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: **MBEN/OLS-IR-028**

Submitted by: MBEN/OLS

Date Submitted: January 10, 2023

Subject Matter: Aquifer integrity

Reference: CEC-IR-009

MSSAC-IR-017

MSSAC-IR-021

MSSAC-IR-024

DLN-IR-011

RMSF-IR-017

RMSF-IR-018

Responses to Technical Experts Reports - Hydrogeology from November 2022 Issues #7, #8 and #93

Technical Expert Reports – Geotechnical, filed November 2022 Issue #6

AECOM, 2021: CanWhite Sands Corp.: Vivian Sand Extraction Project Environment Act Proposal, July 2021. Section 6.2.3, Section 6.2.1, Appendix B FERGURSON-4

Arcadis Geotechnical Review

Stantec, 2022 Geotechnical Analysis for SioSilica Extraction Project, January 2022.Expert Reports – Hydrogeology – filed on November 29, 2022 - Issue #7

Preamble: In the Environment Act Proposal (EAP), Section 6.2.3, the project effect to groundwater quality was assessed as **minor** in magnitude and **adverse to positive** in direction. The duration of the effect was assessed to be **long term**, **intermittent** in frequency, **project region** for the scope and **reversible**.

The Arcadis Geotechnical review noted that the, "*Winnipeg Shale ... has limited structural strength and, ... will collapse downward if it is not supported. The shale also serves as an important aquitard (i.e., water barrier) that limits the flow of water between the Red River Carbonate Limestone aquifer and the underlying Winnipeg Sandstone aquifer.*"

In response to RMSF-IR-017 and RMSF-IR-018, the proponent acknowledged the potential for degradation/collapse of the Winnipeg Shale, and it can be anticipated

that the lateral extents could range from 14 m to 40 m and would progressively expand over time.

It is also noted in Sio Silica's materials that aquitards can be effective hydraulic barriers to protect aquifers' water quality from potential contamination. The comments of Dr. Grant Ferguson on the isotopic analysis state the following (AECOM, 2021; Appendix B FERGURSON-4): "*These shales [Winnipeg Formation Shales] have long been suspected to provide a low permeability barrier between the sandstone of the Winnipeg Formation and the overlying carbonates of the Red River Formation and the analyses presented here support that idea*".

The AECOM response to the FRIESEN-3 comment also noted that "*However, as shown on Figure 5-13 (G0SA014/G05SA015) and Figure 5-14 (G050J163/G050J175), water levels remain significantly different in each aquifer, indicating the aquitard [Winnipeg Formation Shales] remains intact. Further, the pumping test conducted by AECOM in 2020 indicated the aquitard [Winnipeg Formation Shales] was intact despite the presence of several wells in the area.*"

Sio Silica's response to the Technical Expert Reports at Geotechnical Issue Number 6 notes that "*the Hydrogeological and Geochemistry Assessment also considered the possible collapse of the shale aquitard from a geochemistry perspective.*" An inter-aquifer mixing geochemical compatibility assessment was performed using PHREEQC (Responses Technical Expert Reports – Hydrogeology Issues #8 and #93), but did not consider the irreversible effect of reduced hydraulic barrier or increased vulnerability from potential contamination of both aquifers.

Request:

a) Please confirm that downward vertical hydraulic gradients can reasonably be expected to increase during project operations due to pumping from the Winnipeg Sandstone aquifer.

b) Please confirm that downward vertical hydraulic gradients can reasonably be expected after project closure as the multi-aquifer groundwater system establishes a new hydrodynamic equilibrium in response to changes in porosity and hydraulic conductivity caused by mining activities.

c) Please confirm that if past or future anthropogenic activities have or will release contaminants to groundwater in either the Red River Carbonate or the Winnipeg Sandstone aquifers, the deterioration or collapse of the Winnipeg Shale aquitard would result in enhanced contaminant migration between the aquifers.

d) Please confirm that deterioration or collapse of the Winnipeg shale aquitard would increase aquifers vulnerability due to the potential for enhanced cross contamination, and that it could lead to degraded water quality extending beyond the project area in the long-term, for conservative contaminants.

e) Please clarify whether or not it is Sio Silica's position that the effects of deterioration and/or collapse of the Winnipeg Shale aquitard with regards

to potential cross contamination of both aquifers were assessed as part of the EAP.

