Manitoba Clean Environment Commission
Hearing for the Vivian Silica Sand Extraction Project (Project)
Sio Silica Corporation (SSC) Responses to Information Requests (IRs) Round No. 2

IR Number:	**DLN-IR-001**
Submitted by:	DLN
Date Submitted:	January 5, 2023
Subject Matter:	Air injection
Reference Documents:	Section 2.2.1 Extraction Method

Background/ Preamble:

The response of Sio Silica to DLN-IR-001 on the potential aquifer contamination resulting air injection is unsatisfactory. Sio Silica refuses to accept the documented evidence from industry publications that compressor air gathers in and concentrates air pollutants including microbes, NO2, SO2, CO2, and toxic hydrocarbons such as diesel fumes, oil vapour from the compressor oil breather, and benzene. Sio Silica did not measure air contamination in their field air-lift extraction operations. Sio Silica did not measure contamination levels in the compressed air injected into the aquifer. Sio Silica has no intention of making such measurements during production. Sio Silica does not recognize air contamination as a problem despite the documented evidence provide with DLN IR 001 from industry sources. Sio Silica ignores the submitted documented evidence on air pollution from the diesel powered air compressor. Sio Silica does not recognize the need to filter the compressed air injected into the sandstone aquifer to remove pollutants. Sio Silica therefore will not filter the injected air from the compressor during production and has no plans for removal of any such contamination. Sio Silica states;

"*This question assumes filtration methods are required beyond the standard utilized equipment already used every day in the water well industry worldwide. Sio contracted licensed and authorized water well drilling companies who used industry accepted and standardized equipment for the purposes of drilling and developing water wells.*

Sio is not proposing to monitor air quality in the compressed air, as this is neither a regulatory requirement nor common industry practice."

This is a deliberately misleading statement. The air-lift technology to be used to extract sand on a large industrial scale is novel and not industry standard water well technology. In the EAP for extraction Sio Silica states;

"*The first four years of sand extraction activities are expected to result in improvements and efficiencies to this* ***proposed new sand extraction method***."

This statement by Sio Silica confirms the air injection extraction technology to be implemented is new and not industry standard.

The intents and purpose of the Manitoba Environment Act states;

"*this Act (e) prohibits the unauthorized release of pollutants having a significant adverse effect on the environment*."

A pollutant is defined as;

""pollutant" means any solid, liquid, gas, smoke, waste, odour, heat, sound, vibration, radiation, or a combination of any of them that is foreign to or in excess of the natural constituents of the environment, and
(a) affects the natural, physical, chemical, or biological quality of the environment, or
(b) is or is likely to be injurious to the health or safety of persons, or injurious or damaging to property or to plant or animal life, or
(c) interferes with or is likely to interfere with the comfort, well being, livelihood or enjoyment of life by a person; (« *polluant* »)"

Injection of nitrogen has been used for the hydraulic fracturing of coal seams in Alberta to extract coal bed methane.[2] The nitrogen used for injection into the coal is a pure separated source of gas with no microbial or hydrocarbon pollutants. Injection is normally carried out below the base of groundwater protection. Special permission is required for coal bed methane extraction in potable aquifers.[1] This industrial application of gas injection for resource extraction demonstrates that pure uncontaminated gaseous sources are deliberately used rather than potentially contaminated surface air.

Air injection to extract sand from a potable aquifer is not standard industry practice. Sio Silica give no evidence to support the absurd claim that their novel air lift extraction technology use only common accepted industry standard methods.

Sio Silica could claim that injection of air is commonly used to clean water wells. This is a small scale operation of limited time duration not comparable to the large industrial scale continuous air injection with up to seven injection wells operating simultaneously that would occur during silica sand extraction. Air pollutants would likely enter the aquifer during air injected well cleaning operations. This practice should be considered unacceptable without air filtration. A small scale commonly used practice that would inject pollutants into the aquifer should not be used to justify a large scale operation that would lead to far more serious contamination.

The monitoring of the air quality of the compressed air is a regulatory requirement to prevent the release of pollutants into the aquifer. This requirement is not constrained by any industry practice therefore Sio Silica's argument about industry practice, in addition to being false, is irrelevant.

Sio Silica has ignored and not responded to the calculations and evidence given in the IR 001 of the concentrations of NO2, SO2, CO2 and benzene that could be in the extraction cavity for an air capture fraction of 0.01. Sio Silica dose not dispute the calculations and potential for capturing the toxic gases. Sio Silica simply ignores

the evidence presented. Sio Silica also ignores the evidence from industry publications provided in DLN IR 001, that microbes in the air will be injected into the aquifer.

Sio Silica states:

"*With respect to air emissions, the vehicles and equipment used for Project activities (listed in Table 2-1 of the EAP) would not all be operating simultaneously and will move around the Project Site as extraction wells are drilled and progressively decommissioned. This equipment is also not all concentrated in one small location, nor is there a large volume of equipment*."

These are vague non quantitative statements with no calculations or measurements to demonstrate "*that this equipment and activity would not cause significant air quality impacts*." The air quality for breathing may well be acceptable although there is no evidence for this. Sio Silica has provided no evidence that the pollutants released from the Project equipment would not be drawn into the compressor and continuously discharged into the relatively small extraction cavity volumes and would not create unacceptable concentrations of pollutants in the sandstone aquifer. The air compressor concentrates pollutants and continually injects pollutants into a small extraction cluster cavity. Thus a much smaller concentration of pollutant in the air drawn into the compressor could contaminate the aquifer than could contaminate the breathing air.

The Project site for each extraction year is not large. From figure 1-2 in the Extraction EAP the extraction area is only about 750 meters by 750 meters. Sio Silica lists the diesel powered equipment to be used in the extraction site in Table 6-3 of the extraction EAP that includes the compressor trailer, excavator, various trucks including water trucks and vacuum trucks, light plant, earth drillers, and telescopic handlers. The total operating hours of this mobile onsite equipment (exclusive of the extraction rigs) is 85,200 hours which is more operation hours that the 60,000 hours for the extraction rigs and certainly not insignificant in the relatively small area of about 750 by 750 meters. The total GHG for this mobile equipment per year according to Table 6-3 is 4.34 kt CO2e. Along with this large emission of CO2 using the NPRI emission factors given in DLN IR 001 would be approximately 0.1171 kt NO2, 0.0077 kt of SO2 and 2.48 kg of benzene. The allowed limit of benzene in drinking water is only 5 micrograms per litre. These calculations demonstrate that the Sio Silica assumption that the concentration of pollutants from the mobile equipment in the extraction site is insignificant with respect to the air quality of the compressed air is unjustified.

Sio Silica ignores that compressor itself is to be diesel powered. Sio Silica ignores the presence of the compressor air breather that is a part of the compressor and emits oil vapours that would be sucked into the compressor intake. Sio Silica gives the fuel consumption and GHG emissions for the extraction rigs which would include the air compressors in response to IR MBEN-OLS-016. For all the extraction rigs operating for a total of 60,000 hours the total fuel consumption is given as 889.2 kl/yr. A kl (kilolitre) is the same as a cubic meter. I estimated the diesel fuel

consumption for the compressor for an extraction rig operating for 5 days to be 2.568 cubic meters. The fuel consumption for 5 days (120 hours) from the MBEN-OLS-016 IR is 889.2/60000x120 =1.778 cubic meters which is smaller by a factor of 0.7 but still significant. Sio Silica likely determines smaller fuel consumption for the extraction rigs by using a smaller value for the pressure of the compressed air that ignores higher pressures that would be required to loosen sand as described in the Sio Silica patent information.

Sio Silica provides no evidence to show that some emissions from the sources given in Table 6-3 of the EAP will not be drawn into the compressor. Sio Silica does not propose any precautions to avoid the emissions from entering the compressor. Sio Silica does acknowledge that emission sources exist and simply refutes the possibility that these emissions will be dawn into the compressor and injected into the aquifer without evidence or measurement. Sio Silica refuses to measure the pollutants in compressor air that would quantify this problem.

Sio Silica states in their response;

"*Sio sampled pH results from routine samples taken periodically from monitoring and extraction wells, which yielded pH results ranging from 8.12 to 8.35. Sio also took microbial samples 6 months after the extraction test both on the extraction test location including the extraction well and monitoring wells, as well as monitoring wells off location. The results were all negative for total coliforms and E.coli."*

These measurements were made, as documented in the Hydrogeological Report, on the wells used in the hydrogeological testing were no water was re-injected into the aquifer. The changes in pH and microbial populations by re-injection of aerated water that Sio Silica made are not relevant for water re-injection. It is the re-injection of water that is the primary environmental risk of this project not withdrawal of water.

Sio Silica attempts to deflect the issue of requirement to measure the pollutants drawn in and concentrated by the air compressor and subsequently injected into the aquifer by stating;

"*Although it has not been stated in the EAP, Sio expects that the Environmental Approvals Branch (EAB) will include requirements for air quality monitoring during Project operations within the terms and conditions of the EAL, and Sio will comply with any air quality monitoring requirements as stipulated*."

The word "*unauthorized*" in the Environment Act statement; "*this Act (e) prohibits the unauthorized release of pollutants having a significant adverse effect on the environment*" is significant. To authorize the release of pollutants into the aquifer from the compressed air, the regulator first must be informed that pollutants could be in the compressed air injected into the aquifer. It is the responsibility of Sio Silica to inform the regulator of this risk. However Sio Silica does not accept the risk occurs and will therefore not inform the regulator. To authorise the release of

pollutants that may be found in the compressed air the regulator must have evidence from the proponent, Sio Silica, that the concentrations of pollutants injected into the extraction cavity are below allowed limits. In accordance with requirement of the Act, Sio Silica conducted an air quality assessment for the Vivian Sand Processing Facility that determined the concentration of pollutants in an affected area around the facility. Sio Silica could conduct an air quality assessment in the same manner to determine the concentration of pollutants in the ambient air around the air injection compressors. All the potential sources of pollutants would have to be modelled including all sources of emission documented in Table 6-3 and the compressor oil breathers. Sio Silica is not following the requirements of the Act and the precedent of air quality measurements completed for the processing facility.

The concentration of pollutants in the water in the extraction cavity can be determined by the rate of air injection from the compressor and the rate of return of air in the production tube. The rate of return of air in the production can be determined by the air fraction in the production tube and the rate of movement of air water and sand in the production tube. The rate of movement in the production tube can be determined from the average sand to water and air ratio, the duration of pumping and the total amount of sand withdrawn per well based on the target of 21,000 tonnes of sand per cluster. As well the concentration of pollutants in the compressed air can be measured directly by a field test where the compressor is simply operated in the downwind of all potential sources of pollutants that are operating under worst case conditions. This test can be done on the surface with no air injection or sand extraction.

Such measurements and modelling are a statutory requirement that Sio Silica must fulfil. The unsupported statements issued by Sio Silica dismissing the risk without addressing the evidence of the risk presented here is unacceptable, unwarranted and cannot be allowed. I assert that the reason Sio Silica is so adamant about dismissing this risk without measurement quantification and mitigation is that mitigation is unfeasible. Filtering all the air for compressors used for sand extraction that are operating continuously for over 200 days including disposal of filters and filtrate is likely not possible.

Request:

1. I request further clarification as to the evidence that the airlift extraction process that injects air into the aquifer is standard industrial practice.

2. I request further clarification as to the evidence of instances where raw unfiltered surface air is used for air-lift resource extraction on a large industrial scale in a heavily used potable valuable near surface aquifer.

3. I request further clarification as to why standard industrial practice for water wells can be used to justify that there is no requirement for measurement, assessment and mitigation of the potential risk from pollutants introduced into the aquifer by the injected air for compressors. Take into consideration in this clarification that the Act prohibits the

unauthorized release of pollutants with no caveat concerning standard industrial practices.

4. I request further clarification as to why Sio Silica has ignored the calculations and data given in the DLN IR 001 regarding the potential NO2, SO2, CO2 and benzene contamination in the injected air.

5. I request further clarification as to the evidence that shows that no significant amount of airborne pollutants will be drawn into the compressor and injected into the aquifer. Take into consideration in this clarification the large amount of airborne CO2, NO2, SO2 and benzene documented to the released at the extraction site as documented in EAP Table 6-3 and here.

6. I request further clarification by Sio Silica why it is the responsibility of the regulator (EAB), to determine air quality conditions for the compressed air injected into the aquifer when Sio Silica claims without evidence or measurement or modelling that compressor air quality is not a concern.

7. I request clarification as to why Sio Silica has not done and will not do air quality monitoring for the extraction site taking into account all the sources of emissions listed in Table 6-3 of the Extraction EAP and calculated above.

8. I request further clarification as to why measurements and modelling by Sio Silica to determine concentration of pollutants injected into the aquifer from the air compressor are not required to fulfill the requirements of the Act as described above.

9. I request further clarification as to why harmful microbes would not be present in the compressed air injected into the aquifer specially considering the evidence given here, readily found elsewhere and documented in the Arcadis technical report that microbes in the ambient air would be drawn into the air compressor.

10. Please clarify who responded to DLN IR 001, who will respond to the request for clarification, and their qualifications.

Conclusion

This Project must not be allowed to proceed unless Sio Silica acknowledges the documented risk of pollutant contamination of the aquifer by air injection and demonstrates effective measures to remove pollutants from the injected air. Sio Silica statements unsupported by evidence that dismiss this problem are unacceptable and must not be allowed. This Project must not be allowed to proceed until the issue of pollutants introduced into the aquifer from air injection during airlift extraction is properly assessed and mitigated.

References:

1. Alberta Groundwater – Science and knowledge, https://www.alberta.ca/groundwater-science-and-knowledge.aspx#:~:text=The%20Base%20of%20Groundwater%20Protection

2. Alberta Energy Regulator, Directive 083: Hydraulic Fracturing – Subsurface Integrity May 21, 2013, https://static.aer.ca/prd/documents/directives/Directive083.pdf

Response:

1. Air is not injected into the aquifer; it's pumped down the airline into the extraction pipe to lift the sand and water to surface.

   Air lift systems are routinely used to drill water wells.

   Air lift is also routinely used to stimulate or develop pre-existing wells that have become clogged with scale or solids or new water wells.

2. Sio disagrees with the suggestion that "raw unfiltered air" will be used for the proposed extraction. Most compressors come with a standard intake filter which is designed to remove 99% of 5 micron or larger contaminants and 95% of 3 micron or larger contaminants.

   Using air lift methods intentionally for mining is not common. This is one of the reasons why the method has been patented by Sio.

3. As previously noted, air lift systems are routinely used for domestic ground water wells. There is no evidence of contamination associated with this practice. The majority of the air will return to surface with the drill cuttings and sand slurry. The Groundwater Monitoring and Mitigation Plan will collect baseline water quality information for a range of constituents, and ongoing monitoring for the same constituents will continue on a regular basis to determine if there are any changes as a result of sand extraction.

4. Sio is relying on standard industry practice by established leaders in the sector to be the authority on this subject. With respect, Sio does not agree that contamination of intake air for the compressors is meaningful risk for Sio's extraction proposal. In addition to the other information Sio has provided to Mr. LeNeveu on this subject, Sio notes that compressors are mobile units. They can be set up at distances from other equipment, much of which will be electrified during operations. This will further limit the potential for contaminants entering through the intake at the compressors.

5. See the response to #4 above.

6. Ultimately the EAB will be making the final decision on the requirements Sio must meet for the extraction proposal. Sio is committed to meeting or exceeding the requirements set out by the EAB.

7. Sio has not conducted air quality monitoring to date because it is currently not operating any equipment (and therefore there are no emissions to monitor) and it has not performed a field trial employing all of its proposed equipment simultaneously.

   It is Sio's intention to electrify as much of the field equipment as possible in the early years of the project, which will reduce air emissions from the project.

8. Please refer to the responses to #3, 4 and 6 above.

9. Microbial contamination is not a known issue for air lift systems. As stated in Round 1 DLN-IR-001(d) "*Sio also took microbial samples 6 months after the extraction test both on the extraction test location including the extraction well and monitoring wells, as well as monitoring wells off location. The results were all negative for total coliforms and E.coli*."

   In addition, as has been stated in previous IRs, the air injected comes back to surface and is not injected directly into the aquifer. The water is UV treated prior to its return back to the aquifer and therefore would not contain bacteria or microbes.

10. Sio prepared all of the IR responses, with input and support from subject matter experts at AECOM and Stantec, as needed. There was no individual author responsible for any of the IR responses. Representatives from Sio, AECOM and Stantec will be available to answer questions about the IR responses at the hearing, and Sio will file a summary of qualifications for each of those witnesses in advance of the hearing.

References:

1. White, M. 2018. How to Get Clean, Dry, Oil Free Compressed Air From Any Compressor. Parker Manufacturing Ltd Gas Separation & Filtration Division EMEA, Dukesway, Team Valley Trading Estate Gateshead, Tyne & Wear, United Kingdom. Accessed at: https://www.parker.com/Literature/Hiross%20Zander%20Division/PDF%20Files/Brochres/WPCDOAAC-00-EN.pdf

2. Bayless, R. 2016. USGS Groundwater Monitoring Well Redevelopment Using Air Lift Method. The Indiana Kentucky Water Science Center of the United States Geological Survey. Accessed at: https://www.youtube.com/watch?v=s2K_XBd1H8s

IR Number: **DLN-IR-002**

Submitted by: DLN

Date Submitted: January 5, 2023

Subject Matter: Process Water Re-injection to the Sandstone Aquifer and Geochemical Testing

Reference Documents:

(a) Section 1.7.3 Other Approvals

- Injection permit(s) for return of water to the sandstone aquifer,

(b) Responses to Public Review Comments,

(c) Waste Characterization and Management plan,

(d) Table 4-3 and 4-5 of the Hydrogeology and Geochemistry Assessment Report,

(e) Arcadis Technical Review of Sio Silica Corporation's Environment Act Project Proposal Vivian Sand Extraction Project 13 September 2022, and

(f) Hollander and Woodbury Technical Review Sio Silica Corporation's Environment Act Project Proposal 19. September 2022

Background/ Preamble: Sio Silica gives unsatisfactory responses to all DLN IR 002 information requests. The most important requests pertain to the re-injection of process wastewater and geochemical testing. Sio Silica asserts in their response (g)

"*Water injected by Sio will not be re-injected under any pressure. Water will be returned to the aquifer on open gravity feed to a well that is actively producing. As a result, while Sio will continually monitor its wells, there is no need to test the pressure in the aquifer*."

Sio Silica refuses to give any evidence to support this statement. Sio Silica does not refute the evidence presented that the only well where the production design and gravity feed return of water could have been tested is for well Bru 92-8. The well information report for well Bru 92-8 shows no production tube that is essential for the gravity feed water re-injection system. The injection permit requires the measurement of pressure in the aquifer during injection that could verify Sio Silica's unsupported statement that re-injection does not occur under pressure.

Sio Silica states;

"*Sio declines to answer this question based on relevancy. The production tube is temporary, and therefore not a permanent fixture, which is why it does not appear on the construction or abandonment reports. The information requested would be*

onerous to produce and is irrelevant to the impacts associated with Sio's proposed extraction activities."

The contention that the requests for information on re-injection are irrelevant cannot be supported. Re- injection of aerated water is a critical feature of the Sio Silica extraction process that can negatively impact the aquifer by creating oxidizing conditions that would release selenium and potentially heavy metals and precipitate iron and manganese that would reduce water quality. Sio Silica's own information in the EAP gives evidence of precipitation of manganese and iron under oxidizing conditions. The shake flask tests give evidence of the release of selenium under oxidizing conditions. The well information reports obtained from Manitoba Groundwater give evidence of interbedded shale layers in the sandstone that would be acid producing upon exposure to re-injected aerated water and lead to the release of heavy metals. Sio Silica gives no information to counter this established evidence.

The statement in the email received from Manitoba Groundwater regarding re-injection of water in Bru 92-8 stated;

"*In regards to your questions about liners and the reporting of these, including the extraction method being utilized, I spoke with a company representative from Sio Sands for further information two weeks ago to clarify extraction techniques and whether there are well construction details which should be included in reporting. It was explained that there is no liner being utilized. Reportedly, when they extract the silica sand, a Dual Rotary Method is employed so the sand is removed via this dual drilling casing and upon completion, it is then removed. Therefore, this is not part of the permanent well construction material being installed so there is no requirement within our regulations for the drilling company to report this.*

Specifically, regarding BRU 92-8, an injection well permit was issued for this well. Reportedly, the well was used as a test well for both injection and production and was eventually solely used as an injection well."

This statement by Manitoba Groundwater was never addressed by Sio Silica. Sole use for an injection well would require pressurization contradicting the claim by Sio Silica that only gravity feed water-reinjection is used that does not create pressure. The sole use for injection also negates the statement by Sio Silica that measurement of aquifer water pressure as required by the injection licence is not required since gravity feed re-injection does not create pressure.

Water from the slurry lines and frac tanks used in the extraction process shown in figure 1 may have been injected into Bru 92-8 after sand extraction during the sole injection. After completion of extraction operations at project year-end all the vessels in the dewatering station, slurry lines and UV system must be emptied. Sio Silica plans to release no process waste water to the surface environment thus the end of the Project year water must be injected into the sandstone aquifer. Gravity feed re-injection can only occur through the pressure decrease in the aquifer caused by airlifting. The airlift operation draws water from the aquifer that is re-

injected. Thus airlift and gravity feed re-injection cannot be used at Project year end to empty all vessels and slurry lines. Pressurized re-injection that Sio Silica states does not occur must be used.

Figure 1. CWS injection of extracted water and sand into tanks near Vivian Manitoba, Aug. 18 2021. *Images are used with the photographer's permission*

Entrained air in the process wastewater as documented in DLN IR 002 is major issue overlooked by Sio Silica. Further evidence of air entrainment in a clarifier by the V notch overflow weir of the clarifier and in effluent water plunging into a process water receiving tank is illustrated in figure 2.[7,8]

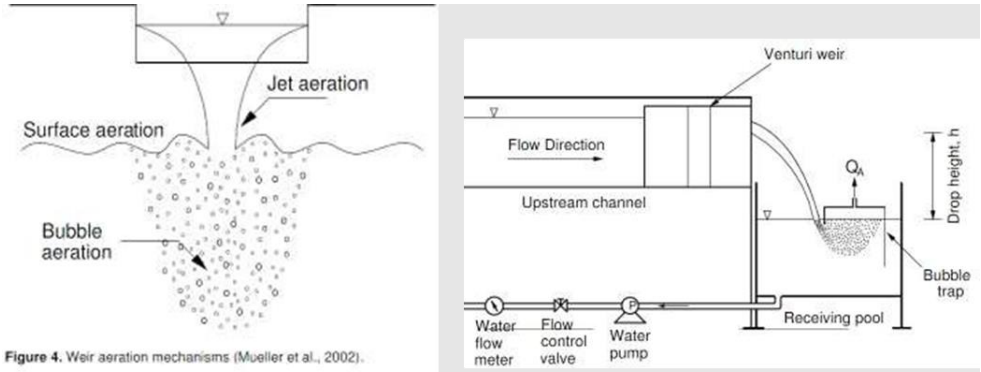


Figure 2. Air entrained in by the overflow v notch weir and the receiving pool of a clarifier tank[7]

Request:

1. Sio Silica states in response to the request on the level of chlorine used for their re- injection of water into the sandstone aquifer; *"The use of chlorine in water wells is a commonly accepted practice in well maintenance and installation. Sio proposed to utilize chlorine for re-injection in its injection permit applications for testing purposes. Sio followed the Groundwater and Water Well Act – Well Standards Regulation Section9(2) b, which provides that the source of water for construction, sealing, etc must:"contain a minimum 10 mg/L free chlorine at all times, except for monitoring wells where chlorine will interfere with water quality analysis."* Ten (10) mg/L free chlorine is for water used in well construction not for drinking water. The Centre for Disease control in the US recommends no more that 4 mg/L in drinking water.[1] The Operational Guideline for Manitoba Water Suppliers restricts the dosing level of chlorine dioxide to no more than 1.2 mg/L.[2] Please clarify why Sio Silica used the level of chlorination for re-injection of water in the aquifer for well construction rather than following drinking water guidelines?

2. Please clarify what approvals Sio Silica obtained for the level of chlorination used for the re-injected water taking into account the well injection permit did not specify the level of chlorination.

3. Please clarify how Sio Silica dispensed the chlorine into the re-injected water and how the level of chlorine was measured.

4. Since Bru 95-2 and 95-3 wells at SE 32-10-8E that were permitted for water re-injection have according to the well information only a single casing penetrating deep into the sandstone aquifer and no open outer annulus into the sandstone for the re-injection of water as specified in the Sio Silica design for production wells, please clarify how water was re-injected into Bru 95-2 and 95-3 by gravity feed without pressurization as stated by Sio Silica in response "g".

5. Sio Silica in response "g" states that there is no need to measure the pressure in injection wells since the re-injected water is returned using

gravity feed that produces no pressure. The well injection permits require pressure measurement. Please clarify if Sio Silica did not measure pressure during injection as required by the permit. If so please clarify why Sio Silica feels they are entitled to disregard requirements of injection permits and will continue to do so during production.

6. According to the Manitoba Groundwater Branch well information reports monitoring well Bru 92-4 opening into the sandstone aquifer was completed on June 7, 2021 close to injection well Bru 92-8. Please clarify if Bru 92-4 was used to monitor pressure in the sandstone during water re-injection in Bru 92-8. If Bru 92-4 was used for monitoring pressure for Bru 92-8 as required by the injection permitplease provide the pressure data. If Bru 92-4 was not measuring pressure for Bru 92-8, please clarify what monitoring measurements were made with Bru 92-4 and provide the data from these measurements.

7. Monitoring wells Bru 92-6 and 92-7 were completed into the carbonate near Bru 92-8 in July of 2021. Please clarify what these wells were measuring and provide the data from these wells.

8. Please clarify if a production tube was used for the re-injection of water during the sand extraction and water re-injection of Bru 92-8 as stated in the Sio Silica response "k" even though the well construction report for Bru 92-8 shows no production tube. Please clarify if a production tube was used during sand extraction of Bru 92-8 was the tube removed after the water re-injection was complete.

