MANITOBA CLEAN ENVIRONMENT COMMISSION

HEARING

VIVIAN SILICA SAND EXTRACTION PROJECT

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Transcript of Proceedings
Held at Brokenhead River
Community Hall
Beausejour, Manitoba
TUESDAY, MARCH 14, 2023

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TUESDAY, MARCH 14, 2023
UPON COMMENCING AT 09:45 A.M.

THE CHAIRMAN: Chair. Good morning, everyone. We have overcome our technical glitch, so we are in business. In terms of how I see the day unfolding, Sio will be doing a rebuttal and that will likely take an hour and a half. There is likely some elements of their rebuttal that will lead to questions from the participants, so I anticipate that will take us probably to lunch or thereabout. I expect we will then adjourn for the day so that the participants have an opportunity to digest the rebuttal and come back tomorrow with their closing statements. At this point in time based on what I've heard, I expect tomorrow will be our last day, but let's take that as -- as it comes. But it seems that all parties indicate that we should be able to fit all closing statements into tomorrow. So with that, I turn the floor back to The Proponent. Thank you.

MR. DUNCANSON: Thank you, Mr. Chair. Sander Duncanson. I'm just going to pass it right over to the witness panel to walk through the rebuttal presentation that they have prepared. I do not anticipate that I will have any questions as we go along, and then once they finish that we can see where we're at in terms of schedule and go from there. So I think, Mr. Mills, you're up first.

MR. MILLS: Thank you. Ryan Mills here. And what I'll do is -- I'll start by walking through a presentation here and we'll be passing the speaking role from person to person and I will navigate the slides.

So we're here to sort of correct the record and -- and kind of clarify a number of issues. We'll walk through a number of clarifications and then we'll kind of work through a number of different topics organized by theme. First, geotechnical -- talk a bit about our pumping tests, groundwater modelling, act for sustainability as a whole, water quality, and then get into some discussion of pilot testing.

So we've kind of organized the clarifications by providing a -- tried to capture the issue or the statement that was made and then rebutting or clarifying some of the -- the statements that were made. Starting with a discussion of and -- and first off before I get started, my name is Ryan Mills. I'm a hydrogeologist, if you haven't met me -- I have been with

AECOM for over 20 years, I have several degrees in geology and hydrogeology, I'm a registered professional in several provinces, and I've made a career out of working in the field of hydrogeology, geochemistry, and groundwater modelling.

So the first statement that was made -- there was some discussion around industry standard and making assertions that that was the same as state-of-the-art. That is in fact not true. State-of-the-art is more parallel with academic research, industry standard is also not bare minimum -- that corollary was made as well. Industry standard relies on proven approaches to collect and analyze data that others can follow and repeat for themselves. They are often captured in standard operating practices or procedures or guidance documents, and the idea is that it can be compared. The work of one can be compared to others, and there is trust in the methodology that is followed.

State-of-the-art or academic research is about testing new ideas or trying to develop new methods to collect and analyze data to expand the knowledge base. The research is intentionally novel, that's why it's called research, but it is not trusted or proven until it has been validated by others and applied. Regulatory agencies typically do not allow us to apply state-of-the-art or academic research themes to our work because it has not been proven and cannot be relied upon. So there's a need to utilize and apply these proven technologies and approaches as primary mitigation measures to address any project impacts.

A key differentiator is that everyone of the technical experts engaged by Sio has a professional designation and is bound by a code of ethics and a code of professional conduct, and a key tenet of all of that is we are bound to protect the public interest. We are all at risk here by taking professional responsibility for our work and applying our seals to our work. We risk loss of our licences, credibility, disciplinary action, and our livelihoods if we do not abide by these requirements.

I'll move on to the second part and this is around the statement that was made that shale collapse was not considered by groundwater modelling. It was alleged that the information provided was only required -- provided during the first week of the CEC hearing and therefore had not been recommended. This is in fact false. Shale collapse was considered in all groundwater modelling conducted to date by assuming it was not present and therefore took on the properties of the underlying sandstone, which will permit the flow of water to the void and the exchange of water between the aquifers. This was explained in detail during a virtual meeting attended by Dr. Hollander, ARCADIS, AECOM, Stantec, and Sio on September 6, 2022. Prior to the finalization of the technical review, at approximately 21 minutes and 10 seconds into the recorded meeting we specifically discussed the assumed 200 metre radius of possible shale collapse and how that was addressed in numerical modelling. It was explained that the analysis explicitly analyzed the scenario that contemplated shale failure. We were very surprised and disappointed to learn that those facts were not considered in the finalized version of comments provided by PorousTec.

Third -- the method. There was discussion around the method of modelling share -- shale collapse and the fact that -- that that may not be appropriate. So this has been discussed again in -- in the last couple of weeks. The facts are that the water -- any groundwater must flow through the sandstone to the void, and the hydraulic conductivity of that void will ultimately govern the rate of reflooding of the void or equalization of pressures. So, the hydraulic conductivity of the sand was assigned to the shale within the numerical model as it will provide some resistance to -- to groundwater flow. And although the statements made -- were made that there is essentially infinite hydraulic connectivity within the void, because it is a void, you cannot assign an infinite hydraulic connectivity. That's not a number that can be assigned in a model. The hydraulic conductivity of the void is of little resistance to the overall -- or little relevance to the overall groundwater flow patterns.

Another comment -- and this is a statement that I wrote in our report that I believe has been applied a bit more literally -- it was in fact a summary statement taken from the literature that on summation the -- the information suggests that the Winnipeg Shale is an effective hydraulic barrier to interaction between the two aquifers at this location. So, what was intended to be meant for by this statement? It was intended to describe the function of the Winnipeg Shale regionally, but there was no intention to apply this statement to the Winnipeg Shale across the model domain as there are clear differences, and those were discussed in the report and have been discussed quite substantially over the past two weeks. You'll see on the right there's a figure that shows every one of those dots is a -- a -- the location of a well that was judged by Dr. Paula Kennedey in 2002 to be a well that interconnected the two aquifers and allowed for exchange of water between the -- the two aquifers. So, this is well documented in the literature by Dr. Kennedey and many others that the Winnipeg Shale is -- is leaky. Although it does provide some resistance to the exchange of groundwater, it is clearly not a perfect hydraulic barrier.

So, effective and perfect are kind of the -- the -- the distinction points here and -- and we have four lines of evidence to support that. One, there's a leaky aquitard response observed during a pumping -- our pumping test. So that is one line of evidence that there was a response in both the carbonate and the sandstone to pumping, and that tells us that there's some leaky aspects to the aquitard. Second, there's the abundance of wells -- over 1,000 reported in the literature -- interconnecting the two aquifers as I described. Third, there's an observed degree of natural weathering in the core that suggests that there has been the movement of fluid and -- and the -- and a process of weathering within that shale. And -- and we know that that -- the thickness of that shale varies regionally. So, that will offer a variable degree of -- of -- of separation between the two aquifers regionally.

There was also some discussion around the fact that the 200 litre per person per day groundwater consumption rate was not an appropriate assumption. I've shown on the right the cover page of a Municipal Groundwater Supply Investigation for the Rural Municipality of Springfield. There's a direct quote that I've -- I've captured on the -- the lower right produced by others -- and we relied on that statement in our work. So, this was a Friesen 2019 report and it says, "Currently water use in both Oakbank and Dugald is approximately 200 litres per person per day according to a report by WSP in 2018, with the average use dropping per year over the last several years." So, in fact the use of this number is expected to -- or has been -- is appropriate and -- and that number has been declining over time, and -- and our work may have been perhaps overly conservative.

Dr. Hollander questioned the integrity of the sample from Brew 96.1 -- so, this is a water sample collected in November 2020 -- and he questioned it because there was, in his words, A significant delay between sampling and testing. In fact, all water quality samples were collected and stored following industry standard procedures and they were delivered to ALS Laboratory by trained professionals under standard chain of custody procedures. The sample from Brew 96.1 was collected on November 13th, 2020, stored on ice, and delivered to the laboratory on November 17th. That's four days later. And that is a routine, you know, separation between sampling and -- and analysis. And in fact, all laboratory tests were completed within the recommended hold times for the parameters and the results were similar to other samples collected later. And with that, I'll -- I'll pass the microphone to Mr. Bullen.

MR. BULLEN: It's Brent Bullen, Chief Operating Officer of Sio Silica. I wanted to talk about the clarifications of statements that were brought up by some of our participants who elected to bring them forth as individuals during the public consultation period or as individuals during questioning. And although we would expect to have truths under oath, I just will highlight a couple of the discrepancies that were brought up.

As the Chief Operating Officer, safety is paramount in our company -- we take it seriously. I find it offensive when it's criticized in the fashion that it has been criticized. So I want to look at the coverings and the use of gates and fencing, as well as signage and appropriate signages which we're accused of not having. What we see here is our typical encapsulation of sandpiles. We use a membrane material, it is actually secured at the ground with overburden and we have our piles -- and there was discussion on our piles, they were inspected by Mines and Safety and they were inspected by Occupational Health And Safety at Centreline. And we're not posed to be a risk, but we were the ones that actually suggested doing the encapsulation and we -- we follow that procedure. The only time those piles are opened is when they're vandalized. We've had over $100,000.00 worth of vandals to our properties. We've reported to the RCMP, there's a record. It's not because we're trying to press charges or anything, but we are a prudent, sound operating body.

We were criticized for our opening statements actually having a safety thing about driving in the winter time. That's just standard practice now when you have large groups that you open with safety statements.

Gates and signage. The picture to the

right, we redacted the e-mail address, but that was our former Operations Manager who actually installed those gates and signage. And that was done in the spring of 2019 before we actually drilled our first water wells, which eventually became a test site that was pictured in Mr. LeNeveu's presentation with some piles of sand and some equipment still on site. We wanted to make sure we had a safety separation, we wanted to make sure we had gates, we wanted to make sure we had signage. That's one of many gates that have been stolen, signage that have been taken down on both sites. But I did want the Chair and -- and members of the board to have a look at the fact we actually do do what we say.

There is a lot of discussion about the intermixing of water and the potential for water contamination from the slurry loop to the extraction. We came up with one more graphic because we just really want to emphasize there is a very clear separation where it's sand only. So that sand is wet, but you know, it does move mechanically into an introduction into the slurry loop. It is impossible -- physically impossible for slurry loop water to go into the extraction mode and be introduced into the wellbore. That cannot happen and we just wanted to emphasize it one more time because it seemed to have some points that were brought up. I'm going to pass it over to Cliff now.