Response:

a) The majority of the groundwater and sand removed during project operations will be derived from the Winnipeg Sandstone aquifer. During operations, downward vertical gradients can be expected to increase.

b) Following operations, vertical gradients are anticipated to recover to pre-mining conditions and be near zero to slightly downward as they are now.

c) All well owners and drillers in Manitoba are required to construct, operate and abandon groundwater wells in a manner that is protective of Manitoba's groundwater and aquifers as defined under *The Groundwater and Water Well Act* and the Well Standards Regulation. The Red River Carbonate and Winnipeg Sandstone aquifers are deeply buried, so it is highly unlikely that anthropogenic activities will release contaminants to those aquifers. If contaminants were released to the aquifers, they would migrate according to prevailing groundwater flow directions which are primarily horizontal. This is supported by the near zero to relatively small vertical gradients between the aquifers in the project area. Over large distances, longitudinal and transverse dispersion would spread the contaminants across the thickness of the aquifers and typically act to reduce concentrations associated with instantaneous point source releases. If contaminants are somehow introduced adjacent to the Winnipeg Shale aquitard in an area where prevailing hydraulic gradients encourage exchange of groundwater between the two aquifers, it is acknowledged that the deterioration of the shale may allow for enhanced exchange of groundwater and its associated constituents between the two aquifers similar to that observed where existing water wells are screened across both aquifers.

d) Please refer to the response to MBEN/OLS-IR-028(c). As noted in Sections 7.2.2, 7.3 and 8.3,in the Hydrogeology and Geochemistry Assessment, exchange of groundwater between the aquifers was simulated to have both positive and negative effects depending on the constituent and aquifer under consideration. The vertical gradients across the aquitard are relatively small now, and may eventually equalize. If that were to materialize, there would be no hydraulic head difference between the aquifers to force the exchange of groundwater and the potential for exchange between the aquifers could eventually reduce to diffusive flow through openings in the shale.

e) The potential effect of the degradation and/or collapse of the Winnipeg Shale was explicitly evaluated using numerical modelling tools by way of calibration, sensitivity analysis, transient simulations of project activities and scenario analysis. Because the groundwater levels recover to pre-mining levels for all scenarios, the vertical gradients across the Winnipeg Shale are interpreted to remain similar to existing conditions (i.e. zero to slightly downward) at the regional scale. Hence, the exchange of

groundwater between the aquifers is anticipated to be similar to that observed presently. Local scale exchange may occur through any areas where the Winnipeg Shale has degraded or collapsed and where there is also a hydraulic gradient driving exchange of groundwater between the two aquifers.

IR Number: **MBEN/OLS-IR-029**

Submitted by: MBEN/OLS

Date Submitted: January 10, 2023

Subject Matter: Aquifer integrity

Reference: CEC-IR-009

DLN-IR-009

Sio Silica Supplemental Filing #3

Preamble CEC-IR-009 requested that Sio Silica describe its closure approach that will be used to prevent groundwater flow between aquifers if portions of the overlying Red River Carbonate and/or Winnipeg Shale formations collapse into the large silica sand extraction voids.

Also, certain Sio Silica filings refer to the use of a grout plug, and some information request responses refer to a cement plug.

Request:

a) For clarification, with the presence of a grout plug outside of the inner casing (see extraction well design described in Stantec Figure 6 and Sio Silica Supplemental Information Document #1 Figure 2-2) please identify the measures proposed to mitigate inter-aquifer mixing under deterioration or collapse of the Winnipeg Shale aquitard and/or partial collapse of the Red River Carbonate aquifer.

b) Please clarify which method will be used to fill the annulus space between the borehole and the inner casing to maximize vertical hydraulic isolation in the vertical section where the limestone may be possibly fractured from silica sand extraction. Please also provide an explanation justifying the choice between grout and cement, including a discussion of the plug and casing's long-term ability to maintain hydraulic isolation where fractures open over time including in the event of partial collapse of the Red River Carbonate limestone.