9. Since the detailed data information requested in IR "i" for all injection wells operated by Sio Silicawas too onerous for a response please provide the data on the duration and rate and amount of water re- injected, sand withdrawn and air injected as a function of time for injection well Bru 92-8.

10. Please clarify the meaning of the statement in the email received from Manitoba Groundwater reported in DLN IR 002; "*Specifically, regarding BRU 92-8, an injection well permit was issued for this well. Reportedly, the well was used as a test well for both injection and production and was eventually solely used as an injection well*." as this would seem to contradict the Sio Silica response "l" that all produced water was returned to well Bru 92-8. What was the source of the water injected when Bru 92-8 was used solely as and injection well? How could gravity feed rather than pressurization apply for Bru 92-8 during sole water injection without sand extraction?

11. Pressurization during sole injection fro Bru 92-8 as stated in the email of Manitoba groundwater would contradict Sio Silica's claim that no pressurization occurred. Please clarify why the requirement of the licence

for aquifer pressure measurement during water injection could be ignored during sole injection.

12. If the water injected in Bru 92-8 during sole water injection was from the earlier sand extraction in Bru 92-8, does this not prove that gravity feed cannot keep up to the water withdrawn with the sand and separate water injection must be done either after sand extraction or in a separate injection well at the time of sand extraction?

13. At Project year end emptying of all the vessels of the dewatering station, slurry lines and UV system is required. As explained above this cannot occur with the airlift gravity feed process since this process itself produces water that must be injected into the aquifer. Please clarify why sole injection as described in the email from Manitoba Groundwater is not required at Project year end.

14. Please clarify the dual rotary method used in the drilling and sand extraction of well Bru 92-8 as described in the email received from MB Groundwater that stated; "*It was explained that there is no liner being utilized. Reportedly, when they extract the silica sand, a Dual Rotary Method is employed so the sand is removed via this dual drilling casing and upon completion, it is then removed.*" A description in the Driller.com states; "*The primary distinguishing feature of a dual rotary drill rig is a lower rotary drive that is used to advance steel casing through unconsolidated overburden. Rotational forces are transmitted to the casing via power-operated jaws. A carbide-studded shoe, welded to the end of the first piece of casing, enables the casing to cut its way through the overburden. A top-drive rotary head simultaneously handles a drill string equipped with either a down-the-hole hammer, drag bit or rolling cone bit to drill the center.*"[5] A dual rotary drill is normally used for drilling into unconsolidated medium and not for airlift sand extraction.[5] The casing used in the drilling is removed after the drilling is complete.[5] This is confirmed in the Sio Silica Supplementary Information Document #1 submitted to the CEC June 2, 2022 which states; "*Extraction wells will first be drilled by a water well rig ahead of extraction activities. Wells are capped and secured once drilled while awaiting extraction. Extraction is performed with a different water well rig and once extraction is complete the equipment is removed*." Furthermore the production tube installed later is PVC while the drill casing for dual rotary drilling is normally steel.[5] Since the statement given to MB groundwater states "*there is no liner being utilized*" and if the dual drill casing was removed before sand extraction, does this not mean that no production casing was used in the sand extraction and that the air tube for air lifting was inserted into the open hole in the sandstone illustrated in figure 4 of DLN IR 002? If so, how could the produced water have been re-injected into the open hole at the same time pressurized air was being forced into the sandstone? Would not the pressurized air enter the sandstone through the open hole and push

water away if there is no production casing for the injected air to return? Thus how could all the produced water be returned to the aquifer as stated in the response "l" if there was no production casing at the time of sand extraction and the casing used for dual rotary drilling had been removed after the drilling and before sand extraction?

15. It is possible that the drilling casing of the dual rotary drill was left in the hole, the drill bit retracted, and the dual drill casing was used as a production tube during sand extraction. According to the Extraction EAP and the description in Supplementary Information Document #1 the drill and extraction rig are separate. Therefore using the dual drill rig casing as a production tube for Bru 92-8 would not be a demonstration and test of the production method to be used by Sio Silica. According to figure 4 of DLN IR 002 the PVC casing terminating 246 feet from the surface deep into the sandstone has an inner diameter of 10.0 inches while the open hole has a diameter of 9.8 inches. If the rotary drill casing that was used to drill the open hole was also used as a production tube that would leave only a maximum annular space for re-injection water of 0.2 inches. Also the rotary drill casing would have to be fitted at the top for sand extraction and air tube insertion. Thus it does not seem possible that the rotary drill casing was used as a production tube and removed as stated in the email from Manitoba Groundwater. Please clarify what was used as a production tube and how and when it was removed in Bru 92-8. Please clarify if the statement provided by Sio Silica to Manitoba Groundwater that "*a Dual Rotary Method is employed so the sand is removed via this dual drilling casing and upon completion, it is then removed, "* is false. Please clarify if no production tube was used and if the air for air lift extraction of the sand was injected into the open hole shown in figure 4.

16. The injection permit for well Bru 92-8 states; "*The outermost 10" steel casing must fully penetrate the carbonate aquifer and finish within or below the shale unit of the uppermost Winnipeg Formation. The entire annular space above the Winnipeg sandstone to the top of the carbonate rock must be fully tremie grouted with cement except over interval(s) where large voids, if present, prevent using this method*." The 10" outer casing documented in the Manitoba Groundwater Well Information report for Bru 92-8 as shown in DLN IR 002 figure 4 is PVC not steel as required. Please clarify why PVC was used in Bru 92- 8 rather than steel as required by the injection permit.

17. The most current extraction well design in Supplementary Information Document #1 specifies PVC casings rather than steel. Please clarify why PVC casings will be used during production when the injection permit for Bru 92-8 specifies steel?

18. Please clarify if injection permits will be obtained for all the 342 extraction/injection wells planned during full production.

19. The injection well for Bru 92-8 required continuous pressure monitoring to ensure the formation is not over-pressurized. Please clarify if this pressure measurement will be made during production as required by well injection permits.

20. Please clarify what pressure would be allowed in the formation during production operations.

21. Please clarify what studies and measurements Sio Silica has undertaken and will undertake during production to quantify the maximum pressure that the formations can withstand.

22. Please clarify what statements in request "f" Sio Silica disagrees with and why. In particular does Sio Silica disagree that the sandstone contains interbedded shale as recorded in the well information reports that has been shown by their own testing to be potentially acid generating and contains selenium that was released at toxic levels during their shake flask tests? Does Sio Silica disagree that the sandstone contains concretions contains acid generating pyrite and marcasite as documented in a peer reviewed paper by Schieber and Riciputi, (2005)?[4] Does Sio Silica disagree that the sandstone contains oolite layers that Watson (1985) reported as being pyritic?[3] Please clarify why Sio Silica continually ignores or disagrees with documented evidence such as this with no supporting contrasting evidence of their own?

23. Please clarify if Sio Silica disagrees with the information presented above that even if the sand contains calcium carbonate that would neutralize acid formed from the oxidation of the documented sulphide in the sand, the neutralization reaction would release CO2 that would form acid in the aquifer.

24. Please clarify what wells were used to demonstrate and test gravity feed for re-injection of water as stated in the Sio Silica response "g" and clarify when these gravity feed tests occurred.

25. Please clarify Sio Silica's response "m" pertaining to the water draw of Sio Silica operations on the sandstone aquifer. Sio Silica only referred to the water removed to the sand stockpiles at the processing sit and did not quantify the amount of water removed in a year. Sio Silica ignored the requests for the amount water removed from the aquifer that entrained in all waste streams including fines/ overs and in the filtrate from the UV filtration system and sand drying beds. Please clarify why Sio Silica has not answered the question as to the total amount of water withdrawn from the sandstone aquifer.

26. Please clarify response "o" that "*the information requested is irrelevant to the impacts associated with Sio's proposed extraction activities*." Pertaining to the request about the extraction, storage handling, and chain of custody

of core logs for Bru 121-1 and Bru 146. The geochemical analysis of the cores gives essential information on the potential for release of toxic substances and of acid generation in the aquifer due to Sio Silica extraction operations. Exposure of the samples of air could lead to oxidation of sulphide and underestimation of acid generating potential. How can this information be irrelevant to the impacts of Sio's proposed extraction activities? If the requested information is irrelevant why did Sio Silica perform geochemical document on these samples?

27. The water in the frac tanks will contain large amounts of entrained gaseous air as illustrated by the aerated water jet filling the frac tanks show in figure 1. The water plunging into the tank would entrain more air.[6] Bubbles of entrained gaseous air when injected into the aquifer at year end would rise, enter the carbonate aquifer through the degraded shale, spread rapidly through the water bearing fractures of the carbonate aquifer causing precipitation iron and manganese and fostering the proliferation of well- fouling iron bacteria. The degradation of the shale aquitard is modelled in the Hydrogeological Report. The precipitation of iron and manganese due to oxidizing conditions and the proliferation of iron from the aerated water is documented in the public comments for the Extraction EAP by Dr. E. Pip. Please clarify why this re-injection of vessel and slurry line water at Project year end would not contradict the statement in response (h), "*Sio similarly does not expect any adverse impacts on local water supplies from extraction activities.*"

28. The entrained air in the process water would be in all the water re-injected into the sandstone aquifer throughout the extraction process, not just at year end. Air would be entrained in the clarifier tanks and hydrocyclones used for the UV filtration systems. For example air would be entrained in plunging water from the v notch overflow weir in the clarifier and in the plunging water entering the collection tank for the wastes water from the clarifier as illustrated in Figure 2.[7,8] Hydrocyclones have an air core as illustrated and documented in DLN IR 002 that would entrain gaseous air. Please clarify why the adverse impacts of re-injection of water containing entrained gaseous air described in request for clarification 16, that would occur throughout the Project year, would not contradict the statement in response (h), "*Sio similarly does not expect any adverse impacts on local water supplies from extraction activities*"

29. A complaint of brown water in a domestic well near the Sio Silica Centre line Road extraction site that occurred only during Sio Silica sand extraction was documented in the response to public comments key issue 204 of the Vivian Processing Facility EAP. Several well owners documented Feb. 5, 2021 in a Report of Suspected Violation of the Groundwater and Water Well Act occurrence of discoloured water and increased iron staining following Sio Silica's extraction operations in the Vivian area. These complaints are consistent with the scenario of adverse impacts from the

re-injected aerated water described in request for clarification 16. Please clarify why Sio Silica did not consider these complaints in their statement in response (h) to DLN IR 002, "*Sio is not aware of any impacts to local water supplies associated with its testing to date*." Please clarify why the described adverse impacts to re-injection of aerated water are not valid and would not occur by providing documented evidence. Please clarify why the documented evidence from E. Pip on the adverse impacts of aerated water and the photographs demonstrating aerated water with entrained gaseous air in figure 1 are not valid.

30. Please clarify who responded to DLN IR 002, who will respond to the request for clarification, and their qualifications.

References:

1. Water Disinfection with Chlorine and Chloramine, Drinking Water, CDC, US, https://www.cdc.gov/healthywater/drinking/public/water_disinfection.html

2. Operational Guideline for Manitoba Water Suppliers, Manitoba Conservation and Climate, https://www.gov.mb.ca/sd/pubs/water/drinking_water/odw_og_09.pdf

3. Economic Geology Report ER84-2 Silica in Manitoba By D.M. Watson Manitoba Energy and Mines Geological Services Report, 1985 https://www.manitoba.ca/iem/info/libmin/ER84-2.pdf

4. Pyrite and Marcasite Coated Grains in the Ordovician Winnipeg Formation, Canada: an intertwined record of surface conditions, stratigraphic condensation, geochemical ''reworking,'' and microbial activity, Jurgen Schieber and Lee Riciputi, Journal of Sedimentary Research, 2005, v. 75, 907– 920, https://www.semanticscholar.org/paper/Pyrite-and-Marcasite-Coated-Grains-in-the-Winnipeg-Schieber-Riciputi/c7260c14eefc435745019d169ed8f741ed4da6df

5. The Drillerill Rigs, Sept. 1 2006, https://www.thedriller.com/articles/85259-dual-rotary-rig- basics

6. Visualisation of air entrainment by a plunging jet, 5th BSME International Conference on Thermal Engineering, A. K. Roy, B. Maiti, P.K. Das, Procedia Engineering 56 (2013) 468 – 473, https://www.sciencedirect.com/science/article/pii/S187770581300502X

7. Study of the influence of Venturi weir type on air bubble entrainment, Scientific Research and Essays 4(11):1184-1193, December 2009, Fahri Ozkan et al.,

https://www.researchgate.net/publication/228537632_Study_of_the_influence_of_venturi_weir_type_on_air_bubble_entrainment

8. Introduction to Wastewater Clarifier Design, N. Voutchkov, A SunCam Continuing Education Course, https://s3.amazonaws.com/suncam/docs/278.pdf

Response:

1. Sio did not find any specific requirements for treatment of water returned to the aquifer and proposed 10 mg/L as a conservative approach. Chlorine does dissipate and in a large body of water would not remain at such a concentration. Sio has not proposed any chlorine for the EAP before the CEC. Therefore this topic is not relevant to the CEC process.

2. There is no set specification. Sio took a conservative approach to not risk any contamination and outlined its intention on the injection permit application. Sio has not proposed any chlorine for the EAP before the CEC. Therefore this topic is not relevant to the CEC process.

3. Sio declines to respond based on the relevancy.

4. Sio did not re-inject any water into Bru 95-2 and Bru 95-3. This is out of scope of the current application before the CEC.

5. Sio monitored water gravity feed to the well visually. If the gravity feed flow exceeded the ability for the well to receive water the feed would be reduced or shut off completely because the water could overflow around the wellbore as the wellbore is open to atmosphere.. Please note, these are testing configurations and not necessarily the configuration of the proposed extraction operations.

   The subject of what Sio did or did not do on previous tests is outside of the scope of the application before the CEC.

6. Sio declines to respond to this question due to relevancy to the EAP application.

7. Sio declines to respond to this question due to relevancy to the EAP application.

8. This has already been explained in the previous response to Round 1 DLN-IR-003 (k). The production tube is used for extraction of sand and water only. Sio does not return water down the production tube. Water returns back to the aquifer outside the production tube and inside the cemented casing. Sio is not obligated to put the production tubing on a well construction report as it is not permanent and is suspended from the water well rig during extraction then it is removed after extraction is complete.

9. Please refer to CEC-IR-014 for data that was released on extraction.

10. Sio notes that this question is relying on an email from the Groundwater Management Section about Sio's test wells, but the information provided by the Groundwater Management Section in that email is not entirely accurate. Sio maintains that no pressure was used. Please see the response to #5 above.

11. See the response to #5 above.

12. No pressure was applied. See the response to #10 above.

13. As stated in the Round 1 responses, DLN-IR-007 (cc) and (kk) and acknowledged in Round 2 IR 007 by the author, the remaining water in the system after extraction is complete will be taken to a water treatment facility for disposal.

    Where possible, water will be moved to a holding tank for the winter months to reduce the volume of water taken to a treatment facility. However, some fluid from the slurry line and very bottom of the tanks that cannot be pumped by a small pump to a holding tank will need to be cleaned out with a vacuum truck.

14. Sio notes that this question is relying on an email from the Groundwater Management Section about Sio's test wells, but the information provided by the Groundwater Management Section in that email is not entirely accurate. Please see response to number 8 above.

    The author uses different terminology then Sio's provided documentation and is unclear as to what is meant by a liner. As stated in Supplement Filing #1 – Silica Extraction Method, *"The extraction method combines the traditional method of airlift used to develop water wells and a dual rotary set up usually used to drill wells in unconsolidated formations to extract sand."* Tests to date have been performed using a dual rotary rig.

15. Please refer to responses #8, 10 and 14 above.

16. This request is outside the scope of the application before the CEC.

17. Water wells can be steel or PVC casing. PVC is preferred at this time for ease of handling, and cost. PVC casing also will not rust.

18. An injection permit will be required for all re-injection of water for the extraction process. Whether the permits will be per well, per area or per cluster, that has yet to be determined with the Groundwater Management Section.

19. Sio will follow requirements as per the permits issued. Requirements that will be issued in the permit are unknown at this time.

20. Sio does not intend on applying any pressure, therefore this question is not relevant.

21. Sio will not be pressurizing the formation. This is not necessary.

22. It is agreed that sedimentary formations including carbonate and sandstone may have interbeds of shale.

    It is further agreed that the shale contains trace elements that were released under fully oxic conditions in shake flasks exposed to an unlimited quantity of oxygen.

    Sio disagrees that samples of interbedded shale were demonstrated to be "*potentially acid that has been shown by their own testing to be potentially acid generating and contains selenium that was released at toxic levels during their shake flask tests*". Firstly, the samples of shale were collected from between the Red River Carbonate aquifer and Winnipeg Sandstone aquifer, and not the interbeds. Secondly, the testing results did not result in the classification of those samples as potentially acid generating (PAG). Of the three samples collected, two were classified as Uncertain, and one was classified as Non-PAG. Thirdly, the concentrations of selenium cannot be concluded to be toxic because toxicity testing was not completed on shake flask leachate. Further selenium leaching was only demonstrated under oxic conditions within shake flasks exposed to an unlimited supply of oxygen. These results suggest that selenium is a constituent of potential concern that must be included in routine monitoring, and that shale may require careful management as outlined in the Waste Characterization and Management Plan.

    It is acknowledged that the Winnipeg Sandstone has been documented to contain concretions and oolites that may contain small quantities of sulphide minerals. Specific analysis of these materials has not been conducted, so it cannot be concluded that they are acid generating. As noted in the Waste Characterization and Management Plan, these materials will be mechanically separated during processing and disposed of in accordance with the material properties in an abundance of caution.

    For clarity, laboratory analyses of geologic materials have been conducted by analytical laboratories accredited by the Canadian Association for Environmental Analytical Laboratories (CAEAL) and the results of that testing is considered to be factual.

23. As discussed above, Sio disagrees with some of the information and several statements made above as they are inaccurate and inconsistent with the

factual data derived from laboratory testing or the results of geochemical modelling.

24. Sio has gravity fed tested Bru 92-8 summer 2021 and Den 304-1 summer 2020.

25. The total volumes of water withdrawn were presented in the 50% and 0% re-injection scenarios of the Hydrogeology and Geochemistry Assessment for the extraction. Sio intends to re-inject all water that is removed from the sand during extraction Therefore, the 0% re-injection scenario represents a conservatively high end scenario that includes the volume of water and sand. The 50% re-injection scenario presented in the Hydrogeology and Geochemistry Assessment assumed that sand would be dewatered to reduce the moisture content and the surplus water would be available for re-injection to the sandstone aquifer.

26. Collection of samples for geochemical testing was completed in a manner that is consistent with industry standard practice as defined by the Guidelines for the Prediction of Acid Rock Drainage and Metal Leaching for Mines in British Columbia (Price 1997), the Metal Environment Neutral Drainage (MEND) Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND 2009) and the Global Acid Rock Drainage (GARD) Guide (INAP 2014). For clarity, laboratory analyses of geologic materials have been conducted by analytical laboratories accredited by the Canadian Association for Environmental Analytical Laboratories (CAEAL) and the results of that testing is considered to be factual. The sampling program design and interpretation of results was completed by scientists and engineers with advanced academic training in geology, hydrogeology, geochemistry and several decades of combined experience collecting and interpreting similar information.

27. The Groundwater Monitoring and Mitigation Plan will monitor groundwater in the formation and prior to re-injection for a suite of parameters to confirm the extraction process is performing as expected. The system will be designed to minimize the possibility for proliferation of bacteria. The supply of oxygen to the aquifer will not be unlimited and will therefore not allow for complete oxidation of any reduced form minerals.

28. The Groundwater Monitoring and Mitigation Plan will monitor groundwater in the formation and prior to re-injection for a suite of parameters to confirm the extraction process is performing as expected. The system will be designed to minimize the possibility for proliferation of bacteria. The supply of oxygen to the aquifer will not be unlimited and will therefore not allow for complete oxidation of any reduced form minerals.

29. Sio contacted the landowner who made the complaint in issue 204 who is 1.5 miles away from the site that was active around the same time and the well in question was not in the sandstone aquifer. It was investigated by

Friesen Drillers and deemed unrelated to Sio's activities and more likely a maintenance issue. Sio has committed to investigating any complaints going forward. Landowners would have to contact Sio. Sio has not seen the document referenced by the author or been contacted by multiple landowners.

30. Sio prepared all of the IR responses, with input and support from subject matter experts at AECOM and Stantec, as needed. There was no individual author responsible for any of the IR responses. Representatives from Sio, AECOM and Stantec will be available to answer questions about the IR responses at the hearing, and Sio will file a summary of qualifications for each of those witnesses in advance of the hearing.

IR Number: **DLN-IR-003**

Submitted by: DLN

Date Submitted: January 5, 2023

Subject Matter: Slurry Line Contamination

Reference Documents:

(a) Table 4-2, 4-3 and 4-4 of the Sio Silica Hydrogeology and Geochemistry Assessment Report

(b) Section 2.2.4 Sand Slurry Conveyance to Processing Facility

(c) 6.9 Accidents and Malfunctions – 6.9.2 Spills and Leaks

(d) Appendix H. Production Schedule

(e) 7.4 Prediction Confidence and Uncertainty

Background/ Preamble:

Request:

1. In response to the request 1; "*Give detailed information on the connection between the slurry line and the water re-injection system. Evaluate the potential for malfunction of this connection leading to toxins accumulated in the slurry line entering the water to be re-injected into the aquifer. Give mitigation measures to minimize such malfunctions*." Sio Silica replies, "*The slurry loop and the extraction, dewatering and UV system are completely independent of each other*." Please clarify how the extracted sand enters the slurry line loop. Please give an illustration of this process. Please clarify how the process of sand entry into the slurry line loop is configured in such a way to eliminate the possibility of slurry line water entering the water re-injection system through malfunction or leakage.

2. Sio Silica in response to request 2 in DLN IR 003 states that they do not agree with the premise that toxins can accumulate in the slurry line. Extensive evidence has been given in DLN IR 003 to substantiate that toxins including acrylamide, selenium, acid and heavy metals can accumulate in the slurry line. Sio Silica does not address this evidence. Documented evidence form the EU and from the Great Plains Sand Processing Plant[1,2] establishes there will be a manufacturing residual of acrylamide in the polyacrylamide flocculent that the EAP for the Sio Silica Sand Processing Facility states will be used in the clarifier. Please clarify why this evidence does not apply and is disagreed with.

3. The shake flask tests in the Hydrogeological study showed toxic levels of selenium for the sand samples. Sio Silica attributed the selenium leaching to shale fragments in the sand. It has been established in the Sio Silica

Hydrogeological Report and the Stantec studies that shale from the aquitard would collapse into the sand. The photograph in Figure 1 of DLN IR 011 establishes that fragments of shale that the Hydrogeological report show contains up to 13.1 ppm selenium would be extracted with the sand. (Please note that there is an error in the Table 1 of DLN IR 003. The concentration of selenium for Bru 121-1 should be 13.1 ppm not 3.2. The correct value of 13.1 ppm was used in the modelling). Well information reports from Manitoba Groundwater establish that interbedded shale that occurs in the sand that would be extracted. Given this evidence please clarify why selenium and acrylamide could not be released in the slurry line where these toxins could accumulate.

4. It has been established by Schieber and Riciputi, (2005), and Watson (1985)[3,4] that pyritic concretions and oolite that would be extracted with the sand could form acid in the slurry line. Similarly the interbedded shale according to literature reports and the Hydrogeological Report would be potentially acid generating. Please clarify why this evidence that acid could from in the slurry line from extracted concretions, oolite, and interbedded shale and collapsed aquitard shale can be disagreed with.

5. Revidence from the peer reviewed paper by Xiong et al. (2018)[5] establishes that the presence of iron and acid from the shale, concretions and oolite in the slurry line would degrade polyacrylamide into the highly toxic monomer acrylamide further increasing the acrylamide concentration in the slurry line. Please clarify why the evidence from Xiong et al. (2018)[5] of polyacrylamide degradation in the slurry line is disagreed with. Please clarify why Sio Silica dismisses all the provided evidence without any contradictory evidence to substantiate their dismissal.

6. Please clarify that Sio Silica has a professional, ethical and legal responsibility to substantiate with evidence, simple assertions, such as disagreeing with the factual statements and premise of request 2.

7. Given this responsibility please provide evidence for the disagreement of the factual statements and premise of request 2.

8. Please clarify if the automated pressure transducers that would be used to detect leaks would trigger shut off valves in the line segments. Please clarify how much slurry leakage could occur until automated shut- off occurs.

9. Please clarify the slurry line minimum pressure decrease that would trigger the automated shut-down system.

10. Please clarify how much gradual leakage would go undetected by the pressure sensors.

11. Please clarify that the non-toxic biodegradable flocculant is polyacrylamide as stated on page 13/129 of the Sand Processing Plant EAP.

12. Please clarify why evidence that the evidence given in request for clarification 1 above, that there will be a manufacturing residue of toxic acrylamide monomer in the flocculant, is not considered.

13. Please clarify why the evidence that selenium accumulation and acid that would release heavy metals given clarification request 1 above is not considered.

14. Please clarify that even though the acrylamide is biodegradable the modeling evidence given in DLN IR 003 demonstrates that accumulation of toxic levels of acrylamide can occur in the slurry line despite biodegradation.

15. Please clarify why the modeling studies and evidence from DLN IR 003 is not considered.

16. Please clarify why the slurry line crossing of the Winnipeg aqueduct is outside the project proposal. During the first four years of the licence approval the slurry lines might not cross the aqueduct but must cross the aqueduct within the 24 year Project duration as shown in the Project layout illustrations. The mandate of the hearing is to review the entire Project without an explicit restriction to limit the time frame to a small segment when the Winnipeg aqueduct would not be crossed. A project alteration to cross the aqueduct could be filed later in the Project that could be accepted by the Director or the Minister of the Environment without input or approval from the City of Winnipeg.

17. Please clarify if Sio Silica is planning to cross the Winnipeg aqueduct with the slurry lines without approval of the City of Winnipeg.

