the -- this panel is -- they're the experts on hydrogeology, so all things groundwater. In terms of how the void spaces were designed, that's something that the geotech experts were available to speak to yesterday and the day before. The way that we've set up these panels was to try to be as efficient as possible and focusing questions on certain disciplines, but unfortunately those -- those witnesses are not on this panel. And this panel is available to answer any questions related to groundwater but not geotech.

MR. FORTIN: I understand your point, but the point was pointed out to me that with the group that was before us, the geotechnical, the only obligation was to show that -- that there would be no collapse of the surface, not the collapse of the shale. Every question I asked was referred back to Silica. Because it was the hydrology -- all they did was set up that portion. The portion that I'm asking, Silica should be able to handle -- or answer.

MR. BULLEN: It's Brent Bullen with Sio Silica. Mr. Fortin, what you're asking is a geotechnical calculation for separation on capacity. In the discussion with the geotechnical panel, which I also sat on, there was discussion on the side scan sonar, and the void, and the void spaces created. And they would be the best panel to talk to in their modelling. I mean, I -- I'm not the expert on the modelling, Stantec is, and Stantec's not up here, so it's impossible for us to go into your modelling questions without asking our Stantec representative.

MR. FORTIN: No, I understand that, but did -- because you're on the board, did you ever request them to do that analysis?

MR. BULLEN: Brent Bullen with Sio. As mentioned yesterday in the geotech, they used a safety factor of two which is above an extreme danger damming event, which is at 1.5. When we looked at it, we went through and went through the application of no subsidence and -- to be as conservative as possible. So, our direction was to always be as safe and conservative as possible. And the modelling was presented. So, as for the interpretation of the model and how the model was created, I can't speak to that.

MR. FORTIN: No, but the consultants get their direction from Silica. Did you ever request them to do an analysis on the shale -- obviously it would be much less than what they've proposed in the 25 -- or the 15 metre collapse regime that exists now.

MR. BULLEN: Mr. Fortin, Brent Bullen with Sio Silica. You know, as mentioned yesterday in the -- in the panel the strength, integrity of the shale was never taken into consideration. And so, you know, I respectfully ask you to address those questions to Stantec. I mean, you're -- you are asking the wrong panel and I'm not -- you know, we brought 16 experts down here to -- we've had a fulsome discussion on all of these items. I -- I wish you would have asked that question when the panel was sitting up here, and the opportunity was made to you.

MR. FORTIN: I ran out of time.

THE CHAIRMAN: Chair. And with that, Sir, I've given you 25 minutes, so that's ---

MR. FORTIN: Thank you.

THE CHAIRMAN: Chair. I understand that Dennis would like some additional time. How about 15 minutes, Sir, in fairness to the other participants that didn't have the opportunity for half an hour since we had to parse up the day somehow.

MR. LENEVEU: Hello, Dennis LeNeveu. I didn't have time this morning to finish some of my questions. Could you put up slide 10, please?

UNIDENTIFIED SPEAKER: (inaudible).

MR. LENEVEU: I'll just quickly set the stage for this. Sio Silica, in response to some questions, Has admitted there be up to 15 percent interbedded shale concretions and oolite, which are known all to be pyritic in the formation and these will be brought to the surface with the sand, and that could constitute, out of 1.36 million tonnes, 200 -- around 200 -- oh, is that Slide 10?

UNIDENTIFIED SPEAKER: You want ten?

MR. LENEVEU: Yes, and you can see those concretions there on a pile of extracted sand, and as well, the shale on the right and that may be up to 200,000 tonnes which requires more than 80 samples. And so, the question is, in consideration of these other components in the sand that will be brought up that are known to be pyritic, it would seem that three samples is not nearly enough. Can you answer that question?

MR. MILLS: Ryan Mills with AECOM. First, we dispute the fact that additional sampling is required to characterize the volume of material that we are looking at here. We have followed industry standard guidelines and exceeded them for the materials that are present here and have adequately characterized them to exceed industry standard. The second point comes to the characterization of oolites and concretions, and any waste materials generated as part of -- of the extraction process will be collected and managed in accordance with their material properties. As you might have noted in the waste characterization and management plan, Sio intends to take those materials that are generated during drilling, and as a result of extraction, and -- and properly dispose of them at a licensed facility.

MR. LENEVEU: Thank you for that clarification. In the waste characterization plan, it says explicitly the sandstone will not -- is not considered to be a waste stream, so it will not be analyzed in waste characterization. So, this pyritic material here that can constitute up to 200,000 tonnes, it says in your waste characterization plan, will not be analyzed. Is it not necessary to specifically analyze this material that you see in your sandpiles? It's never been analyzed in your geochemical analysis. Is it not a requirement to analyze it?