Response:

a) Sio intends to 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. Well decommissioning will be conducted in accordance with the Progressive Well Abandonment Plan that will be provided prior to the Hearing.

No shale collapse will occur during well construction. The well abandonment/sealing activities will occur within the wellbore and prevent

surface potential contamination in addition to aquifer isolation within the wellbore.

The scenario of shale collapse, or shale not being present was considered in the Hydrogeology and Geochemistry Assessment and considered to not be a concern should this occur: *"Interconnection between the two aquifers is a common occurrence because many drinking water wells have been screened across the Red River Carbonate and the Winnipeg Sandstone. Should project operations result in a more interconnected aquifer system comprising the Red River Carbonate aquifer and the underlying Winnipeg Sandstone aquifer, groundwater quality would tend to reflect conservative mixing of the two water types (i.e. limited geochemical reactions) resulting in water quality that is similar or slightly better."* As discussed in the response to MBEN-IR-030, Sio will monitor groundwater quality before, during and after extraction operations and will employ appropriate mitigation if this monitoring identifies unexpected results. The details of Sio's groundwater monitoring and mitigation will be set out in its Groundwater Monitoring and Mitigation Plan.

b) Cement is conveyed down the annular space using 1" tremie line. This is a standard water well practice and allows for precise placement of cement.

Cementing is preferred over grouting as grouting can migrate over time. A cement with a 5% bentonite additive allows the cement to be more flexible in the event of any movement or fracture existence/ development. Although grouting is also accepted and utilized regularly in the water well industry.

IR Number: **MBEN/OLS-IR-030**

Submitted by: MBEN/OLS

Date Submitted: January 10, 2023

Subject Matter: Water quality

Reference: MSSAC-IR-021e

Preamble: Sio Silica's response to MSSAC-IR-021e states that "*as indicated in the Hydrogeology and Geochemical Assessment Report, water quality is not anticipated to be materially affected by Project operations. In situations where water quality impacts are observed, there are many examples of sites where water quality impacts can be reversible.*"

Request:

a) Please clarify how mitigative water quality measures can be reversible and sustainable, if inter-aquifer mixing conditions are the root cause of cross contamination between aquifers?

Response:

a) There are several physical and chemical processes that may act to reverse water quality impacts or otherwise attenuate constituent concentrations. The relevance, magnitude, importance and reversibility of each mechanism is different for each constituent. Notable mechanisms that affect contaminant fate and migration include: dispersion, dilution, sorption, chemical precipitation/dissolution, decay and volatilization, among others. Many of the relevant geochemical reactions are equilibrium reactions that are reversible dissolution/precipitation reactions. Others rely on reagents (e.g. oxygen) that are finite in their abundance, and once depleted, prevailing geochemical conditions in advance of disturbance are anticipated to be restored. Further, the groundwater flow pathways are very long which will encourage dispersion and therefore dilution of constituents emanating from a point source into the over/underlying aquifer.

During Sio's water quality testing to date, only one parameter (iron) exceeded Guidelines for Canadian Drinking Water (CDWQ) Aesthetic Objectives (AO) in the Red River Carbonate aquifer. Similarly, two parameters (iron and manganese) exceeded CDWQ AO in the Winnipeg Sandstone aquifer. Iron and manganese have aesthetic objectives only and there is no toxicological concern with the numerical values. Therefore, these parameters are arguably not contaminants. Other parameters (e.g. F, S, etc.) exceed criteria for agricultural/irrigation or aquatic life use in both aquifers.

The most notable changes in concentrations as a result of aquifer mixing were observed for iron and manganese. When dissolved (reduced) iron and/or manganese interacts with oxygen, it will oxidize to a form iron oxyhydroxides or manganese oxide that are less soluble and become relatively insoluble precipitates. Following depletion of oxygen or replacement of local groundwater with anoxic or reduced groundwater, precipitates may redissolve in response to prevailing oxidation-reduction

conditions. In the absence of precipitation/dissolution reactions or other geochemical equilibrium reactions, water quality in the aquifers was simulated to follow a conservative mixing line that reflects proportional mixing of the fresh waters.

