Manitoba Clean Environment Commission
Hearing for the Vivian Silica Sand Extraction Project (Project)

Sio Silica Corporation (SSC) Responses to Information Requests (IRs) Round No. 1

Part 1 – MBEN/OLS IR 001, 002, 007, 008, 010 to 016, 021, 026 and 027

IR Number: **MBEN/OLS-IR-001**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Air Quality

Reference:
i) Environment Act Proposal at vii, 37 (section 4.2.1), 69 (section 6.3.1)

ii) "Technical Review of Sio Silica Corporation's Environment Act Project Proposal", 13 September 2022, prepared by Arcadis Canada Inc. at 19-20 (Conclusion #8).

Preamble: Sio Silica concludes that "the impact of the Project on air quality is assessed as minor to negligible."

Arcadis Inc. notes that "Quantitative analyses are required to confirm the Proponent's conclusions that the Project will not result in significant air quality impacts. These analyses should include baseline air quality assessments, the preparation of emissions inventories, atmospheric dispersion modelling and air quality monitoring."

Request:
b) Please provide an explanation, including any testing, modeling, or analysis completed, supporting Sio Silica's conclusion that "the impact of the Project on air quality is assessed as minor to negligible."

c) Please describe the decision-making process by which it was determined that "the impact of the Project on air quality is assessed as minor to negligible."

d) Please provide explanations of why the assessments identified by Arcadis Inc. as necessary to support Sio Silica's conclusion with respect to Project impacts on air quality were not conducted.

Response:
a) As stated in the Responses to the Technical Expert Reports – Geotechnical, filed November 29, 2022 issue 9 and in the response to MSSAC-IR-007(a):

"*Arcadis is in agreement that the Extraction Project is unlikely to result in the atmospheric emissions of silica sand that would have a significant negative impact on air quality.*

However, Arcadis suggests that a quantitative analysis of emissions from mobile and stationary equipment be conducted. It is our opinion that the

quantitative analysis proposed by Arcadis, including the development of an air emissions inventory and air dispersion modelling, is not warranted given the scope and scale of the Extraction Project. 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. Where possible, equipment will be electrified thereby further reducing the potential for emissions. For these reasons, Sio concluded that this equipment and activity would not cause significant air quality impacts.

The greenhouse gas (GHG) calculations for the EAP (Section 6.3.2) are based on guidance in Canada's Greenhouse Gas Quantification Requirements (Environment and Climate Change Canada, 2019). The annual calculations reflect the full numbers of diesel equipment types, expected engine Tier (i.e., age of equipment), hours of operation (detailed in the EAP, Table 6-3) and fuel consumption during extraction operations. The calculation also includes all electrical power consumed for extraction activities.

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."

b) See the response to MBEN/OLS-IR-001(a).

c) See the response to MBEN/OLS-IR-001(a).

IR Number: **MBEN/OLS-IR-002**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Air Quality

Reference:

i) Environment Act Proposal at vii, 37 (section 4.2.1), 69 (section 6.3.1)

ii) "Technical Review of Sio Silica Corporation's Environment Act Project Proposal", 13 September 2022, prepared by Arcadis Canada Inc. at 19-20 (Conclusion #8)

Preamble

At section 4.2.1 of its Environment Act Proposal, Sio Silica acknowledges multiple regional influences on air quality including adjacent agriculture and open-pit aggregate/quarry operations, vehicle traffic, and rail traffic within, adjacent to, and near the project site.

Sio Silica has also stated that "the impact of the Project on air quality is assessed as minor to negligible."

Request:

a) Please explain and demonstrate how the regional influences listed in section 4.2.1 were taken into account in assessing the impact of the Project on air quality.

Response:

a) A cumulative impact assessment regarding air quality that would consider past, current and reasonably foreseeable regional influences on air quality is not an information requirement for the Environment Act Proposal as per the Province of Manitoba's *Information Bulletin – Environment Act Proposal Report Guidelines.* Also see response to MBEN/OLS-IR-001.

IR Number: **MBEN/OLS-IR-007**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Waste Management

Reference: i) Environment Act Proposal section 2.3.3

Preamble: Sio Silica explains in its EAP that drill cuttings generated from operations will be captured and contained, and that "as containment fills up, these cuttings will be disposed of in accordance with applicable regulations."

Request:

a) Please provide a detailed description of the plan for containment of drill cuttings.

b) Please provide a detailed description of the plan for disposal of drill cuttings.

c) Please identify the "applicable regulations" which are to guide the disposal of drill cuttings.

Response:

a) Please refer to the Responses to the Technical Expert Reports – Geotechnical, filed November 29, 2022 issue 16 on Follow Up Plans.

b) Please refer to the Responses to the Technical Expert Reports – Geotechnical, filed November 29, 2022 issue 16 on Follow Up Plans.

c) Applicable regulations regarding the disposal of drill cuttings include: Drilling and Production Regulation under *The Oil and Gas Act*; the Waste Management Facilities Regulation under *The Environment Act*; *The Dangerous Goods Handling and Transportation Act* and associated regulations. As indicated in Section 1.7.2 of the EAP, a Closure Plan will be developed and submitted for this Project in accordance with the Manitoba Mine Closure Regulation 67/99 General Closure Plan Guidelines.