18. If Sio Silica plans to obtain approval of the City of Winnipeg please clarify how and when this will be done.

19. Since the City of Winnipeg could refuse the crossing of the aqueduct by slurry lines please clarify how such a refusal would not affect the current Project proposal.

20. If a future refusal could affect the Project please clarify why approval must not be obtained before the Project can proceed.

21. The Project slurry lines must cross an international transmission line during the first four year period. Approval must be obtained from Manitoba Hydro to cross the transmission line. Please clarify if and when approval from Manitoba Hydro will be obtained.

22. Manitoba Hydro could refuse crossing of the slurry lines which would put the Project in jeopardy. Please clarify why approval from Manitoba Hydro has not already been obtained.

23. Please clarify why approval from both the City of Winnipeg and Manitoba Hydro for the crossing of the slurry lines should not be obtained at this time before the Project can continue.

24. Sio Silica has refused to answer the request "j" about the water balance in the slurry line on the grounds that they do not accept the premise of accumulation of toxins in the line. The amount of water on average entering the slurry line with the sand is required to determine not only potential toxic accumulation in the line but the amount of water re-injected into the aquifer and amount of water used to keep sand wet at the processing facility to suppress hazardous airborne silica dust and to determine the total amount of water permanently withdrawn from the sandstone aquifer among other issues. The CEC Participant RMSF in RMFSF IR 009 asked the origin of the 10 US gpm of water that Sio Silica states enters the slurry line with the sand. Sio Silica replied that based on literature values of dewatering methods the average water content of the sand entering the slurry lines after the dewatering process is 3.6%. The processing plant EAP states the water content of the sand exiting the slurry line loop at the processing facility is 15%. Thus more water leaves the loop than enters and the slurry line would eventually dry up and be inoperable. On average water balance in the slurry loop must be maintained. Please rectify this discrepancy in the amount of water entering the slurry loop with the sand and the amount leaving and make the necessary changes to the EAP documentation and all IR requests and response to public comments with respect to this issue.

25. Sio Silica answered the question about the origin of the 10 US gpm of water entering the slurry line for RMSF-IR-005 but refused to answer substantially same question for the DLN IR 004 request. A question about the 10 US water rate being sufficient for removal of the sand was asked in MSSAC-IR-016. If the request for RMSF and MSSAC about the 10 US gpm warrants a response then the request by DLN also warrants a response. If the water content of the sand in the stockpiles at the processing plant must be lowered to correct this deficiency please clarify if the air quality studies for the processing plant should be revised to account for the lower moisture content of the sand stockpiles which would result in higher respirable silica release.

26. The modelling of acrylamide and selenium accumulation in the slurry line was based on the 15% water content in the sand at the processing plant. A lower amount of water content in the sand would lead to a higher amount of accumulation of toxins. Sio Silica does not substantiate its refusal to accept accumulation of toxins in the slurry line with evidence and does not give evidence to counter the evidence documented to substantiate the

accumulation studies. The evidence included an industry study of the accumulation of acrylamide in a closed water loop at the Great Plains Sand Processing Plant. This evidence must be accepted until Sio Silica gives contrary evidence. Simply assertions by Sio Silica without evidence cannot be accepted by any credible regulatory and review process. Please clarify why Sio Silica does not accept the evidence from the Great Plains study and why this evidence cannot be applied tot the Sio Silica process.

27. The revelation that Sio Silica used literature values to obtain the residual moisture content in the sand after dewatering demonstrates Sio Silica has never field tested and measured this critical process. This is part of a pattern where Sio Silica has not tested documented, calculated and provided engineering plans and evaluations for almost all the critical sand extraction and sand processing operations as documented in DLN IR 004 Which Sio Silica has almost entirely refused to answer. Please clarify why Sio Silica has not field tested and measured critical processes such as waste separation and processing and relies on literature values.

28. Sio Silica does not answer the question about the inadequacy of the rates of sand and water extraction given in appendix H only stating in response (l) that, *"a revised extraction plan will be filed with the Approvals Branch and the CEC prior to the hearing as a project update letter to address updated information."* Please clarify if the technical reviewers will submit new comments on this revised plan for the Hearing.

29. The round of IR's will be completed thus no IR's can be submitted by the participants for the revised plan. Please clarify how the participants can properly address any issues with the revised plan.

30. Sio Silica states in response (l) that; *"At the time of field testing, Sio saw production rates with sand (solids) as high as 90% sand concentration."* Sio Silica has not measured or given the porosity of the in- situ sand in the sandstone aquifer. In the Hydrogeological Report, 25% is given as the assumed value. Please clarify how the air lift extraction process can preferentially draw sand at 75% in-situ out of the 25% water to obtain 90% in the extracted sand. Please clarify how the 90% value in the extracted sand was measured.

31. Appendix H gives the sand fraction as 50%, thus the sand to water ratio must vary during the extraction process. Section 2.4 of the Hydrogeological report states; *"Early in the extraction process for each well, the slurry will consist primarily of solids (est. 70%) and will slowly reduce to approximately 20-30% near the end of well production."* This statement contradicts the 90% value of the maximum sand fraction in the extracted water and further establishes the water to sand ratio varies with extraction time decreasing to as low as 20% sand. Sio Silica does not document how these values were

obtained and measured. Figure 1 of DLN IR 0-02 shows a slurry jet of extracted sand that appears from the colour to be mostly water providing evidence that a high water fraction occurs during extraction. Please clarify if the sand to water ratio as a function of extraction time has ever been measured. If so please provide data on the sand to water ratio as a function of extraction time, the wells where this was measured, the dates and the duration of extraction.

32. Please clarify why Sio Silica has never documented in the EAP measured data on the time course of the sand to water ratio during sand extraction.

33. The time variation of the sand to water ratio and the average sand to water ratio for sand extraction is critical to determine the amount of water returned to the aquifer and the time duration and feasibility of the extraction operation. The request measurement of the sand to water ratio during extraction is essential. It is a fundamental failure in the EAP for Sio Silica to have not supplied detailed information and measurement of this data. This is another demonstration of Sio Silica failure to conduct proper measurement and calculations on their extraction process in the EAP. There is no indication that Sio Silica will provide the essential data on the time variation of the sand to water ratio during extraction in the project update letter. If this data has never been obtained it cannot be supplied in the update letter. This Project should not proceed until this data has been supplied, reviewed by the external technical experts, and the participants. Please clarify if a new round of IR's for the updated information on extraction will be carried out.

34. Please clarify what will be done to supply the required essential data on the time variation of the sand to water ratio during extraction if this data cannot be provided in the project update letter.

35. In response (n), Sio Silica states, *"The French drain system is not part of the Extraction Project - Environment Act Proposal and is therefore outside the scope of the CEC process. Sio notes, however, that the French drain system will not drain into the slurry loop, contrary to the premise in the question."* The notice of alteration for the Vivian Sand Processing Facility that includes the French drain system posted on Feb. 16, 2021 states; *"CanWhite will install a French drain style system to capture all runoff water from the stockpiles, including rain and snow. This water will then be returned to the loop system for recycling within the processing facility so that no system water is discharged to the natural environment at any point during Project operation."* This statement contradicts the Sio Silica response that, *"the French drain system will not drain into the slurry loop."* Please clarify why Sio Silica has made a clearly false response that contradicts the notice of alteration.

36. A large amount of water returned to the loop system for recycling that cannot be accommodated within the loop would affect the operation of

the loop and the ability to deliver extracted sand into the loop. Therefore the water returned to the slurry loop is an essential part to the extraction process and not outside the scope of the CEC process. Please clarify and quantify how a large amount of water from a sudden deluge collected by the French drain system will be delivered into the slurry loop without compromising the operation of the loop and the ability to deliver extracted sand into the slurry loop.

37. For the entry of water from the French drain into the slurry loop, please quantify how water balance would be maintained in the loop where the amount of water entering the loop must be balanced by the amount of water leaving the loop.

38. Please clarify why Sio Silica has never considered the fundamental engineering requirement of water balance in the slurry loop.

39. Please clarify why Sio Silica did not address the documentation of the concern about water balance in the public response to the notice of alteration posted on the processing facility project registry.

40. Please clarify why Sio Silica has not acknowledged and responded to the DLN IR requests about lack of water balance both for the French drain system and for the 3.6% water in the sand entering the slurry loop at the extraction site and the 15% water in the sand exiting the loop at the processing facility.

41. Please clarify who responded to DLN IR 003, who will respond to the request for clarification, and their qualifications.

References:

1. Technical Memorandum, Great Plains Sand, T.Holstrom, March 9,2012 https://www.scottcountymn.gov/DocumentCenter/View/880/Exhibit-M-PDF?bidId=

2. European Union Risk Assessment Report, Acrylamide CAS No: 79-06-1, 2002 https://echa.europa.eu/documents/10162/50218bf9-ba0f-4254-a0d9-d577a5504ca7

3. Economic Geology Report ER84-2 Silica in Manitoba By D.M .Watson Manitoba Energy and Mines Geological Services Report, 1985 http://www.manitoba.ca/iem/info/libmin/ER84-2.pdf

4. Pyrite and Marcasite Coated Grains in the Ordovician Winnipeg Formation, Canada: an intertwined record of surface conditions, stratigraphic condensation, geochemical ‘‘reworking,’’ and microbial activity, Jurgen Schieber and Lee Riciputi, Journal of Sedimentary Research, 2005, v. 75, 907–920, https://www.semanticscholar.org/paper/Pyrite-and-Marcasite-

Coated-Grains-in-the-Winnipeg-Schieber-Riciputi/c7260c14eefc435745019d169ed8f741ed4da6df

5. Polyacrylamide degradation and its implications in environmental systems. NPJ Clean Water 1, 17 (2018), Xiong, B., Loss, R.D., Shields, D. et al, https://doi.org/10.1038/s41545-018-0016-8 https://www.nature.com/articles/s41545-018-0016-8#:~:text=The%20presence%20of%20degraded%20polyacrylamide

Response:

1. Extracted sand passes over a dewatering screen where the water is separated from the sand. The water drops below to a different level of the screen and the sand remains on top. The sand travels off the dewatering screen into a sump which is fed by the recycled slurry line water and feeds into the slurry loop. The water that comes off the dewatering screen, comes out of the screen in a different location where it flows into the water filtration and then UV system. It is not mechanically possible to mix the two.

   The sand and groundwater slurry brought to surface will pass through vibrating screens installed over a sump pit at the extraction site which will capture overs such as concretions (calcified sand) which are commonly encountered.

   The sand and groundwater slurry will then move to a dewatering station at the extraction site where the sand will be separated from the groundwater.

   Appendix A provides a rendering example of a dewatering screen. Detailed design with precise configurations, etc., are still being finalized and those details are not required to understand and assess the potential environmental effects from the proposal.

2. Polyacrylamides have been used for industrial water clarification, potable water purification, and solids thickening for decades. It is one of the most studied family of chemicals because of its place in people's lives. In Sio's application, polyacrylamide is used to settle fines after it is removed from the sand particles.

   The products recommended for the facility are Potable Water Grade and can be used for drinking water or food waste thickening environments.

   Residual acrylamide monomer is not present in finished polyacrylamide product at sufficient levels to be considered toxic and have not been shown to accumulate to toxic levels.

   Sio's suppliers have offered some additional references for the author to consider and provided comments below:

For information about residual acrylamide levels in the anionic polyacrylamide powder product. Listed references for some of the relevant points in these documents include:

- *El Mamouni et al, 2002, showed that a combination of photolysis and microbial attack leads to natural attenuation of these polymers. After 48 hours of exposure to UV, the oligomer (MW<3000 Daltons) increased from 2% to 80% chain length.*
- *El Mamouni et al, 2002, also went on to state that once the macromolecule is broken down to a molecular weight under 10,000 Daltons it will be indistinguishable from the organic background in the soil/environment and will eventually degrade to a size where it can be biomineralized*
- *Hennecke et.al. 2018. conducted a 3 year study that demonstrated;*
  - *There was no deleterious effects on plant growth or yield.*
  - *The polymer was degraded biologically by at least 20% in 2 years giving a degradation half-life of 5.4 years. .*
  - *There was no uptake of acrylamide by the plants.*
  - *The molecular weight of the polymer was drastically reduced showing substantial degradation of the polymer backbone.*
- *Dennis E. Marroni et al. state that even at operating dose of 100mg/L, the residual monomers released into the environment will never reach concentrations which could constitute a risk to aquatic life.* The studies supporting this are on aquatic life that is highly sensitive to environmental chemical imbalances.

Regarding production of polyacrylamide and residual acrylamide monomer present in finished product;

- *SNF production takes steps to ensure as much acrylamide is polymerized as possible. Trace amounts are unavoidable; however, QA assures residual acrylamide monomer is <1,000ppm and in fact is more typically about 400ppm. Potable water grade products such as the one in question have even lower levels of residual acrylamide.*
- *Acrylamide is present at very low levels and will not accumulate to reach levels that will be a risk for toxicity. Dry powder may have levels 400-1,000ppm but these will not reach toxic levels in the environment (Marroni et al.).*

Sio notes that the author's reference, Xiong, et.al (2018) [Polyacrylamide degradation and its implications in environmental systems | npj Clean Water (nature.com)], does not provide any data that overwhelmingly shows that the degradation of polyacrylamide to acrylamide monomer will be an issue especially given the conditions of the process in question.

The conditions the article discusses for potential breakdown of polyacrylamide to the acrylamide monomer are not likely to exist in Sio's application;

- *"**Mechanical degradation** is mostly likely to occur in oil and gas processing due to the high shear and elongated rates under turbulent flow through the small pores and fractures within the porous media in these formations".* This refers to high pressure pumping of polyacrylamide down hole in EOR flood applications and hydraulic fracturing applications. These are not conditions Sio will encounter and is therefore, not applicable.

- *"**Chemical degradation** of polyacrylamide that leads to chain scission involves activation of the polymer by free radicals, most commonly hydroxyl radicals generated in the environment from the Fenton reaction, interactions between oxygen and dissolved Fe2+ or other transition metals, and sulfate radicals through persulfate activation."* This point discusses the chemical degradation of polyacrylamide by chain scission (which will not occur if Fe2+is not present) which will reduce the chain size and MW of the individual chains but it does not claim to produce acrylamide monomer as a result of these chain scissions. So it does not seem to be relevant or supportive of the claim that acrylamide will be a product of chemical degradation of polyacrylamide. Persulfate induced degradation will not be a problem as that is an additive used in oil and gas applications and will not be present Sio's process.

- **Chemical degradation** via the Fenton reaction. *"Studies of PAM degradation by the Fenton reaction alone did not detect any acrylamide monomer, although there is evidence for acrylamide release from combined UV/Fenton reactions."* The Fenton reaction will not be an issue. The article shows that the Fenton reaction alone does not produce acrylamide monomer through polyacrylamide degradation. In the presence of UV light there is evidence of acrylamide as a product of the Fenton Reaction but UV light is not used in the slurry system.

- **UV light degradation.** *"However, there are still many unresolved questions regarding the release of acrylamide after exposure to UV, with conflicting results reported in the published literature."* UV light will not be used in the slurry system.

This article does bring up some points regarding the breakdown of polyacrylamide but not to the acrylamide monomer, only by scission into smaller polyacrylamide chains. Furthermore, most of the conditions described for the breakdown of polyacrylamide will not be present in the Sio process.

3. The Groundwater Monitoring and Mitigation Plan will monitor groundwater in the formation and prior to re-injection for a suite of

parameters to confirm the extraction process is performing as expected. The system will be designed to minimize the possibility for proliferation of bacteria. The supply of oxygen to the aquifer will not be unlimited and will therefore not allow for complete oxidation of any reduced form minerals. A range of possible constituents of concern will be monitored before, during and after operations.

4. Please refer to the response to DLN-IR-002 (22).

5. This question assumes the build up of polyacrylamide in the slurry line. Sio disagrees with the premise of the question as there is no build up of polyacrylamide in the slurry loop. See the response # 2 above.

6. Sio understands that it is required to reasonably respond to all information requests submitted to it that are relevant to its extraction proposal. Sio believes it has done this.

7. See the response to #2 above.

8. The Automated Pressure Transducers will be used to detect leaks and monitor system performance. A leak of 50 US gpm will initiate a shut down sequence and will be identified within minutes of a failure.

9. Pressure will be monitored using two methods of variation, real time pressure levels versus moving average pressures. This allows exception reporting and trends indicating system performance changes and sudden changes. Using exception reporting the system can initiate shut down over a declining pressure average, a real-time to moving average change, or a sudden real time change. These systems can see as little as 1 psi change, however a set point for initiating shut down will be calculated factoring acceptable operating fluctuations, and it could be as little 2-5 psi.

10. The ratio of real time pressure to moving average pressure will show a system operating exception within 20 minutes. Should this be a result of a gradual leak the volume would be 20 minutes times the gradual leak flow rate. This assumes that the flow meters and system balance, or manual inspection does not detect a gradual leak first.

11. As stated in the Facility Project EAP ". *A non-toxic biodegradable flocculant will be used for fines settling in a contained system."*

12. See the response to #2 above.

13. The Groundwater Monitoring and Mitigation Plan will monitor groundwater in the formation and prior to re-injection for a suite of parameters to confirm the extraction process is performing as expected. The system will be designed to minimize the possibility for proliferation of

bacteria. The supply of oxygen to the aquifer will not be unlimited and will therefore not allow for complete oxidation of any reduced form minerals. A range of possible constituents of concern will be monitored before, during and after operations. This will include selenium.

14. See the response to #2 above.

15. See the response to #2 above.

16. The mandate of the hearing is to review the EAP and the scope of the application. Sio maintains that the Winnipeg aqueduct is outside the scope of this application.

17. Sio maintains that the Winnipeg aqueduct is out of scope of this application. Sio notes that no crossing of the Winnipeg aqueduct would occur without permission or approval. Sio has never said that a crossing would occur without approval.

18. Sio would obtain approval in advance of the crossing being required which is outside the scope of the current filing. It may be 13 -14 years before the slurry line would need to cross the aqueduct or more.

19. There are other locations that Sio can extract sand from without crossing the aqueduct. This is out of scope for this current application.

20. Sio maintains that the discussion of the aqueduct is outside the scope of the current application.

21. Sio and Manitoba Hydro have been working towards securing approval and discussions remain ongoing.

22. Sio and Manitoba Hydro have been working towards securing approval and discussions remain ongoing.

23. Sio and Manitoba Hydro have been working towards securing approval and discussions remain ongoing.

    The aqueduct is out of scope of this current application.

24. Water will be added to the system by the water captured from the French drain system. The Facility project EAP states in section 2.1.1.1 Processing Description, "*Any additional remaining water not used in the Wet Plant or slurry loop system, will be stored in an on-site surface tank, as shown in Figure 22.*" After this point the water will either evaporate or be added back to the slurry line to maintain the same volume of water. Some water may be used for keeping the waste stock piles damp. The Water Management Plan will describe the flow of water and solids as part of the project.

25. The water content in the sand stockpiles is unrelated to the 10 US gpm value. Sand is stockpiled and estimated 15% moisture content as stated in the Facility Project EAP. Different equipment produces different moisture contents.

26. See the responses to #2 and #20 above.

27. Sand separation occurs all around the globe at sand facilities everyday with the same type of equipment that Sio is evaluating. Sio will be using industry accepted and proven methods for sand separation. This is not novel. These are "off the shelf systems."

28. A revised Extraction Plan was submitted to the CEC on January 24th 2023 with Sio's IR responses. Sio will be available during the hearing to respond to questions pertaining to the revised plan which adheres to the geotechnical parameters recommended by Stantec.

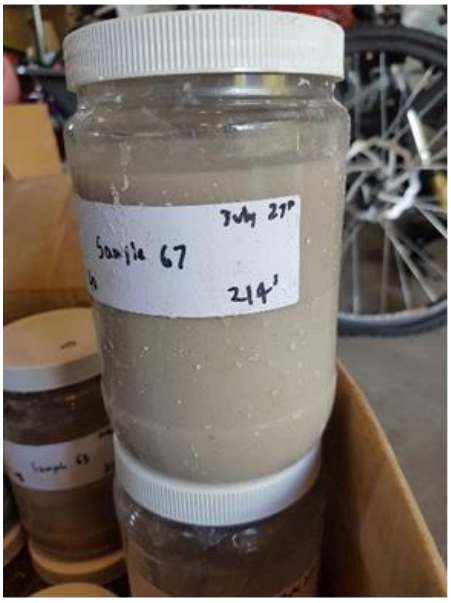
    It is important to note that this reviewed extraction plan is a reduction in the number of wells overall.

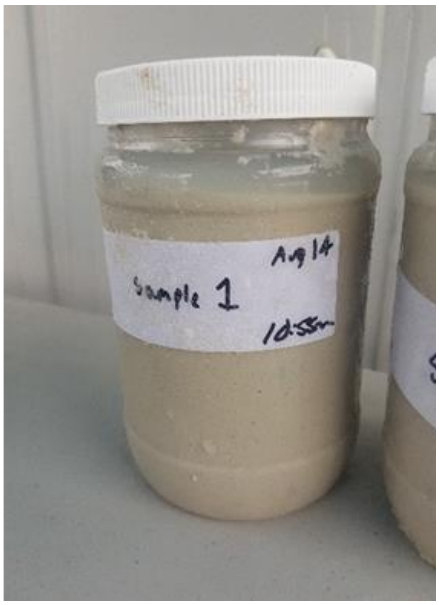
29. Sio will be available during the hearing to respond to questions pertaining to the revised plan which adheres to the geotechnical parameters recommended by Stantec.

30. The percentage of sand concentration that comes to surface during extraction testing is measured by volume in grab samples taken periodically during production. An example of a grab sample is presented below.

    More recently, Sio keeps these samples from the field and later records the % by weight of the dried sample.

Examples:





31. Generally speaking, the sand water ratio will decrease over the life of the well. However testing conducted after the issuance of the Hydrogeology and Geochemistry Assessment observed a more consistent sand ratio.

    Sio cannot speak to the photo referenced in the question as the photo was taken by an unauthorized trespasser. Sio was unaware of the individual on the site. The individual did not announce themselves, or present to the main office to alert the site supervisor of their presence. Sio deems this as very unsafe and an act of trespass. Without a grab sample, the author is making an assumption that what they saw was a high concentration of water, but this cannot be verified.

32. See the response to #30 above.

33. Please see the response to #30 above. As previously stated, Sio will be available during the hearing to respond to questions pertaining to the revised plan which adheres to the geotechnical parameters recommended by Stantec.

34. Sio disagrees with the statements in this request and declines to provide such additional data.

35. The author misunderstands the statement made in the notice of alteration. The French drain system will drain into the water recycling system. This means the first stop of the water is the clarifier, not the slurry line. The Facility project EAP also states in section 2.1.1.1 Processing Description, "*Any additional remaining water not used in the Wet Plant or slurry loop*

system, will be stored in an on-site surface tank, as shown in Figure 22" After this point the water will either evaporate or be added back to the slurry line to maintain the same volume of water. Some water may be used for keeping the waste stock piles damp.

36. See the response to #35 above.

37. See the response to #35 above.

38. Sio has considered this, see the response to #35 above.

39. The Facility Project Notice of Alternation is not within the scope of the application before the CEC.

40. The French drain system is part of the facility and represents a safeguard against surface drainage. It is subject to snow, rain and dewatering from the Work in Progress (WIP) pile.

    Water will be added to the system by the water captured from the French drain system. The Facility project EAP states in section 2.1.1.1 Processing Description, "*Any additional remaining water not used in the Wet Plant or slurry loop system, will be stored in an on-site surface tank, as shown in Figure 22."* After this point the water will either evaporate or be added back to the slurry line to maintain the same volume of water. Some water may be used for keeping the waste stock piles damp.

    15% is a common dewatering output, however mechanical options are available to reduce sand moisture to lower levels. Final options are under review.

41. Sio prepared all of the IR responses, with input and support from subject matter experts at AECOM and Stantec, as needed. There was no individual author responsible for any of the IR responses. Representatives from Sio, AECOM and Stantec will be available to answer questions about the IR responses at the hearing, and Sio will file a summary of qualifications for each of those witnesses in advance of the hearing.

References:

1. Hennecke, D., Bauer, A., Herrchen, M. *et al.* Cationic polyacrylamide copolymers (PAMs): environmental half life determination in sludge-treated soil. *Environ Sci Eur* **30**, 16 (2018). Accessed at: https://doi.org/10.1186/s12302-018-0143-3
2. Marroni, D. E. Polyelectrolyte use in the oil Sands industry: Safety Aspects and Environmental Benefits. Safety, Health, Environment & Regulatory Affairs SNF Group of Companies.
3. El-Mamouni, Rachid & Frigon, Jean-Claude & Hawari, Jalal & Marroni, Dennis & Guiot, Serge. (2002). Combining photolysis and bioprocesses for mineralization of high molecular weight polyacrylamides. Biodegradation. 13. 221-7. 10.1023/A:1021272519714.

4. SNF Water Science. Anionic Polyacrylamide. FLOPAM AN 900. 2002-01.

IR Number: **DLN-IR-004**

Submitted by: DLN

Date Submitted: January 5, 2023

Subject Matter: Design specifications and drawings

Reference Documents:

a. 2.1 Components and Activities

b. Figure 2-1: Sand Extraction Circuit Process

c. Figure 2-4: UV Water Treatment

d. 2.4.3 Dewatering and Pumping Stations

e. Figure 2-5: General layout of Mobile Slurry and Water Lines and Temporary Access Trails

f. 2.4 Ancillary Components

Background/ Preamble: Sio Silica refuses to respond to most requests for design specification and drawings based on the statement, "*at the time of submission of an EAP, applicants are not required to have completed their detailed engineering and design. Detailed engineering and design is typically completed during and after the regulatory review.*" Enough information on the Project processes must be submitted for an adequate review for the approval process and for the Hearing. Sio Silica has provided almost no measured and documented data on critical processes such as the volume of waste products, the mechanism of dewatering and separation of the silica sand at the extraction site, connection and operation of the slurry lines and implementation of the UV filtration system.