IR Number: **MBEN/OLS-IR-031**

Submitted by: MBEN/OLS

Date Submitted: January 10, 2023

Subject Matter: Cumulative Impact Assessment

Reference:

b) CEC-IR-003

c) RMSF-IR-017

d) RMSF-IR-018

e) MSSAC-IR-001

f) Responses to the Technical Expert Reports – Geotechnical, filed November 29, 2022 issue 3

Preamble: In response to RMSF-IR-017 and RMSF-IR-018, the proponent acknowledged the potential for degradation of the Winnipeg shale at each extraction well location, noting that the extents could range from 14 m to 40 m, and would progressively expand over time. The magnitude and extent of this irreversible effect is increasing with the number of extraction wells proposed. With increasing number of extraction wells, the contamination vulnerability of the Red River Carbonate and Winnipeg Sandstone aquifers will increase.

In response to CEC-IR-003, the proponent provided some details on a possible groundwater monitoring plan which is described as "*Sio will actively monitor water quantity and most water quality parameters surrounding its operations 24/7. Additional water quality measurements will be taken regularly before, during and after the extraction activities.*"

Request:

a) In the absence of a cumulative effects assessment (*MSSAC-IR-001; Responses to the Technical Expert Reports – Geotechnical, filed November 29, 2022 issue 3*) covering the entire lifespan of the project, describe what baseline (pre-mining) and operational data from the first phase of the project would be collected and how these data would be analyzed and used to assess the degree of Winnipeg Shale aquitard deterioration that may have occurred over the course of the initial phase of mining, and thereby support regulatory approval for expansion phases to the project.

b) Please clarify how long after the extraction activities are completed, Sio will continue to monitor groundwater quality at downstream monitoring wells, considering the estimated average linear groundwater velocity that is established post-operations.

Response:

a) A groundwater monitoring well network will be established to monitor subsurface conditions in the overburden, Red River Carbonate and Winnipeg Sandstone aquifers in advance of mining. The configuration of the monitoring well network will focus on the perimeter of the 5-year

operational footprint. Wells will be installed in proximity to early-stage extraction wells to monitor system performance and validate previous assumptions and the results of groundwater modelling assessments. As part of routine operations, additional monitoring wells will be established between extraction wells and any nearby private wells to monitor aquifer response to extraction activities.

Baseline information will be collected to determine groundwater elevations, vertical gradients, horizontal gradients, hydraulic properties, infiltration rates and groundwater quality prior to development, during operations and following operations.

Aquifer testing will be conducted in all monitoring wells following installation and well development. A pumping test will be conducted on at least one large diameter extraction well within the centre of the annual operational footprint to measure local aquifer properties and determine if they are significantly different from those previously determined or assigned in the groundwater model.

Infiltration testing will be conducted at up to twenty (20) locations within the 5-year operational footprint to directly measure infiltration rates using a Guelph Permeameter. Combined with groundwater level monitoring in the overburden aquifer, this information will be used to understand the spatial variability in groundwater recharge rates across the study area.

Groundwater elevations will be continuously monitored using pressure transducers to understand seasonal fluctuations. Manual water levels will be recorded monthly from monitoring wells and dataloggers will be downloaded if not connected via telemetry. Water levels will be measured in private water wells in advance of, during and following any extraction activities.

Groundwater quality sampling will be conducted quarterly for perimeter monitoring wells, and monthly for wells in proximity to extraction wells during operations. Samples will be collected directly from private water wells in advance of any extraction activities, and again during and after operations. Sampling activities will continue at a quarterly frequency following operations for at least five years. Monitored parameters will include field parameters, physical parameters, anions, dissolved and total metals, pathogens and isotopes.