IR Number: **MBEN/OLS-IR-008**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Soil

Reference: i) Environment Act Proposal page vi; section 6.2.2

Preamble: The Proponent's discussion of soils in the EAP relate solely to risks of erosion and does not address contamination.

Request:

a) Please confirm that no assessment of soil quality was undertaken and that no data on baseline soil quality is included in the EAP.

b) If confirmed, please provide an explanation of how Sio Silica determined that the proposed Project did not pose potential risks to soil quality such that an assessment of soil quality was not necessary.

c) If an assessment of soil quality was undertaken, please provide it.

Response:

a) Data on baseline soil quality was not obtained and not included in the EAP for the following reasons:

1. It is expected that soil quality within the proposed locations of project components will be of similar quality to the soil within most of the undeveloped region. Project components will be placed in locations that have not been subject to industrial or other development and therefore the presence of existing contaminants in not expected.

2. The specific locations of where Project components will be placed and areas where soil will be disturbed have not been finalized. Locations will be finalized during the detailed design stage.

To properly assess native soil conditions prior to development, soil samples will be sampled and tested at the confirmed project locations prior to development to establish baseline soil conditions. Proposed mitigation measures provided in Section 6.9 of the EAP regarding Accidents and Malfunctions are the measures that will be applied to minimize the probability of soil contamination. Implementation of the Waste Characterization and Management Plan as outlined in Section 8.1 of the EAP will also minimize the potential for Project impacts on soil quality.

b) See the response to MBEN/OLS-IR-008(a).

c) See the response to MBEN/OLS-IR-008(a).

IR Number: **MBEN/OLS-IR-010**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Extracted materials

Reference: i) Environment Act Proposal at page 3

Preamble: Sio Silica claims that the silica sand resource to be extracted is of "high purity", averaging 99.85%" Silica Dioxide.

Request:

a) Please identify the remaining components of the sand resource other than Silica Dioxide.

b) Please provide the data and results of analysis in support of the response to #1.

Response:

a) The other minor elemental components in the parts per million can include: sulfur, magnesium, barium, boron, nickel, manganese, chromium, copper, titanium, strontium, zirconium, iron, cerium, aluminum, calcium, lithium, potassium, yttrium and sodium.

b) Refer to the response to DLN-IR-006(b) – Appendix A for an example of lab results.

IR Number: **MBEN/OLS-IR-011**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Wildlife; Amphibian Surveys

Reference: i) Environment Act Proposal at page 44, section 4.4.2

Preamble: Section 4.4.2 of the EAP explains that amphibian surveys were conducted within the regional project area during a period from May 14, 2018 to May 18, 2018.

Request:

a) Please confirm whether or not subsequent amphibian studies have been conducted since May of 2018.

b) Please provide a detailed analysis determining whether or not the May 2018 amphibian study provides reliable baseline data of the regional amphibian population in 2022 and into the future. Please include an explanation of whether, for example, the precipitation levels in the Winter of 2017/18 and Spring of 2018 and surface water levels in Spring 2018 were above, below, or consistent with average levels for the region.

Response:

a) No further amphibian surveys have occurred since May 2018.

b) The limited amount and type of landcover within the Project Site (EAP, Section 4.4.1 'Vegetation') that may potentially provide suitable amphibian habitat from year to year with varying precipitation levels, and that may be disturbed by Project activities, does not warrant additional amphibian surveys or detailed investigations of historic and future precipitation levels. The existing landcover was considered in the determination of Project effects on regional wildlife populations, including amphibian regional populations. With the application of the mitigation measures proposed in Section 6.5 'Terrestrial Environment' of the EAP, Project effects on wildlife, including regional amphibian populations, was assessed as negligible.

IR Number: **MBEN/OLS-IR-012**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Effects Assessment Methods

Reference: i) Environment Act Proposal at page 62-63, Section 6.1

Preamble: Sio Silica's EAP explains that "the biophysical and socioeconomic components potentially affected by the project due to the potential for interactions with the Project activities and components" were identified based on two considerations:

- Professional judgment; and
- An understanding of Project components, construction methods, operation processes and the assumption that standard environmentally responsible construction techniques and operating procedures will be applied during Project construction, operation and decommissioning/closure.

Request:

a) Please provide an explanation justifying the selection of the two considerations noted above and on page 62 of the EAP. Please also include any applicable references to literature supporting these considerations as elements of best practice in environmental impact assessment.

b) Recognizing that identification of potential interactions between project components and biophysical or socioeconomic components relied on the professional judgment and understanding of the Project held by certain individuals, please provide the following information:

   a) The role or title of the individuals who identified the potential interactions by exercising these two considerations;

   b) The qualifications of these individuals; and

   c) An explanation of the connection between these qualifications and each of the determinations made in section 6 of the EAP respecting potential interactions between project components and biophysical or socioeconomic components.