Sio Silica states;

"Further, as Sio's detailed designs are still being finalized, Sio declines to release any additional details of its designs at this time. Many of the technical components of the extraction proposal are being negotiated with arm's length third parties and disclosure of additional information could prejudice Sio's negotiations with these parties. Sio also maintains that details of technical components that have not yet been finalized are not relevant to the CEC's review of the extraction proposal."

Request:

1. Sio Silica is planning to update central and essential information on the extraction method. Please clarify why the details of the extraction method are not essential for a complete review.

2. Sio Silica is reviewing and evaluating the filtration for the UV system that is essential for adequate process water disinfection. The filtration process could generate unmanageable quantities of waste and cause risk of exposure of workers and the public to silica dust. Please clarify why the

details of the UV filtration method are not an essential for a complete review.

3. Sio Silica has never implemented and evaluated the sand separation methods and the quantity and character of the waste produced during this separation process. Please clarify why detailed information on the sand separation and waste production including detailed documentation of the type and quantity of waste produced is not essential for a complete review.

4. Sio Silica has not documented and given any data on the essential gravity feed method of water re- injection. Sio Silica has not supplied information on the testing and implementation of the production design given in supplemental document #1 submitted to the CEC including the names of wells were this process has been implemented. Please clarify why detailed data and measurement on the well extraction of silica sand and re-injection of process water is not essential for a complete review.

5. Sio Silica has not supplied any data on the volume and pressure of air to be injected into the aquifer for air-lift extraction and on the ratio of water to sand to air as a function of time during sand extraction. This information is essential to determine how much process water and air will be injected into the formation. It is impossible to determine the environmental impact of air and process water injection if the quantities are unknown and not documented. Please clarify why detailed data and measurement on the rates and quantity of process water and air injection into the sandstone aquifer is not essential for a complete review.

6. The data in the EAP supporting project processes is non existent. Figures 2-1 to 2-4 illustrating the sand extraction process, dewatering, waste removal, and UV disinfection are cartoons. There is no description of the connection to the slurry loop. These processes have never been tested. It appears that process wastewater was re-injected only in one well Bru 92-8 and even that re-injection does not appear to conform to the production plans. No data has been given on the waste water re-injection in Bru 92-8. The Hydrogeological study was simply another drawdown exercise many of which have been done on a similar scale throughout the sandstone and carbonate aquifers. The drawdown information from the Hydrogeological study is meaningless without water re-injection and sand extraction. No wastewater was re-injected and no sand was extracted. Re-injection was modeled by simply reducing withdrawal with no re-injection. How could re-injection be modelled if no water was re-injected? The geochemical anlysis was inadequate in number of samples and coverage area. Samples were exposed to air. Bru 121-1 and Bru 146 geochemical samples were years old, had no records of extraction, sample handling, storage and chain of custody. The sand sample for Bru 146 was from a borehole that was not completed into the sandstone, terminating in the shale aquitard. How

could sand be obtained from a borehole that did not penetrate into the sand? In more than five years of testing all Sio Silica has done is,

- extracted sand and water, injected contaminated air into the sandstone aquifer,
- discharged a large amount of process wastewater under temporary authorization permits onto the surface environment with no measurement of pollutants in the discharged water,
- submitted an inadequate EAP with no documented testing, data and evidence to support essential project processes,
- documented a meaningless hydrogeological drawdown study,
- submitted an unacceptable geochemical analysis on air exposed samples,
- submitted, after the EAP, an incomplete geotechnical study based on a two dimensional model with no adequate analysis of sand pillar slope stability, and
- submitted in June of 2022 an invalid project extraction design that violated the Stantec Table 9 data of the January 2022 Stantec report.

All these deficiencies and lack of data has been documented in the DLN IR's DLN motion brief and in the DLN submission to the public comments. Please clarify what information and data Sio Silica has provided in enough detail to complete a proper review and assessment of environmental impact.

7. Please provide a detailed illustration and description of the connection of the sand extraction system to the slurry loop.

8. Sio Silica states in response (i), "*When overs are captured, they will be stored in covered, open to* atmosphere *tankage, fines, which are estimated at about 1.9% of total extracted material, will be collected at the extraction site and pressed into a filter cake similarly to the fines captured at the Facility*." For key issue #190 in the response to public comments for the extraction Project Sio Silica states, "*Mine waste (e.g., overs) is estimated to range from 0.1% to 0.8% of the extracted material*." For key issue # 11 in the response to public comments Sio Silica states, "*Oolites and concretions comprise a very small proportion* (*<5%*) *of the overall sandstone aquifer*." These responses demonstrate that Sio Silica has never measured or properly quantified the amount of the waste produced during extraction. The conflicting values quoted ranging from a low as 0.1% to 5% shows Sio Silica has no idea of the volume and nature of the waste that will be produced. Please clarify the source of the data for the values given in the

quoted information on the quantity and nature of waste produced for extraction.

9. Please provide consistent information on the nature and quantity of wastes that would be produced during extraction including detailed documentation on the source of the information.

10. Oolite and the concretions have been identified as containing acid generating pyrite and marcasite.[1,2] Five (5)% of pyritic concretions and oolite would amount to 68,000 tonnes of acid generating waste per yearat full production of 1.36 million tonnes per year. In key issue # 11 Sio Silica states, "*Oolites are commonly composed of calcium carbonate and are not likely to negatively influence water quality*" In the brief supporting my motion for delay of hearings submitted to the CEC, I documented the following evidence contradicting the Sio Silica assertion that oolites would not affect water quality. "*Sio Silica gives no evidence to support that oolite and concretions found near Vivian are composed of calcium carbonate. There has been no quantification of the amount of oolite and concretions in the samples in the Sio Silica EAP Hydrogeological report. Watson writes in Economic Geography ER-84-2*[1] "*The next layer is 0.5 to 1 m in thickness and is composed of sand with numerous desiccation cracks and burrows. These structures are filled with either silty sand or pyrite oolites. Oolites are typical of the next 2 m layer. The pyrite oolites have been described by Genik (1952). The layer in which they occur consists of up to 75% pyrite with lesser amounts of sand and silty material. In some other areas the oolites are limonite.*" *Limonite is a form of iron oxide/hydroxides not calcium carbonate.*[3] *The oolite in the Winnipeg formation is up to 75% pyrite with silt, sand and limonite as the remainder - not calcium carbonate*." Please clarify how such a large amount of acid generating waste would be handled.

11. In response (l) Sio Silica states; "*As a point of clarification, a UV filtration system has never been* proposed *by Sio. A UV disinfection system is proposed to follow the filtration as a precaution. Other equipment listed in this question is based on speculation of the author as Sio has not finalized the filtration and UV system design.*" The filtration system has been established as a requirement for the operation of the UV system that is part of the design documented in the Extraction EAP. The equipment listed in my request for the UV filtration system is not based on speculation but on the report by Matt Kowalski, PhD, P.Eng., on the Process Wastewater Treatment Options, submitted by Sio Silica to the hearing on June 24, 2022. Please clarify why Sio Silica terms the process water equipment given in the report by Matt Kowalski, PhD, P.Eng, as speculation.

12. In response (l) Sio Silica states, "*Sio is confident that water can be effectively treated utilizing UV and filtration, and that reinjection of water into the aquifer will not cause any* significant *impacts to water quality.*" The basis for this statement cannot be established until the full information on

the UV filtration system is provided. The statement by Sio Silica that this component is "*outside the scope of this Environment Act Proposal and the CEC process,*" contradicts the submission of the report by Matt Kowalski, PhD, P.Eng, to the Hearing. Sio Silica has no plans to submit the final plans for this essential component to the Hearing. Please clarify what technical review process the UV filtration system will undergo once the final plans are completed after the regulatory review process.

13. Please clarify that the final plans for the UV filtration system will not undergo review by the Hearing.

14. Please clarify why a complete review of the UV filtration process is not essential for the Hearing.

15. Please clarify that if the detailed designs for all the processes detailed above will not be submitted until after completion of the regulatory process that these processes and designs will have no independent technical review. Please clarify how the Hearing can fulfil its mandate if detailed designs are not submitted until after completion of the regulatory process since the Panel would not be able review these detailed designs for essential processes.

16. Please clarify who responded to DLN IR 004, who will respond to the request for clarification, and their qualifications.

References:

1. Economic Geology Report ER84-2 Silica in Manitoba By D.M .Watson Manitoba Energy and Mines Geological Services Report, 1985 https://www.manitoba.ca/iem/info/libmin/ER84-2.pdf

2. Pyrite and Marcasite Coated Grains in the Ordovician Winnipeg Formation, Canada: an intertwined record of surface conditions, stratigraphic condensation, geochemical ''reworking,'' and microbial activity, Jurgen Schieber and Lee Riciputi, Journal of Sedimentary Research, 2005, v. 75, 907–920, https://www.semanticscholar.org/paper/Pyrite-and-Marcasite-Coated-Grains-in-the-Winnipeg-Schieber-Riciputi/c7260c14eefc435745019d169ed8f741ed4da6df

3. Wisconsin Natural History Geological and Natural History Survey, Limonite, https://wgnhs.wisc.edu/minerals/limonite/#:~:text=Description%3A%20Limonite%20is%20a%20general

Response:

1. Sio is not clear as to what the author is requesting.

2. As stated in Round 1 DLN-IR-007 (m) "*Fines from the waste system will be stored in enclosed tankage before they are taken away from the Project site. Fines are damp when they enter the containment. The fines are largely kaolinite clay material and are therefore a salable material to industries such as paper, porcelain, paint, cement filler, cosmetics, medical and*

others. Sio plans to sell these fines to markets as listed, otherwise they will be disposed of at a licensed landfill."

Management of the waste from the filtration process, would be similar to that of the waste at the facility. Sio is required to keep the fine waste material damp, and contained, which is what is being proposed for the filtration system. Sio would expect the same requirements.

3. Sand separation occurs all around the globe at sand facilities everyday with the same type of equipment that Sio is evaluating. Sio will be using industry accepted and proven methods for sand separation. This is not novel. As stated in the response to DLN-IF-007 (m) "*The fines are largely kaolinite clay material".* Sio has conducted sieve analysis of sampled material and therefore has an estimation of the expected % of waste. This was shared in Key Issue / Question # 190 in Sio's Responses, and in its responses to CEC-IR-008 (a) and Round 1 DLN-IR-005 (a): "*In addition, fines, which are estimated at about 1.9% of total extracted material,"*

4. Please refer to the responses to CEC-IR-014 data filed, DLN-IR-002 (5) and (24).

5. Sio would like to clarify as has been stated prior, that no air is injected directly into the aquifer. Air injection occurs in the extraction production pipe and because it's inside the pipe, it will be forced back to surface rather than out the end into the formation.

6. Please refer to the response to CEC-IR-014 for additional data that was filed. The summary of deficiencies presented above are an opinion of the author, which are not shared by Sio.

7. Please refer to the response to DLN-IR-003 (1) where this question was already responded to.

8. This statement "*Oolites and concretions comprise a very small proportion* (*<5%*) *of the overall sandstone aquifer"* does not refer to waste on surface, but the actual concentration estimate in place in the aquifer. This is not the same as the waste to surface.

   The overs and fines waste values are derived from sieve analysis from random samplings of material that came to surface. The waste data may vary as no well is 100% the same as another. Sio feels this is representative of the expected waste.

9. See response #8 above.

10. Please refer to the response to DLN-IR-002 (22). Sio disagrees with the volumetric estimates contained in this comment as it is inconsistent with field observations. The characterization and management of waste

products will be conducted in accordance with the Waste Characterization and Management Plan.

11. The author in Round 1 IRs assumed that Sio would be using drying beds, when in fact there is more then one type of method to process the fines and Sio is considering other options. Many assumptions were made in round 1 surrounding this, when Sio has never stated that drying beds would be used. It is included in the Process Wastewater Treatment Options, as one option being considered.

12. As previously stated in the response to Round 1 DLN-IR-004, at the time of submission of an EAP, applicants are not required to have completed their detailed engineering and design. Detailed engineering and design is typically completed during and after the regulatory review process, incorporating input from government agencies and other interested parties.

    Sio will ensure that its final design of the filtration system and UV system adhere to Sio's commitment that, "*The quality of the water returned to the aquifer following the sand extraction process will be similar to or better than the water removed from the aquifer during the extraction process*." This has been documented and committed to by Sio (Public Comment Response to issue #24). Sio will also adhere to any requirements in a licence. This is the basis for the design and if Sio stays within these constraints, there would be no reason for additional review.

    Additionally, samples have been provided of produced water to suppliers and testing was conducted to confirm the filtration and UV treatment are capable of successfully treating the produced water.

    As indicated in Table 1, Response #11 in Sio's 'Response to the Technical Advisory Committee (TAC) Review Comments', posted on the Public Registry on December 20, 2021:

    > *"Regarding technical specifications of the UV treatment system, a design dose of 25-30 mJ/cm² is typical for wastewater treatment systems designed to meet 200 MPN/100mL fecal coliform limit, but a higher dose may be required based on local water quality and UV lamp fouling estimates. At this preliminary stage, the final design criteria for the UV treatment system are being developed. The final system design may also include a system that provides a target of 3-log (99.9%) inactivation of both Giardia and Cryptosporidium in accordance with local drinking water standards, although this is a higher level of treatment than is typically used in other applications when returning treated water back to the environment. An upstream filtration system may be required."*

13. Detailed design and final plans are still being finalized and those details are not required to understand and assess the potential environmental effects

from the proposal. The design constraints have been previously provided and restated in #12 above.

14. Detailed design and final plans are still being finalized and those details are not required to understand and assess the potential environmental effects from the proposal. The design constraints have been previously provided and restated in #12 above.

15. Please refer to response #12 and 13 above.

16. Sio prepared all of the IR responses, with input and support from subject matter experts at AECOM and Stantec, as needed. There was no individual author responsible for any of the IR responses. Representatives from Sio, AECOM and Stantec will be available to answer questions about the IR responses at the hearing, and Sio will file a summary of qualifications for each of those witnesses in advance of the hearing.

IR Number: **DLN-IR-005**

Submitted by: DLN

Date Submitted: January 5, 2023

Subject Matter: Waste management information for exploration activities

Reference Documents:

a. 2.2.3 Sand Slurry Pre-Screening and Overs/Fines Temporary Stockpiling

b. 2.3 Waste Management.

c. 8.1 Waste Characterization and Management Plan

Background/ Preamble:

Request:

1. In response to DLN IR 005 (1), which Sio Silica has relabelled as (a), Sio Silica questions as to where the reference up to 5% of the sandstone aquifer being comprised of oolite and concretions comes from. In the clarification for DLN IR 004, for key issue #11 in the response to public comments for the Extraction Project Sio Silica states, "*Oolites and concretions comprise a very small proportion* (*<5%*) *of the overall sandstone aquifer*." Please clarify why Sio Silica is unaware of their response to key issue #11 in the responses to public comments.

2. Sio Silica states in response to DLN IR 005 (1) that, "*mine waste (overs) is estimated to range from 0.1% to 0.8% of the extracted material*" and "*in addition fines are estimated at about 1.9% of extract*ed material." Please clarify how the data on the quantity of overs (0.1% to 0.8%) and fines (1.9%) were obtained.

3. Please clarify that no actual testing and separation of fines and overs has been done in Sio Silica over at least five years of silica sand extraction testing.

4. Please clarify that no measurement of the amount of fines and overs extracted with the sand has been done by Sio Silica in over at least five years of advanced exploration activities.

5. Please clarify if the estimated amount of concretions and oolite of <5% is included in the estimation of overs from 0.1% to 0.8%.

6. If the oolite and concretions have been included in the estimation of overs please explain why the numbers of <5% and up to 0.8% for overs are so different.

7. It is clear from the Sio Silica response (b) that not even drill cutting waste volumes were measured during the testing phase of at least five years. Please clarify that since the estimates vary and no actual measurements have been done under production conditions, that the amount of waste that would be produced during production is extremely uncertain and essentially unknown.

8. Please clarify; given the uncertainty in the amount of waste, it can be determined that storage in covered tanks is feasible. For example 5% of the design target of 1.36 million tonnes is 68,000 tonnes. For a Project extraction time of 224 days per year as given in Appendix H, the amount of overs could be up to 303 tonnes per day. For the stated total of 1.9% fines plus 0.8% overs, the total amount per day of fines plus overs would be 163 tonnes. From DLN IR 007 about 37 tonnes of mostly silica fines from the UV filtration process be generated requiring onsite storage and disposal. Thus the total amount of waste would range from about 200 to 340 tonnes. Articulated trucks for sludge haulage waste trucks have a gross load of about 46 tonnes.[1] Articulated trucks could probably not be used in the field where extraction would occur. For a single non-articulated truck of 23 tonnes anywhere from about 9 to 15 trucks per day would be required for haulage.

9. Please clarify how such a large volume of tank storage and haulage would be managed for 9 to 15 tanks and waste haulage trucks per day.

10. Please clarify if waste truck haulage has been considered in the calculations of Project GHG.

11. Please revise the total Project GHG emissions to include waster truck haulage if necessary.

12. Please clarify if the emissions from this large volume of waste truck haulage would have a detrimental effect on Project air quality.

13. Please clarify why the emission of such pollutants as CO2, NO2, SO2 and benzene, from waste haulage trucks, has not been evaluated in terms of capture by the airlift compressor and subsequent injection into the aquifer.

14. Please clarify the exposure potential to workers to respirable silica dust during the movement and handing of waste from the UV filtration system to tank storage and final disposal. Please consider in this response; after the water has been removed from the UV filtration waste bya filter press or through sand drying beds, the waste containing mainly silica fines would be relatively dry.

15. Please clarify the air monitoring methods that would be used to determine the risk to exposure to respirable silica dust.

16. Please clarify the worker protection measures that would be enforced to prevent exposure to respirable silica dust from the UV filtration system.

17. From the response (c to f) to DLN IR 005 it is clear Sio Silica has not completed any geochemical characterization of the extracted waste overs, fines and drill cuttings in more than five years of testing involving over 44 wells many of which were used for sand extraction. It has been established in the geochemical testing of a small number of core samples, documented in the Hydrogeological Report that toxic quantities of selenium, acid and heavy metal could leach from these wastes. Please clarify how the potential for toxic leaching from the volume of waste calculated above would be measured and handled at the extraction site and for ultimate disposal. Please consider in this response the evidence given in the DLN IR's, the DLN motion brief and in the DLN submission for public comments, that the waste would contain harmful amounts of acid generating concretions, oolite, and interbedded shale, and selenium and other heavy metals.

18. Please clarify where and how this potentially hazardous waste would be disposed of. Give the name and location of a licensed disposal facility that could manage this waste.

19. Please clarify why Sio Silica has not measured the toxic potential of the waste from sand extraction in over five years of extraction considering that the handling and disposal of toxic waste would have major environmental impact and a major impact on the feasibility of this Project.

20. Sio Silica as stated in responses (d) and (e) refuses to give detailed information on the design of the waste separation equipment and waste characterization activities. Sio Silica claims detailed design specifications can be completed after the regulatory process. Such detailed information is required to evaluate the potential environmental impacts of the Project. Please clarify what independent technical oversight and evaluation the detailed plans and specifications that may be provided after the regulatory process and by whom? Please consider in the response that the Director and Minister of the Environment can approve minor alterations without TAC or public input. Please clarify if the future detailed plans and specifications would be submitted as a major Project Alteration complete with updates to the EAP and with responses to TAC and public comments. If so the external technical advisors for the CEC and the CEC Hearing would not be a party to

the review of such critical project information and therefore would not be able to fulfil its mandate.

21. Completion of detailed plans and specifications for waste disposal until after the regulatory process and the Hearing will result in no independent technical oversight and evaluation of waste disposal which is unacceptable. Please clarify why delaying the detailed plans and specifications for waste disposal until after completion of the regulatory process would not undermine the Hearing.

22. Please clarify that in order for the Hearing to fulfil its mandate that Sio Silica must provide these detailed plans and specifications to the Hearing.

23. Please clarify who responded to DLN IR 005, who will respond to the request for clarification, and their qualifications.

References:

1. CES Environnemental Services, Bulk Sludge Waste Haulage, https://www.cesenvironmental.ie/bulk- sludge-waste-haulage/

Response:

1. This statement "*Oolites and concretions comprise a very small proportion* (*<5%*) *of the overall sandstone aquifer"* does not refer to waste on surface, but the actual concentration estimate in place in the aquifer. This is not the same as the waste to surface, which was the subject of Round 1 DLN-IR-005(a).

2. As previously stated, the overs and fines waste values were derived from sieve analysis from random samplings of material that came to surface.

3. As previously stated, the overs and fines waste values were derived from sieve analysis from random samplings of material that came to surface.

4. As previously stated, the overs and fines waste values were derived from sieve analysis from random samplings of material that came to surface.

5. This statement "*Oolites and concretions comprise a very small proportion* (*<5%*) *of the overall sandstone aquifer"* does not refer to waste on surface, but the actual concentration estimate in place in the aquifer. This is not the same as the waste to surface, which was the subject of Round 1 DLN-IR-005(a). Waste to surface for overs is estimated to be from 0.1% to 0.8% as previously stated.

6. Please refer to the responses to #1 and #5 above and DLN-IR-004 (8).

7. No, Sio disagrees with this statement. As previously stated, the overs and fines waste values were derived from sieve analysis from random samplings of material that came to surface.

8. Sio disagrees with the assumptions made in this request. Waste volumes have been listed as 1.9% fines and 0.1 to 0.8% overs. These are maximum values. This would amount to a conservative estimate of approximately seven trucks of waste per day if utilizing the values from the author's question for tonnage per truck.

9. See the response to #8 above.

10. Waste truck hauling was not considered in the calculations for the Project GHG emissions as these emissions are considered to be a very minor to limited value and would not have any significant impact on GHGs.

11. If the waste hauling trucks are added to the GHG emissions calculations, based on the maximum percentages of fines and overs (resulting in seven truck loads per day) this would be a 3.4% increase in project emissions, or an additional 7.03 kt/year. This is not a material increase, particularly considering the project accounts for an estimate of only 0.0296% of annual emissions in Manitoba.

12. This is not a material increase, particularly considering this is an increase of seven trucks per day and the project accounts for an estimate of only 0.0296% of annual emissions in Manitoba.

13. Please refer to response #12 above.

14. As previously described in DLN-IR-004, and Round 1 DLN-IR-007 (m); *"Fines from the waste system will be stored in enclosed tankage before they are taken away from the Project site. Fines are damp when they enter the containment. The fines are largely kaolinite clay material and are therefore a salable material to industries such as paper, porcelain, paint, cement filler, cosmetics, medical and others. Sio plans to sell these fines to markets as listed, otherwise they will be disposed of at a licensed landfill."*

    "Management of the waste from the filtration process, would be similar to that of the waste at the facility. Sio is required to keep the fine waste material damp, and contained, which is what is being proposed for the filtration system. Sio would expect the same requirements. "

15. See the response to #14 above.

16. See the response to #14 above.

17. Please refer to the response to DLN-IR-002 (22). Sio disagrees with the statements made by the author regarding toxicity of selenium and the quantity of acid generating concretions, oolites and interbedded shale. However, Sio recognizes that there will be waste and that waste will be managed in a manner that is protective of human health and the environment. All the details pertaining to the handling, storage and removal of waste will be outlined in the draft Waste Characterization and Management Plan to be issued prior to the CEC hearing.

18. All the details pertaining to the handling, storage and removal of waste will be outlined in the draft Waste Characterization and Management Plan to be issued prior to the CEC hearing. All hazardous waste management will be conducted in compliance with applicable regulations, and Sio will employ the services of licensed contractors to dispose of hazardous wastes. Currently there are multiple licensed hazardous waste disposal contractors operating in Manitoba.

19. Sio disagrees with the statements made in this comment. The Hydrogeology and Geochemistry Assessment involved testing of waste materials and the results of laboratory testing and analysis of waste material were provided. The Waste Characterization and Management Plan will describe suitable methods for the handling, storage and disposal of waste in a manner that is protective of human health and the environment.

    In addition, water wells are drilled every day in the province of Manitoba where the limestone, shale and sandstone may be encountered. The drill cuttings are typically brought to surface using mud rotary or dual rotary drilling methods and deposited on surface without any special mitigation. With approximately 800 wells drilled per year for over 100 years in the province and the drill cuttings left on surface, a reasonably large quantity of subsurface waste has been deposited on surface without any reports of toxicity associated with the drill cuttings that Sio is aware of.

20. Sio will adhere to any outlined requirements in a licence and as has been previous stated, a Waste Characterization and Management Plan will be issued prior to the hearing and finalized after a licence issued. This plan, as with the other proposed follow up plans, will have to be approved by the EAB. This is the basis for the design and if Sio stays within these constraints, there would be no reason for additional review. Additionally, Sio notes that the province

regulates and monitors project activities and progress over its life cycle.

As also previously stated in Round 1 DLN-IR-004, at the time of submission of an EAP, applicants are not required to have completed their detailed engineering and design. Detailed engineering and design is typically completed during and after the regulatory review process, incorporating input from government agencies and other interested parties.

21. See the response to #20 above.

22. See the response to #20 above.

23. Sio prepared all of the IR responses, with input and support from subject matter experts at AECOM and Stantec, as needed. There was no individual author responsible for any of the IR responses. Representatives from Sio, AECOM and Stantec will be available to answer questions about the IR responses at the hearing, and Sio will file a summary of qualifications for each of those witnesses in advance of the hearing.

IR Number: **DLN-IR-006**

Submitted by: DLN

Date Submitted: January 5, 2023

Subject Matter: High Purity Sand

Reference Documents:

(a) Executive Summary

(a) 1.1 Project Overview

(b) 1.3 Company Profile

Background/ Preamble:

Request:

1. Please clarify and provide the location, date of sampling, well Id, extraction method, storage and transportation methods, and chain of custody records for the silica sand analysis results in Appendix A, Sample Silica Sand Lab Testing DLN – IR – 006(b). In the response please take into account that similar information has already been given in the Hydrogeological report for the samples that under went geochemical analysis. Similar information regarding geological samples is on the public record with the Manitoba Groundwater Section. Similar information for boreholes is released by the Mines Branch after two years. Core samples must be stored and records kept in accordance The Mines and Minerals Act, Drilling Regulation, 1992.[2] Thus the information in Appendix A is not proprietary and must be released.