UNIDENTIFIED SPEAKER: Inaudible 00:52:10)
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MR. OULD ELEMINE: Cheibany Ould Elemine, AECOM. The characterization that we follow, and you probably are aware of that, in the MEND, deal with the characterization of the waste material, whether that's coming from the shale or the -- the carbonate unit. The sandstone that's been extracted, it's extracted almost 98 percent pure, and this conclusion that you're showing here, we don't see them in the sand we have collected. And those samples, if they exist, they are processed as part of the material. When we do a characterization program, we are not looking at characterizing individual particles. What we're looking at doing is developing our understanding of the leachate that might come out from a given formation, not one particular solid or one particular mineral. And that's why we collect a large sample, send it to the lab so it can be homogenized, and that leachate could represent the material that comes out of that sample is assessed.

MR. LENEVEU: Thank you. I do see these materials on this picture, so, that they do exist.

I want to have one other slide put up about entrained air that comes out with your airlift process. So, the water that -- the material that -- returned water that you put back won't have just dissolved there, it'll have dissolved gaseous air, which you call entrained air. And my question is, in addition to dissolved air, in the returned water, will you measure the gaseous entrained air that -- well, it's actually air bubbles, rather than just dissolved air, and it can be much more air in that returned water is a gaseous entrained air then dissolved air. And there are instruments to measure entrained gaseous air that are quite different than your dissolved there. Will you measure entrained air and -- and also try and get rid of it?

MR. MEUZELAAR: Tom Meuzelaar, Life Cycle Geo. So, it is important to acknowledge the difference between the oxygen content of water and the oxygen content of air, since that's come up a lot. Water cannot hold nearly as much oxygen as air can. The saturation limit is about six to eight milligrams per litre. We do not expect to have a lot of entrained air in the aquifer because we've got a -- a passive disposal system. And so, we will be measuring dissolved oxygen content.

I think the other important thing to recognize is the mining industry regularly uses water covers. Part of the reason they do that is because oxygen does not move readily in the water phase, and we expect to have a saturated water column beneath, when we return the water.

MR. LENEVEU: Thank you for your question. If you look at this picture, it's obvious, yeah, that milky white water being sent into the tank has entrained air, and also if the colour of it would show there's not much sand there. So, I would respectfully suggest there is evidence for entrained air in your removal process.

MR. MILLS: Mr. LeNeveu, Ryan Mills with AECOM. I'll respond directly to that before you move on. This photograph -- I'm not sure that there were any measurements of entrained air taken, so it's not fair to postulate that there was entrained air. I agree, it is exposed to the atmosphere, and that that water then sits in a tank. It does contain an extensive quantity of sand, as you can also see the sand entrained in the water. Because the sand is so white and pure, it gives it a white colour. So, it's not just air bubbles or agitation that -- that gives it a white colour in this case.

Second, once that water is allowed to settle in a tank, it comes into equilibrium with the atmospheric pressure of oxygen and the partial pressure, and it would exsolve from solution the vast majority of the air and oxygen within the air would exsolve to the atmosphere. It is acknowledged that some would remain in the dissolved phase, but as my colleague Dr. Meuzelaar pointed out, that fraction is very small.

MR. LENEVEU: Thank you for your answer. Just to be cautious, wouldn't it be wise to measure the entrained air? It's a different measurement than dissolved air.

MR. MEUZELAAR: This is Tom Meuzelaar, Life Cycle Geo. We don't agree that there is value in doing that.

MR. LENEVEU: So, you don't agree you should take a precaution?

MR. BULLEN: Mr. LeNeveu, it's Brent Bullen with Sio. I think the answer was given to you, so, to postulate with another summary statement, I don't feel it was fair.

MR. LENEVEU: That -- that's fine. I just want to move on to another issue, and that's the 15 percent water about -- I asked before -- in the sand and the total amount of water removed from the aquifer. And I heard a number, but there is concern of people that if that would be sustainable, the total draw from the aquifer over these many years every year of taking a permanent draw from the aquifer. And I think your hydrogeological model should be able to handle that question. Kennedy and Woodbury's model addressed it in -- but you, of course, have to take into account all the other draws that are going on, industrial draws, to see if your incremental draw over the period, with respect to sustainability -- and of course, you have to determine accurately, how much water you're withdrawing from all sources including in your waste streams, from that aquifer. So, can your hydrogeological model answer this question about the sustainability from the permanent water removal from that aquifer?

MR. HARVEY: Miln Harvey, AECOM. So, a couple of points. First of all, we did a -- a long-term pumping test and during that pumping test, we pumped and then showed recovery, very quick drawdown, and very quick recovery of the water levels after the cessation of pumping.

A second point, the 15 percent of water that remains in the sand is equivalent to a permanent withdrawal of about equal to what a golf course commonly uses. So, it's -- it's similar to the operation of a golf course. This -- in this case, the operation occurs in a time varying way where during the spring, summer, and fall months pumping occurs, but then for a period of - of a few months over the winter, there's cessation of pumping and the water levels recover. Just like the pumping test, water level drawdown recovers to static, pre-pumping levels. And this is because there is natural recharge to the aquifer that's replacing the water that has been taken out. So, Sio's proposal is a short-term proposal over a period of 25 years. Each year it's operated in a way -- it's operated in a way where recovery occurs, so it is not a long-term draw on the aquifer.