MR. SAMOILOFF: Good morning. Cliff Samoiloff. I'm a senior scientist and environmental professional with AECOM here in Winnipeg. I was one of the co-authors of the EAP along with Marlene Gifford, and I'm just here to provide some clarifications on a few items.

My experience is approximately 25 years, a little bit more than that in primarily environmental assessment and permitting work in Manitoba, most notably for the mining sector. Projects I've worked on in the past include the Lalor Mine, Reed Copper Project, Wanipigow Sand Project, and -- and a number of other mining properties. I just want to speak to two items that require clarification.

The first one came up last week from Matrix regarding mining and their presence in communities. The comment was made that there are no examples of mining in proximity to developed areas, and I'm just here to say that that's absolutely not true. There's -- there's hundreds of examples of communities operating within vicinities of mine sites, infrastructure, water, within close proximity to mines. In fact, mines tend to be the cornerstone of communities, whereby the residences and -- and businesses develop around the mine sites as opposed to the other way around.

So, plenty of examples to choose from. I've highlighted a few of them in the presentation. Most notably, I mean, the RM of Springfield should be noted. They do have a long history of sand and gravel quarrying, some of them within close proximity to residences. Anybody who's been to Flin Flon or Snow Lake knows that the Flin Flon operations are very close to the community of Flin Flon, in addition to Creighton, Saskatchewan. In Snow Lake, the former New Britannia Mill, there's houses within the shadow of the head frame of that mill. So, they -- they -- there's plenty of development that occurs around those. And Thompson's another example with Vale's facilities that have been in operation for -- for over 60 years. Other examples in Manitoba include the 1911 Gold site, formerly SanGold in Bissett, and even the Stonewall Quarry, which is now a provincial heritage site and an area that's used widely by the community as a park. Outside of Manitoba, I've listed a few other examples. K+S Potash is one that's identified primarily because most potash mining is done as room and pillar, which is similar to what will be occurring for this particular project. And Butchart Gardens. I don't know if anybody's been there before. I encourage you to go if you haven't. It's quite beautiful. And what a lot of people don't realize is that that was formerly a limestone quarry and a cement plant. So, it's been converted to -- I think it's a national historical site in fact, and a widely visited area within -- within Victoria. So, just wanted to clarify that mining communities certainly do exist near mining operations.

If we go to the next slide. I just wanted to speak to the issue of chitosan absorption. Now, I am not a water treatment specialist. I'm not a chitosan specialist. But we did have a panel member during the first week, day four, Mohsen Barkh from Recens. He did speak to the issue of chitosan. None of the technical reviewers identified chitosan as an issue, but it was brought up yesterday by Mr. LeNeveu regarding chitosan absorption, and he indicated that it is effective only under acidic conditions with pH less than six where it is soluble, and it becomes insoluble after absorption. In speaking with our specialist, and he presented evidence during the first week, that is simply incorrect. Chitosan works without any adjustment between the pH of 6.5 and nine, and that's the range in which Sio will operate this project.

Mr. LeNeveu actually did cite a paper yesterday that discusses the use of chitosan outside of that pH range, but it's not relevant to this particular project. That was actually a different mechanism that was -- that was brought to the table by Mr. LeNeveu.

And finally, the issue of coagulant. Although it is true that in certain cases coagulant or flocculants are used for chitosan systems, there's no coagulant or flocculant needs to be -- no coagulant or flocculant needs to be used on this particular project for the proposed -- or contemplated filter press that will be used. So, even the issue of a filter press is -- is still in the -- sort of the -- the decision-making process and is currently just being contemplated at this time.

With that, I will hand it over to Doug.

MR. MCLACHLIN: Thank you, Cliff. My name is Doug McLachlin. I'm a senior geotechnical engineer with AECOM. I was here during the first week, and I'm here in the capacity as a reviewer of the work that has been carried out by Stantec. And I'm here to really address some of the questions that have come up and to provide clarification on some issues related to the geotechnical assessment, as -- in my role as an independent reviewer of the work carried out by Stantec.

On this first slide I want to discuss some questions that have come up, and these were raised by Mr. LeNeveu, about the reason for assessing the stability of the sand based on the side scan sonar information, the survey data, and also the values of cohesion that have been used in the analysis for the sand. He also raised the potential that there may be other types of failure mechanisms that could potentially be -- could arise from the -- the project, and I want to talk about those.

First of all, the side scan sonar survey data is very clear. And so, it shows unequivocally that the -- the vertical slopes and overhanging slopes are present. So, we have that data. That data is available. We presented that. And I'll provide more details and clarification on that as well.

Secondly, we have in situ testing of the sand materials using standard penetration tests that indicate very dense material, weakly cemented. Essentially, it behaves as a sandstone until it becomes disturbed through the extraction process. So, the sand strengths that have been used in the analysis are very reasonable, and they're actually quite conservative. Based on a literature review of weakly cemented rock, cohesion in these materials often exceeds 1,000 KPA. However, in their back analysis and calculation and to be conservative, Stantec used a value of 220 KPA in their assessment. They also used a strain weakening model, which means that over the period of assessment, the strength goes from 220 KPA to zero. So, essentially, it reduces in strength over time, and they've used that in the analysis to develop the final slope of 65 degrees, which is considered a reasonable and conservative approach. So, for these reasons, the information that we have to date all suggests that the work done by Stantec is reasonable, conservative, and appropriate for this stage in the design.

Another comment was made that cover subsidence could be an alternative method of -- of failure, and this is simply not possible. The reason is that Stantec have done all of their analyses to ensure and state, as it says in their table nine, that there must be a certain thickness of competent limestone above the cavity, and this will prevent any subsidence, and what is called cover subsidence, and which was raised by Mr. LeNeveu in his comments. And the other reason it's not possible is that at every extraction location when there's drilling for the extraction, there'll be detailed information on the thickness of the overburden and the thickness of the limestone, and table nine will be followed. Also, there will be additional investigation which we'll be talking about during our presentation. We will -- there will be further assessment using angled boreholes to provide further information. So, their work will not be carried out in areas where there's -- the table nine values are -- and the thicknesses are not present, or where any karst topography were to be experienced.

Next slide. Another question has been raised on the limestone, and this was raised by KGS in -- in their -- in their comments, that if there were to be vertical fractures, that somehow there would be -- this would -- would cause the -- the work done by Stantec to be incorrect. And -- and in fact, Stantec have, throughout their assessment, considered vertical fractures. Stantec assessed the potential for competent limestone and vertical fracture -- fractures based on the -- all the data that has been carried out and obtained to date, both the vertical boreholes, the logging, the OTV and ATV optical televiewer, acoustic televiewer all suggest that this is very competent limestone. Very competent. It's also dolostone, dolomitized, which means it's very competent as well. So, there's been mineralization that's taken place. And all of the information to date is clear that it is very competent and there are -- there's no evidence of -- of this sort of continuous vertical fracturing.

On the right-hand side of this graphic, this actually depicts exactly the information that is being shown by Stantec in their assessment. So, this -- this is actually a representation of what Stantec have included. They've added vertical fractures in this beam, that sort of structure that's shown on the right-hand side, and I'll go into that in more detail. So, the bending failure mode remains valid for this condition, and this is exactly what Stantec have assessed and included in their assessment. It's very clear that Sio has committed to doing additional boreholes to look at angle boreholes to assess for potential for continuous vertical fractures, but so far all the information today suggests that that is not present.

So, again, if vertical joints are present, the bending failure mode remains valid. And again, based on everything we have shown to date, there is no evidence of continuous vertical fractures, but even if there were vertical fractures, they have been considered in the assessment. And so -- and the graphic below here. Now, this graphic is zooming in, in a very localized area. So, this is -- this would be sort of at the very top of a cavity right in this area here. There are vertical and also horizontal stresses that maintain the stability of these beams, and here's an example of one right here, both as cantilevers. Here's a pin cantilever here. And this is basically showing pin stresses at these locations. And Stantec in their modelling have assessed this, and that's all included in their stability modelling.

Another point of clarification. This has come up and -- and perhaps because some of the information that was presented previously on the side scan sonar surveys included multiple surveys on -- on a single piece of paper. So this graph right here shows it split up into three -- the three different conditions. One is post extraction right here, second one is about two months following extractions, and this is four months. And so these are now placed directly on this cross section here and this is what we're seeing and observing. As time goes by, we're seeing -- yes, there is failure here of the shale above the cavity, and also in this one. And also, in the third, four-months after extraction, what's happening is these materials are falling down into the cavity and filling the cavity over time. So we're not seeing ongoing failure on the sides, we're seeing just the effects of the shale and weathered limestone failing and falling into the cavity. So, one thing to note and we will talk and this was discussed earlier -- all of this has been assessed in the hydrogeological assessment. So there has been allowance made in the assessment for hydrogeology and this is also being observed here.

And one of the other things to raise on this is that there's a commitment following a issue of a licence that Sio is prepared to continue to go in and monitor for longer periods of time and assess these -- the size and shape of the cavity over time.

Another question -- question came up was raised by KGS suggesting that no sensitivity analyses have been completed for the project, which in terms of the geotechnical assessment, and that's simply not true.

First of all, in the assessment of the site all of the geological information was included in the geotechnical assessment. So, thousands of water wells and we went well beyond just the limited area of a -- the extraction for the first four years. We looked well beyond that and -- and assessed a lot of information beyond just the local area. And the reason for doing that is to assess the -- the variability spatially and to look at how consistent the information was across the site, and one of the things that came up is it's very consistent. The depositional history, it's laid down in layers, we're finding the same geology across the site with varying thicknesses. And that has been assessed as part of this assessment of variability and sensitivity, looking at the variability of the information across the site. Also, the data was analyzed separately, put into groups, and using both a range of typical standard and also looking at outliers and reasonably conservative numbers for the analysis. So each assessment included both a most likely and also reasonable worst case failure modes and with all of those modes, the information that was provided to us as AECOM and also to CEC reviewers, we've reviewed that and we've confirmed that that is reasonable and representative and that the factors of safety that are presented are -- are -- are acceptable to be able to protect the project from a geotechnical perspective.