2. Please clarify why geochemical results from the Appendix A sand samples were not reported in the EAP Hydrogeological Report.

3. In the Noble conference analysis results were provided for sand sample. Please clarify the location, date of sampling, well Id, extraction method, storage and transportation methods, and chain of custody records for the silica sand samples reported for the Noble conference in 2019 and any other sand samples taken and analyzed for the phase of the Project up to the Noble Conference in 2019.

4. Please clarify why the sand samples used for the Noble conference were not subject to the geochemical testing and analyses done for the EAP Hydrogeological Study.

5. Please complete all the geochemical tests done in the EAP Hydrogeological study for all the raw sand samples collected prior to the Noble conference

and for the analysis in Appendix A provided that these samples were collected and stored to prevent exposure to air and moisture.

6. The analytic results for the sand sample in Appendix A show far smaller impurity content than the results from the Noble conference given in Figure 1 of DLN IR 006. For instance in Figure 1 the Fe2O3 content varied from 0.24% (2400 ppm) to 0.34% (3400 ppm) while the Fe content in Appendix A results was a maximum of 109 ppm. These results imply that the sand sample for Appendix A had undergone significant purification before analysis. Please clarify the purification procedures on the samples in Appendix A before analysis.

7. Please clarify and provide documentation on how the laboratory sand purification procedures can be scaled up and used in production for high purity glass for such uses as solar panels.

8. Please clarify why the markets for high purity silica sand are confidential. Sio Silica should be able to provide the names of the companies that would be the customers for Sio Silica product without revealing any commercially sensitive information. To undertake a viable business Sio Silica would have necessarily determined the market for their product and the purity of the silica sand that they would be able to produce to meet these markets. Sio Silica can reveal information on the markets for their product and documentation on the purification methods and values without exposing commercially sensitive or proprietary data. Please provide the names of companies that would purchase the Sio Silica product and the products that these companies would sell.

9. Most high purity silica sources are from quartzite minerals that are crushed and powdered to form quartz sand.[1,3] Please distinguish the quartz sand sources from silica sand sources for high purity markets.

10. Please clarify and provide information on the purification (beneficiation) tests and procedures Sio Silica has performed in order to meet the demands of the high purity market.

11. The original market for the silica sand was for hydraulic fracturing as shown by the information presented by CanWhite now Sio Silica at the Noble Conference. Sio Silica has pivoted to new markets without providing any information that they can meet the needs of these markets especially in regard to the viability of novel purification (beneficiation) methods that would be required. Water soluble toxic chemicals and acid could be used in purification of silica sand. The clarifier would remove only suspended matter. Dissolved chemicals would accumulate in the wash plant and slurry loop as quantified in DLN IR 003. The toxic dissolved pollutants would be released to the surface environment in a malfunction or leakage from the slurry lines and wash plant system. Sio Silica has a responsibility quantify the risk of toxic release to the environment from the wash plant and slurry

line system. Please clarify and provide information on the purification procedures required and the chemicals used in the purification (beneficiation) process. The slurry lines are part of the extraction EAP thus Sio Silica must not dismiss this request as being not applicable.

12. If the purification procedures to be used by Sio Silica are industry standard please clarify and provide information on these standard silica sand purification procedures and the markets served. Such information would not be proprietary.

13. In response (j) Sio Silica has named two main suppliers of high purity Silica sand, US Silica and Covia and two main suppliers of quartz. The suppliers of quartz serve the high purity silica market. Both US Silica and Covia supply quartz sand obtained from crystalline quartz type rock deposits. Please clarify and identify the high purity silica sand sources of US. Silica and Covia and what markets these high purity silica sand sources supply distinguishing these silica sand sources from quartz sand obtained from crystalline rock deposits.[1]

14. Sio Silica has given no evidence that the silica sand from the Vivian area can be used for high purity applications that would be normally served by crystalline quartzite minerals not sand. Please provide evidence that the Vivian silica sand can be used for high purity markets such as such as silicon metal, silicon carbide, photovoltaic glass, medical glass, smart glass, semiconductors, coatings, and ceramics. Until Sio Silica provides such evidence their claim to serve the high purity silica market is merely speculation.

15. Please clarify who responded to DLN IR 006, who will respond to the request for clarification, and their qualifications.

References:

1. Quartz Sand VS Silica Sand, July 21, 2020, https://mineraldressing.com/blog/quartz-sand-vs-silica-sand/

2. The Mines and Minerals Act, Drilling Regulation, 1992, https://web2.gov.mb.ca/laws/regs/current/_pdf-regs.php?reg=63/92

3. Crystalline Silica Primer, Staff, Branch of Industrial Minerals, U.S. Department of the Interior Manuel Lujan, Jr., Secretary U.S. Bureau of Mines T S Ary, Director, https://www.silica-safe.org/know-the-hazard/body/1-Crystalline-Silica-Primer.pdf

Response:

1. Sio declines to respond to this request due to lack of relevancy. Purity of the sand and the lab results to demonstrate the purity is not relevant to the issues to be determined in the CEC process.

2. The sand samples provided in Round 1 Appendix A were collected on June 23, 2022. Therefore, they were collected well after the submission of the EAP and the Hydrogeological and Geochemistry Assessment filed in July 2021.

3. Sio declines to respond to this request due to lack of relevancy. Purity of the sand and the lab results to demonstrate the purity is not relevant to the issues to be determined in the CEC process.

4. The Hydrogeology and Geochemistry Assessment was initiated in 2020. Samples were collected by AECOM representatives in fall 2020 for use in the Hydrogeology and Geochemistry Assessment.

5. Sio declines to conduct this testing due to relevancy. Purity of the sand is not relevant to the issues to be determined in the CEC process.

6. Sand from Round 1 Appendix A was water washed and sieved only. Sand from the Noble conference cannot be directly compared to the Appendix A sand results as these are different lab testing methods. Regardless, Sio notes that purity of the sand is not relevant to the issues to be determined in the CEC process.

7. This is a facility process and/or laboratory testing question which is outside the scope of the current license application under review by the CEC.

8. This question pertains to commercial business terms with clients which are outside the scope of the current license review in front of the CEC.

9. Market data and product analysis are commercial business issues unrelated to the current license application in front of the CEC.

10. Sio declines to conduct this testing due to relevancy. Purity of the sand is not relevant to the issues to be determined in the CEC process.

11. Sio has never applied for or stated that any chemicals will be used for beneficiation. Sio applied for a simple wash plant, sizing and dry facility, which is what has been approved. No chemicals have been proposed. Therefore, the assumption that chemicals will be present due to beneficiation activities is not correct.

12. Washing sand with water is standard in the silica quartz industry and part of the approved facility which is not subject of the current CEC review.

13. The competitive market landscape for silica sand is outside the scope of the current license application under review by the CEC.

14. Although this question is outside of the scope of the current license application under review by the CEC, please find in **Appendix B** an excerpt from a third party verification that Sio's silica is Crystalline Quartz.

15. Sio prepared all of the IR responses, with input and support from subject matter experts at AECOM and Stantec, as needed. There was no individual author responsible for any of the IR responses. Representatives from Sio, AECOM and Stantec will be available to answer questions about the IR responses at the hearing, and Sio will file a summary of qualifications for each of those witnesses in advance of the hearing.

IR Number: **DLN-IR-007**

Submitted by: DLN

Date Submitted: January 5, 2023

Subject Matter: Process Water Treatment Options

Reference Documents:

(a) 2.1 Components and Activities

(b) Figure 2-4: UV Water Treatment

(c) Process Wastewater Treatment Options

(d) Technical Memorandum Sio Silica Corp. June 2022

Background/ Preamble: Sio Silica refuses to answer almost all the requests in DLN IR 007 on the grounds that;

"*As it has been noted in other IR responses, at the time of submission of an EAP, applicants are not required to have completed their detailed engineering and design. Detailed engineering and design is typically completed during and after the regulatory review process, incorporating input from government agencies and other interested parties. Sio is working with industry leading water and wastewater treatment specialists to determine appropriate equipment selection for management of process water waste material*."

Sio Silica will not provide the details or even the fundamental processes to be employed for UV filtration for the Hearing. UV filtration is a critical component of the Project. The Panel will not be able to fulfil its mandate without being able to assess the effectiveness and feasibility of the UV filtration system. Completion of the UV filtration process after the regulatory process will result in no independent technical oversight and evaluation of this critical process which is unacceptable.

Sio Silica states;

"*The volumes of water used in the author's calculations are also assumptions. As has been previously stated, in DLN-IR-003 (l) and the Hydrogeology and Geochemistry Assessment Report - Section 2.4 Groundwater use During Extraction, sand/water ratios fluctuate. The sand water ratios can be as high as 90% sand, 10% water.*"

In the request for clarification DLN IR 004 I documented that 90% sand cannot be achieved without drawing sand preferentially from the water for the assumed 25% porosity of the sandstone aquifer. The reduction of sand content from 70% to 20-30% with extraction time is given in section 2.4 of the Hydrogeological Report. Sio Silica gives no documentation for how these values were obtained and measured. Appendix H of the Hydrogeological report uses a reference value of 50% sand.

Therefore the use of 50% sand by DLN is not an assumption but a documented reference value provided by Sio Silica.

Sio Silica does not dispute the calculations of the impractically large size of the drying beds and the unfeasibility of returning water collected from a large deluge over the drying beds to the dewatering system. Instead Sio Silica states;

"Sio *is also exploring other options such as a filter press which have a far smaller footprint*."

This implies that Sio Silica has recognized and accepted that drying beds are impractical and cannot be used.

One disadvantage of filer presses is the chemicals that must be used to coagulate fine particle for the filter press to operate efficiently. [1,2] Ferric chloride is commonly used for chemical treatment of filter presses however ferric chloride cannot be used for drinking water sources due to its toxicity.[3] Polyelectrolyte such as polyacrylamide are also used for flocculants in filter presses[1] however the acrylamide monomer that appear as a manufacturing residual and from degradation is extremely toxic as documented in DLN IR 003. For this reason, the Process Wastewater Treatment Options, Technical Memorandum states, "*chemicals aiding in the treatment process used commonly for coagulation and flocculation of solids are not allowed*." The non toxic chitosan polymer recommended for use in the clarifier in the Wastewater Treatment Options, Technical Memorandum states is a polysaccharide composed of glucosamine monomers. Residual glucosamine from manufacturing or degradation is soluble and would be transferred into the aquifer as documented in DLN IR 007. The clarifier removes only suspended solids not dissolved. Dissolved components would be sent into the sandstone aquifer with the process wastewater. Glucosamine in the aerated re-injected water would promote the growth of microbes that could be harmful. Glucosamine itself is not toxic but could adversely affect the water quality.

Request:

1. Sio Silica has misunderstood the DLN IR 007 requests Sio Silica has relabelled as "dd, ee and ff." These requests do not refer to residual chitosan but the monomer glucosamine that makes up the polysaccharide chitosan. Chitosan may contain the water soluble glucosamine monomer as a manufacturing residual or through degradation of the polysaccharide during use.[4] The soluble glucosamine monomer would be re- injected along with the returned water into the sandstone aquifer. Biodegradation of chitosan may produce soluble degradation products other than glucosamine that would be transferred to the sandstone aquifer.[4] Please clarify and re-answer requests "dd, ee and ff." with respect to soluble glucosamine and soluble chitosan degradation products that would be transferred to the sandstone aquifer in there-injected water not chitosan itself.

2. Sio Silica has maintained that there will be no surface discharge of process waste water yet in response to request "kk" about the disposal of all the water in the dewatering tanks and filtration vessels at Project year end states that vacuum trucks will be used to dispose of this process wastewater. It is clear from figure 1 in request for clarification IR 002 that there will be a large volume of process wastewater in the dewatering and water collection tanks and slurry lines used in sand extraction and transport. Similarly clarifiers and hydrocyclones and other UV filtration vessels would contain large amounts of process waste water as shown in the figures of the Wastewater Treatment Options Technical Memorandum. Please clarify how much wastewater will be in all the dewatering tanks, UV filtration vessels including clarifier tanks, and slurry lines that will be disposed of at Project year end using vacuum trucks.

3. Please clarify where the vacuum trucks will dispose of all the process wastewater at Project year end.

4. Please clarify why disposing of all the process wastewater at year end with vacuum trucks does not contradict the policy of Sio Silica to avoid discharge of process waste water to the surface environment. This policy is reinforced in Wastewater Treatment Options Technical Memorandum statements; "*All surface water collected by the drain system beneath the sand stockpiles is to be combined with the process wastewater stream and recycled within the Facility*," and, *"It is expected that the drainage from the drying beds would need to be collected and returned to the treatment train."*

5. To enforce the policy of no surface discharge of process wastewater would not all vessels and slurry lines containing the process wastewater be passed through the UV sterilization process and re-injected into the sandstone aquifer? Please clarify.

6. It could be the process wastewater from the vacuum trucks is to be sent into the sandstone aquifer. If so, please clarify how this would be done. Please clarify if the process waste water in the vacuum trucks would pass through the UV filtration and sterilization process before being routed into the sandstone aquifer.

7. If the year end process wastewater is to be sterilized and re-injected in accordance with Sio Silica's policy of no discharge to the surface environment, how could the re-injection occur without pressurization? Gravity-fed injection by airlift that is claimed not to create pressure cannot be usedat Project year end since airlifting extracts water that itself must be re-injected. Please clarify.

8. Please clarify why the chemicals required for treatment of sludge for the proposed filter presses to be used instead of sand drying beds does would not compromise the aquifer drinking water. Please take into consideration

that the monomers constituents of flocculent polymers are water soluble. Manufacturing residuals of the soluble monomers would be expected to be present in the polymer feed. Take into account, soluble degradation products of polymers and soluble monomers would enter the sandstone aquifer through wastewater re-injection.

9. Please clarify why the required use of chemicals in the proposed filter presses[1,2] that are to be used instead of sand drying beds does not contradict the stated requirement of the Wastewater Treatment Options Technical Memorandum, "*chemicals aiding in the treatment process used commonly for coagulation and flocculation of solids are not allowed*."

10. Were not sand drying beds specified in the Wastewater Treatment Options Technical Memorandum to avoid the chemicals that would be used in a filter press? Accordingly are not the sand drying beds a necessity that cannot be replaced with filter presses? Please clarify.

11. Please clarify the amount of GHG that would be emitted in the operation of all the UV filtration equipment such as clarifiers, hydrocyclones and drying bed equipment or filter presses. Please revise the GHG estimates if necessary.

12. Completion of the UV filtration process after the regulatory process and the Hearing will result in no independent technical oversight and evaluation of this critical process which is unacceptable. Please clarify why delaying the detailed specifications of the UV filtration system until after completion of the regulatory process would not undermine the Hearing.

13. Please clarify that in order for the Hearing to fulfil its mandate that Sio Silica must provide detailed plans and specifications of the UV filtration system to the Hearing.

14. Sio Silica has refused to answer request (pp) as to measurement of pollutants in the water from the UV system to be returned to the aquifer. There are many Manitoba regulations governing the quality of water to be discharged in aquifers used for drinking water such as; The Public Health Act Protection of Water Sources Regulation5 which states; *"2(2) No person shall commit any act that will or may contaminate any underground water supply by the discharge of any sewage, surface drainage, liquid waste, or filth into any well, abandoned well, hole, or other opening, and no person shall fill or replenish any existing well, except with water from an approved source satisfactory to the medical officer of health"* The Environment Act (C.C.S.M. c. E125) Water and Wastewater Facility Operators Regulation requires classification of a water and wastewater facility, record keeping and laboratory analysis of the wastewater.[6] Sio Silica may state that they will follow any measures required as part of their licence. However in the well injection permit for Bru 92-8 for the process wastewater that was re-injected into the aquifer required only; "*The use of the injection well must*

cease immediately if any local water supplies are negatively impacted as the result of the use of the injection well." No measurement of pollutants in the re-injected water was required to determine negative impacts. This demonstrates that the licence may not require measurement of the wastewater. For example the licence for the Sio Silica Processing Facility does not require measurement of the Facility process water that is to be stored over winter in a tank except upon request of the Director. Please clarify what measurement of re-injected process wastewater quality and pollutant content Sio Silica will undertake in field tests prior to production and during production.

15. Please clarify how Sio Silica will conform to the Environment Act (C.C.S.M. c. E125) Water and Wastewater Facility Operators Regulation regarding the treatment and disposition of process wastewater.

16. Gaseous entrained air in the re-injected water, that has been established in DLN motion brief and the DLN IR's as certain to occur, must be considered as a pollutant. The potential detrimental effects of gaseous entrained air have been documented in the DLN motion brief, DLN IR requests and requests for clarification. Entrained air was not considered in the Extraction EAP thus the Approvals Branch is unlikely to have requirements for the entrained air content of the re-injected process wastewater in a licence. Please clarify what measurements Sio Silica will make of the entrained air content of re-injected process wastewater during production.[7]

17. Please clarify the measures Sio Silica will take to removes gaseous entrained air from re-injected process wastewater during production..

18. Please clarify who responded to DLN IR 007, who will respond to the request for clarification, and their qualifications.

References:

1. Sludge dewatering with different coagulants, University of Groningen, Marte Sveistrup, July2, 2013, https://fse.studenttheses.ub.rug.nl/11040/1/BA_Marte_Sveistrup_final_versi_1.pdf

2. Sludge Press Conditioning, Universal Filtration and Pumping, http://automaticfilterpress.com/sludge-conditioning/3

3. Emergency do not consume/do not use concentrations for ferric chloride in drinking water, Hum Exp Toxicol, https://pubmed.ncbi.nlm.nih.gov/?term=%22Hum+Exp+Toxicol%22%5Bjour%5D&sort=date&sort_ord 2013 Mar;32(3):260-74, C. C. Willhite, G. L. Ball, V. S. Bhat, https://pubmed.ncbi.nlm.nih.gov/23111879/

4. The Use of Chitosan and Starch-Based Flocculants for Filter Backwash Water Treatment, Materials (Basel) 2022 Feb; 15(3): 1056, Piotr Maćczak et al., https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8838026/

5. The Public Health Act, Protection of Water Sources Regulation, August 29, 1988, https://web2.gov.mb.ca/laws/regs/current/_pdf-regs.php?reg=326/88r

6. The Environment Act (C.C.S.M. c. E125) Water and Wastewater Facility Operators Regulation, April 22, 2003, https://web2.gov.mb.ca/laws/regs/current/_pdf-regs.php?reg=77/2003

7. Measurement of volume fraction of air in water: experimental Study, J Dilip Singh and G Senthilkumar 2021 IOP Conf. Ser.: Mater. Sci. Eng. 1197 012031, https://iopscience.iop.org/article/10.1088/1757-899X/1197/1/012031/pdf

Response:

1. Since chitosan as a natural polymer it is not going through a synthetic polymerization process and there would be a very slim chance of having any unreacted monomer in the structure of the polymer.

   In addition, the process of converting chiton (as a raw material) to chitosan included several stages of washing the polymer to demineralize, deproteinization, deodorize and purify the polymer before generating a chitosan solution (Dotto, 2017). Those stages were designed to eliminate any potential minerals and monomers from the chitosan and modified the quality of the final solution. Therefore, it is a commonly accepted fact that there is no concerning concentration of the glucosamine monomer in the chitosan from the manufacturing process.

   In reference to the author's referenced material "The Use of Chitosan and Starch-Based Flocculants for Filter Backwash Water Treatment", it is important to mention "*Chitosan may contain the water-soluble glucosamine monomer as a manufacturing residual or through degradation of the polysaccharide during use*.[4]". The Discussion and Conclusions sections of the paper did not mention any concern about the potential impact of the residual monomers on the environment. It is not clear what the author of the request is referring to as evidence of his claim.

   Sio also notes that the chitosan derivative in the author's referenced paper was produced by using a harsh chemical such as sodium periodate at 40 ^{O}C. Since one of the main functions of the periodate is opening saccharide rings which could cause depolymerization and monomer formation, any reference to monomer in this paper might be the result of this process. The

used chitosan in the Sio Silica process is not going through this type of harsh chemical process; therefore, we believe depolymerization will not be a concern.

The other potential way of generating monomers in the chitosan solution is by completing the enzymic decomposition of the chitosan. Based on conducted research, the optimum temperature for chitosan decomposition is 51.4 °C and the optimum pH is 4.8 (Aguila-Almanza, 2019). These conditions are very different than the designed water treatment operation at the Sio Silica site.

Further, the main requirements of the reaction noted in the request are the existence of the enzyme and the chitosan as the raw materials. At this point, due to the absence of the required enzymes and extremely low concentration of the chitosan (less than 0.2 ml of 1% chitosan solution per litre of untreated water which mostly will be removed by filtration process), Sio does not believe enzymic decomposition will occur.

According to the chitosan supplier, "*The starting polymer chains are monomer free to begin, and if there is any chain cleavage, which can happen during the reactions, if there are any monomers, they would end up being rinsed away during the rinsing steps. Thus I have no evidence over the years of monomers being present in the final products. This does not mean it is impossible, but evidence suggests that it is negligible if present at all.*"

2. Where possible, water will be moved to a holding tank for the winter months to reduce the volume of water taken to a treatment facility. However, some fluid from the slurry line and very bottom of the tanks that cannot be pumped by a small pump to a holding tank will need to be cleaned out with a vacuum truck.

3. All the details pertaining to the handling, storage and removal of waste will be outlined in the draft Waste Characterization and Management Plan and the Water Management Plan to be issued prior to the CEC hearing.

4. This is about the definition of the term "surface discharge". Sio has never said it would not remove water in vacuum trucks if necessary, where it would be disposed of at a licensed waste treatment facility. Sio maintains that it will not discharge wastewater on the surface of the project site.

5. Please refer to response #4 above and DLN-IR-002 (13). Sio will not re-inject water after extraction has ceased and there will remain a small volume of water to run the system that cannot be returned to the aquifer.

6. No water from the vacuum trucks will be re-injected to the aquifer.

7. The year end process wastewater will not be re-injected to the aquifer.

8. Sio has not finalized if it will use a filter press or not. Sio is exploring the use of filter presses without any additives.

9. Sio has not said that any chemicals will be used in the filter presses that are being considered. The quoted wording from the Wastewater Treatment Options Technical Memorandum is: "*chemicals aiding in the treatment process used commonly for coagulation and flocculation of solids are not allowed*." This wording is Sio's own constraint imposed, not a constraint imposed by the province at this time.

10. Sio has not finalized if it will use a filter press or not. Sio is exploring the use of filter presses without any additives.

11. The UV system and filter press systems that Sio is evaluating are electric. In the short term they would require the use of a generator and rigs, but Sio is seeking to convert the majority of all the field equipment to electric within the first several years of operations.

12. Please refer to the response to DLN-IR-004 (12).

13. Please refer to the response to DLN-IR-004 (12).

14. Sio has committed to the following: "*The quality of the water returned to the aquifer following the sand extraction process will be similar to or better than the water removed from the aquifer during the extraction process*." This has been documented and committed to by Sio in Public Comment Response to issue #24. Sio will also adhere to any requirements in a licence. This is the basis for the design and when combined with ongoing monitoring of both the returned water from the system and the water quality in the surrounding monitoring wells, Sio will be able to verify that no contamination occurs.

15. Refer to the response to #14 above.

16. As outlined in Sio's Hydrogeology and Geochemistry Assessment, *"The activities associated with project operations and post-closure phases of the project were determined to have only a minor impact on groundwater quality, and in many cases the impact was simulated to be positive due to reduction of concentrations of iron and manganese when oxygen is introduced into the aquifer or is allowed to mix with water containing lower concentrations of those elements."*

    Please also see the response to #14 above.

17. Please see the responses to #14 and 16 above.

18. Sio prepared all of the IR responses, with input and support from subject matter experts at AECOM and Stantec, as needed. There was no individual author responsible for any of the IR responses. Representatives from Sio, AECOM and Stantec will be available to answer questions about the IR responses at the hearing, and Sio will file a summary of qualifications for each of those witnesses in advance of the hearing.

References:

1. Aguila-Almanza, E. (2019). Enzymatic Depolymerization of Chitosan for the Preparation of Functional Membranes. Hindawi Journal of Chemistry, 1-9.

2. Dotto, G. L. (2017). Chitosan Based Materials and its Applications (Vol. 3). Bentham Science Publishers.

IR Number: **DLN-IR-008**

Submitted by: DLN

Date Submitted: January 5, 2023

Subject Matter: Extraction Well Cluster Design, Limestone and Sand Pillar Stability

Reference Documents: (b) 2.2 Silica Sand Extraction Process

a. 2.2.2 Layout of Sand Extraction Sites

b. SIO SILICA SUPPLEMENTAL INFORMATION

c. Document #1 – Silica Extraction Method June 2, 2022

d. Technical Review Sio Silica Corporation's Environment Act Project

e. Proposal, H. M. Hollander and A. D. Woodbury, Sept. 19, 2022

Background/ Preamble:

Request:

1. Sio Silica does not answer the request (1) in DLN IR 008 relabelled as request (a). Request (1) is;"*Revise the well extraction location and schedule to conform to the information from Manitoba well reports that limestone thicknesses east of highway 302 are less than the minimum allowable thickness of 15 meters determined by Stantec*." Sio Silica refers to the filing prior to the Hearing of new extraction plans with Geotechnical design recommendations and parameters. Filing of new extraction plans will have no bearing on the Stantec requirement of 15 m of competent limestone for sand extraction. The Manitoba groundwater well information reports and the well logs documented in the Hydrogeological report demonstrate the competent limestone thickness in the area east of Highway 302 is less than 15 meters. Therefore sand extraction east of highway 302 as shown in the plans in the Extraction EAP cannot occur. Please clarify if Sio Silica will revise its production plans to extract sand only west of Highway 302 in accordance with Stantec requirements and the documented Sio Silica well logs.

2. Sio Silica has repeatedly avoided responding to documented information that the competent limestone thickness east of Highway 302 is less than the Stantec extraction limit of 15 meters. This information was documented in my public comments for the extraction EAP, repeated in the brief to support the DLN motion and repeated once more in DLN IR 008. Please clarify why Sio Silica has not and will not respond directly to this information.