Data will be evaluated on a regular basis (minimum annually) and the results will be shared publicly. Groundwater in proximity to ongoing operations and private wells will be monitored and evaluated monthly. A comprehensive database of borehole logs, groundwater elevations, aquifer testing results, infiltration testing results and groundwater quality will be developed and maintained. Specific attention will be focused on evaluation of the water balance and the response of water levels in both aquifers to sand extraction and groundwater reinjection. The results of monitoring will be used to

validate the existing numerical groundwater model. Any material differences between simulated changes and measured data during operations will be rectified by refining the conceptual model, recalibrating the numerical groundwater model or addressing any residual data gaps. Mitigations will be implemented in accordance with the Trigger Action Response Plan (TARP) outlined in the Groundwater Monitoring and Mitigation Plan which will be provided in advance of the Hearing.

b) Groundwater monitoring will continue for at least five years following completion of sand extraction and well decommissioning activities. Thresholds for cessation of monitoring will include groundwater levels that have recovered to baseline conditions and are in dynamic equilibrium with the surrounding aquifer, and groundwater quality that is similar to baseline conditions.

IR Number: **MBEN/OLS-IR-032**

Submitted by: MBEN/OLS

Date Submitted: January 10, 2023

Subject Matter: Soil quality

Reference: MBEN/OLS-IR-008

Preamble: Sio Silica explained that baseline soil quality was not obtained and not included in the EAP.

Request:

a) Please explain the measures, if any, Sio Silica intends to implement to ensure that any contaminants that may be present in the soil at project component locations are not introduced to the affected aquifers through project activities.

Response:

a) Soils will be visually inspected within the annual operational footprint to determine the potential for surface contamination. It is anticipated that agricultural runoff from livestock grazing areas or manure stockpiles have the greatest potential for contamination of soils. Where it is deemed necessary based on the results of the inspection, soil samples will be collected and analyzed for contaminants that may be present based on the type of contaminant source observed (hydrocarbons, metals, nutrients, pathogens, pesticides). Should contamination be confirmed through chemical testing, remedial action (removal of contaminant source, removal of contaminated material) will be undertaken prior to the initiation of drilling operations. Introduction of contaminants into the aquifer will further be prevented with the implementation of the Follow-up Plans identified in Section 8 of the EAP, including the Progressive Well Abandonment Plan which will minimize the potential for preferential pathways connecting ground surface to the aquifers. Positive drainage will be established to divert any surface water away from drilling locations.

IR Number: **MBEN/OLS-IR-033**

Submitted by: MBEN/OLS

Date Submitted: January 10, 2023

Subject Matter: Biophysical and socioeconomic components affected

Reference: MBEN/OLS-IR-12

Preamble: Sio Silica explained that "there is no one method that is universally accepted provincially, nationally or globally by all regulatory authorities. The effects assessment approach and methods described in Section 6.1 of the EAP have been used by AECOM in EAP submissions for other proposed developments and have not been deemed an unacceptable approach by the Manitoba Environmental Approvals Branch."

Request:

a) Please provide a reference confirming that the effects assessment approach and methods described in section 6.1 of the EAP are consistent with best practice.

Response:

a) As indicated in the Preamble, the effects assessment approach and methods described in Section 6.1 of the EAP have been used by AECOM in EAP submissions for other proposed developments and have not been deemed an unacceptable approach by the Manitoba Environmental Approvals Branch (EAB). The matrix method developed by AECOM follows a common approach that is widely utilized and accepted within the environmental assessment community and regulatory agencies across Canada. If the effects assessment approach and methods used by AECOM were deemed unacceptable by the EAB, we expect that the EAB would not have accepted EAPs produced by AECOM, and the EAB would not have issued Environment Act Licences (EALs) for other projects based on AECOM EAPs (e.g., Vivian Sand Facility Project; EAL No. 3367).

IR Number: **MBEN/OLS-IR-034**

Submitted by: MBEN/OLS

Date Submitted: January 10, 2023

Subject Matter: Biophysical and socioeconomic components affected

Reference: MBEN/OLS-IR-014(a), (b)

MBEN/OLS-IR-015

Preamble: Sio Silica declined to apply the Noble (2015) General Classification System to each potential interaction identified in Table 6-1. However, even using AECOM's selected classification system the discussions in sections 6.2 through 6.6 only address each biophysical or socioeconomic component rather than each potential interaction.