Another question came up and was suggested by KGS that Arcadis did not thoroughly review the geotechnical report in underlying assumptions, which is strictly and simply not true. Over the past year, Arcadis requested additional information from Stantec and AECOM, including drilling information, borehole logs, and all of the geotechnical information, and they had that available to them during their review. And Arcadis has confirmed through their review that they've looked at the detailed assumptions and how the modelling results came out of that and those assumptions, and they also made it clear that the information on borehole logs were requested, that was received, and they understood and -- and accepted that our strength factors are -- the strength factors that were provided by Stantec are correct and our AECOM reviewers also confirmed that. So again, this is just to confirm that it's -- the work that was done by Stantec was reviewed by Arcadis and AECOM in detail. And also we had on -- a meeting on September 6, 2022 that was attended by Arcadis, AECOM, Stantec, designers, where we were had an opportunity to discuss all of those details and make sure that they had all the information that they needed for their assessment. So now I'll pass -- so now to Miln.

MR. HARVEY: Dr. Miln Harvey for AECOM. I am a groundwater engineer, I've been an engineer for 30 years. I have a licence to practice engineering in Manitoba, in Ontario, and Nova Scotia. I've been registered as a professional engineer since the mid '90s and I have a PhD in civil engineering from the University of Waterloo. My area of research was groundwater modelling and I have been working as a groundwater modeler for about 25 years. I'm going to talk about the analysis of the pumping tests and then I'm going to talk about the groundwater modelling and some issues that have been brought up related to these.

First of all, with regards to the -- the pumping test -- a statement was made that the pumping test was not interpreted using all possible analytical solutions to consider leaky shale aquitard. We agree with this. We then took all of the data that was collected during the pumping test and we applied a leaky aquifer test to it. Below on the table you can see two sets of results. The first set of results was what previously was published and that is assuming a confined aquifer. That -- the test methods included Theis and Cooper Jacob, which are both confined aquifer solutions. The value that we obtained was approximately 9.5 times 10 to the minus 5 metres per second, and that's a geometric mean. Last week we took the same data and we applied a leaky confined aquifer test to it and we used three different methods. Those methods include Neuman-Witherspoon, Moench, and Hantush -- three classical approaches to analyzing time drawdown data using type curve analysis. The results -- the geometric mean is 9.9 times 10 to the minus five. So, we do agree that this is the -- the leaky aquifer approach is valid. When you do an analysis using type curves to time drawn data, you can also take the derivative of the data curve. And the derivative is simply the difference between the data points and how that changes with time. So early on in the pumping test the derivative is very large and it increases because time drawdown is increasing. As the -- the test continues, that derivative reduces. And if you have a leaky confined aquifer it will reduce to zero -- essentially a flat line, no more time drawdown. And then the difference between the two data points is zero, and that's what we saw when we applied the derivative curve to the data. So we agree. The -- the Winnipeg Sandstone is a leaky confined aquifer, and the shale is a leaky aquitard.

Next slide. A second issue that came about -- about the pumping tests, was that a single pumping test is not adequate to characterize the aquifer and that was put forward by Dr. Hollander. We disagree. The -- if you take a look at the table on the right hand side, there is a summary of all of the aquifer tests that have been completed to characterize the Carbonate Aquifer, the Shale Aquitard, and the Winnipeg Sandstone as well as -- as other hydrogeological units within the area. There are approximately 2,700 aquifer tests that were completed to characterize the Carbonate Aquifer and there are -- there have been approximately 78 to characterize the sandstone, and at least 590 to characterize the shale. So these are well characterized systems. Several publications, including Wang, Kennedy, Betcher and Render, acknowledge the hydraulic connectivity of the pumped aquifer -- which is the Winnipeg Sandstone -- is relatively uniform. However, the overlying carbonate is more variable. Other experts have agreed that there were no issues with our pumping test. We -- we did a pumping test to -- to determine local aquifer properties, and the values that we obtained are within the range of values that have been obtained by other historical field investigations.

Several slug tests and one pumping test were conducted locally and the results are consistent with -- with the work that's been previously done. Additional pumping tests are proposed for the project in advance of development when the Groundwater Monitoring Network is well established. Results will then be used to inform updates to the numerical model to look at how Sio's design impacts groundwater quantity in the area.

Next slide. Another issue that has been raised is that the groundwater model is not properly calibrated and the results cannot be relied upon, and this was brought up by Dr. Hollander. So I'd like to talk about this in three slides, each slide addressing a different issue associated with the development, calibration, and use of the model to make predictions.

The first issue is the issue of equifinality, and that issue essentially is that numerous parameter values -- numerous sets of parameter values can be used to give you a similar calibration. While it is true that many possible combinations of parameters could result in an acceptable calibration, this applies to every groundwater model ever developed. It is an issue with the modelling process. So we have to -- we -- we -- we develop methodologies to make sure we address it. This issue will have also been an issue with previous studies by Kennedy, Wang, Stafford and Hollander -- all would have addressed this issue as a part of their groundwater modelling development, calibration, and predictions. So the methods that we have in the modelling process to help us deal with this issue are shown on the right hand side. There's an image, and this image is the groundwater modelling process. This was developed -- so, this image was -- is after a presentation by Anderson and Woessner in a classic textbook called Applied Groundwater Modeling from 1992. It essentially was the -- the first textbook which started discussing the groundwater modelling process when all of these new groundwater models -- MODFLOW and FEFLOW were starting to develop. So it's been around for 30 years and we all use this textbook as a guide for how we develop groundwater models.

What do you do? First of all, you determine or define the objectives of your model and based on those objectives you choose an appropriate size and parameterization for your model domain. We collect data to do that parameterization. So, we collect data on act for properties and hydrologic boundaries, and also observations of groundwater heads and flows so that we can calibrate our model. Then we develop a conceptual model and that conceptual model has been presented in the Hydrogeological and Geochemical Assessment Report, and it contains all of the discussions of historical reports and field investigations completed at the site in order to confirm conceptually how we see the groundwater flow system operating. Once you have a -- a well developed conceptual model, you then can develop a numerical model. And that numerical model is developed by assigning a boundary, assigning layers, properties, and -- and boundary conditions. When you have all of those components you can run the model, but we don't know how well would run -- that model will run. So we add to the model observations of -- of groundwater elevations and groundwater flows and that allows us to calibrate the model. If the model is calibrated well and we've presented the statistics and we -- we have proposed that those statistics are reasonable, then you can go on to do a sensitivity analysis and then predictive simulations to -- and often those predictive simulations are done as scenarios -- to -- to -- to provide an -- an understanding of how different input conditions can impact model predictions. So, calibration, sensitivity analysis, and predictive simulations are methods that we use to -- to make sure that we have a -- a model which best -- it best represents the conditions we have in the conceptual model and thus is -- is a more unique representation of groundwater conditions.

The next issue that I'd like to discuss with regards to groundwater modelling is the definition of an industry standard. So many of the peer reviewers for this project including Dr. Ferguson, Matrix and KGS, agreed that AECOM followed industry standard protocols within the development of the model and the calibration of the model. Dr. Hollander -- Dr. Hollander did not agree with the others, but he is holding the project to an academic research standard or state-of-the-art, as described by Mr. Mills -- which is not reasonable or achievable at the scale of the project. It is not reasonable to hold this project to higher standards than his own work, which he presented in papers, hasn't presented the calibration data on it. It also is not reasonable to -- to hold this project to a higher standard than other similar projects which have done -- used the -- the groundwater modelling methodology and produced similar models which are -- are -- are providing reasonable predictions. This project has gone above and beyond what has been completed for other EAPs in this area.

And finally, the other -- the -- the final issue with the groundwater modelling that I could discuss is recharge. Recharge is one of the most difficult parameters to -- to estimate. Although recharge values were higher than those employed in some other groundwater models, it is -- it should be recognized that the recharge values we assigned to the -- as input parameters to the Sandilands area are based on previous academic research. So, we used the research of -- of Ferguson and Cherry as a guide for signing -- for assigning recharges and input parameter. So it was not used as a calibration parameter but as an input parameter and then we calibrated around hydraulic connectivity of the -- the hydrogeological units. The other models have different objectives, encompass different study areas with different geology. It is of no consequence to predictions on the -- of local scale -- of the local scale impacts and it's only relevant to regional scale aquifer sustainability assessments. It should be noted this model was not intended to evaluate regional scale sustainability of the groundwater supply across southwestern -- or sorry, southeastern Manitoba. The purpose of this model was to evaluate local scale impacts associated with extraction and recovery wells for Sio's operations.

Another issue that has arisen is that the groundwater flow system will change as a result of the void spaces and shale collapse, and this was brought up by Dr. Hollander. Our rebuttal is that no, the overall groundwater flow system will not change. The governing boundary conditions and aquifer system will largely -- remain largely unaffected by the project. To -- to show this, we've got two images. On the left is an image of the groundwater heads in the Red River Carbonate before extraction has -- has started. So, this is essentially baseline conditions. In this image, the black outline is the model domain, and inside there's a series of contours and those contours are contours of groundwater head in the Red River Carbonate. On the right hand side is an image showing the -- the groundwater heads in the Red River Carbonate after extraction has occurred. And this -- this is the simulation, which is most conservative, where we assume that there's no reinjection, and we've assumed shale degradation. So we've got a connection between the Winnipeg Sandstone and the Red River Carbonate. There is almost no difference between these two images because the overall groundwater flow system will not change. We did the same thing -- next slide -- for the Winnipeg Sandstone. So we have two images -- on the left is an image before extraction, on the right is an image after extraction, again assuming no reinjection with shale degradation. And you can see these little contours, these lines -- the squiggly lines inside the model domain remain essentially identical. There are small differences within the study area but with -- you know, the overall groundwater flow system has not been affected by Sio's operations. Next slide.

And the final issue, which was raised by Dr. Hollander about the modelling, is that density dependent modelling is required to simulate groundwater flow within the project area. So to address this I've -- have -- we have two images on the right hand side. In the upper right hand corner is an image from Phipps, Betcher and Wang, and it is a -- it shows the distribution of hydrogeological units within southeastern Manitoba. So the blue is the Red River Carbonate and below it is the sandstone, and the pink is the Precambrian Bedrock. There are some black dots with numbers beside them within the area of the blue. Those are water quality measurements of total dissolved solids, and that reflects the -- the -- the total dissolved solids can be equated to groundwater density. These -- the numbers on this graph, if you go back to the original literature, range from 200 milligrams per litre to approximately 1,300 milligrams per litre. So let's say between 200 and 1,300.