MR. LENEVEU: Thank you for that answer. There's still a permanent draw of water and if you do the -- take 15 percent of 1.36 and divide by the density, I think you get nearly 800,000 cubic metres a year, which I don't think is a golf course.

MR. HARVEY: So, to answer that question, we dispute that it's a permanent draw. It is a transient -- this is a transient process which is occurring over a given period of time and during that -- the operation of the wells, after each year there will be recovery. So, we will have operation of the wells, withdrawal of slurry, some removal of -- permanent removal of water, but at the end of the drilling season, the water levels will be able to -- will be allowed to recover because the pumps will be off. So, each year drawdown and recovery, drawdown and recovery. So, there -- it's not a permanent withdrawal -- not a long term permanent withdrawal of -- sorry, it's not a long-term withdrawal of water.

MR. LENEVEU: Thank you for that answer. I think the water that evaporates are gone from the sandpile, that's a permanent draw on the aquifer. It may be replenished by infiltration, but you know, everybody -- if you add up all the draws from the aquifer, at some time it becomes unsustainable. And Woodbury and Kennedy's calculation showed we were nearing the sustainable limit right around now and -- and extra draws like this are a concern.

That's -- so just move on to the next one. The other issue I'm having is a concern about the amount of air in the aquifer, and I hear that all the water that comes in your pipe -- production pipe will circulate back up. But I've seen examples where just a little over-pressurization of your air compressor and it comes out the bottom -- leaks out the bottom -- and you can't see down there. So, how do you measure -- guarantee that there will be no water leaking out that pipe -- at the bottom of the production, -- air leaking out the bottom of the production pipe, that there's no measurement for -- you have no -- no known way that I've heard of determining if you're getting leakage out the bottom of your production pipe -- leakage of air on a sustained basis.

MR. MILLS: Ryan Mills with AECOM. First off, you minimize the volume of air that enters the aquifer that is -- in a manner that is implicit in the design of the project. The air injection pipe is well above the base of the -- the steel casing, and therefore, the easiest -- the air will take the path of least resistance and generate that buoyancy effect. There will be mass movement of that air plug upward to surface. That is its shortest path to ventilating to the atmosphere. That will draw in water from the aquifer with sand and that is the foundational basis for all air rotary and dual rotary drilling. That is the foundational basis for that technology. The reason there's mass movement to surface is because that is the path of least resistance -- is from the point of air injection at the drill bit to surface. That's how cuttings, and water that comes with the cuttings, moves to surface.

MR. LENEVEU: Thank you for that explanation. I think that's clear, Otherwise you wouldn't have airlift, but I still don't hear a way to measure if you actually put a little bit too much pressure in there, if you get air coming out the bottom of the pipe.

MR. MILLS: Apologies, I -- I didn't quite address that question specifically. Ryan Mills with AECOM. The way that you could measure that, and it could be captured in a monitoring program, is by monitoring field parameters as we have specified in the Groundwater Monitoring and Mitigation Plan. There could be field characterization at the time of water quality sampling to address this specifically.

MR. LENEVEU: Thank you. So, you haven't measured this parameter up to now, in five years of development?

MR. BULLEN: Mr. LeNeveu, it's Brent Bullen with Sio Silica. Airlift does not work if the air comes out the bottom of the extraction tube. You will see it at surface, so you have no returns. It's just that simple.

MR. LENEVEU: Thank you.

MR. MILLS: Ryan Mills with AECOM. We will add that we have measured field parameters including various indicators of -- of redox conditions. And oxidizing conditions are not found in the aquifer before or after testing.

THE CHAIRMAN: Chair. I will allow one more question, briefly please.

MR. LENEVEU: Thank you. I think those tests you made were during your drawdown study, where you didn't inject any air, and you didn't extract any cyan (ph) as part of your hydrogeological study there, tabled in the EAP before and after drawdown. But these are not studies where you actually had air and sand operating, so they're not relevant to the process water that would be extracted with the sand.

MR. MILLS: Ryan Mills with AECOM. I'll respectfully disagree with that opinion. These boreholes and monitoring wells were drilled with compressed air and rotary drilling techniques that are similar, and very similar, if not identical, to the processes used to lift the proposed slurry and water to surface. We have -- as a hydrogeologist, I routinely drill, and install, and test monitoring wells and sample the water quality during development and this is not something that we see. We do not see elevated concentrations of dissolved oxygen, or oxygen in general, in groundwaters that are mature.

MR. LENEVEU: Do I hear you say you actually measured the -- for the water that came out with the sand, the processed water, during sand extraction, you measured the quality of that water, the dissolved oxygen and entrained air actually during -- with water that was taken out during sand extraction? And if so, can we see the results of that analysis?

MR. MILLS: No, I did not say that. Ryan Mills with AECOM.

MR. LENEVEU: Thank you.

THE CHAIRMAN: Thank you, Dennis. Thank you, panel. I think that draws us to a close for today. So, we will adjourn. I will remind the panel that we have yet to hear from Byron Williams from MBEN, who will have roughly an hour and a half tomorrow morning for questions. We will then swear in the permitting team, and we will leave it from there. Thank you very much. Have a great night all.

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