3. Please clarify and confirm that extraction cannot occur east of Highway 302.

4. Please clarify how the Stantec condition of no extraction for competent limestone thickness less than 15 meters, that necessarily excludes extraction east of highway 302, affects the production plans and layout.

5. Sio Silica gives a self contradictory response to DLN IR 008 request (b) which illustrates that Sio Silica does not understand the background information pertaining to the request 008. Sio Silica states that they disagree with the factual statements and with the premise of the question. Sio Silica further states; "*Sio Silica will be adhering to this design and these parameters as set out in Table 9 by Stantec.*" The premise and factual statements for the analysis of allowable long-term cavity spans are based on the design parameters of Table 9 by Stantec. The background information in DLN IR 008 states; "*The cavity span calculated by equation 1 is compared in figure 2 to the Stantec maximum allowable cavity span from **Table 9** in Attachment A of the Sio Silica Responses to Public comments in Project Registry 6119.00*." In fact Sio Silica is confirming that the analysis based on Stantec Table 9 given in the background to DLN IR 008 is relevant and must be adhered to. Table 9 gives long-term allowable cavity spans as determined by Stantec for various limestone thicknesses ranging from 10 to 25 meters and overburden thickness (glacial till) of 25 and 35 meters. The allowable cavity spans in Table 9 for this range of overburden and limestone thickness range from 26 to 50 meters. There are no allowed spans in Table 9 up to the Sio Silica production design of 60 meters. From the well information reports obtained from Manitoba groundwater over the entire 24 year Project area the limestone and overburden thicknesses are almost all within the range of those given in Table 9. Thus even at first glance the Sio Silica production cavity span design of 60 meters is not viable over the Project area. Figure 2 of DLN IR 008 using the data from Table 9 shows that as the limestone thickness increases for a fixed overburden thickness, the allowed cavity span increases in a linear fashion. The two straight lines in figure 2 are parallel demonstrating that as the overburden thickness decreases the allowed cavity span increases linearly. The linear equation (1) is fitted to the data from Stantec Table 9. The linear equation predicts the allowed long-term cavity span from any overburden thickness and limestone thickness within the range of data given in the Stantec analysis and somewhat beyond based on extrapolation. Based on equation (1) and the paired limestone thickness and overburden thickness taken from forty-four Sio Silica well information reports, the histogram of DLN IR 008 figure 3 shows, except for two well locations, all the long-term cavity spans over the entire 24 year project are less than the 60 meter production design thickness. It must be emphasized that the histogram of figure 3 is based on the data from Stantec table 9 thus according to Sio Silica the results of figure 3 must be adhered to. I thank Sio Silica for confirming that the results in the background of DLN IR 008 must be adhered to even though Sio Silica has misunderstood the analysis. Please clarify that, considering equation (1) and figure 2 and 3 of the factual

statements and analysis of DLN IR 008 are derived directly from the data in Stantec Table 9.

6. Please clarify what factual statements in DLN IR 008 and what premise does Sio Silica disagree with?

7. The analysis of DLN IR 008 is a simple linear fitting of the data in Stantec Table 9 that is commonly done in scientific and engineering analysis. It is difficult to understand how this common simple linear fitting to data from Stantec Table 9 could be disagreed with and why. Figure 2 of DLN IR 008 definitely illustrates the *"*goodness of fit*"* of the data from Stantec Table 9 to straight lines from equation (1). Please clarify the Sio Silica refusal to accept the analysis pertaining to figure 2.

8. Please clarify who responded to request (b) or (2) as originally labelled, of DLN IR 008 and their qualifications.

9. Please have an independent expert skilled and experienced in linear interpolation of data review the factual statements and analysis in the background of DLN IR 008. I request the Panel undertake a similar review of the anlysis. If any deficiencies are found I would be pleased to revise the information. Please note that the data in Table 9 for limestone thickness less than 15 meters was not used in the linear interpolation equation (1) because of the Stantec condition; "*Limit extraction to areas with competent limestone thicker than 15 m.*" The Stantec condition for minimum allowed limestone thickness is specified in Attachment A of the Sio Silica Responses to Public comments in Project Registry 6119.00.

10. Please clarify why the Sio Silica Supplemental Information on the Silica Extraction Method submitted to the CEC on June 2, 2022 specifies a cavity span of 60 meters, when the data from Stantec table 9 posted on the Project Registry 6119.00 on Jan. 25, 2022 establishes, for the limestone and overburden thicknesses found throughout the Project area, the long-term allowed cavity span varies from 24 to 50 meters. The data in Stantec Table 9 submitted 4 months before clearly invalidates the well cluster design of the Supplemental Information Document #1. The submission to the CEC of an invalid cluster design clearly undermines the credibility of all information submitted by Sio Silica.

11. Sio Silica does not acknowledge that the two dimensional geotechnical model "FLAC" used in the Stantec analysis cannot be used to determine sand pillar stability and that a three dimensional stability model is required. Please clarify why Sio Silica will not acknowledge that a three dimensional model is required to determine sand pillar stability.

12. Sio Silica disregards the references in DLN IR 008 to missing required data for sand pillar stability such as modified angle of internal friction and cohesion for the silica sand.[1,2] Please clarify what sand stability data has been measured,

what are the data values and what data will be measured for the production phase.

13. Please clarify how sand pillar stability will be determined in the new geotechnical analysis to be filed to the Approvals Branch and the CEC and how required data on slope stability will be gathered

14. In response (e) Sio Silica states that there is no requirement for the cluster design to be universal across all areas. Please clarify how the cluster design will be determined for each new extraction site consistent with the Stantec data of Table 9 that Sio Silica will be adhering to.

15. I would suggest that equation (1) of DLN IR 008 derived from the DATA in Stantec Table 9 can be used by Sio Silica to determine long-term allowable cavity span at each new extraction site. The well cluster spacing cannot be determined from the data in Table 9. Please clarify how the well cluster spacing consistent with sand pillar stability would be determined for each new extraction area.

16. The Arcadis technical report stated that the cavity shape one of the two extractions reviewed for wells Bru 92-8 and 92-2 was not uniform in shape (Bru 92-8). A non uniform cluster cavity would diminish and destabilize the sand pillar between extraction clusters. Please clarify in the new extraction plans how a non uniform cavity shape would be taken into account in well cluster spacing considering that such non uniform shapes cannot be predicted in advance of extraction.

17. The data from Table 9 and the analysis in DLN IR 008 clearly demonstrates that the 60 meter cavity span production design is too large. Allowable spans of 30 – 50 meters would be required. Likely larger cluster spacing than in the production design would be required based on the documentation of non uniform cavity shape, the lack of proper three dimensional analyses for sand pillar stability, and the lack of measured required data for sand slope stability such as modified angle of internal friction and cohesion.[1,2] Smaller cluster spans and large cluster spacing would result in a significantly larger yearly Project footprint. Please clarify how a larger Project footprint would impact the economics and feasibility of the Project.

18. Please clarify how Silica will determine the new Project footprint in the new extraction plan submission.

19. Please clarify who responded to all of the requests in DLN IR 008, who will respond to the request for clarification, and their qualifications.

References:

1. Groundwater, R.A. Freeze and J. A, Cherry, Prentice Hall Inc. Englewood Cliffs New Jersey, 1979 Aquifer Capability and Groundwater

2. Introduction to Rock Mechanics, Second Edition, R.E. Goodman, John Wiley and Sons, 1989

Response:

1. A revised Extraction Plan was submitted to the CEC on January 24th 2023 with the IR responses. Sio will be available during the hearing to respond to questions pertaining to the revised plan which adheres to the geotechnical parameters recommended by Stantec.

   It is important to note that this revised Extraction Plan is a reduction in the number of wells overall.

2. Sio does not agree with the comments made by the author. Sio's new extraction plan follows the Stantec geotechnical recommendations and model. Extraction is to be carried out to follow extraction limits. The geotechnical and geological models were based upon publicly available data and Sio's borehole logs.

3. Sio does not agree with the comments made by the author. Sio's new extraction plan follows the Stantec geotechnical recommendations and model. Extraction is to be carried out to follow extraction limits. The geotechnical and geological models were based upon publicly available data and Sio's borehole logs

4. Please refer to the new Extraction Plan document filed on January 24th, 2023.

5. The 60 m span is no longer utilized, as the spans are dictated in Table 9 of the Geotechnical Assessment (Stantec 2022).

6. See the response to #3 and #5 above.

7. See the response to #3 and #5 above.

8. This request is irrelevant to the application before the CEC as the Round 1 question (b) requests a new well extraction design, which has been provided.

9. Sio will follow the guidance of Stantec as they are qualified to assess and direct on this issue.

10. Sio has since issued a new Extraction Plan and no longer uses the 60 meter span value. This is now irrelevant as Sio has repeatedly acknowledged it would be implementing Table 9's requirements.

11. The two-dimensional FLAC analysis used the axisymmetric geometry model option which considers the 3D geometry of the spherical sand cavity. This approach effectively characterizes sand pillar stability.

12. The sandstone parameters used in the FLAC model were back calculated from side scan sonar data and with consideration of the range of strengths for similar materials.

13. Sand pillar stability was identified using FLAC modelling. Required data for modelling and any future geotechnical analysis is gathered from results of borehole drilling – rock core logging and photography, point load and laboratory testing, downhole acoustic and optical televiewer and side scan sonar survey and instrumentation monitoring.

14. Please refer to the new Extraction Plan which identifies the number of wells per cluster. This number is determined based on the allowable span of the overall cavern, and tonnage per well. Number of wells per cluster vary from 1 to 5 wells.

15. Sio did not request the author to generate any form of equation. Sio will follow the guidance of Stantec as they are qualified to assess and direct on this issue.

    Please refer to the new Extraction Plan which identifies the number of wells per cluster. This number is determined based on the allowable span of the overall cavern, and tonnage per well. Wells per cluster vary from 1 to 5 wells.

16. Sio will follow extraction plan limits. During full scale testing, Sio will confirm the range of cavity shapes and will design well locations and spacing for the confirmed range.

17. Economics are outside the scope of the application before the CEC. Please refer to the new Extraction Plan.

18. Please refer to the new Extraction Plan filed on January 24th, 2023.

19. Sio prepared all of the IR responses, with input and support from subject matter experts at AECOM and Stantec, as needed. There was no individual author responsible for any of the IR responses. Representatives from Sio, AECOM and Stantec will be available to answer questions about the IR responses at the hearing, and Sio will file a summary of qualifications for each of those witnesses in advance of the hearing.

IR Number: **DLN-IR-009**

Submitted by: DLN

Date Submitted: January 5, 2023

Subject Matter: Extraction Well Cluster Design and Sealing

Reference Documents:

a. 2.2 Silica Sand Extraction Process

b. 8.3 Progressive Well Abandonment Plan

c. SIO SILICA SUPPLEMENTAL INFORMATION

d. Document #1 – Silica Extraction Method June 2, 2022

e. Arcadis Technical Review Sio Silica Corporation's Environment Act

f. Project Proposal Results Reported page A-4 13 Sept. 2022

Background/ Preamble:

Request:

1. Sio Silica in the response to the request "a" as to why Bru 92-2 and 92-3 are different than the production design, stated; "*Sio has tested several different well designs and Bru 92-2 and Bru 92-3 are virtually the same as what is proposed in the supplementary filing – Silica Extraction Method. Figure 2-2 in the filing shows virtually the same design as what was constructed for Bru 92-2 and 92-3. It is not clear what the author understands to be different from the proposed design other than steel casing was used in the Bru 92-2 and Bru 92-3 wells due to* availability *at the time, whereas PVC casing is proposed. Both steel casing and PVC casing are regularly used in water wells every day all around the world.* The difference between Bru 92-2 and 92-3 and the production design is that Bru 92-2 and Bru 92-3 have no production casing. Bru 92-2 has only an open hole penetrating into the sandstone. Bru 92-3 has a stuck liner that does not reach to the surface. The liner does not reach far into the sandstone so that the air tube to access deeper sand was likely inserted into the open-hole portion of the sandstone. In Bru 92-2 the air injection tube would have been fully in the open hole. Large amounts of injected air from air lifting would enter directly into the sandstone through the open hole in the sandstone rather than being confined to the production casing. Bubbles of air injected into the sandstone would move upwards. Stantec reported that the shale aquitard is not supportive. The shale aquitard would be expected to collapse into the extraction cavity created by the Sio Silica removal of sand. Air bubbles would then enter the carbonate aquifer

and travel rapidly through the fractures that carry water to domestic wells. The air bubbles would not enter the glacial till layer because of the strong capillary forces (entry pressure) in this fine grained medium. There is much literature to corroborate that air or gas bubbles cannot enter relatively impermeable media and will follow the least resistive pathway. For example I have published a peer reviewed paper pertaining to the escape of CO2 through well bores for CO2 sequestration that refers to this property.[1] The air bubbles would take the path of least resistance through the larger water bearing fractures in the limestone. As the air dissolves in the fractures it would precipitate iron and manganese due to the oxidizing conditions discolouring carbonate well water as documented in the public comments by Dr. E. Pip for the Extraction EAP. The discolouration of water in this fashion has been corroborated in the public comments for the Sio Silica Processing Facility Project where one resident near the Centre Line Road extraction site reported brown water in their well during Sio Silica extraction operations. Several residents of Vivian filed a Report of Suspected Violation of Manitoba Groundwater and Water Well Act by the Operation of CanWhite Wells to the Manitoba Agriculture and Resource Development Water Branch on Feb. 5, 2021, reporting discoloured water and increased iron staining in the their well water during Sio Silica extractions operations near Vivian. The complaint was dismissed without investigation. The formation of iron bacteria would be fostered that would foul the wells as documented in the public comments by Dr. E. Pip in the Extraction EAP. Based on this information I request clarification for the evidence that the injected air in Bru 92-2 and any other extraction well such as Bru 92-8 that has no production tube to confine the injected air would not spread into the aquifer through the open hole in the sandstone and rise an spread into the carbonate through a collapsed shale layer causing the precipitation of manganese and iron and proliferation of well fouling iron bacteria. No doubt Sio Silica will simply reject the scenario described here. Sio Silica, the CEC Panel, and the regulators must understand that simple denials without evidence in the face of well documented evidence to support scenarios, is not acceptable. Sio Silica has consistently ignored the references and information used to establish the evidence presented in the information requests and elsewhere.

2. Sio silica sated in response to question "b" if the design for 92-2 and Bru 923 will be used for production; *Yes. This is the intended design at this time.*" Please clarify if this means the design of the design of Bru 92-2 with an open hole into the sandstone with no production casing is the intended production design.

3. Please clarify the response to information request, "n" about the stuck liner in Bru 95-3 illustrating that a moveable production casing would also get stuck and thus the production design of Sio Silica is not feasible. Sio Silica states in response; "*This was an isolated occurrence where the production pipe became stuck and was unable to be retrieved. Sio has since*

refined the design of both the surface parameters/forces applied to the production pipe and the production pipe design itself to address this issue." Please describe in detail how the production pipe and production design was refined including illustrations with updated dimensions. Please describe in detail how the forces applied to the production pipe will be refined. Please give data on how this new design and force application was implemented and tested including the names of the well where the new design was applied and the dates of implementation and testing. If no testing has been done would please explain what evidence there is that this problem would not persist during production.

4. The production pipe (liner) for Bru 92-3 according to the well information report is steel. Sio Silica has stated that the production liners will be PVC. Please clarify how a new design and new forces applied to a steel liner would be applicable to the PVC production tube. Only Bru 92-8 has a PVC insert. Bru 92-2 and 92-3 have steel well tubes. Please clarify where the methods to remove PVC production tubes have been developed and tested.

5. Sio Silica has stated in response to information request, "n" that the occurrence of the production pipe getting stuck in Bru 92-3 was an isolated instance. Please clarify this response by giving detailed information on production pipes that have been successfully removed including the names and locations of the wells and the dates of installation and removal of the production pipes.

6. Sio Silica in response to information request "n" Sio Silica refers to the liner from 165 to 225 feet below surface in the sandstone of Figure 1b as a production pipe. Please clarify that the liner in Bru 92-3 was used as a production pipe during sand extraction.

7. A production pipe would extend all the way to the surface whereas the liner show in figure 1b begins at 165 feet below surface. Please clarify if the top portion of the production tube was removed after sand extraction leaving only the liner or bottom portion of the production pipe showing in the well information report of Figure 1b. If the top portion of the production pipe was removed, please clarify how long was the removed portion? Please clarify why the bottom portion of the production pipe does not extend to the bottom of the open hole.

8. The patent for the Sio Silica design states that the air tube is moveable and can be extended below the production tube to loosen sand using bursts of higher pressure. Please clarify if the air tube during sand extraction was lowered below the bottom of the production tube in Bru 9-3 in order to loosen and extract sand below the level of the liner shown in figure 1b terminating at 225 feet below surface.

9. Sio Silica did not answer the request for information "p". Figure 1 b clearly shows the space between the inner steel casing of diameter 12.6 inches and outer steel casing of diameter 16 inches at the surface of Bru 92-3 has been left unsealed and open to ingress of surface water which is forbidden by the Groundwater and Water Well Act Well Standards Regulation. According to Figure 1b surface water could enter the carbonate aquifer through the unsealed space between the inner and outer steel casings. Please clarify why the space between the outer and inner steel casing of Bru 92-3 shown in figure 1b has been left unsealed at the surface and open to ingress of surface water in violation of Groundwater and Water Well Act Well Standards Regulations. Is this an example of the well sealing that will be used during production?

10. Sio Silica's response "s" that the cloth skirt duct taped to the outside of Bru 92-2 and 92-3 at the surface is a deterrent against sabotage and tampering is absurd. I assert that the cloth skirt is to disguise the unsealed opening at the surface of Bru 92-3 and the temporary shale trap at the surface of Bru 92-2. Please clarify how a flimsy layer of cloth duct taped to the outside of the well could prevent sabotage or tampering.

11. Please clarify this statement in regard to releasing testing data for Bru 92-2, Bru 92-3 and Bru 92-8, "*Sio declines to release testing data, as some of the information is proprietary, not all items in the above list were collected as it was not required by the province, and this information is not relevant to the extraction proposal before the CEC."* The well information reports that are available to the public often give well pumping rates and duration of pumping. Sio Silica released such information for the Hydrogeological testing. The well construction information report is released to the public. Appendix H of the EAP gave data on the cluster pumping rate of both sand and water and gave the water ratio as 50%. In response to DLN IR 007 Sio Silica states the sand to water ratio can be as high as 90% sand. The sand to water ratio would vary with time. Sio Silica has given the rate of compressed air injection into the sandstone in the patent information released in supplementary report #1 submitted to the CEC. Since data on the rate and ratio of sand and water extracted and rates the air injection has already been given by Sio Silica in other instances, please clarify why such data for Bru 92-8, Bru 92-2 and Bru 92-3 isproprietary.

12. The Manitoba Well Standards regulations require that a well yield test be done on a production well soon after installation that records on the well construction report (i) method of testing (pumping, air-lifting, bailing, recovery or other method), (ii) water level immediatelyprior to the start of the test, (iii) measured rate of water discharge or estimated rate of water discharge if a measured rate cannot be made, (iv) water level immediately prior to the stop of the test, (v) duration of the test.[2] The well construction report is either publically available or can be obtained from the Director. Thus the data on rates of withdrawal of material from the

well must be measured and reported and are not proprietary according to Manitoba regulations. In accordance with Manitoba Well Standard Regulations please provide the requested data.

13. Please clarify why the information requested is not relevant to the extraction proposal before the CEC considering that the adverse environmental consequences of large amounts of air released into the extraction cavity has been documented in request 1 above, in public comments and elsewhere. The information introduced into the extraction cavity both by air injection and re-injection of aerated water containing air bubbles is crucial to the CEC Hearing and must not be withheld. Sio Silica is being deliberately obstructive and has no justification to withhold the requested data.

14. Please clarify who responded to DLN IR 009, who will respond to the request for clarification, and their qualifications.

References:

1. Analysis of potential acid gas leakage from wellbores in Alberta, Canada, LeNeveu, D. M., International Journal of Greenhouse Gas Control, **5:** 862-879, 2011, https://www.academia.edu/es/47056509/Analysis_of_potential_acid_gas_leakage_from_wellbores_in_Al berta_Canada

2. The Groundwater and Water Well Act (C.C.S.M. c. G110) Well Standards Regulation, December 21, 2015, https://web2.gov.mb.ca/laws/regs/current/_pdf-regs.php?reg=215/2015

Response:

1. The author describes methods and wellbore components that Sio is not proposing to use in its project. Sio is not aware of the referenced complaints occurring with airlift system testing. As previously stated in the response to DLN-IR0-004 (4), no air will be forced into the aquifer.

2. Please refer to the design diagram filed in the Supplemental Filing – Silica Extraction filing and the EAP filing for the design. The well design and the stuck production pipe are two different things. The stuck pipe was not part of the design. All wells are open hole into the sandstone. That has always been the design of the constructed well so that the production pipe can be lowered and utilized unobstructed in the well.

3. The production pipe that became stuck had a manufactured connection fail at the thread. Sio has since changed the required grade specification and thread type for the production pipe.

4. Sio has never said the production pipe would be PVC. It will be steel. The wellbore casing will be PVC. All production pipes, which are not documented on the well construction reports, are steel and suspended from the rig during extraction.

5. The wells listed below are wells that have successfully been extracted utilizing a production pipe style extraction and the production pipe was removed.

Production Casing Removed Date	Well Name	Claim	BH License	Latitude	Longitude
10/4/2019	Bru 82-10	Bru 82	BH 17-19	49.8415	-96.499
9/19/2019	Bru 82-11	Bru 82	BH 17-19	49.8418	-96.4992
9/12/2019	Bru 82-14	Bru 82	BH 17-19	49.84192	-96.49863
6/28/2019	Bru 95-2	Private	BH 7-19	49.8732	-96.4637
7/16/2019	Bru 95-3	Private	BH 7-19	49.8731	-96.4638
7/29/2020	Bru 154-1	Bru 154	BH 7-20	49.69213	-96.46988
8/17/2020	Den 304-1	Den 304	BH 8-20	49.6043	-96.4466
10/11/2020	BH02-20B	Private	BH 2-20	49.88873	-96.47094
5/6/2021	Bru 92-2	Bru 92	BH 2-21	49.86298	-96.47357
8/26/2021	Bru 92-8	Bru 92	BH 5-21	49.8623	-96.4727

6. Sio does not use the term “liner”. Sio uses the term production pipe. Without the definition of what the author considers a “liner”, Sio cannot answer the author’s question definitively. However, Sio’s production pipe is a removable steel pipe that is suspended from the extraction rig temporarily during extraction to the sandstone and acts as a conduit for the removed sand and water to flow to surface with the air.

7. Bru 92-3 has a stuck production pipe left in it. It broke during extraction at approximately 165 ft down (TOF 166.5’). The water well driller at the time tried to retrieve it but was not successful. Therefore it was noted on the well construction report that Sio has elected to cement it in place as part of the well sealing/abandonment procedure. This will not be the case in future wells because Sio has revised the design to be able to remove the production pipe.

8. This is a point of the process in the patent that is broadened to protect process infringement, but not a part of Sio’s proposed production in the licence application before the CEC.

9. Sio disagrees with the statements made in this request. The licence application before the CEC shows Sio’s proposed well design and cementing practices, which comply with : *The Groundwater and Water Well Act* and regulations; Manitoba guidance documents, including Constructing and Sealing Wells in Manitoba, Information for Well Drillers

and Well Sealers and Constructing and Sealing Wells in Manitoba - Information for Private Well Owners; and *The Mines and Minerals Act* and regulations thereunder governing well drilling, construction and well sealing procedures and standards.

10. While this request is unrelated to the licence application before the CEC, Sio notes that there are images in the public realm that demonstrate sabotage of Sio wells being dug up or opened up by unauthorized individuals. Sio's equipment or that of Sio's contractors has also been damaged, sabotage or stolen. Cloth and tape were photographed for visual reference in case of sabotage.

11. Sio declines to release testing data, as some of the information is proprietary. Please refer to the response to CEC-IR-014 for data that has been released.

12. Sio does not drill or complete traditional domestic water well designs that would facilitate a well yield test such as a well screen. The point of a well yield test is irrelevant to Sio's operations. Sio declines to respond to the remainder of this request based on relevancy, as the requested information is unrelated to the issues before the CEC.

13. Sio disagrees with the author that "*large amounts of air will be released into the extraction cavity.*" The air utilized in extraction is not injected directly into the aquifer as previously stated in the response to DLN-IR-004 (4). The hydrogeological study examined the potential impacts of a possible small volume of dissolved oxygen.

14. Sio prepared all of the IR responses, with input and support from subject matter experts at AECOM and Stantec, as needed. There was no individual author responsible for any of the IR responses. Representatives from Sio, AECOM and Stantec will be available to answer questions about the IR responses at the hearing, and Sio will file a summary of qualifications for each of those witnesses in advance of the hearing.

IR Number: **DLN-IR-011**

Submitted by: DLN

Date Submitted: January 5, 2023

Subject Matter: Shale Aquitard Degradation

Reference Documents:

(a) 4.3.2 Groundwater Quality in Response to Mixing of Waters from Red River Carbonate and Winnipeg Sandstone Aquifers,

(b) 6.10 Predictive Scenarios,

(c) 7.2.2 Groundwater Quality,

(d) Table 4-2, 4-3 and 4-4 of the Sio Silica Hydrogeology and Geochemistry Assessment Report,

(e) Arcadis Technical Review of Sio Silica Corporation's

(f) Environment Act Project Proposal Vivian Sand Extraction 5.3 Groundwater Impact Assessment

Background/ Preamble:

Requests:

1. Incredibly Sio Silica ignores all the documented evidence of the adverse environmental consequences of shale aquitard collapse documented in DLN IR 011. Sio Silica simply states in responses (a), (g) and (h) ; "Sio disagrees with the factual statements in the request and the premise of the question" and "Sio disagrees with the assumptions made;" without identifying what factual statements in the request, the premise of the question and the assumptions made. Please clarify and identify what "factual statements in the request, the premise of the question and the assumptions made" Sio Silica disagrees with.