Response:

a) The Province of Manitoba's *Information Bulletin – Environment Act Proposal Report Guidelines* do not stipulate any specific environmental assessment document/reference that must be applied to complete the effects assessment in the EAP. There are many published documents available that describe various frameworks, guidelines and methods for environmental assessment. 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.

b) The environmental assessment within the EAP was coordinated by Marlene Gifford, M.Sc., P.Biol., R.P.Bio. (Terrestrial and Aquatic Environment Lead) of AECOM. She has over 27 years of environmental assessment experience. Marlene also completed the environmental assessments for the Socioeconomic Environment valued components, except Heritage Resources. Marlene coordinated environmental assessment input included in the EAP from the following technical specialist leads from AECOM: Ryan Mills, M.Sc., P.Geo. (MB, BC, AB) for Hydrogeology and Geochemistry; and Randy Rudolph. M.Sc. for Air Quality / GHG Inventory. Additionally, the geotechnical assessment was led by Steve Bundrock, P.Eng. and Arash Eshraghian, Ph.D., P.Eng. of Stantec, and Heritage Resources were assessed by Lisa Bobbie, M.A., of Western Heritage.

IR Number: **MBEN/OLS-IR-013**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Effects Assessment Methods

Reference: i) Environment Act Proposal at page 64, Table 6-2

Preamble: Table 6-1 in the EAP identifies potential interactions between various biophysical and socioeconomic components and project activities.

Table 6-2 describes each of the 6 criteria used to evaluate potential environmental impacts associated with the potential interactions identified in Table 6-1.

Sections 6.2 through 6.6 apply the criteria described in Table 6-2 to the potential impacts on biophysical and socioeconomic components identified in Table 6-1.

Request:

a) Please explain the source and selection process for each of the six criteria described in Table 6-2.

b) Please confirm that the criteria described in Table 6-2 differ from the criteria set out in the General Classification System for Environmental Effects and Impacts, found in the leading text on environmental impact assessment [Noble, B. (2015). Introduction to Environmental Impact Assessment: A Guide to Principles and Practice (3rd ed.). Don Mills, ON: Oxford University Press at p 129, Table 6.5]. Please also confirm that the General Classification System in the Noble textbook was not used to characterize the potential environmental impacts described throughout section 6 of the EAP.

Response:

a) See the response to MBEN/OLS-IR-012(a). The criteria listed in Table 6-2 of the EAP are typical criteria used in environmental effects assessments (e.g., see Sec. 9 of the federal 'Generic Guidelines for the Preparation of an Environmental Impact Statement – Pursuant to the Canadian Environmental Assessment Act, 2012 - Canadian Nuclear Safety Commission').

b) See the response to MBEN/OLS-IR-012(a).

IR Number: **MBEN/OLS-IR-014**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Effects Assessment Methods

Reference: i) Environment Act Proposal at page 64, Sections 6.2-6.6

Preamble: Table 6-1 identifies potential interactions between various biophysical and socioeconomic components and project activities.

Table 6-2 describes each of the 6 criteria used to evaluate potential environmental impacts associated with the potential interactions identified in Table 6-1.

Sections 6.2 through 6.6 apply the criteria described in Table 6-2 to the potential impacts on biophysical and socioeconomic components identified in Table 6-1.

Request:

a) Please explain why sections 6.2 through 6.6 of the EAP provide general descriptions of the potential impacts on each biophysical or socioeconomic component, but do not describe the potential impacts related to each individual interaction identified in Table 6-1.

b) Please prepare and file revised versions of sections 6.2 through 6.6 of the EAP that apply the General Classification System for Environmental Effects and Impacts from Noble, B. (2015) to each individual interaction identified in Table 6-1. For greater clarity, this will involve an application of the General Classification System to each "x" in Table 6-1, rather than only to each biophysical or socioeconomic component.

Response:

a) See the response to MBEN/OLS-IR-012 (a).

b) See the response to MBEN/OLS-IR-012 (a).

IR Number: **MBEN/OLS-IR-015**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Uncertainty

Reference: i) N/A

Preamble: It is acknowledged on the record of this proceeding[1] that there is uncertainty respecting the potential environmental risks and impacts of the proposed Project.

Request:

a) Please provide a consolidated list of all identified sources of uncertainty respecting the potential environmental risks and impacts of the proposed Project.

Response:

a) The level of uncertainty of Project effects on the environment after the application of mitigation measures described in the EAP is considered in the determination of potential impacts on biophysical and socioeconomic components. When the level of uncertainty is sufficiently high, follow-up programs are implemented, and adaptive management actions may be required. Section 8.1 of the EAP, and responses to the Technical Advisory Committee and the public comments on the EAP filed in December 2021 and January 2022, lists the follow-up plans that will be implemented that are expected to address uncertainty respecting the predicted impacts of Project activities during the construction, operation, and decommissioning phases.

[1] See, for example, the October 28, 222 Response to the Motions filed by Sio Silica.

IR Number: **MBEN/OLS-IR-016**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: GHG Emissions

Reference: i) Environment Act Proposal at page viii

Preamble: Sio Silica has assessed the Project's impacts on GHG contributions to the atmosphere as "negligible".

The EAP also notes that "Overall, the Project is estimated to generate 0.006797411 tonnes (Mt) of CO2e annually with the application of the above mitigation measures, which is 0.0296% of the reported Manitoba emissions in 2019 which were 23 Mt CO2e, about 0.000931% of the reported 730 Mt CO2e from Canada in 2019."

Request: a) Please provide the calculations underlying the estimates of GHG emissions referenced in the Preamble.

Response: a) The GHG emission rates from the significant sources of Project emissions were estimated in accordance with requirements of Canada's greenhouse gas quantification. The maximum emission scenario will occur when all processes and equipment within the Facility are operating simultaneously at their maximum production capacity.