Now in order to do density dependent modelling, we have to relate those concentrations to density, and that's what this Excel spreadsheet output does in the bottom right. In this, the -- the horizontal axis along the bottom is Total Dissolved Solids Concentration, and the vertical axis is Groundwater Density. So what you can see that -- from this -- this relationship is, as you increase in total dissolved solid concentration, at some point the density of groundwater increases. It is not linear. It starts at a very small value and for quite a large range of total dissolved solids concentrations, there is absolutely no impact on density. We do not use density dependent modelling for anything less than around five to 10,000 milligrams per liter. To give you -- to give you a sense of how this -- how density dependent modelling is used, the saltwater -- the density -- or sorry, the concentration of -- of -- of chloride in salt water is about 30,000 milligrams per liter. So we would use density dependent modelling to represent coastal impacts from saltwater on freshwater aquifers. That's in the 30,000 milligram per litre range. In that 10,000 -- less than 10,000 milligrams per litre, you can't -- there's very, very, very little impact on the density. And so, we don't do it. And if you remember back to the upper right image, the values of TDS Concentration are less than 1,300.

Now -- so, the Red River Carbonate, the Winnipeg Shale, and the Winnipeg Sandstone contain freshwater with low TDS Concentrations except beneath the Red River. Effects of variability in TDS is negligible within the project area. And this is supported by conclusions from Kennedy, Wang et al, and even from Stafford and Hollander. Many of the models that have been done in this area do not include density dependent flow. Those that did concluded the effects are relatively minor as the water is fresh. With that -- that, I'll pass it over to Mr. Mills.

MR. MILLS: Thank you. Ryan Mills speaking. With that, I just wanted to kind of revisit a couple of topics. There was a lot of discussion last week about aquifer sustainability and a statement made that the cumulative effects and sustainability of the aquifer are important and were not assessed. In response to that, you know, the responsibility for establishing the sustainable yield of an aquifer is with Manitoba Water Stewardship. This is a graphic. The pyramid on the right comes from the report that is captured in the upper right image, and that's the Southeast Regional Groundwater Management Plan. It has a clear groundwater management responsibilities pyramid with Manitoba Water Stewardship at the top and several approving authorities and several others supporting parties that would aid with implementation of activities with potential impacts. So you can see that the responsibility lies with others for evaluating the sustainability of the aquifer.

Second, the use of the -- of groundwater by the project is relatively small in comparison to others. The focus of an EAP is related to how an individual project rather than all projects, will affect groundwater quantity. This is what was assessed and the effects were assessed to be minor. Continuing on that theme, other Environment Act proposals for Springfield in 2019 and Park Road in 2015 requested much larger volumes of groundwater, did not include the development of numerical groundwater models, did not evaluate the cumulative effects of -- on groundwater quantity and quality, and -- and all of the EAPs were approved and issued Environment Act licences and water rights licences for those projects.

There were also some questions around, you know, the effects of extracting sand over the full 24 years of mining. It's important to remember that this is a transient effect and the impacts are not cumulative. Sand extraction is seasonal -- it occurs over a period of about 224 days per year. The majority of that water is reinjected to the same aquifer. Water levels have been demonstrated to fully recover following operations each year, and the only change is the location of the project activities associated with the sand extraction. So, the location of the impacts, they move over time, but the expected drawdown and radius of influence associated with each well cluster is expected to be the same because it's in the same aquifer or very similar. Had we completed the 24 year assessment it is likely that there would not have been any changes to the conclusions and recommendations of our work.

There were also some concerns expressed about impacts on water quantity and the availability of groundwater. Again, this is a screen capture, the two tables -- the table and the figure on the right. They illustrate -- the upper table illustrates licenced groundwater users within the RM of Springfield, and that comes from a -- a reference in 2017. On the -- on the bottom there's a -- it shows the distribution of groundwater users by licence type. And -- and what you'll see -- the -- the green arrows in both cases represent the two project scenarios that were evaluated -- one involving zero percent reinjection, and the other involving 100 percent reinjection of the available water -- which is 85 percent of the total that is removed. And you can see that, you know, this project in the most conservative case is around, you know, the -- the same level of extraction as -- as all of the municipal users. But with 100 percent reinjection has proposed, it is -- is much, much smaller -- and it -- it's -- it's on the far right hand side of the lower graph. The use of groundwater by the project is very small, especially in comparison to the other users.

The impacts of sand extraction are temporary in nature and full recovery occurred following pilot tests and pumping tests, and was simulated by the groundwater model to also occur following each year of operations. There will be minor impacts to water levels in private wells, but there was -- there's no effect on the availability of water, and this was proven out with pilot tests and the pumping test that was conducted to simulate full scale extraction. We did observe slight water level decreases in private wells that were monitored as part of that pilot study, but there were no complaints or impacts on the availability or the quality of the water. Groundwater modelling predictions again support those observations in the field -- so, direct measurements. Extensive monitoring is proposed before, during, and after operations to confirm the findings in recognition that groundwater is an important resource, and it -- it must be confirmed.

There were some discussions and I believe an anecdotal story provided at one of the sessions by one of the participants, and discussion around plumbing fixtures corroding a -- a childhood farm. Due to the presence of acid rock drainage in the aquifer it was inferred that that was related to development in the area and the reaction of pyrite to the sand in the area.

We've got two figures on the right, both showing -- they're both plan maps of the area. The -- to the best of our knowledge, that childhood farm is -- is in the area of the Yellow Star, and the project area is in the location of the Blue Star. The lower figure on the -- the lower right illustrates, you know, from recent work by Friesen that shows the approximate boundaries of freshwater, brackish water, and saline water in the area. And that Yellow Star, as you see it, falls within the Blue

Zone, which is the area of saline water. And we all know that salt water also causes corrosion. Further, acid rock drainage cannot be initiated in the subsurface because that requires an infinite source of oxygen, abundant sulfide minerals -- such as pyrite -- and they are not present. The corrosion of plumbing fixtures in the area is likely due to the presence of saline water, not acidic water as has been documented in the literature for decades. Saltwater is also known to rust metal, which would cause that orange discoloration. We've all seen rust. Due to the slower flushing of the saline water from that portion of the Winnipeg Sandstone Aquifer, that -- that has left behind this saline water in that area, but it's totally unrelated to the development of acid rock drainage. The project area or the Blue Star is a long way from that saline groundwater interface, and there will be no impacts on salinity or ARD.

There were also some conversations and -- and -- and discussion about the vulnerability of the aquifers to surface contamination. I believe that was Matrix discussing that last week. And it was stated or inferred that the collapse of the Winnipeg Shale Aquitard will increase the vulnerability of the aquifers to surface contamination. First and most importantly, the geotechnical modelling and design criteria are specifically designed -- it's a purpose to avoid all subsidence. And the modelling as my colleague has just discussed, demonstrates that that will not occur. Further -- and -- and just for reference, we have a -- a map on the -- the right hand side of this slide. The green areas are mapped as areas of low vulnerability and the yellow areas are marked mapped as areas of moderate vulnerability, and the red areas as areas of high vulnerability to surface contamination, based on the work by Friesen for the Rural Municipality of Springfield. This is their -- one of their 2019 reports. Essentially all of the project activities will occur in the areas mapped in green. In other words, they are mapped and it is known that they are not or have a low vulnerability to surface contamination. There are thick -- and when I say thick I mean approximately 100 feet thick -- fine grained quaternary sediments overlying all of the bedrock aquifers in the area. Even where there is sand at surface, there's typically a till unit above the bedrock. This provides substantial protection to all of the underlying aquifers. Geotechnical modelling and subsidence monitoring indicates that sand extraction will not cause failure of the limestone cap rock or the quaternary sediments.

Vertical groundwater gradients do not promote flow between the two aquifers now, and this will not change, as shown by Dr. Harvey in the last couple of slides. Collapse of the shale will therefore have no vault -- no bearing on the vulnerability of the Carbonate Aquifer because the shale is actually below the Carbonate Aquifer. And only minor influence on the vulnerability to the underlying Sandstone Aquifer. Well abandonment will also preserve that level of protection from surface contamination.

There's been some discussion of intermixing of aquifers and the statement was made that it is critical that the Red River Carbonate and -- and Winnipeg Sandstone aquifers remain separated. While it is agreed that that is much -- is important, where -- where the aquifer -- the Sandstone Aquifer saline much further West of this project, it is not true in the project area where both aquifers are fresh. They are not separated now, they are already over 1,000 wells in the area that interconnect the two aquifers, they are both fed by the same source of recharge.

Water in the project area in both aquifers is fresh and potable and much more variable spatially within each aquifer than they are between the aquifers at a given location. And this variability is common in aquifers. You can see in the figures on the right, the upper figure is again showing the interconnected wells as mapped by Kennedy in 2002, and the figure in the lower right illustrates the different water types across the aquifer. And -- and this -- this is -- this is showing in the carbonate, so you can see that it's quite variable within the carbonate depending on where you are now. They're not that distinct. Further, just as another, you know, line of hard evidence, there are no reported water quality impacts from the interconnection of the aquifers over the past hundred years in areas where those aquifers are fresh. There are reported issues further west where the underlying sandstone is saline and there are strong driving heads that have pushed that saline water up into the carbonate. And that condition does not exist in the project area. All those historical issues are much further west through those interconnected boreholes and -- and have resulted in that -- that impact. Again, not present locally. In closing on this issue, the water in both aquifers is fresh within the project area and mixing is of little to no consequence.

The primary effect of the project will be -

- or sorry of those interconnection of -- of wells has an equilibration of water levels. So the water levels equalize over time in the two aquifers, and that will reduce or eliminate the vertical hydraulic gradients between the two aquifers and limit the bulk exchange of waters between the aquifers. That is the primary driving force -- is a difference in water levels, and if that difference is not there, there's nothing driving the exchange of the water. This is shown in -- in our figure that we presented last week and this was as part of an undertaking. These are the predevelopment gradients and these are the post development gradients. And it's -- and you -- you see there it's a very, very minor separation here prior to development between those lines, and they essentially become one line after the fact, and that is showing the equilibrium -- equilibration of heads in the two aquifers. And that is -- is exactly what we're describing -- that the vertical gradients will go to essentially zero. They're presently neutral in the area to slightly downward, and they're assuming -- they are simulated to reduce even further following operations. Again, no vertical gradient, no exchange of water. With that, I'll pass -- pass it to Dr. Elemine to discuss water quality.

MR. ELEMINE: Thank you, Mr. Mills. It's Cheibany Ould Elemine. I'm a senior geochemist with AECOM and a registered professional geoscientist in British Columbia, Saskatchewan, Northwest Territories. I have 20 years of experience in the industry and my project experience include mining, infrastructure, pipeline, as well as carbon sequestration. And I'm here to provide some clarification regarding issues raised with respect to the impact of the shale pore water on the water quality.