2. Please clarify what evidence was used to support the factual statements in the background of DLN IR 011 Sio Silica disagrees with and why.

3. Please clarify why Sio Silica disagrees with the evidence in DLN IR 011 without providing credible contrary evidence.

4. Please provide evidence to support the Sio Silica disagreements with "statements in the request and the premise of the question".

5. For instance does Sio Silica disagree with the evidence that manganese and iron would precipitate under the oxidizing conditions introduced by airlift

sand extraction and water re-injection containing gaseous entrained water? If so give evidence.

6. Does Sio Silica disagree with the evidence presented that the precipitated manganese and iron would not necessarily be filtered by the sandstone and enter domestic wells deteriorating water quality? If so give evidence.

7. Oxidizing conditions would be created in the carbonate aquifer from mixing of oxidizing waters in he sandstone aquifer and by ingress of gaseous air introduced into the sandstone by the Sio Silica extraction operations as documented in the DLN motion brief and the DLN IR's. There would be no sand to potentially filter out precipitated iron and manganese. Please clarify with evidence why iron and manganese would not enter domestic wells in the carbonate deteriorating water quality.

8. Does Sio Silica disagree with the evidence from Dr. E. Pip that iron bacteria and other harmful microbes introduced by multiple pathways, including unfiltered air injection and well drilling, would proliferate under oxidizing conditions and deteriorate water quality? If so give evidence.

9. In response (a) Sio Silica does not address the need for state of the art geochemical modelling for the shale aquitard and ignores the request about the likelihood of shale aquitard collapse. Instead Sio Silica refers to their response to "Technical Expert Reports – Geotechnical, filed November 29, 2022 issue 6." In their response to the geotechnical report Sio Silica states, "from a geotechnical perspective, the assessment was conducted assuming that the shale aquitard could collapse." Given that Sio Silica accepts that the shale aquitard will collapse I agree that detailed three dimensional modelling of the shale aquitard to determine the likelihood of collapse is not necessary. Given that Sio Silica accepts that the shale aquitard will collapse please clarify why Sio Silica does not address the evidence given in DLN IR 011 of the adverse consequences of the aquitard collapse. Such consequences include shale fragments in the extracted sand that would cause acid, selenium and uranium accumulation in the slurry loop and cause toxicity and acid in waste products.

10. Sio Silica ignores the requests in DLN IR 001 (b), (d) and (e) concerning remedial measures to address the shale aquitard collapse. Instead Sio Silica refers to the responses in the Technical Expert Reports – Geotechnical, filed November 29, 2022 issue 6. The response to issue 6 of the Technical expert reports does not mention remedial measures concerning shale aquitard collapse. Please clarify why Sio Silica refers to issue 6 of the technical expert report to address remediation for shale aquitard collapse when the response in issue 6 of technical expert report does not mention remedial measures.

11. In response to the request (e) "If the aquitard cannot be stabilized terminate the Project due to violation of Groundwater and Water Well Act

Well Standards Regulation 3(1) that prohibits mixing of aquifer waters." Sio Silica states that this request "is a matter of legal argument" and refers to "Technical Expert Reports – Geotechnical, filed November 29, 2022 issue," that does not mention the regulation. Sio Silica admits in the Hydrogeological Report that shale aquitard collapse would result in the mixing of aquifer water. Without remedial measures to address the shale aquitard collapse there is no legal argument that regulation 3(1) would not be violated. Please clarify why Sio Silica refuses to deal with the consequences of violating Groundwater and Water Well Act Well Standards Regulation 3(1) with respect to mixing of aquifer water that Sio Silica admits will be violated as a result of their sand extraction operations.

12. If effect, Sio Silica admits violating the Regulation, and yet claims there is a legal argument concerning the violation. Clearly the consequence of violating the Regulation, without remedial action to address the violation that Sio Silica has not and will not specify, is necessary termination of the Project. Please clarify why Sio Silica will not terminate the Project if no remedial measures, to address the violation of the Regulation concerning the prohibition of mixing of aquifer waters, are determined.

13. For request (f), concerning the inadequacy of the Sio Silica geochemical sampling, Sio Silica refers to the responses to, "DLN-IR-002(f), (p) and (q) and public comments for the Extraction Project, response #5 and #17." Response #5 for the public comments states, "The environmental samples were not contaminated. Industry accepted methods for sampling, handling, preservation, and shipping of drill cuttings, water samples, and core samples were applied by the professional consultants retained by CanWhite. Proper Chain-of-Custody (COC) procedures were applied and all testing was conducted by independent accredited laboratories. Sampling methods are described in the Hydrogeology and Geochemistry Assessment Report (Appendix A of the EAP) and in the geotechnical report (Stantec 2022). Copies of completed COC Forms are provided with the laboratory analytical reports included in Appendix F ('Part 6' in the Public Registry) of the Hydrogeology and Geochemistry Assessment Report (Appendix A of the EAP)." This statement contradicts the evidence presented in the DLN submission for public comments concerning the sampling methods used by Sio Silica. Below is an excerpt from the DLN public comments submission.

- "Particularly egregious was exposure of silica sand samples to air. According to the HGR sand was sampled from stockpiles. The sand was extracted by air-lift methods that would have exposed the sand to air during extraction. Well Bru 95-3 was completed on June 28, 2019 according to drilling records obtained from MB Groundwater. The sand stockpiled outside was exposed to air and moisture until the time of sampling in November of 2021. Any marcasite in the stockpiled sand as was reported for Winnipeg formation sand from Wanipigow would have long been leached out. 1 Well records obtained from MB

groundwater show well Bru 121-1 was completed on Feb. 19, 2019. Well Bru 146 would have been completed at a similar time. Sand samples from wells Bru-121-1 and Bru 146 would have been exposed to air and weathering since the time of well completion.

- Question 3 and Reference 9 gives methods to prevent oxidation of pyrite in core samples in the attached questions document. A further reference by Basu et al. (2000) describes methods to prevent oxidation of shale samples including airtight containers and refrigeration at 4 degrees.,2 A reference, König et al. (2000) documents the oxidation pyrite in core samples that are exposed to air during storage reporting, "Massive Fe(II) to Fe(III) oxidation, which involved between 24% and 45% of the initial Fe(II), occurred within only 6 months of refrigerated storage." 3 These references establish that oxidation of pyrite in samples can occur rapidly. Core samples for the shale aquitard and carbonate aquifer were placed in core boxes that were not air tight. The core samples sent to analysis were not in air tight sealed containers and were not kept refrigerated at 4 C. The geochemical results conducted in the HGR would underestimate sulphide concentrations.

- Ryan Mills, senior hydrogeologist who helped prepare the HGR admitted at the CWS Virtual Open House the core log samples were exposed to air but stated that the samples were prepared according to standard industry practice. He stated that pyrite oxidation was sufficiently slow, that very little would have oxidized before analysis. This contradicts the evidence by Basu et al. (2000) and Konig et al. (2000) that air oxidizes pyrite in shale or sediment core samples readily. Iron pyrite in quartz or other crystalline ore bodies might oxidize slowly because the crystalline structure prevents ingress of oxygen and moisture. Shale and concretions are porous and would allow air and moisture ingress. A publication by Nolan (2019) states; 4

- "When iron sulphide is exposed to oxygen it reacts rapidly, releasing large amounts of heat. This exothermic reaction can be an ignition source for any oil or gas that is present. "To keep core logs exposed to air in core boxes is standard practice for preserving a record of the extent of an ore body but is not acceptable for geochemical analysis. According to the HGR two of the three core log samples Bru 121-1 and Bru 146 were held in storage in Steinbach for over a year where they would have been exposed to air. The core log from the site near Vivian, Bru 95-8, extracted on Nov.11, 2020 and analyzed Jan.5, 2021, was not in an air tight container nor maintained at 4C. The samples were sent in low density polyethylene (LDPE) bags that allow air ingress.5"

14. Please clarify why the evidence presented in the DLN public comments repeated in (12) above has been ignored by Sio Silica. The fact that Sio Silica

was allowed to leave this evidence unaddressed in the approvals process is an illustration of systemic failure in the approvals process. Public comments are entered after the TAC comments. The TAC does not see or take into account public comments. There is no follow up by the Approvals Branch to ensure that public comments are properly addressed. The technical experts reporting to the CEC Hearing did not review the public comments. There is a great deal of evidence presented in the public comments that, to date, has not been properly addressed, including all the evidence from the forty four Manitoba Groundwater well information Reports that were gathered by public commenters. This crucial evidence was among the host of evidence gathered in the public comments documents that was not in the EAP and not reviewed by the technical experts.

15. Please clarify why the list of references in the public comments and all the hearing documents I have submitted are ignored. All technical statements and information are supported by numbered references. The numbers are placed as superscripts above the technical statements and information provided. A numbered list of references appears at the end of the submitted documents. These references are evidence for the approvals process and the Hearing and must not be ignored. Please clarify why Sio Silica has ignored or dismissed all referenced evidence without providing referenced evidence or data to support statements that disagree with the referenced evidence.

16. Since the deadline for submission of the public comments more information has been obtained as presented in the DLN Motion Brief that the Bru 146 sand sample was taken from a borehole that did not extend into the sandstone. Please clarify how a sand sample from Bru 146 was obtained from a borehole that did not extend into the sandstone aquifer.

17. The work order chain of custody forms in Appendix A Part 6 of the Hydrogeological report give inconsistent sampling dates for Bru 121-1 and Bru 146. All samples were list as received in LDPE bags which are known not to be air tight.5 The sampling dates for Bru 121-1 24.28 m to 37.0 m were given as 11-Nov- 2020. The sampling date for Bru 121 -1 from 174 m to 179 m was 10-Dec-2018. The sampling date for Bru 146 36.82 m to 50.29 m was 11-Nov-2020. The sampling date for Bru 146 189 to194 m was 06-Dec- 2018. The chain of custody forms and work orders given in EAP Appendix A Part 6 that verify these dates are reproduced in figures 1 to 4 at the end of the requests. Please note the work orders state; “If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.” The date drilled for Bru 146 was according to the borehole report 23-Nov-2018 with a maximum drill depth of 50.3 m. Please clarify why the sampling times for Bru 121-1 and Bru 146 varied by almost two years for

different borehole depths. Please clarify why the depth of sampling for Bru 146 189 to 194 m was greater than the documented borehole depth of 50.3 m

18. The Chain of Custody records in Part 6 of Appendix A are obviously erroneous in the sampling dates. The sampling dates in the chain of custody records for Bru 121-1 and Bru 146 vary from 2018 to 2020 for the same boreholes. The well information reports and borehole records establish that the sampling dates were 2018 not 2020. Sio Silica states in the EAP Appendix A Part 1; "Bru 121-1 and Bru 146 were drilled as part of historical investigations. Samples of Red River Carbonate and Winnipeg Shale were collected from core boxes stored in CanWhite's core storage facility in Steinbach, and the samples of Winnipeg Sandstone associated with these locations had been previously collected and submitted by others to ALS Environmental Laboratories (ALS)." This statement verifies that the core samples for Bru 121-1 and Bru 146 were not sampled in 2020 as stated in the Chain of Custody information. The records do not give the information of storage and information on sampling and extraction methods from 2018 to time of analysis. The samples for Bru 121-1 and Bru 146 were received for analysis in non airtight LDPE bags. Please clarify how and where were the Bru 121-1 and Bru 146 stored since 2018? Please clarify who collected the samples and name "others" Please clarify if the samples were air exposed from the sampling time in 2018 to the time of analysis in 2020.

19. Please clarify why Sio Silica does not recognize that air exposure will oxidize sulphide in the marcasite and pyrite in the samples for geochemical analysis invalidating the acid base accounting results given in the Hydrogeological Report. Please consider the evidence I provided in my public comments submission and repeated here in the reference list, that air oxidizes pyrite and marcasite in core and sediments samples readily. Please consider that Ryan Mills, senior hydrogeologist is on record at the CanWhite (now Sio Silica) Virtual Open House stating the hydrogeological samples were air exposed.

20. Please clarify the location extraction method, time of extraction, name of the extractor, and storage method of the Bru 146 sand sample from the time of extraction to the time of analysis.

21. Please clarify the location extraction method, time of extraction, name of the extractor and storage method of the Bru 121-1 sand sample from the time of extraction to the time of analysis.

22. Please clarify the location, name of the extractor, and storage method of the Bru 146 and Bru 121-1 core samples from the time of extraction to the time of analysis.

23. The work order chain of custody for Bru 95-3 states that the sampling date was 19-Nov-2020. The depth of the sample was not given. In fact Bru 95-3, according to the EAP, was taken from a stockpile that was extracted presumably by airlift. Bru 95-3 was completed on June 28, 2019 as documented above in the public comments submission. The chain of custody work order form is misleading and has inaccurate information for the sand sample for Bru 95-3. Hollander and Woodbury state in their technical report that the sampling of sand from a stockpile at Vivian is unacceptable. This statement corroborates the evidence I have given to substantiate the inadequacy of the geochemical sampling.

24. The definition of a chain of custody is; "A process that tracks the movement of evidence through its collection, safeguarding, and analysis lifecycle by documenting each person who handled the evidence, the date/time it was collected or transferred, and the purpose for any transfers."8, According to an Environment Canada Guidance Document the chain of custody record should include (adapted from USEPA, 1986, 2006): 9

- site information (address, contact person, telephone number)
- client information (name and contact details) or project number
- sample identification number or code
- date and time of sample collection
- sample volume or mass
- brief description of the sample including contaminants of concern
- testing requested
- special instructions for soil handling, preparation or testing, including whether or not subsamples are to be collected for chemical analyses
- special safety precautions
- transport conditions

The chain of custody records for Bru 121-1, Bru 146 and Bru 95-3 give false information and have missing information. Please clarify and explain the inaccuracies in the chain of custody records documented above for Bru 121-1, Bru 146 and Bru 95-3. Please clarify that inaccurate chain of custody records that disguise the true source and method of the geological sampling of Bru 121-1 Bru 146 and Bru 95-3 would constitute professional malfeasance.

25. What specifically in the calculations in DLN IR 011 estimating the selenium concentration release from the aquitard into the excavation cavity does Sio Silica disagrees with?

26. In response (h) Sio Silica disagrees with the assumption made. Please clarify which assumption Sio Silica disagrees with. The assumption includes that the selenium documented to occur in the shale aquitard, based on the shake flask test results, would be released into the extraction cavity when exposed to re- injected aerated water and to air from air-lift injection. Does Sio Silica disagree that their geochemical results showed the shale can contain up to 13.1 ppm selenium? Does Sio Silica disagree that the shake flask tests showed toxic levels of selenium leaching for shale, carbonate and sand samples? Please consider the statement on page 40 of EAP Appendix A Part 1 for Red River Carbonate, "Selenium: All three samples exceeded the applicable guidelines for dissolved selenium." Please consider the statement on page 41 of EAP Appendix A Part 1 for Winnipeg Shale, "Selenium: All three samples exceeded the applicable guidelines for dissolved selenium." Please consider the statement on page 41 of EAP Appendix A Part 1 for Winnipeg Sandstone, "One out of three samples (Bru 121-1_174 to 179) exceeded the applicable guidelines and standards for dissolved selenium." Please consider re-injected air with gaseous entrained water would agitate and mix with fragments of shale from the collapsing aquitard providing a similar aggressive leaching environment to shake flask tests. Therefore the shake flask test results would not be an over prediction of dissolution of aquifer pollutants.

27. Does Sio Silica disagree with the documented evidence in DLN IR 002 and DLN IR 007 requests for clarification that the re-injected water would contain not only dissolved air but also gaseous entrained air?

28. Does Sio Silica disagree with the information in their patent that the air tube can be extended below the production pipe and air can be injected directly into the aquifer to loosen the sand?

29. Does Sio Silica disagree that all the sources of air introduced into the aquifer, will create oxidizing conditions? If Sio Silica disagrees give evidence to support the disagreement.

30. Measurement of entrained gaseous air is not difficult. Instruments are available for this measurement.6,7 Please clarify why Sio Silica has not measured the amount of entrained air in extracted process wastewater and in the aquifer cavity after airlift extraction and continues to refuse to plan to make such measurements in further field tests and during production.

31. Does Sio Silica dispute that the selenium and uranium, documented to occur in the shale aquitard as shown in Table 1 of DLN IR 001 and as would be found in interbedded shale documented to occur in the sandstone

aquifer, would dissolve under oxidizing conditions into the aquifer water? If so give evidence.

32. Does Sio Silica disagree with the evidence in Table 1 of DLN IR 001 taken from the Hydrogeological Report that heavy metals occur in the shale fragments and that the shale has an uncertain acid generation potential. Please consider that the acid generation potential would be underestimated due to air exposure of the shale samples.

33. Does Sio Silica not consider even uncertain acid formation in the aquifer from shale, to be unacceptable? Must we not be certain that the aquifer water will not be contaminated by acid leaching and subsequent mobilization of heavy metals?

34. Does Sio Silica disagree that oxidation of sulphide in the shale and sand would cause the release of sulphuric acid? Does Sio Silica disagree that the neutralization of the acid formed by CaCO3 would form CO2 that in turn would form carbonic acid in the aquifer? Please give evidence to support the disagreement by Sio Silica.

35. Does Sio Silica disagree that the acid formed, either sulphuric or carbonic or both would mobilize heavy metals into the aquifer? Please give evidence to support any disagreement by Sio Silica.

36. Does Sio Silica disagree with the evidence in Figure 1 of DLN IR 011 that shows fragments of shale in the sand extracted south of Vivian in June of 2019? If Sio Silica disagrees give evidence to support the disagreement.

37. Does Sio Silica disagree that the evidence of figure 1 DLN IR 001 demonstrates shale fragments will occur in the extracted sand during production? If Sio Silica disagrees give evidence to support the disagreement.

38. Does Sio Silica disagree that the shale as shown in figure 1 of DLN IR 001 would be in the waste at the extraction site? If Sio Silica disagrees give evidence to support the disagreement.

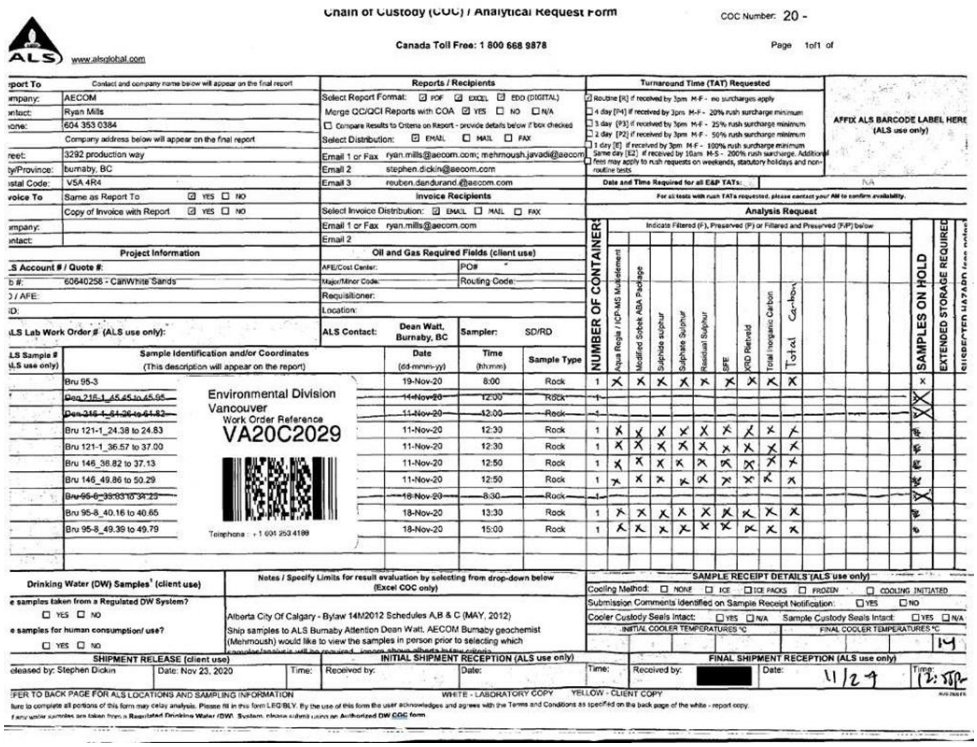
39. Does Sio Silica disagree that the waste containing shale would require specialized disposal methods due to the documented leaching of selenium and other heavy metals and due to the documented potential for acid generation? Please consider that the acid generation potential would be underestimated due to documented air exposure of the shale samples. If Sio Silica disagrees, give evidence to support the disagreement.

40. Does Sio Silica disagree that shale fragments as illustrated in figure 1 of DLN IR 001 having similar diameter to sand extracted grains would appear in

the slurry line and would leach selenium. If Sio Silica disagrees, give evidence to support the disagreement.

41. If the sand contains much more marcasite and pyrite than measured due to the documented air exposure and weathering of the sand samples, does Sio Silica disagree that there would be unacceptable leaching and release of heavy metals into the aquifer. Please give evidence to support any disagreement by Sio Silica.

42. For response (i) please clarify why does Sio Silica not commit in the approvals process to conduct comprehensive publicly available testing of water quality and pollutant level concentrations in the extraction cavity before and after field-test sand extraction operations and during production if a licence is obtained? Consider all the evidence presented in my submission to the public comments, the DLN Motion Brief and the DLN IR's that pollutants including gaseous air and microbes will be introduced into the aquifer by Sio Silica extraction activities. Please consider that Sio Silica has given no documented evidence and measurements to the contrary other than unsupported statements of denial.


Chain of Custody (COC) / Analytical Request Form

COC Number: 20 -

ALS www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Page 1of1 of

Report To — Contact and company name below will appear on the final report
Company: AECOM
Contact: Ryan Mills
Phone: 604 353 0384
Company address below will appear on the final report
Street: 3292 production way
City/Province: burnaby, BC
Postal Code: V5A 4R4
Invoice To: Same as Report To ☑ YES ☐ NO
Copy of Invoice with Report ☑ YES ☐ NO
Company:
Contact:

Project Information
ALS Account # / Quote #:
Job #: 60640258 - CanWhite Sands
PO / AFE:
LSD:
ALS Lab Work Order # (ALS use only):

Reports / Recipients
Select Report Format: ☑ PDF ☑ EXCEL ☑ EDD (DIGITAL)
Merge QC/QCI Reports with COA ☑ YES ☐ NO ☐ N/A
☐ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax: ryan.mills@aecom.com; mehmoush.javadi@aecom
Email 2: stephen.dickin@aecom.com
Email 3: reuben.dandurand.@aecom.com

Invoice Recipients
Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax: ryan.mills@aecom.com
Email 2:

Oil and Gas Required Fields (client use)
AFE/Cost Center: PO#:
Major/Minor Code: Routing Code:
Requisitioner:
Location:
ALS Contact: Dean Watt, Burnaby, BC Sampler: SD/RD

Turnaround Time (TAT) Requested
☐ Routine [R] if received by 3pm M-F - no surcharges apply
☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum
☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum
☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum
☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum
☐ Same day [E2] if received by 10am M-S - 200% rush surcharge. Additional fees may apply to rush requests on weekends, statutory holidays and non-routine tests.
Date and Time Required for all E&P TATs: N/A
For all tests with rush TATs requested, please contact your AM to confirm availability.