The extraction operation requires various types of equipment that are used in the extraction, drilling, sealing, and support phases, respectively. These equipment all use diesel fuel and emit greenhouse gases through combustion. Environment and Climate Change Canada's recommended emissions calculations were applied to each type of equipment. The GHG emission factors were obtained by using the ECCC (2020a) greenhouse gas quantification requirements. The following table lists the emission factors for each piece of equipment used in the process of calculating direct emissions for the project.

Table 1: Emission Factors for Direct Emission Equipment (ECCC, 2020b)

Equipment Category	Tier	CO_2 Emission Factor (kg/kl)	N_2O Emission Factor (kg/kl)	CH_4 Emission Factor (kg/kl)
Global Warming Potential (GWP)		**1**	**298**	**25**
EXTRACTION				
10 x Extraction Rigs- Off-Road	**4**	**2681**	**0.227**	**0.073**

Compressor trailer for extraction / OFD1550 Tier 4 Final Oil Free Rotary Screw Air Compressor	**4**	**2681**	**0.227**	**0.073**
Excavator per cluster	**4**	**2681**	**0.227**	**0.073**
Light Plant x 8 - Stationary	**4**	**2681**	**0.022**	**0.078**
Flat Deck Truck (2015 F650 XLT Super Duty w/ 17' bed)	**4**	**2681**	**0.227**	**0.073**
Zoom Boom / Manitou MT 5519 Telescopic Handler	**4**	**2681**	**0.227**	**0.073**
DRILLING				
TH60 for Drilling	**3**	**2681**	**0.022**	**0.073**
DR24 for Drilling	**4**	**2681**	**0.227**	**0.073**
2022 Ford F750 Water Truck Heavy Duty	**4**	**2681**	**0.227**	**0.073**
Grouting System	**4**	**2681**	**0.022**	**0.073**
SEALING				
DR24 for Abandonment	**4**	**2681**	**0.227**	**0.073**
Picker Truck On-Road	**4**	**2681**	**0.227**	**0.073**
SUPPORT				
Welding Truck F350 Light Duty	**4**	**2681**	**0.227**	**0.073**
Mechanical Service Truck F350 Light Duty	**4**	**2681**	**0.227**	**0.073**
SLURRY HANDLING				
CAT C18 Diesel Generator Set - Stationary	**4**	**2681**	**0.022**	**0.078**
Pipe Welding Machine - Stationary	**4**	**2681**	**0.022**	**0.078**
Vac Truck	**4**	**2681**	**0.227**	**0.073**

The following are sample emission calculations for direct emissions. Global warming potentials were obtained from ECCC (2019).

Equipment Information:

- Equipment type: Extraction Rig
- Utilization: 6000 hrs per year
- Fleet Size: 10
- Total Utilization: Fleet Size x Utilization for each unit = 60000 hrs per year
- Fuel Consumption per each unit: 14.82 LPH
- Fuel type: Diesel, Tier 4

According to ECCC (2020b), the emission factors for onsite transportation equipment >= 19kW, Tier 4 are:

- CH_4: 0.073 kg/kl
- CO_2: 2681 kg/kl
- N_2O: 0.227 kg/kl

Total Fuel Consumption =Total Utilization $*$ Fuel consumption per each unit:

Total Fuel Consumption $=60{,}000\frac{hr}{yr} * \ 14.82\frac{L}{hr} * \frac{kl}{1000L} = 889.2\ kl/yr$

CO_2 Emission (kg/yr) = CO_2 Emission Factor (kg/yr) * Total Fuel Consumption

CO_2 Emission (kg/yr) $=2681\frac{kg}{kl} * \frac{889.2kl}{yr} = \ 2{,}383{,}945\ kg/kl$

CH_4 Emission (kg/yr) = CH_4 Emission Factor (kg/yr) * Total Fuel Consumption

CH_4 Emission (kg/yr) = $0.073\frac{kg}{kl} * \frac{889.2kl}{yr} = \ 65\ kg/kl$

N_2O Emission (kg/yr) = N_2O Emission Factor (kg/yr) * Total Fuel Consumption

N_2O Emission (kg/yr) = $0.227\frac{kg}{kl} * \frac{889.2kl}{yr} = \ 202\ kg/kl$

Total CO_2e GHG Emission from Extraction Rig (kg CO2e/yr.) = CO_2 Emission * CO_2 global warming potential (GWP) + N_2O Emission * N_2O GWP + CH_4 Emission * CH_4 GWP

Total CO_2e GHG Emission $=2{,}383{,}945\frac{kg}{kl} * 1 + 65\frac{kg}{kl} * 25 + 202\frac{kg}{kl} * 298 =$

$2{,}445{,}719\ kg\ CO2e/yr$

Indirect emissions from electricity use in operations were based on estimated consumption and the GHG intensity of the grid. Environment and Climate Change Canada's recommended emissions calculations were applied to power consumption of equipment. The GHG emission factors were obtained by using the greenhouse gas quantification requirement's publication which is accessible at ECCC (2020a) and summarized in Table 2.