In our presentation over the last two weeks, we had indicated that the sandstone and the carbonate aquifer were fresh. They had low TDS, less than 500 milligram per liter. They also had low chloride sulphate and sodium. This is not only the case of the two aquifer, this -- the sandstone -- the -- the shale unit is also fresh. We do not anticipate any impact of the shale on the aquifers simply because the volume of water in the -- in the -- in the shale is very, very limited or small compared to the aquifers. And the water quality data we have collected today has shown no impact whatsoever on any of these aquifers. These two table on the right side show the range of total dissolved solid and chloride in the carbonate, the shale, and the sandstone. They also show the Canadian and Manitoba drinking water guideline for the

TDS and chloride.

One thing you can see is that the shale -- the TDS and the chloride of the shale and the sand are quite comparable in terms of range, although the shale has slightly higher TDS. You can also note that the carbonate has slightly lower TDS and chloride compared to -- to the two others. However, in all three cases, the water quality is below the drinking water guideline. On this slide we've compiled the Friesen data -- the water quality data they compiled in 2019 using a large data set and we're providing this for -- just for a reference and to provide some context. As you can see, the water quality data at the site are within the -- this -- within the range of the data compiled by Friesen. More importantly, the high values -- high TDS values that were compiled in that study are not present at the project area. The groundwater in -- in the aquifers as well as in the -- in the shale all have met drinking water guideline with the exception of turbidity, iron and manganese. And just for -- for your reference, iron and manganese guideline are just aesthetic guidelines, they are not maximum concentrations.

Many of the parameters we analysed for were below the detection limit and that includes selenium. Selenium was in fact below the detection limit in 80 percent of the samples. There were also low concentration of arsenic, selenium and uranium in the Winnipeg shale -- and the reason I'm now bringing up these three elements is because during our ARD testing, they showed elevated element -- elevated concentration in shake flask test and that was assumed to reflect subsurface condition. This table show the maximum concentration for these three element in the carbonate, the sandstone and the shale, and on this right side you have the drinking water guideline. And as you can see, these values are very, very low compared to the guideline. In fact, they represent five to an order of magnitude. There are five to an order -- more of an order of magnitude lower than the guideline.

I also would like to address some concern raised with respect to -- to the water quality that it has not been measured at the -- following the pilot test, and this is not accurate at all. Water quality samples were taken from monitoring wells after historical extraction -- those measurements showed that there was no significant material changes. It is however correct that water quality sample were not taken from the void following the collapse of the shale, but this will be part of future program. From -- those future program will include the collection of groundwater samples from existing and future void to characterize the impact of the shale collapse and to validate the model we have developed -- we have developed to explain the impact. We will continue to conduct additional geochemical testing and water -- and groundwater quality modelling to validate those impact and to validate our modelling results. I will now pass it to Dr. Meuzelaar to talk about the ARD.

MR. MEUZELAAR: I'm Dr. Tom Meuzelaar. I am principal geochemist at Life Cycle Geo. I hold a PhD from the Colorado School of Mines. I have spent over 25 years looking at water quality issues in the mining industry, both beneath the surface and above the surface, with -- and a special focus on acid rock drainage and metals leaching. You can also call acid rock drainage ARD. I was asked to also, like my colleague beside me, be a reviewer on this project and I want to talk specifically about a couple issues, namely ARD and shale collapse.

So the first thing I want to point out is when Mr. LeNeveu brought up the example of underground ARD yesterday -- it's very important that everybody understand that that mine operation is an underground mine operation where all groundwater gets pumped out across the entire project footprint for the duration of mining operations. In other words, you've got large voids underground that are filled with air, and that's very different from what Sio is proposing to do here. When Sio is extracting, they're extracting from a void that remains filled with water. And so if you think about ARD potential, you'll look at the three -- see if I can get my pointer up here -- but there's really -- you need three parts to even initiate ARD. You need air, you need a fuel source -- which is sulfides, and you need water. So the shale is heavily weathered, that's part of the reason that it collapses into the void, it's been weathering over geologic time. That weathering removes the sulfides -- a large portion of the sulfides, okay? So you're basically taking the fuel out of the rock. It then falls into a saturated cavity -- a water filled cavity. So you've essentially removed two parts of the three that you need to start ARD. This is really a nonstarter here, this is not an issue that we would typically look at in an environment like this as an ARD practitioner.

So then the question becomes, are there other water quality risks that are reasonable to look at? So I've -- I've created this other diagram or this --

borrowed this other diagram, it's an industry standard and it kind of shows you the range of water quality issues that we typically look at in mining. On the X axis you've got pH, towards the right is more neutral pH, towards the left is acidic pH. When we think about ARD, it kind of encompasses this large field on the left here. The Y axis here is how much stuff is dissolved in water. So with ARD, we had -- we tend to have acidic waters with -- with a lot of dissolved materials in it. There's two other types of mine drainage that we typically look at. One is called saline drainage and Dr. Mills talked a little bit about that just a minute ago. Again, we don't have very salty waters here -- our waters are down in this red circle here. And so that falls within a field that we would call neutral mine drainage, so mine drainage that occurs under neutral pH. And there's a few elements that we typically focus on. We -- we typically focus on arsenic, we focus on selenium, antimony, molybdenum, uranium. Those elements can sometimes be mobile in a neutral mine drainage environment. Next Slide.

So, that brings us to shale collapse. There are concerns have been raised that we have not evaluated the following aspects of shale collapse. So the impact of shale collapse on groundwater quality overall, the leaching of arsenic, selenium and uranium, and the influence of changing redox conditions. Now I want to just briefly talk about redox because it's a complicated topic in geochemistry at a high level. If you're not familiar with redox, one way you can think about it -- waters that are close to the atmosphere, so our higher waters, higher up in the water table, are more oxidizing. It means they just have a higher dissolved oxygen concentration in them. As you go deeper and deeper and deeper into groundwater, you become isolated from the atmosphere, and those waters are called reducing, it's also known as anoxic. And in order to understand the behavior of arsenic, selenium, uranium, you have to understand how those metals behave under those different redox conditions. So we've looked at all three of these issues and our opinion is that there is not a major risk of significant travel of any of these elements outside of the void, and I want to talk about why that is.

So, the first thing that we looked at is -- we looked at the mixing of pore waters and the voice -- in the void. So what do I mean by pore waters? When the shale and a little bit of the fractured carbonate collapse into the void, those rocks have water in -- they hold water themselves, okay? That's what we call pore water.

So the carbonate has some pore water, the shale has some pore water. As -- as my colleague Dr. Elemine has just pointed out, those water qualities are generally good. Okay? So we'll get some mixing of those three water quality types. We'll mix limestone pore water and shale pore water in the void that is mostly filled with sandstone water quality. As you can see from this slide, the concentration of shale pore water is only two percent. So one of the first things that we get is a lot of dilution. Now there's an additional mechanism that you really have to look at here and that is that when the rock fractures, that rock -- that fracturing creates some additional surfaces of rock that get flushed. Okay? So that adds some additional loading, it puts some more dissolved stuff in the water. So the effects of that -- we looked at that from a mass balance perspective and from a geochemical modelling perspective.

And the key mechanisms, one -- as I mentioned already -- the first mechanism is that we've got a lot of dilution in the void and that dilution will reduce the concentrations, especially of arsenic and uranium, to below drinking water quality guidelines in the void. Selenium -- because we have some dissolved oxygen in the water, and because we have natural iron present in the water, that iron precipitates out and takes a lot of the selenium with it. Any remaining oxygen in the water, any remaining selenium in the water -- if it starts to migrate out of the void, it will be reduced by additional iron in that system. And so whether the water is oxic -- which is where we have iron and selenium being removed by precipitation of iron precipitates -- or if the water becomes anoxic -- so the -- the -- the oxygen essentially is all consumed, then we kind of restore the aquifer to the condition that it's in now, which is mostly anoxic. And in that case, the selenium takes on a different form, it goes from Selenium 6 to Selenium 4 which is not stable in water, so it will also drop out.

This analysis we deem conservative. The reason we deem it conservative -- one is our mixing ratios I think are very appropriate. We have also assumed that all shale and limestone directly above the void will collapse into the void, which is unlikely to be the case. And there's other geochemical -- what we call geochemical attenuation mechanisms that that we didn't consider. So there are other things that will remove selenium, uranium, arsenic from the water column that we did not put into this model. And then finally, we really didn't allow these components to go anywhere and we know that other effects if they start to travel, things like dilution, dispersion will provide further attenuation.

MR. MILLS: Ryan Mills speaking again. With that we'll kind of come -- come to our concluding slides and just a couple of brief words here.

One of the final statements that was made was that no pilot test has been completed to date, that reinjection of water using gravity drainage is not possible, that there are no inclined boreholes advanced to characterize any sub vertical discontinuities in the limestone cap rock. First, it is false that no pilot testing has been completed to date. Sio's conducted multiple extraction tests to refine the -- their design including a test involving extraction from two wells simultaneously. Second, they have successfully reinjected produced water during extraction using gravity drainage. That was measured, it was observed the water did go back down hole under gravity drainage. Third, they are committed to a full scale pilot test for multi-well extraction and the maximum void space not exceeding 50 metres for the long term allowable span based on the recommendations of Stantec 2022. They are also committed to confirmatory drilling of inclined boreholes based on the recommendations of Stantec, and then also expressed by reviewers. And with that, I'll turn it to Feisal Somji for a brief word.

MR. SOMJI: Thanks, Ryan. It's Feisal Somji, I'm the President and CEO of Sio Silica. I guess like most things that I'm used to, when I go for dinner, I'm usually the one that pays the bill. So I'm here to make the -- the financial commitments and the corporate commitments and we think it is important for you guys to hear from the company as well as the experts.

We've heard a lot of feedback in the past couple weeks about this full scale pilot test about inclined boreholes. Generally, these types of tests are done after permitting and before production. And the reason that's the case is because conditions are applied as part of our permits and then we implement those conditions into the ongoing tests that are done prior to production. I recognise that over the last couple weeks though, there's been some curiosity about what these tests would look like, how they will be done, what would be done, and so on. And so what I did is we asked our experts and our -- our team here to start putting the plan together now. You know, I want to state that it's not a -

- an acknowledgment of any deficiencies, I believe that we have provided all the data and done all the work that is normal or above normal for a project at this level of -- of licencing. But we also want to provide some comforts both to the panel as well as to the public about our commitments and what we would do. So I did ask the team here to put this together and -- and I am here to -- to state that we are committed to doing all of this work after permitting but prior to production.