AFFIX ALS BARCODE LABEL HERE (ALS use only)

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	Aqua Regia / ICP-MS Multielement	Modified Sobek ABA Package	Sulphide sulphur	Sulphate Sulphur	Residual Sulphur	SPE	XRD Rietveld	Total Inorganic Carbon	Total Carbon	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED
	Bru 95-3	19-Nov-20	8:00	Rock	1	X	X	X	X	X	X	X	X	X	X	
	~~Bru 216-1_45.45 to 45.95~~	~~14-Nov-20~~	~~12:00~~	~~Rock~~	~~1~~										X	
	~~Bru 216-1_61.26 to 61.82~~	~~11-Nov-20~~	~~12:00~~	~~Rock~~	~~1~~										X	
	Bru 121-1_24.38 to 24.83	11-Nov-20	12:30	Rock	1	X	X	X	X	X	X	X	X	X		
	Bru 121-1_36.57 to 37.00	11-Nov-20	12:30	Rock	1	X	X	X	X	X	X	X	X	X		
	Bru 146_36.82 to 37.13	11-Nov-20	12:50	Rock	1	X	X	X	X	X	X	X	X	X		
	Bru 146_49.86 to 50.29	11-Nov-20	12:50	Rock	1	X	X	X	X	X	X	X	X	X		
	~~Bru 95-8_39.93 to 39.23~~	~~18-Nov-20~~	~~8:30~~	~~Rock~~	~~1~~										X	
	Bru 95-8_40.16 to 40.65	18-Nov-20	13:30	Rock	1	X	X	X	X	X	X	X	X	X		
	Bru 95-8_49.39 to 49.79	18-Nov-20	15:00	Rock	1	X	X	X	X	X	X	X	X	X		

Environmental Division
Vancouver
Work Order Reference
VA20C2029
Telephone : +1 604 253 4188

Drinking Water (DW) Samples† (client use)
Are samples taken from a Regulated DW System? ☐ YES ☐ NO
Are samples for human consumption/ use? ☐ YES ☐ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)
Alberta City Of Calgary - Bylaw 14M2012 Schedules A,B & C (MAY, 2012)
Ship samples to ALS Burnaby Attention Dean Watt, AECOM Burnaby geochemist (Mehrmoush) would like to view the samples in person prior to selecting which

SAMPLE RECEIPT DETAILS (ALS use only)
Cooling Method: ☐ NONE ☐ ICE ☐ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED
Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO
Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A
INITIAL COOLER TEMPERATURES °C FINAL COOLER TEMPERATURES °C 14

SHIPMENT RELEASE (client use)
Released by: Stephen Dickin Date: Nov 23, 2020 Time: Received by: Date:
INITIAL SHIPMENT RECEPTION (ALS use only) Time: Received by: Date:
FINAL SHIPMENT RECEPTION (ALS use only) Received by: [redacted] Date: 11/29 Time: 12:55pm

TRANSFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY
Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.
If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Figure 1. Chain of Custody forms for Bru 95-3, Bru 121-1 and Bru 146 reproduced from the Sio Silica Extraction EAP Appendix A Part 6

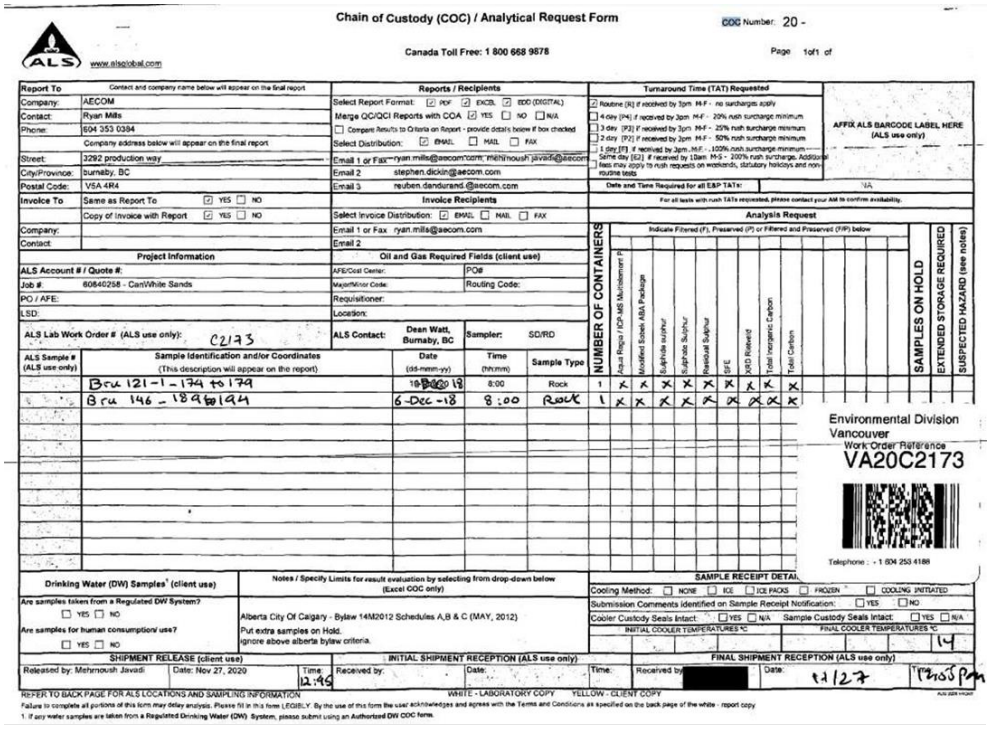
Page : 5 of 18
Work Order : VA20C2029 Amendment 2
Client : AECOM Canada Ltd.
Project : 60640258 - CanWhite Sands

Matrix: **Soil/Solid**

Evaluation: ✸ = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation: Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis: Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Acid Base Accounting : Received Sample Weight										
LDPE bag Bru 95-8_49.39 to 49.79	WEI-21	18-Nov-2020	----	----	----		05-Jan-2021	180 days	48 days	✓
Acid Base Accounting : Received Sample Weight										
LDPE bag Bru 121-1_24.38 to 24.83	WEI-21	11-Nov-2020	----	----	----		05-Jan-2021	180 days	55 days	✓
Acid Base Accounting : Received Sample Weight										
LDPE bag Bru 121-1_36.57 to 37.00	WEI-21	11-Nov-2020	----	----	----		05-Jan-2021	180 days	55 days	✓
Acid Base Accounting : Received Sample Weight										
LDPE bag Bru 146_36.82 to 37.13	WEI-21	11-Nov-2020	----	----	----		05-Jan-2021	180 days	55 days	✓
Acid Base Accounting : Received Sample Weight										
LDPE bag Bru 146_49-86 to 50.29	WEI-21	11-Nov-2020	----	----	----		05-Jan-2021	180 days	55 days	✓
Acid Base Accounting : Residual sulfur by LECO and IR										
LDPE bag Bru 95-3	S-IR04B	19-Nov-2020	----	----	----		05-Jan-2021	180 days	47 days	✓
Acid Base Accounting : Residual sulfur by LECO and IR										
LDPE bag Bru 95-8_40.16 to 40.65	S-IR04B	18-Nov-2020	----	----	----		05-Jan-2021	180 days	48 days	✓
Acid Base Accounting : Residual sulfur by LECO and IR										
LDPE bag Bru 95-8_49.39 to 49.79	S-IR04B	18-Nov-2020	----	----	----		05-Jan-2021	180 days	48 days	✓
Acid Base Accounting : Residual sulfur by LECO and IR										
LDPE bag Bru 121-1_24.38 to 24.83	S-IR04B	11-Nov-2020	----	----	----		05-Jan-2021	180 days	55 days	✓

Figure 2: ALS work order giving sampling dates and hold times before analysis reproduced from Sio Silica Extraction EAP Appendix A Part 6



Chain of Custody (COC) / Analytical Request Form

COC Number: 20 -

Canada Toll Free: 1 800 668 9878

Page 1of1 of

www.alsglobal.com

Report To	Contact and company name below will appear on the final report
Company:	AECOM
Contact:	Ryan Mills
Phone:	604 353 0394
	Company address below will appear on the final report
Street:	3292 production way
City/Province:	burnaby, BC
Postal Code:	V5A 4R4
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☑ YES ☐ NO
Company:	
Contact:	

Reports / Recipients

Select Report Format: ☑ PDF ☑ EXCEL ☑ EDD (DIGITAL)
Merge QC/QCI Reports with COA ☑ YES ☐ NO ☐ N/A
☐ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ryan.mills@aecom.com; mehrnoush.javadi@aecom
Email 2 stephen.dickin@aecom.com
Email 3 reuben.dandurand@aecom.com

Invoice Recipients

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ryan.mills@aecom.com
Email 2

Turnaround Time (TAT) Requested

☑ Routine [R] if received by 3pm M-F - no surcharges apply
☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum
☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum
☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum
☐ 1 day [P1] if received by 3pm M-F - 100% rush surcharge minimum
☐ Same day [E2] if received by 10am M-S - 200% rush surcharge. Additional fees may apply to rush requests on weekends, statutory holidays and non-routine tests

Date and Time Required for all E&P TATs: NA

For all tests with rush TATs requested, please contact your AM to confirm availability.

AFFIX ALS BARCODE LABEL HERE (ALS use only)

Project Information

ALS Account # / Quote #:
Job #: 60640258 - Can/White Sands
PO / AFE:
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (ALS use only): C2173
ALS Contact: Dean Watt, Burnaby, BC Sampler: SD/RD

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	Aqua Regia / ICP-MS Multielement P	Modified Sobek A&A Package	Sulphide sulphur	Sulphate Sulphur	Residual Sulphur	SPE	XRD Rietveld	Total Inorganic Carbon	Total Carbon	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	Bru 121-1-174 to 179	18-Dec-18	8:00	Rock	1	X	X	X	X	X	X	X	X	X			
	Bru 146 - 189 to 194	6-Dec-18	8:00	Rock	1	X	X	X	X	X	X	X	X	X			

Environmental Division
Vancouver
Work Order Reference
VA20C2173

Telephone : - 1 604 253 4188

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☐ NO
Are samples for human consumption/ use? ☐ YES ☐ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

Alberta City Of Calgary - Bylaw 14M2012 Schedules A,B & C (MAY, 2012)
Put extra samples on Hold.
ignore above alberta bylaw criteria.

SAMPLE RECEIPT DETAIL

Cooling Method: ☐ NONE ☐ ICE ☐ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED
Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO
Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A
INITIAL COOLER TEMPERATURES °C | FINAL COOLER TEMPERATURES °C: 14

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (ALS use only)			FINAL SHIPMENT RECEPTION (ALS use only)		
Released by: Mehrnoush Javadi	Date: Nov 27, 2020	Time: 12:45	Received by:	Date:	Time:	Received by: [redacted]	Date: 12/27	Time: 12:55 pm

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Figure 3. Chain of Custody forms for Br 121-1 and Bru 146 sand samples reproduced from the Sio Silica Extraction EAP Appendix A Part 6

Page : 3 of 10
Work Order : VA20C2173
Client : AECOM Canada Ltd.
Project : 60640258 - CanWhite Sands

ALS

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 15:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 15:00 is used for calculation purposes.

Matrix: **Soil/Solid** Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation: Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis: Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Acid Base Accounting : Acid Base Accounting (Modified Sobek)										
LDPE bag Bru 121-1_174 to 179	OA-VOL08m	10-Dec-2018	----	----	----		23-Jan-2021	----	----	
Acid Base Accounting : Acid Base Accounting (Modified Sobek)										
LDPE bag Bru 146_189 to 194	OA-VOL08m	06-Dec-2018	----	----	----		23-Jan-2021	----	----	
Acid Base Accounting : IC by coulometer										
LDPE bag Bru 121-1_174 to 179	C-GAS05	10-Dec-2018	----	----	----		23-Jan-2021	----	----	
Acid Base Accounting : IC by coulometer										
LDPE bag Bru 146_189 to 194	C-GAS05	06-Dec-2018	----	----	----		23-Jan-2021	----	----	
Acid Base Accounting : Received Sample Weight										
LDPE bag Bru 121-1_174 to 179	WEI-21	10-Dec-2018	----	----	----		23-Jan-2021	180 days	775 days	× EHTR
Acid Base Accounting : Received Sample Weight										
LDPE bag Bru 146_189 to 194	WEI-21	06-Dec-2018	----	----	----		23-Jan-2021	180 days	779 days	× EHTR
Acid Base Accounting : Saturated Paste pH										
LDPE bag Bru 121-1_174 to 179	OA-ELE07	10-Dec-2018	----	----	----		23-Jan-2021	----	----	

Figure 4: ALS work order giving sampling dates and hold times before analysis for Bru 121-1 and Bru 146 samples reproduced from Sio Silica Extraction EAP Appendix A Part 6

References:

1. Technical report and preliminary economic assessment on the Seymourville Silica Sand Project, Manitoba, Canada for Claim Post Resources Inc., NI-43-101 & 43-101F1, Eugene Puritch, P.Eng., Richard Sutcliffe, P.Geo., Ph.D.,Yungang Wu, P.Geo., David Burga, P.Geo., Jarita Barry, P.Geo., Kenneth Kuchling P.Eng., David Orava, P.Eng., David Anthony, P.Eng., Michael Esposito, P.E., P&E Mining Consultants Inc., Report No. 292, November 1, 2014 sedar.com

2. Best Practices for Shale Core Handling: Transportation, Sampling and Storage for Conduction of Analyses. February 2020, Journal of Marine Science and Engineering 8(2):136,S. Basu, Adrian P Jones, Pedram, Mahzari, https://www.researchgate.net/publication/339426332_Best_Practices_for_Shale_Core_Handling_Transportation_Sampling_and_Storage_for_Conduction_of_Analyses

3. Iron oxidation in sediment cores (Site 1062) during six months of storage in the Ocean DrillingProgram archive, September 2000, Proceedings of the Ocean Drilling Program: Scientific Results 172:1-11, I. König et al. https://www.researchgate.net/publication/262791290_Iron_oxidation_in_sediment_cores_Site_1062_during_six_months_of_storage_in_the_Ocean_Drilling_Program_archive

4. Control of Ignition Sources, Dennis P. Nolan, in Handbook of Fire and Explosion Protection Engineering Principles for Oil, Gas, Chemical, and Related Facilities (Fourth Edition), 2019, Ch 4.14 Pyrophoric Materials https://www.sciencedirect.com/topics/earth-and-planetary-sciences/iron-sulfide

5. Core alteration and preservation From AAPG Wiki from Methods in Exploration, Wellsite methods, Core alteration and preservation, AAPG special Volumes, 1992, Caroline J. Bajsarowicz https://wiki.aapg.org/Core_alteration_and_preservation

6. Measurement of volume fraction of air in water: experimental Study, J Dilip Singh and G Senthilkumar 2021 IOP Conf. Ser.: Mater. Sci. Eng. 1197 012031, https://iopscience.iop.org/article/10.1088/1757-899X/1197/1/012031/pdf

7. Entrained Air Measurement in Coolant Filtration and Hydraulic Systems, Machinery Lubrication Magazine, published by Noria, Steve Dougherty, https://www.machinerylubrication.com/Read/855/entrained-air-measurement

8. NIST Special Publication 800-101 Revision 1 Guidelines on Mobile Device Forensics, Appendix B, Rick Ayers Sam Brothers Wayne Jansen, May 2014, https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-101r1.pdf

9. Environment Canada Guidance Document on the Sampling and Preparation of Contaminated Soil for Use in Biological Testing EPS 1/RM/53 – February 2012, https://publications.gc.ca/collections/collection_2013/ec/En49-7-1-53-eng.pdf

Response:

1. Sio disagrees with the statement about Figure 1 in round one by the author that states: "*Figure 1 provides direct evidence that the friable shale aquitard would collapse into the Sio Silica sand extraction cavities.*" Pictures of shale do not prove that a shale aquitard would collapse. This is not substantial evidence. Geotechnical investigations and modelling completed under the direction of geotechnical engineers is the industry standard for evaluating stability of the rock mass surrounding any cavities.

   Core samples did not sit out exposed to rain or other weathering factors which could compromise the integrity of the material. Core samples were protected from weather. The carbonate, shale and sand samples were collected, documented, handled and shipped to the laboratory a per standard solid phase sampling standards described in Price (2009) and MEND (2001). The sand pile from which the Bru 94-3 sand sample was taken was covered by tarp and not exposed to weather for an extended period of time. The samples were stored in standard sampling bags and zip

lock and sent the laboratory for testing. Photos of the 2020 Bru 95-8 core box show that the core was allowed to dry which is a common method for preventing sulphide oxidation.

Sio does not agree with the implication that the core samples are an underestimation of the sulphur content. Samples would have had to sit for a substantial amount of time to be compromised (many years). The presence of sulphate minerals such as gypsum and jarosite in X-ray diffraction and HCL extractable sulphate sulphur in acid-base accounting are generally evidence of the sulphide oxidation. The results of laboratory testing show that only a trace amount of gypsum was identified in the 2020 Bru 95-8 shale sample and HCL extractable sulphate sulphur content were below the detection limit in all samples precluding sulphide oxidation in the majority of samples. Also, photos of 2020 fresh core indicate that shale unit was already degraded in-situ, thus there is no data to indicate that material in Bru 121-1 and Bru 146 was significantly more weathered than fresh core. The 2018 and 2020 samples of Winnipeg Sandstone showed no signs of sulphide oxidation. The sampling of old and new core is a standard practice in ARD/ML characterization to ensure that all material with potential for generating acidity is assessed.

The development of oxidizing conditions in the aquifers that the author refers to is hypothetical. A small volume of dissolved oxygen may remain in the water upon return of water to the aquifer because of the low solubility of oxygen in water. A significant and sustained source of oxygen is required to sustain sulphide oxidation until the neutralization potential is exhausted which is a required precursor for ARD. This is not expected from the re-injection of water in the aquifer. The quantity of oxygen will be a finite amount. Once it exolves or is consumed there is no infinite source of oxygen to continue to feed the oxidation reaction. Sulphide oxidation resulting in the onset of acidic conditions and metal leaching is a complex process generally happening under atmospheric and unsaturated conditions. Without biological activity, the rate of sulphide oxidation is very slow (Refer to Figure 2-9 of GARD Guide (INAP, 2009). The sulphide oxidation rate is also dependent on the form of sulphide minerals, their surface area, exposure to oxygen and water, mineral association, and assemblages.

The carbonate aquifer is a large source neutralization potential and will buffer any possible reactions that generate minimal acidity generated if the shale aquitard collapses. The current neuralization potential of the carbonate unit is capable of neutralizing as much as 20% pyrite which far exceeds the maximum pyrite content of 1.3% measured in Winnipeg Shale samples. Also, there are reactive carbonates and some aluminosilicates in the shale that contribute to the acid neutralization if oxidation of the sulphides in the shale occur.

2. Refer to response #1 above.

3. Refer to response #1 above.

4. Refer to response #1 above.

5. Refer to response #1 above. Air lifting will not introduce oxygen directly into the aquifers.

6. Iron and manganese oxide/oxyhydroxide that may form as a result of oxidation will precipitate out of the solution and are not expected to migrate through the aquifer to a domestic well. These solid mineral phases would precipitate relatively rapidly following interaction with any oxygen which is only likely to occur in proximity to extraction wells. Solid particles are not typically mobile in aquifers because they are present in a solid form that is denser than water and therefore settle. Further, groundwater flow velocities are very slow and are not usually high enough to entrain solids.

   Also refer to response #1 above.

7. Also refer to response #1 and #6.

8. As previously stated in the response to Round 2 DLN-IR-001 , compressors are standard equipped with an intake filter.

   Also refer to response #1 above.

9. Sio's response states that the shale aquitard "could", not "will", collapse and Sio stands behind Stantec's geotechnical model. The Hydrogeological and Geochemistry Assessment outlines potential impacts to the aquifer in the event of a shale collapse and no irreversible effects were determined. Sio disagrees with the statement that shale will "cause acid". Of the three shale samples analyzed to date, two were classified as Uncertain, and one was classified as Non-PAG. No samples to date have been classified as PAG.

   See response #1 above.

10. See the response to MBEN/OLS-IR-029.

11. Sio maintains that this is a matter of legal argument and will address this issue in its closing submissions in the hearing. Water in both aquifers is fresh, and geochemical modelling suggests the possibility of minor changes in water quality (some positive) as a result of mixing.

12. Sio maintains that this is a matter of legal argument and will address this issue in its closing submissions in the hearing. Water in both aquifers is fresh, and geochemical modelling suggests the possibility of minor changes in water quality (some positive) as a result of mixing.

13. There is no question here. The author also references sand results from Wanipigow sand, an area which is a different geologic member. This is therefore irrelevant as Sio is targeting the Carman sand member above. Sampling methods were consistent with industry standard practice for the evaluation of acid rock drainage and metal leaching, including Price (1997), MEND (2009) and GARD (2014). Oxidation rates are dependent on the quantity, surface area and form of pyrite, the availability of oxygen and water. Oxidation of pyrite will not proceed without an abundance of water and oxygen. Because drill core was stored in a dry environment, sulphide oxidation did not progress to an extent that would have affected geochemical testing results. Pyrite concentrations in samples were very low to below detection limits, and oxidation products were not present in quantities that support the assertions made in the comments above.

    Also see response #1 above.

14. Sio maintains that its responses to the public comments respond to the questions.

15. Sio has reviewed the references provided by the author. As documented in DLN-IR-007 (1) and DLN-IR-003 (2), the author is utilizing a reference claiming there is a concern for environmental impacts when there is none listed, or a reference in the wrong circumstance, or the situation is not applicable or comparable to Sio's project. The author repeatedly uses examples from the sand deposit to the north in Wanipigow area which is a different geologic member even though Sio has clarified this many times in the past. Therefore Sio does not agree with many references. The author also presents his own work as evidence, which has not been reviewed by licensed professionals (e.g. engineers or geoscientists) with academic training and experience in the assessment of metal leaching and acid rock drainage.

16. At the time the Report of Required Work was submitted (November 30, 2018), Bru 146 had just been cored and drilled to the shale unit. On December 5/6, 2018, we re-entered the borehole where we drilled the entirety of the sandstone and collected samples. This matches with the well construction report filed on our behalf by Friesen Drillers.

17. Depths are in meters on one sheet (limestone interval) and feet on another (sand samples). This matches with the well construction report filed on our behalf by Friesen Drillers for both wells in question.

    Also refer to response #1.

18. Samples were stored in Sio's storage facility in Steinbach as the author has already noted. Samples were collected from the storage facility in 2020

however the material was stored since 2018. Sampling was conducted under the joint supervision of one representative from Sio and a professional geoscientist employed by AECOM.

Additional details about the chain of custody for historic samples is irrelevant to the issues before the CEC.

19. Refer to response #1 and #13 above.

20. Samples were stored in Sio's storage facility in Steinbach as the author has already noted. Samples were collected from the storage facility in 2020 however the material was stored since 2018. Sampling was conducted under the joint supervision of one representative from Sio and a professional geoscientist employed by AECOM.

    Additional details about the location, time and name of extractor is irrelevant to the issues before the CEC.

21. Samples were stored in Sio's storage facility in Steinbach as the author has already noted. Samples were collected from the storage facility in 2020 however the material was stored since 2018. Sampling was conducted under the joint supervision of one representative from Sio and a professional geoscientist employed by AECOM.

    Additional details about the location, time and name of extractor is irrelevant to the issues before the CEC.

22. Samples were stored in Sio's storage facility in Steinbach as the author has already noted. Samples were collected from the storage facility in 2020 however the material was stored since 2018 for Bru 146. Sampling was conducted under the joint supervision of one representative from Sio and a professional geoscientist employed by AECOM.

    The name of the extractor is irrelevant to the issues before the CEC.

23. There is no question in this Information Request. This is an opinion of the author, which Sio disagrees with.

24. Details about chain of custody for test well data are irrelevant to the issues before the CEC.

25. It is not possible to predict leachable selenium concentrations from the solid phase concentration. The leachability of a metals depends on several parameters including but limited to concentration, pH, oxidation-reduction

conditions, salinity, solubility limit, hydrogeology, etc., and most of these parameters were not considered in the calculation.

26. *"Please consider re-injected air with gaseous entrained water would agitate and mix with fragments of shale from the collapsing aquitard providing a similar aggressive leaching environment to shake flask tests*" is an assumption made by the author and should not be taken as factual. The majority of the air injected into the production pipe will return to surface. Oxygen concentrations in re-injected groundwater will be very low and finite, so are unlikely to allow for the aggressive dissolution of minerals and constituents simulated by the highly conservative shake flask testing methodology.

27. The solubility of oxygen in water is very low. Entrained air will be allowed to exsolve to the atmosphere in open tanks at ground surface. Detailed design of the civil infrastructure, tankage and water treatment system will consider incorporation of degassing infrastructure to further reduce the quantity of entrained air in reinjected water. Sio has not observed entrained air in water returning to surface from extraction wells during operations. By the time water is returned to the wellhead for reinjection to the aquifer, any entrained air has dissipated.

28. See response #8 in DLN-IR-009.

29. See response #1 above.

30. The measurement of gaseous air is not defined by oversight and regulation. In the absence of oversight requirements, Sio has committed itself to monitoring. Sio will also adhere to any requirements in a licence.

31. See response #1 above.

32. See response #1 above.

33. Please refer to response #1. Oxidation of sulphide minerals requires an abundance of sulphide minerals, water and oxygen for an extended period of time. Neither abundant sulphides, nor abundant oxygen will be present within the sandstone aquifer as demonstrated by geochemical analysis, groundwater monitoring and geochemical modelling. The Groundwater Monitoring and Mitigation Plan will collect baseline water quality information for a range of constituents, and ongoing monitoring for the same constituents will continue on a regular basis to determine if there are any changes as a result of sand extraction.

34. See response #1 above.

35. See response #1 above.

36. These sites have been the subject of trespass, vandalism and theft reported by Sio to the municipality and RCMP. Sio cannot comment on photos taken illegally with no control standards in place as to the validity of the photo or content.

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    The image of shale in a photo does not demonstrate that shale would be produced regularly during extraction.

38. These sites have been the subject of trespass, vandalism and theft reported by Sio to the municipality and RCMP. Sio cannot comment on photos taken illegally with no control standards in place as to the validity of the photo or content.

    The image of shale in a photo does not demonstrate that shale would be produced regularly during extraction.

39. The characterization and management of waste products will be conducted in accordance with the Waste Characterization and Management Plan. It will include provisions for additional sampling and geochemical analysis to confirm the findings of the Hydrogeology and Geochemistry Assessment in accordance with industry standard practice.

    The Groundwater Monitoring and Mitigation Plan will collect baseline water quality information for a range of constituents, and ongoing monitoring for the same constituents will continue on a regular basis to determine if there are any changes as a result of sand extraction.

40. These sites have been the subject of trespass, vandalism and theft reported by Sio to the municipality and RCMP. Sio cannot comment on photos taken illegally with no control standards in place as to the validity of the photo or content.

    The image of shale in a photo does not demonstrate that shale would be produced regularly during extraction.

41. There is no visual or laboratory data to indicate that the Winnipeg Sandstone contains sulphides at detectable levels. Additional geochemical testing will be conducted as part of routine operations to confirm the findings of the Hydrogeology and Geochemistry Assessment and ensure waste materials are appropriately characterized and managed to be protective of human health and the environment.

42. Sio has previously stated in the Responses to the Geotechnical Review issue #16 that the Management Plans will be developed for mitigation and monitoring prior to operations:

    "*Currently, AECOM is preparing draft plans that will be circulated prior to the CEC hearing*."

    This issue was previously addressed in the EAP and in our Vivian Sand Extraction Project (File# 6119.00) - Environment Act Proposal Review Responses to the Public table submitted to Manitoba Conservation and Climate, Environmental Approvals on January 14, 2022, and posted on the Public Registry on January 25, 2022. Please refer to our response to Key Issue / Question # 234 in our Responses to the Public which includes the following:

    "*It is best and common practice for mitigation and monitoring plans, and operating procedures, to be prepared in association with or on completion of detailed design of the Project, and for these plans to be reviewed and updated periodically. In this manner, continual environmental planning is built into both the commencement and on-going operation of the Project, and environmental management reflects current operational, legislative and permitting requirements*.

    Thus, it is essential that such plans and operating procedures be handled as 'living documents' to ensure that they will be subject to ongoing and periodic revisions to capture operational refinements that are acquired through experience, monitoring and inspection, compliance review, equipment upgrades, and follow-up assessments. Plans and procedures will also be reviewed and revised when there are any changes to licensing and permitting conditions, applicable legislation, or roles and responsibilities within Sio. Maintaining current plans and procedures will allow for continuous operational improvement and further protection of the environment. Where required revisions to these documents will be prepared with the cooperation of the applicable regulatory authority and will be provided for regulator review."