Table 2: Emission Factor for Indirect Emissions

Equipment Category	CO_2e Emission Factor (g CO2 eq/kWh)
POWER CONSUMPTION	
Pump Station	**1.3**

Following is a sample calculation of indirect emissions using the following equipment information:

- Equipment Type: Pump station
- Utilization: 8,784 hrs per year. To be conservative, it was assumed that the pump station runs 24 hours a day for 366 days in the year.
- Fleet Size: 1
- Total Utilization: Fleet Size x Utilization for each unit = 8,784 hrs per year
- Power Consumption per each unit: 1,460 hp

According to ECCC (2021), the emission factor for electricity grid in the province of Manitoba is 1.3 g CO2 eq/kWh for the year 2018.

Total Power Consumption =Total Utilization $*$ Power consumption per each unit

Total Power Consumption =$8{,}784\frac{hr}{yr} * \ 1460\ hp = 12{,}824{,}640\left(\frac{hp-hr}{yr}\right)$ =$9{,}563{,}334\left(\frac{kWh}{yr}\right)$

Total CO_2e GHG Emission (kg CO2e/yr) = CO_2 Emission Factor (kg CO2e/KWh) * Total Power Consumption (KWh/yr)

Total CO_2e GHG Emission = $1.3\ \frac{\text{g CO2eq}}{\text{kWh}} * \ 9{,}563{,}334\left(\frac{kWh}{yr}\right) * \frac{kg}{1000g} = 12{,}432\ \text{kg CO2e/yr}$

References:

1. Environment and Climate Change Canada (ECCC), 2021:
National Inventory Report 1990 – 2019: Greenhouse Gas Sources and Sinks in Canada; Canada's Submission to United Nations Framework Convention on Climate Change, retrieved from:
https://publications.gc.ca/collections/collection_2021/eccc/En81-4-1-2019-eng.pdf

2. Environment and Climate Change Canada (ECCC), 2020a:
Canada's Greenhouse Gas Quantification Requirements; Greenhouse Gas Reporting Program (December 2020), retrieved from:
https://publications.gc.ca/collections/collection_2021/eccc/En81-28-2020-eng.pdf

3. Environment and Climate Change Canada (ECCC), 2020b:
National Inventory Report 1990 – 2018: Greenhouse Gas Sources and Sinks in Canada; Canada's Submission to United Nations Framework Convention on Climate Change, retrieved from:
https://publications.gc.ca/collections/collection_2020/eccc/En81-4-2018-3-eng.pdf

4. Environment and Climate Change Canada (ECCC), 2019:
Global Warming Potentials for Greenhouse Gases; Fourth Assessment Report, retrieved from:
www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/quantification-guidance/global-warming-potentials.html.

IR Number: **MBEN/OLS-IR-021**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Groundwater drawdown

Reference: i) "Technical Review: Sio Silica Corporation's Environment Act Project Proposal", 19 September 2022, prepared by Dr. Hartmut Holländer and Dr. Allan Woodbury at page 7.

Preamble: In their report, Holländer and Woodbury found at page 7 of their report that "there was no testing at a pilot-project site in which the aquifer was actually mined out and drawdowns were measured at various locations from a producing well cluster."

Request: a) Please provide the analysis supporting Sio Silica's assertions set out in its EAP respecting the characteristics of the impacted aquifers and their likely responses to Project activities in light of the finding noted in the Preamble.

Response: a) As stated in the Responses to the Technical Expert Reports – Hydrogeology, filed November 29, 2022 issue 15:

"Several pilot test extractions have been conducted over the past several years by Sio Silica. The data and learnings from these tests have been leveraged into the work to date and will inform the follow up plans, such as the Groundwater Monitoring and Mitigation Plan.

"Mining out" of the aquifer is not permitted until an Environment Act Licence (EAL) is issued. In the absence of an EAL, no mining activity has occurred to date."

See also the response to MSSAC-IR-012 (b) and DLN-IR-009(f).

"IR Number: **MBEN/OLS-IR-026**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Microbial populations in the air

Reference:
i) "Technical Review of Sio Silica Corporation's Environment Act Project Proposal", 13 September 2022, prepared by Arcadis Canada Inc. at page 18.

Preamble: Arcadis Canada Inc. found at page 18 of its report that "the Project Proposal does not address the risks associated with any microbial populations present in the air that will be injected into the aquifer during sand extraction. At minimum, Arcadis expected the Project Proposal would include a qualitative discussion of this risk but none was provided."

Request:
a) Please confirm that no assessment of microbial populations present in the air was undertaken by Sio Silica in preparing its EAP. Please also confirm that no assessment of the risk or potential impacts of microbial populations being injected into the aquifer during sand extraction was undertaken.

b) If confirmed, please provide an explanation of how Sio Silica determined that potential microbial populations present in the air that may be injected into the aquifers do not pose potential risks to the aquifers such that these assessments were not necessary.

c) If assessments of microbial populations present in the air or the risk and impacts of these populations being injected into the aquifer were conducted, please provide them.

Response:
a) Refer to responses DLN-IR-001(b), (c) and (d).

Also refer to Responses to the Technical Expert Reports – Geotechnical, filed November 29, 2022 issue 7 and 8.

b) See the response to MBEN/OLS-IR-026(a).

c) Not applicable

IR Number: **MBEN/OLS-IR-027**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Accidents and Malfunctions

Reference: i) "Technical Review of Sio Silica Corporation's Environment Act Project Proposal", 13 September 2022, prepared by Arcadis Canada Inc. at page 26.