Request:

a) Please prepare and file revised versions of sections 6.2 through 6.6 of the EAP to apply AECOM's selected classification system to each individual potential interaction identified in Table 6-1.

b) Please explain how the level of detail provided by Sio Silica in sections 6.2 through 6.6 of the EAP provide sufficient information for the identification of all potential environmental risks as indicated in the response to MBEN/OLS-IR-015.

Response:

a) Sio maintains that the environmental assessments conducted for the extraction proposal meet or exceed applicable regulatory requirements, and allow the CEC and interested parties to reasonably understand and assess the potential environmental effects of the proposal. For this reason, Sio declines to conduct the additional work set out in this request.

b) See response to A, and also the response to MBEN/OLS-IR-33.

IR Number: **MBEN/OLS-IR-035**

Submitted by: MBEN/OLS

Date Submitted: January 10, 2023

Subject Matter: Heterogeneity of aquifers and aquitards

Reference: MBEN/OLS-IR-019

Preamble: In their report, Holländer and Woodbury refer to publications not referenced in the EAP to note that "the conceptual model provided by the proponent overlooks the documented heterogeneity of the aquifers and aquitards."

The CEC Technical Advisors note further that "there is considerable information on material heterogeneity not considered by the proponent." Throughout their report, the authors identify multiple of these additional sources.

Sio Silica declined to provide the sources referenced by the CEC technical advisors.

Request:

a) Please provide an explanation of Sio Silica's choice to exclude the documented heterogeneity noted in the preamble from its evidence, including an explanation reconciling its evidence with the body of literature referenced by the CEC technical advisors as noted in the Preamble.

Response:

a) Industry standard methods for hydrogeological modelling include utilization of staff with education and experience in hydrogeology and groundwater modelling, application of methods that have a sound theoretical basis, following regulatory guidelines, interpretation of data using sound geological principles, conducting an extensive literature review, following industry guidelines for groundwater modelling (e.g. BC MoE 2012), utilization of peer-reviewed software and codes (AQTESOLV Professional 4.5, PHREEQC, FEFLOW, etc.), analysis of environmental samples at Canadian Association for Laboratory Accreditation (CALA) certified laboratories, and application of professional judgment. Refer to the Responses to Technical Expert Reports – Hydrogeology, filed November 29, 2022, issues #3, #4, #6, #8, #9, #17, #18 and #19 for discussion with regard to characterization of aquifers and incorporation of field data into the three-dimensional model.

The allegation that "there is considerable information on material heterogeneity not considered by the proponent" is unfounded. As demonstrated in several locations within the Hydrogeology and Geochemistry Assessment, the information discussed by the CEC technical advisors was considered during literature review, conceptual model development, numerical groundwater model calibration, sensitivity analysis and scenario analysis, and is discussed in several locations within the report. The ability of the model to achieve acceptable calibration statistics when reasonable hydraulic properties and boundary conditions have been assigned is evidence that the model is not overly simplified, and

the simplifications invoked by AECOM were reasonable and knowingly made as is routine in the field of applied hydrogeology.

IR Number: **MBEN/OLS-IR-036**

Submitted by: MBEN/OLS

Date Submitted: January 10, 2023

Subject Matter: Project Area

Reference: Sio Silica Responses to CEC Technical Reports – Hydrogeology Issue 4

Preamble: Sio Silica does not dispute the CEC technical experts' finding that the "project area is crudely estimated at 168,000 hectares…"

Request:

a) Please reconcile the figure in the Preamble with the statement on the Sio Silica website asserting that the project area covers "over 85,000 hectares…"

Response:

a) Sio's website states "the company has secured a total of 390 mining claims, which covers over 85,000 hectares of land." The 85,000 hectares relates only to the area of land associated to Sio's claims.

Sio is not clear where the 168,000 hectare value came from in the Reference. This is not a value Sio has ever released.