MR. MILLS: Thank you, Feisal. Ryan Mills speaking. And with that I'll -- I'll maybe kind of expand upon that. So this draft plan for -- for an expanded pilot test and -- and including the drilling of inclined boreholes reflects contributions from the -- the geochemical experts, the hydrogeology experts, the groundwater modelling experts, and the geotechnical experts. So this is a collaborative kind of plan that has been fleshed out here as a -- as a -- an indication of what would be done in the next phase of work.

First off on the geotechnical monitoring side of things, there would be advancement and logging of three targeted inclined boreholes including acoustic televiewer and optical televiewer surveys to characterize the sub vertical discontinuities. So these would be drilled at different orientations intentionally to capture those sub vertical fractures. Second, there would be monitoring of the void space. During and following extraction at several timestamps as you've seen in the past couple of weeks, including after one year of time. There would be installation of subsidence monitoring equipment including extensometers angle -- anchored to the cap rock. Piezometers in both the overburden and at the top of cap rock and including very close to the centre of extraction. And this would all add up to confirmation of the competent limestone thickness and ongoing core sampling to confirm the strength of the rock.

On groundwater and geochemistry side of things, there would be some borehole packer testing that you may have seen referenced in the Groundwater Monitoring and Mitigation Plan, loosely referred to as aquifer testing, to understand the variability and permeability with depth through the carbonate sequence. There would be collection of additional solid and aqueous face samples for geochemical testing, and those were also previously described. There would be a -- a groundwater monitoring network established and groundwater levels and groundwater quality would be monitored before, during, and after the expanded pilot test. Taking all of that information -- there were the geotechnical models, the groundwater models would all be updated based on results of that pilot test to validate and update the design criteria as seen appropriate by the experts, and that would support supplemental modelling.

There would be development and finalization of the Trigger Action Response Plan for the geotechnical aspects of the project for review and approval by the regulators. And then as the development expanded into new areas, there would be further confirmation drilling -- drilling, including additional inclined boreholes across the extraction plan area for the first four years to validate the pilot test information and understand whether or not there is any spatial variability in those fracture patterns. So, I believe that concludes our statement here and I'll turn it back over.

THE CHAIRMAN: Chair, thank you very much. This is probably a good time to take ten. Thank you.

(OFF RECORD: 11:15 A.M.)

(ON RECORD: 11:26 A.M.)

THE CHAIRMAN: Chair. So, thank you everyone. We'll get back to it. A quick comment for the -- for the record, when someone is sworn in as a witness to testify, they are assumed or taken to be sworn in for the duration of the hearing. So all of the people that gave evidence this morning as part of the rebuttal had -- were previously sworn in as experts. So, they remain sworn in and under oath. The order of questioning -- well, actually maybe for -- Mr. Duncanson, do you wish to add anything to the record before I proceed to the participants?

MR. DUNCANSON: Thank you, Mr. Chair. Sander Duncanson. I do actually have two further questions of clarification for this panel before we turn it over to the participants. My -- my -- my first question, Dr. Harvey, is -- is for you. And if -- if it's possible to pull up Slide 19 -- I -- I just have one question here. You -- in -- in -- in your presentation earlier talked about the value in the red box and you noted the value in the green box. Can you comment on the difference between those values and -- and what significance that has to the results of the assessment work that was done?

MR. HARVEY: Miln Harvey of AECOM. So these two numbers are essentially the same. The previous analysis, 9.5 E minus five, the updated analysis 9.9 E minus five. The range of possible values of hydraulic connectivity in nature is approximately 14 orders of magnitude. So, it goes from ten to the minus -- ten to ten to the plus four. So the difference between 9.9 and 9.5 is very, very, very small. So these are essentially very, very similar numbers.

MR. DUNCANSON: Thank you, sir. Sander Duncanson speaking again. My -- my second question of clarification is -- is to the Sio representatives. Mr. LeNeveu yesterday in his presentation alleged that the sand that would be extracted for this project would be extracted from the Black Sand formation, not the Carmen Sand formation. Would you like to provide any comments in response to that?

MS. WEEDEN: This is Laura Weeden speaking. I can confirm that we are in the Carmen Sand. There are several papers that can confirm that, including one written by Dr. Ferguson and Robert Becher.

MR. DUNCANSON: Thank you. Mr. Chair -- Sander Duncanson speaking. Those are all the questions that I have.

THE CHAIRMAN: Chair. Thank you very much. So the order of questioning is Mr. LeNeveu, who I don't believe is present today. So I will proceed further down the list, the Rural Municipality of Springfield, do you wish to seek? Thank you. And that was known for the record for the Rural of -- Rural Municipality of Springfield. Our line in the sand?

MR. WILLIAMS: Williams. Just on behalf of Our Line in The Sand and the Manitoba Eco Network -- as you know, our responsibility is to be responsible participants and to the extent that issues have already been addressed in cross examination or in the direct evidence of our witnesses or cross examination, we do not intend to -- to follow up on -- on them. So as you heard repeatedly this morning, there's been lots of discussion. This was discussed in the last couple weeks and so from our client's perspective, to the extent that there is anything new, it is not material to our client's case, so we will not be cross examining. Thank you.

THE CHAIRMAN: Chair. Thank you, Mr. Williams. MSSAC? So, for the record, that was a yes and they will presumably come up to the microphone.

MR. MANN: Jason Mann speaking, I'm working with MSSAC. Thank you Chair, panel, for allowing an opportunity to ask a few questions for clarity and I fully appreciate these are questions. And one small point of clarification, which if you'll allow me, Chair, I'll -- I'll note when -- when we arrive at it. I'll -- I'll add I appreciate Mr. Mills preamble discussing the fact that the -- the panel and participants are licenced professionals whose prime duty is protection of the public. That's important, something I raised last week, so I appreciate a similar perspective on all of the things that are being done here. Being a registered professional, I obviously agree with that sentiment and having been President of the association that governs all engineers and geoscientists in this province, it's clearly something that's important to me.

MR. DUNCANSON: Mr. Chair, Sander Duncanson speaking. I gave Mr. Mann and some of the other questioners a little more latitude two weeks ago with the preambles to their questions. Given the stage that we're at now in the process, I'm not going to be as lenient. So just take this as a warning, Mr. Mann, but I -- I -- my view is any preambles that contain statements of evidence or your views are not appropriate at this stage.

MR. MANN: Noted, and -- and I will stay between the lines. My first question is on Slide 6. There's the -- there's four bullets talking about the shale at the lower part of the left slide. I don't disagree with what's being said there but my question is that I -- I don't recall seeing the discussion of the weathering of the shale in the core, and I'll just ask the panel respectfully if that is contained in -- in the prior reports.

MR. MILLS: Ryan Mills speaking. Yes, that is contained both in the discussion of geochemistry, I believe there was -- it was certainly reflected in some of the literature and you can see that there is evidence of weathering from the isotopic signatures and how they've evolved from their historical signatures to present.

MR. MANN: Thank you for that response. Mann speaking. There's a discussion here of the -- of the shale being leaky or -- or observing a leaky -- leaky aquifer -- aquitard response during the pumping test. There was some discussion last week that the -- the response in that shale because of its properties, would be largely a pressure response. And -- and that's probably part of -- of -- of the observation. However, my question is specifically -- would you need to run a longer term pumping test to definitively -- definitively show that the shale at this location in this testing was leaky?

MR. HARVEY: Miln Harvey, AECOM. So the derivative curve heads towards zero, doesn't go completely to zero, but effectively it's showing that it's -- it's leaky so a longer-term test isn't needed to confirm that.

MR. MANN: Thank you for that answer. Mann speaking. My next question is related to Slide 13 related to Geotec. There's -- the second last bullet describes strain weakening model used and that the cohesion was allowed to go to zero effectively during the modelling work. And -- and I appreciate we had a lot of discussion about the geometry of the slopes with respect to the sand, etcetera. But my question is if the sand in the modelling was allowed to go to a state of no cohesion effectively, then was the modelling done to reflect an angle of repose of that material? I'm just looking for clarity.

MR. MCLACHLIN: Doug McLachlin, AECOM. So in the modelling that Stantec did -- and they've shown that graphic in that cross section numerous times -- the modelling assumed that over a period of time, yes, the cohesion in the area that was under stress at the sides of the cavern, the cohesion would go to zero. So that's the area that's under stress and is being failed at that location. Elsewhere within the deposit, no. I mean that's beyond the cavity that's -- continues to stay intact because it's not been disturbed. So it's only related to the areas where that sand has been disturbed.

MR. MANN: Thank you for that answer. Mann speaking. On Page 14 -- and again we there was discussion on this prior about data collection and drilling and -- and the work done -- all -- all good stuff -- and -- and the continued statement and no evidence of vertical fracturing. And again, I -- I ask this question and I appreciate the commitment that's been made for the drilling of inclined boreholes to work to resolve that discontinuity feature that exists in -- in the rock. Would you expect -- if you didn't drill into one, would you expect to resolve a vertical discontinuity if you're drilling vertical boreholes?

MR. MCLACHLIN: Doug McLachlin. The -- we can -- we're basing the model on all the evidence that we have today, and so far, today we have not identified evidence of karst topography or vertical -- vertical fractures, jointing patterns. In fact, even horizontal, I mean the ATV and OTV show that even horizontally it's very, very competent limestone material. So the answer is that all the evidence to date suggests that we haven't seen it. However, we recognize and acknowledge and see it was committed to doing the angle boreholes to assess it in more detail. I should add that the modelling that Stantec carried out did assume vertical jointing, so the -- on Slide 14 which we're referring to on the right hand side, that pattern of jointing is actually what they did model in their assessment. So they have -- even though it was identified to be conservative, they included that in their modelling.

MR. MANN: Mann speaking. Yeah, I don't -- I don't know if I'll ask this question. I -- I'm -- I'm not sure if the -- the drawing shown reflects it properly, but I'll -- I'll leave it there. So on Page 15, vertical joints -- there's -- the second bullet, vertical joints, it's spacing greater than the required span, would not expected an impact on what's been modeled. I wouldn't necessarily disagree with that. What would you think about a vertical joint spacing that may be at lesser spacing than what's required of these cantilevers?

MR. MCLACHLIN: Doug McLachlin, AECOM. So as Stantec have described in their assessment, they have based the geometries that they modeled on all the information that they've received to date. And also they've mentioned -- and this has been during our -- our presentation of evidence the first week -- that with the angled boreholes and additional information, that would be factored into additional modelling. So if for some reason there were to be a -- a change beyond -- you know, that would show closer spacing or geometry that's not presented here -- as part of additional sensitivity analysis, more modelling would be done and that would be assessed at that stage.