Preamble: Arcadis Canada Inc. found at page 26 of their report that "the Project Proposal and supporting documents do not include an assessment of impacts that would be caused by accidents and malfunctions."

Request:

a) Please confirm that the project proposal and supporting documents do not include an assessment of impacts that would be caused by potential accidents and malfunctions.

b) If Sio Silica has not considered these potential impacts, please explain why not.

c) If Sio Silica has considered these potential impacts, please provide a list of these potential impacts and explanation of the mitigation and/or response plans for each.

Response:

a) As stated in the Responses to the Technical Expert Reports – Geotechnical, filed November 29, 2022 issue 15:

"Potential impacts and mitigation measures associated with accidents and malfunctions is provided in Section 6.9 of the EAP.

It should be noted that the Project has been specifically designed such that no subsidence is expected. If the assumption is made that a major subsidence at surface has occurred, impacts would be limited to Project areas within the extraction area with progressively lesser impacts further from the extraction area. This would be expected to result in little to no impacts outside the Project area."

a) See the response to MBEN/OLS-IR-027(a).

b) See the response to MBEN/OLS-IR-027(a).

Manitoba Clean Environment Commission
Hearing for the Vivian Silica Sand Extraction Project (Project)

Sio Silica Corporation (SSC) Responses to Information Requests (IRs) Round No. 1

Part 2 – MBEN/OLS IR 003 to 006, 009, 017, and 019-025

IR Number: **MBEN/OLS-IR-003**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Groundwater Quality

Reference: i) Environment Act Proposal Appendix A at p 46; Table 4-7

Preamble: Appendix A to the Environment Act Proposal confirms that groundwater samples were submitted for analysis of parameters which included Dissolved Metals

Table 4-7 in Appendix A to the Environment Act Proposal appears to confirm that groundwater samples were assessed for dissolved metals.

Request:

a) Please confirm that the groundwater samples analysed for the purposes of the Environment Act Proposal were assessed for dissolved metals and not for total metal concentrations.

b) Please confirm that the standards set out in the 2022 Canadian Drinking Water Quality Guidelines for assessment of water samples are intended for comparison against total metal concentrations.

c) Please file a copy of the 2022 Canadian Drinking Water Quality Guidelines on the record of this proceeding.

d) Please confirm that the Canadian Council of Ministers of the Environment Water Quality Guidelines for the Protection of Agriculture Water (for both Irrigation Water Use and Livestock Water Use) are intended for comparison against total metal concentrations.

e) Please file copies of the Canadian Council of Ministers of the Environment Water Quality Guidelines for the Protection of Agriculture Water for both Irrigation Water Use and Livestock Water Use on the record of this proceeding.

Response:

a) Confirmed, the samples were assessed for dissolved metals.

b) Yes, the Canadian Drinking Water Quality Guidelines are intended for comparison against total metal concentrations. However, only dissolved metals were collected during 2020 Hydrogeology and Geochemistry assessment, and the results were compared against Canadian Drinking Water Quality Guidelines for comparison purposes. Due to the low turbidity values in

groundwater samples, it is expected that most constituents remained in dissolved phases.

A Groundwater Monitoring and Mitigation Plan will be developed and implemented to monitor groundwater levels and quality before, during and after mining to verify analytical results and ensure groundwater users are protected. Groundwater samples at select locations will be analyzed for all parameters under consideration, including field parameters, general parameters, major anions and total and dissolved metals at a minimum.

c) Please refer to **Appendix A**.

d) Yes, the Canadian Council of Ministers of the Environment Water Quality Guidelines for the Protection of Agriculture Water are intended for comparison against total metal concentrations, unless where specified for dissolved phases. However, only dissolved metals were collected during 2020 Hydrogeology and Geochemistry assessment, and the results were compared against applicable Water Quality Guidelines for comparison purposes. Due to the low turbidity values in groundwater samples, it is expected that most constituents remained in dissolved phases.

A Groundwater Monitoring and Mitigation Plan will be developed and implemented to monitor groundwater levels and quality before, during and after mining to verify analytical results and ensure groundwater users are protected. Groundwater samples at select locations will be analyzed for all parameters under consideration, including field parameters, general parameters, major anions and total and dissolved metals at a minimum.

Some aquifer water quality parameters can be monitored in real-time. Sio intends to install monitoring wells in the areas where operations will occur and monitor long term. As stated in the response to CEC-IR- 003a, “These monitoring locations will always be between the operations and any landowner wells.“

Also refer to the response to MSSAC-IR-022(d).

e) Please refer to **Appendix A**.

IR Number: **MBEN/OLS-IR-004**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Groundwater Quality

Reference: i) Environment Act Proposal Appendix A at Table 4-10; Table 4-11

Preamble: Table 4-10 presents the results of groundwater quality assessments against a series of parameters taken both before and after pump tests. Table 4-11 predicts groundwater quality changes based on simulated changes to Redox conditions.

Request:

a) Please provide an explanation of the process by which the assessment parameters presented in the left-hand column of Tables 4-10 and 4-11 were selected. Please include an explanation of why fewer parameters were selected for these analyses than others, for example the analyses presented in tables 4-7 and 4-8.

b) Please confirm that arsenic, cadmium, chromium, lead, nickel and mercury were not among the parameters assessed in the data presented in Table 4-10.

c) Please confirm that cadmium, chromium, lead, nickel, and mercury were not among the parameters assessed in the data presented in Table 4-11.

d) Please confirm that arsenic, cadmium, chromium, lead, nickel, and mercury are potentially of concern to human health

Response:

a) Since many metals were below detection limits and far below applicable criteria, only parameters of interest were included in Table 4-10 and 4-11 to further assess the impact of pumping and change to redox conditions. Parameter selection was based on the following considerations:

- Both pre and post concentrations were above detection limits and above the laboratory method detection limit.
- Dissolved metals (i.e. fluoride, boron, iron, manganese, molybdenum and zinc) which exceeded the applicable guidelines.
- Parameter may be impacted by mineral solubility controls (calcium, magnesium, sulphate, iron and manganese etc.)

b) Arsenic, chromium, cadmium, copper, lead, mercury, nickel and selenium were not presented because their concentrations in one or more water samples were below detection limits or below the laboratory method detection limit.

c) Chromium, cadmium, lead, mercury, nickel were not presented because their initial concentrations in all three water samples were below detection limits.

d) Sio declines to respond to this question on the basis that it is not relevant to the Extraction proposal, per the responses to MBEN/OLS-IR-004(a), (b) and (c).

IR Number: **MBEN/OLS-IR-005**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Groundwater Quality

Reference:
i) Environment Act Proposal section 8.4

ii) Responses to TAC Comments 35, 56

Preamble: Sio Silica has indicated its intention to assess groundwater quality in advance of project operations and to develop a comprehensive groundwater quality monitoring plan after completing the project licensing process.

Request:
a) Please identify which, if any, specific inorganic, nutrient, and metal parameters will be monitored and the criteria data will be assessed against.

b) Please confirm which, if any, domestic or agricultural wells in the study area would be included in the groundwater quality monitoring program.

c) Please confirm whether or not Sio Silica has further developed its plans for mitigation of adverse impacts on groundwater observed through its groundwater quality monitoring program, and if so, please file these plans on the record of this proceeding.

Response:
a) Groundwater samples will be analyzed for all parameters under consideration, including field parameters (pH, conductivity, temperature, dissolved oxygen, Oxidation-reduction potential, TDS, salinity), general parameters (pH, alkalinity, hardness, conductivity), major anions (sulphate, chloride, bromide, fluoride, nitrate, nitrite and ammonia) and total and dissolved metals at a minimum.

Refer to Table 4-A of the Hydrogeology and Geochemistry Assessment Report for applicable criteria which will be considered.

b) Specific wells that will be included in the monitoring program will be based on the location of the extraction at the time and long-term monitoring once extraction is complete.

Sio will be installing its own monitoring wells and as stated in the response to CEC-IR- 003a, “These monitoring locations will always be between the operations and any landowner wells. “

Please also see the response to MBEN/OLS-IR-005(c).

c) As stated in the Responses to the Technical Expert Reports – Geotechnical, filed November 29, 2022 issue 16:

“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."

IR Number: **MBEN/OLS-IR-006**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Groundwater Quality; Waste Management

Reference: iii) N/A

Preamble: N/A

Request:

a) Please confirm that neither the Environment Act Proposal nor the Hydrogeological Assessment Report (Appendix A to the EAP) identify the presence or absence of naturally occurring radioactive materials ("NORMs") in groundwater or in extracted silica.

b) If confirmed, please explain how Sio Silica determined that NORMs would not pose potential environmental risks related to project operations such that an assessment of the potential presence or absence of NORMs was unnecessary.

Response:

a) NORMs were not specifically targeted in the list of analytical parameters.

b) Historical groundwater investigations have identified concentrations of NORMs, such as uranium, at levels which exceed standards applicable to drinking water. These elevated concentrations are either naturally occurring or the result of historic human activities. Sio's operations are designed to maintain (or in specific cases, potentially slightly improve) water quality. The water will be contained and under continuous flow during extraction and treatment, and therefore it will not have been exposed to contaminants, including uranium. Geochemical modelling indicates water quality will be similar or better following exposure to oxygen due to precipitation of metals. Therefore, the extraction process will not alter NORM concentrations in the aquifer.

IR Number: **MBEN/OLS-IR-009**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Extraction Operations; Groundwater

Reference:
i) Environment Act Proposal at pages 11, 15

ii) Environment Act Proposal Appendix A at page 75

Preamble: Sio Silica explains on page 11 of its EAP that "a minimal amount of groundwater is used by sand extraction activities each year of operation." On page 15, it states that "very little extraction of groundwater from the aquifer is required."

On page 75 of the Hydrogeology and Geochemistry Assessment Report, it is explained that there is "operational and parameter uncertainty" related to how much extracted groundwater will be reinjected into the aquifers.