MR. MANN: Thank you for that answer. Mann speaking. Slide 18 is still related to Geotec. And thank you for your answers so far, I appreciate that. My question really here then -- which perhaps may have helped with clarity, but I'm uncertain -- you described a meeting that took place between the team and -- and the geotechnical reviewers, questions were asked, et cetera. Was -- was there a meeting minutes of that meeting or information shared from that meeting? That's really my question.

MR. MILLS: Ryan Mills speaking with AECOM. And so just to be clear, we're referring to the September 6, 2022 meeting and it was attended by AECOM, Sio, Arcadis, and the CEC technical reviewers. And that meeting was recorded and I did reference direct quotes from that meeting and timestamps where many of these issues were -- were discussed.

MR. MANN: Mann speaking. Thank you. So, I appreciate that answer. Page 22, and this is one shared -- and Mr. Duncanson, I'm going to stay in bounds, but I -- I -- I don't agree with the first bullet, and -- and if I can give a preamble, I'll -- I'll provide that if I'm -- if I may.

THE CHAIRMAN: Chair. Sorry, I was -- actually back on your last comment you said, can you state that again please?

MR. MANN: Mann speaking. Page 22, first bullet -- the statement made there I would just wish to provide clarity and it's clarity that will -- is whether there were vertical fluxes or exchanges of water as well resolved in the model or not. On Page 32 -- and again I asked this question very respectfully -- the -- the opening statement is that it's critical the Red River Carbonate in Winnipeg Sandstone Aquifers remain separated, and the first bullet states that it's not true where both aquifers are fresh. I'm -- I'm -- who -- who makes that determination?

MR. MILLS: Ryan Mills speaking. And -- and I'll go back to the -- the map in the upper right and -- and that shows that it has not been viewed as being critical to keep the aquifers separated for 100 years of drilling in this area. So I'm not sure who made that decision, but that decision was taken.

MR. MANN: Mann speaking. Thank you for that answer. I don't believe I have any other questions at this time and I thank the panel and the Chair for allowing a couple of questions today. Thank you -- Mann speaking.

THE CHAIRMAN: Chair. Thank you very much. The panel has some questions and so we'll start with Commissioner Gillies.

MR. GILLIES: Commissioner Gillies speaking. A couple of questions. The first one relates to some evidence that -- that we heard presented by the Matrix consultants last week on the possible degradation or fracturing of the cementing and grouting around the extraction well casings. It wasn't addressed in your material today, but I'm interested to know if you have any reflections on that concern that was raised.

MR. MILLS: Ryan Mills speaking. Thanks for the -- the question and -- and it is an important question. You know, well drilling and -- and construction kind of applies standard practices. You know, many of the drilling and -- and -- and pumping test contractors across the country and -- and in fact internationally are required to be licenced and have training and that is to ensure that wells are constructed in accordance with a standard that is protective of -- of water in the subsurface. The -- the sort of well seals, you know, there are -- there -- the -- the standard for well construction is variable across the country and there is typically some latitude given to professionals to refine the design and -- and typically in -- in Manitoba, there's reference to grout, there's reference to cement. So sulfate resistant cement and bentonite, and there can there's some quantities specified and specifications in the -- in the standard.

To my knowledge, it -- the issues with -- related to degradation of well seals and -- and you know, the -- the level of protection that they offer -- historically a lot of them are related to wells that are terminated below ground surface, so they're prone to flooding. So that's an important issue that must be managed, and so wells must be sealed to deal with that. And then you need to establish a low permeability seal and -- and so cement is derived from limestone and the limestone is what comprises the aquifer that we're sealing into. And so there's sort of, you know, the -- the modern well sealing practices should be protective. You know, they are designed to protect, you know, the integrity of -- of that seal for -- for, you know, the foreseeable future, you know. And -- and the bentonite, you know, again is a natural product and it's fine grained and the reason you add that is to reduce the shrinkage in the concrete as it cures, and also provide some additional hydraulic resistance. So it's some additional sealing kind of power and sometimes the grout mixtures get adjusted by specialists in this area to suit local conditions, and in this case elevated concentrations of sulfate that are known to impact cement and concrete overtime. And that's why there's a specification locally for -- for sulphate resistant grout.

You know, in my anecdotal experience, you know, the -- the issues that I've observed are related to wells constructed below ground that are prone to -- to flooding impacts and improper well seals. There are some very shallow dug wells that are difficult to establish surface fuels, but -- but again, those are kind of not what we're talking about here.

MR. GILLIES: Ian Gillies. Thanks for that response. I won't go down the rabbit hole of foreseeable future with you. That's a long -- longer discussion. I have another question related to the discussion around industry standard. And my question there is -- is there some variability in the industry standard depending on the level of risk foreseen in the particular project that it is applied to? I'd just like a deeper understanding of any adjustment of the standard in relation to a particular project.

MR. MILLS: Ryan Mills speaking. I'll -- I'll take a stab at that. I think there -- there sort of -- there is some industry -- there are industries where a heightened level of analysis and peer review can be applied, you know, I think to engineering colleagues in seismic areas or structural engineers for tall buildings or the nuclear waste management area. And given the -- the kind of risks associated with nuclear waste, you know, members of the panel here have worked locally on nuclear waste projects, and there is a -- a different approach taken to -- to those projects. I think it's important to remember that this system is very well characterized. This system is quite well understood and this is one of the most comprehensive groundwater monitoring networks in the country, and it has been that way due to the foresight of many good hydrogeologists here and the construction of the Red River Floodway. And you know, I was quite surprised when I started working here several years ago to see how advanced it was. There's of course always room for expansion, but it is a very well understood system. So that reduces the level of risk in my -- in my mind and -- and it's what I would call a well behaved system, it's -- it's not doing unexpected things. We saw -- we planned our tests, we conducted them, and we saw what we thought we were going to see. And so, you know, those are some examples I can see where you -- you would -- you might change industry standard to suit a higher level of risk, but the -- that risk is -- is -- is not something that -- that I kind of see associated with the -- the hydrogeological aspects of things.

MR. MCLACHLIN: This is Doug McLachlin. I just want to add on from a geotechnical perspective, one of the areas of potential risk associated with this project is the concern about the long term stability of the -- the cavities or the caverns, and for that reason Stantec selected a factor of safety of 2.0 -- which is very high -- and provides that assurance, that protection for that particularly the, you know -- that -- that particular aspect of the of this project and that's one way that -- that conservatism can be built in.

Another area would be even though no vertical joints were identified any -- any of the drilling to date, the actual geotechnical model did factor that into the model of the -- the beams and showed and included that in their assessment. So that's one area where we -- we've -- I've been able to see in our review that these have been -- these sort of assessments have -- have taken that more conservative approach using factors of safety and factoring in things that were not even observed, just to be sure if they were there, this is how the project would behave.

MR. MILLS: Ryan Mills. Just to -- to add to that, you know, my colleague triggered something in my mind as well. And -- and equal levels of conservatism have been applied in the groundwater modelling work. For instance, we used a zero percent reinjection case as the basis for the impact assessment. That assumes that none of the water gets reinjected. And so those impacts on groundwater quantity are much less than we put forward in the impact assessment. And that was in an abundance of caution, recognizing that that's an important issue.

MR. GILLIES: Gillies here. Thanks for that explanation. One final question and that's to do with issues raised around risks of contamination of reinjected water by surrounding air fumes from diesel engines. They're particulate kinds of substances in the air that may be added to the reinjected water. I think I understand your system a little better as a result of your Slide 10 in today's presentation, but could you talk about the management or containment of risks from that vector in your presentation?

MR. MILLS: Ryan Mills speaking. I'll -- I'll maybe start and pass it to the Sio representatives to comment on the process elements, that's not my area of expertise. But I will speak from this perspective and that is one where we have -- I have personally drilled and overseen drilling of many hundreds of wells using technologies that are proposed for this project involving compressed air, dual rotary -- or air rotary drill rigs that do, you know, have compressors that use compressed air and -- and put it into the subsurface to lift cuttings to the surface. And in my experience there -- there is no, you know, basis for connections between diesel fumes, and you know, contamination of the aquifer.

You know, the -- the -- for the reasons that have been explained, you know, including low gas solubility in water, etcetera, etcetera -- these technologies have been used throughout this area again for hundreds of years -- or maybe perhaps not hundreds, but decades. And to my knowledge there's -- there's no issues attributed to drilling specifically. There are issues that come after the fact, and those are related to well maintenance protocols and -- and -- and stewardship of -- of -- of wells, but none related to the issues postulated yesterday.

MR. BULLEN: I'll just add to Ryan's comment. It's Brent Bullen with Sio Silica. One of the things you have to look at is when we look at the use of -- of compressors -- compressed air, most of the drilling rigs not just within North America but around the world actually have compressors built on them already. And so the use of what's called dual rotary drilling or air drilling is standardized around the world into water wells. So we've -- we've seen for many, many years the use of this technology with no adverse effects.

We look at the basic standard filters that are put in place within the compressors, and we disagree with Mr. LeNeveu's assessment as to how he sees the production of some of these outcomes because he hasn't taken into consideration the placement of the equipment and how the equipment is placed in relationship to any form of combustion engine source.

One of the things that we've mentioned that we've outlined before and we're very serious and working on with manufacturers are electrification options. We've looked at electrification for the extraction rigs, for the compressors, for all the moving components, and we've also worked with the industry on portable power packing solutions that allow us to take line grid electricity, store battery packs, and move them out. And you know, that -- that technology is coming into the marketplace, we're in discussions to bring it into use within Sio Silica. So, we look at the elimination of combustion source and that's why when we talked about our greenhouse gas emission reductions -- and although we hadn't been able to calculate them, it's a direct reduction when you remove all those diesel sources that are there.

The last is there's following of standards, you know, within the drilling industry and drilling practices. And so we rely upon the drillers that we employ and their standard practice of care to make sure that the equipment is -- is placed according, but we see the -- the issue at hand as a short term disagreement because we don't agree with Mr. LeNeveu's assessment. However, there are solutions in place which include the heavy use of electrification which we've committed to.

MR. GILLIES: Gillies here. Thank you.

That's all of my questions.

THE CHAIRMAN: Chair. Thank you. Commissioner Streich.

MS. STREICH: Hi, thank you for that presentation, Laurie Streich speaking. My questions relate to some of the statements that were presented or questions that were raised in the last couple of meetings. One is in regards to the issues of noise and light, and I'm wondering how that will be addressed.

MR. BULLEN: It's Brent Bullen with Sio Silica. I'll -- I'll talk about noise first. You know, we have the -- the wonderful advancements of technology that's used within industries around the world now that allow the use of equipment in short and close proximities to populated areas that have reduced the footprint of noise, and that's just through sound enclosure, sound attenuation, muffler systems and so forth. We're actually more excited about the fact on the electrification side. So, the electrification actually gets your DB points down.

So, when we look at the extraction activities on the part of the CEC mandate, when we look at electrification, you remove mechanical noise that we hear from gearboxes, you remove the mechanical noise you'd hear from the motors. And we've also looked at sound deflection walls and sound attenuation walls, which allow you a capacity to take that noise compression and move it vertically and also reduce it. So, there's absorbency and there's deflections. When you're looking at the line of sight to any form of dwelling or neighbour, you can actually deflect an already reduced footprint of noise. We looked at the facility which I know is not part of the hearing, but we looked at a -- a DB rating at 45DB at the property edge, which is below the 55DB that's set out. And that is calculated from the highest source of noise compression capacity on the facility to the edge. And then when we look at the use of field equipment, we do the same calculation. You look at the source of the noise and what you would look at -at a 100 metre placement to it. And then we've looked at the use of -- of sound attenuating panels and deflection. And those have been used successfully around the world. They're more recently deployed into North America from activities, but they were heavily used and have been used in Europe where you have high concentration of population around any form of activity, including infrastructure development.

When we look at light and light source, you know, the wonderful advent of LED lighting and downlighting -- that directional component and the ability to control downlighting is highly, highly developed and you're seeing it more and more in the implementation even around cities and -- and roadways in their capacity. So you're able to take that lumen output of light and deflect it appropriately and keep it down. So you're not dealing with uplighting issues and -- and the -- the -- the glow, you know. Yes, in a snow condition you're going to have some reflective capacity, but you know, within a facility like this we've kept our -- our operations and the operations in the field with directional lighting, you know.

The -- the image that was put up in one of the hearings there saying, you know, this is how the lighting is going to look -- that was an exploration well with a standard light plant. You know, nowhere did we ever say a light plant like that would be used or that was a specification of -- of equipment. That type of high-pressure sodium lighting and directional reflective capacities is -- is not reflective of the ability for us to actually put down lighting. It's no different than in your house when you actually have a -- a pot light, you can actually focal point it. And so, we're looking at the same type of capacity, which is again an -- an off the shelf capacity for lighting to keep it contained within the source area.

MS. STREICH: Thank you for that. Laurie Streich speaking. One other question that was raised was regarding the slurry lines, and it's been alluded that they would cross over some of the hydro lines and potentially along roadsides. So I'm wondering if you could maybe just address that or speak to that a bit.

MR. BULLEN: It's Brent Bullen with Sio Silica. With respect to the discussions with hydro, you know, it was -- it's in the record. We have had and are in discussions with Manitoba Hydro because there are crossing points. So, they're aware of our activities and what we're going to need to do.

With respect to road allowance and road crossings, you know, that's a discussion with the Manitoba infrastructure and within the RM, and so when you look at a conventional road crossing it's as simple as a culvert to be able to put a removable line across. You know, of course that financial cost would be to Sio, but the ability to put in place would be -- would be there. I'm going to -- sorry, I'm just referring with my colleague here. With respect to Manitoba Hydro, we do have permission verbally from them, but we're still in the finalization of the contract.

MS. STREICH: Thank you for that.

THE CHAIRMAN: Chair. Commissioner Johnson.

MR. JOHNSON: Thank you, Mr. Chair. My questions are directed to the Sio Silica people, I guess because I'm kind of a -- a hands on nuts and bolts person most of my life. And with the information that you provided here as regards to trespass and vandalism that has appeared to have occurred on your property -- if -- if -- if a licence is granted and you move ahead and because you will have exposure of some of the -- the pipes and stuff like that going back and forth in your property -- can you give me some sense of -- of security that you may be entertaining considering the world that we live in today and that might lead to failures in your system that were -- that were not natural by any means.

MR. BULLEN: A good question. It's Brent Bullen with Sio Silica. Yeah, it's unfortunate that we've had vandalism and -- and what's happened, and I think it -- it actually reflects a -- a very small portion of society. But unfortunately it does happen.

When we look at the -- at the operations, you know, we -- we want to be a good neighbour. We've actually had discussions internally and -- and with some of the neighbours on how to put pathways at the edge of our properties to allow people to still communicate from the community to the hydro lines, and so they don't feel like we're interfering with -- with lifelong capacity or access issues.

But within the actual operational areas themselves, you know, the system will have automatic shutdown and sequencing procedure so that if we have a -- a break in a line or -- I hate to say it -- somebody decides to come and put a hole in it and then try and make a soaker hose out of it, you know, it'll shut down and -- and isolate that very quickly.

You know, we talked before about the capacity, you know, have pressure transducers that can see one PSI differential. So it depends on how you actually put your SCADA and your algorithms in for your shutdown, but we can respond very quickly and isolate and do that. You know, we've looked at the capacity of having not only from manual inspections from our facility and lines and supply lines but to remote, which uses the use of -- of high definition facial recognition infrared camera systems that actually have the ability to monitor those lines. So we could see, you know, if there is a -- an issue and it shut down, we can see the extent of it even before people are deployed to it. We're not in a large regional area, so the ability to actually access and have people go to a -- a break in a line, you know, that's very close at hand is very easily quantifiable and dealt with.

With respect to the piles, you know, hopefully people can respect a -- an operational area where you have sand piles. I think would be very difficult for people and children to come in because there's always a barrier containment at the bottom of those piles. So I think within the use of employees. I'm going to pass this over to Laura who's got a few more comments here.

MS. WEEDEN: This is Laura speaking. We've been kind of working on this at the same time. So the other thing I'll note is that the -- all of the equipment sites are active and so there'll always be personnel on location. If a site needs to be shut down for any reason for long term, we outline this in our closure plan that was filed to Mines Branch. So, I appreciate that you probably haven't seen that, but it -- it is standard practice to fence it off and have security posted if it needs to be shut down for any time. So in the winter, for example, a lot of the equipment's going to be cleared away anyway and taken back to the facility for maintenance. But we'll also be gating our facility and all of the slurry lines are also patrolled daily to check to make sure that there's nothing that's been changed or altered at building crossings and things like that, 'cause I know that there is recreational activity in the area and we don't want to obstruct any of that. And we actually also did that when we did our hydro study, we -- we built a little bridge over our equipment so that people could still cross the area.

MR. JOHNSON: Thank you for that answer. I -- I have one -- one -- one last question that -- that you referred to in here about long-term monitoring for the area in question and as it expands over time. And -- and

I -- I think that is a very wise thing to do which leads me to an observation about partnerships that Sio may be involved. Over the course of five or 25 years, you're going to develop a very interesting data set that if you're able to share -- which I'm sure there are parts that could be -- this is going to lead to some very interesting knowledge base that could really benefit the -- the science of what you're doing in the area, and lead to better understanding of the aquifers and stuff like that. Have -- have you considered the partnerships and stuff that you might entertain universities, colleges, RMs and stuff like that to -- to essentially mine the data and stuff here for the benefit of mankind?

MR. SOMJI: It's Feisal Somji. The short answer is -- is yes, but you know, for some background I think everyone heard about a potential partnership yesterday evening that has been in discussions for some time. And I think in the -- in the opening statements on day one I talked about my experience with indigenous partnerships in my past and -- up in the diamond industry in Northern Canada.

The combination of -- of a -- of a database that you just talked about alongside traditional knowledge is a powerful combination and -- and that's why the interest is -- is there between ourselves and the -- the gentleman that spoke yesterday. In addition to that, we have already met with the university, we've initiated discussions, we've met with some of their -- their Masters and PhD students about the research that they're doing here in Manitoba. A lot of the very intensive research that they are currently doing is very applicable to what we are doing and -- and the data is that -- the data sets will get not only from the hydrogeology and the water, but also from the characteristics of the silica and what could be used or how that silica could be used for other technologies going forward. And so we're very interested in -- in that partnership, we've engaged already in -- in discussions, and I think, you know, database sharing is good for -- for everybody and that is -- that is part of our philosophy as well.

MR. JOHNSON: Thank you for that answer.

THE CHAIRMAN: Chair. I also have a question. I'm going to pick up on Mr. Mann's question. Slide 13, a strain weakening model was used that reduces cohesion from 220 kilopascals to zero during deformation and over time. And I'd like to tie that in with your figures on, say, Slide 16. I'm having trouble imagining from your figure the evolution over time of a whole, versus sloughing. I mean, if you look at that right now, you've basically almost entirely filled the hole with sloughing. I find it a confusing graphic and it would be easier if we started with sort of an original hole and imagine how that worked out with time. So let me go back to the first part. Over what time does it slide from 220 to zero?

MR. MCLACHLIN: Doug McLachlin responding. So, the -- the analysis assumed that it went to zero, but it did not include a certain time frame. So in other words, it would be over the lifespan of the project. The other thing is that some of the graphics that Stantec included in their geotechnical assessment did not show the sloughing. And we're learning more about how the cavities infill and how the sloughing occurs as part of the more recently -- the -- these figures that we're showing right here. So, definitely this will be part of the next stage when we're going to look at in detail at the sloughing, at having more and more side scan sonars taken over a period of time. I mean, it would be very helpful to know, for example, what is the density of that. We don't have that sort of information at this point.

I think it would be helpful to look at other aspects of the sand and how it behaves because that's one of the things I talked about earlier. We're only talking about in that very disturbed zone, that's where the -- the -- the strain weakening has taken place. Beyond that we're assuming it's still intact -- it's -- it's in a natural condition, it hasn't been disturbed. So we don't have all the answers right now, but we are getting more information and that will be part of the next stage.

THE CHAIRMAN: Chair. Thank you very much for that. No further questions from Commissioners? I believe we have hit the bottom of our question list. So that will take us to adjournment for the day and we will reconvene tomorrow at 9:30 when I anticipate we will move through all closing arguments. And hopefully conclude ourselves tomorrow, but if that doesn't happen, we've got Thursday as a contingency. Have a great day, all.

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*Stephanie Mayerhofer*

*Shania Chen*

Court Transcriber

March 14, 2023