Request:

a) Please provide a definition of Sio Silica's use of the terms "minimal" and "very little" as used in the excerpts set out in the preamble and confirm whether or not these excerpts refer to specific amounts.

b) Please confirm that Sio Silica's assertion that "minimal" or "very little" extraction of groundwater will be required does not mean that minimal groundwater will be extracted, but is claimed as a result of the fact that the corporation proposes to reinject a substantial proportion of the extracted groundwater such that the net volume of groundwater removed from the aquifer will be "minimal".

c) Please confirm that there is uncertainty respecting the volume and proportion of extracted groundwater that will be reinjected during the extraction process.

d) Please confirm that despite this uncertainty Sio Silica remains of the view that "minimal" or "very little" extraction of groundwater is required, and if confirmed, please provide an explanation justifying this assertion.

Response:

a) "Minimal" and "very little" do not refer to specific amounts as groundwater use will vary depending on the volume of sand removed during an extraction period. However, the proportion of groundwater used during extraction activities compared to the total available groundwater contained within the aquifer is extremely small, especially considering most of the groundwater is returned to the aquifer following sand extraction.

Regarding "operational and parameter uncertainty" during extraction tests conducted by Sio, successful tests resulted in slurry with a 70-90% sand concentration and a small volume of water (10% to 30%). This range of sand to water ratios represents the "operational and parameter uncertainty". It should be noted that the Hydrogeological and Geochemistry Assessment Report assessed sand to water ratios of 50%/50%, which is a higher

proportion of water than what would be expected based on the most recent extraction testing.

Sio does not need the water coming out of the aquifer with the sand. Therefore, Sio will be re-injecting, by gravity, as much water as possible that comes out of the aquifer after UV treatment of the excess water. The only remaining water is the water that is in the sand as the sand is not 100% dry after separation from the water. The proportion of water remaining in the wet sand is very small.

b) See the response to MBEN/OLS-IR-009(a). Sio will strive to remove the lowest volume of water from the aquifer possible. Minimizing the volume of groundwater that is pumped to surface during extraction is beneficial for operations as it will reduce the volume of groundwater that needs to be handled and treated on surface.

c) See the responses to MBEN/OLS-IR-009(a) and (b).

d) See the responses to MBEN/OLS-IR-009(a) and (b).

IR Number: **MBEN/OLS-IR-017**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Aquifer integrity

Reference: i) "Technical Review: Sio Silica Corporation's Environment Act Project Proposal", 19 September 2022, prepared by Dr. Hartmut Holländer and Dr. Allan Woodbury at pages 6, 25.

Preamble: In their report, Holländer and Woodbury state that "The proponent has not considered the risk of saline intrusion into the affected aquifers."

Request: a) Please demonstrate with supporting information that Sio Silica has assessed the risk of saline intrusion into the affected aquifers. If Sio Silica has not assessed the risk of saline intrusion into the affected aquifers, please justify its decision to not undertake this analysis.

Response: a) As stated in the Responses to the Technical Expert Reports – Hydrogeology, filed November 29, 2022 issue 10:

"Within the Project Site, water chemistry in Red River Carbonate and Winnipeg Sandstone is generally comparable and classified dominantly as Ca–Mg–HCO3 water type. The overall low TDS (<500 mg/L) indicates groundwater in the Project Area is fresh and not brackish or saline because much of the water entrained in the rock at the time of deposition and diagenesis has since been flushed by more recent recharge. This is consistent with previous investigations, regional aquifer characterization studies and water source mapping. The Project Area is near the Sandilands area, where the highlands form local recharge areas (Simpson et al. 1987; Betcher et al. 1995). Based on laboratory test results collected within the defined Local Project Area, the water is fresh and density-dependent flow was determined not to be locally important.

AECOM is aware of the work by Kennedy (2002) and recognizes that density-dependent flow is important in areas where water is brackish or saline. It is acknowledged that groundwater in the Winnipeg Sandstone aquifer west of Anola and outside the Project Site exhibits concentrations of TDS that slowly increase in the westward direction. It is important to recognize that the project activities will not be consuming large quantities of water and will reinject essentially all of the groundwater back into the aquifer. The net "pumping" rate will be limited to the volume of groundwater required to replace the volume of solids removed from the sandstone aquifer. The overall groundwater flow direction is west to northwestward toward the Red River and Lake Winnipeg, with localized discharge to the Red River Floodway. The Groundwater Monitoring and Mitigation Plan will monitor groundwater quality with a view to tracking concentrations over time and confirming that water is not becoming more saline as a result of project operations, and confirm the findings of the Hydrogeology and Geochemistry Assessment Report."

IR Number: **MBEN/OLS-IR-018**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Formation Porosity

Reference: i) "Technical Review: Sio Silica Corporation's Environment Act Project Proposal", 19 September 2022, prepared by Dr. Hartmut Holländer and Dr. Allan Woodbury at page 7.

Preamble: In their report, Holländer and Woodbury note that "the proponent has provided no independent measurements of formation porosity, and provides only one reference to an "assumed value"."

Request:

a) Please provide an explanation of the basis and reliability of the "assumed value" referenced by the CEC Technical Advisors.

b) Please provide an explanation justifying reliance on this assumed value of formation porosity for assessment of the potential impacts of the proposed Project.

Response:

a) As stated in the Responses to the Technical Expert Reports – Hydrogeology, filed November 29, 2022 issue 12:

> "*Porosity is rarely directly measured as part of hydrogeological assessments of bedrock formations. However, the porosity has been indirectly accounted for in the measurement of aquifer properties that were used to guide calibration of the numerical groundwater model. At full operation, the Project will have an estimated annual production rate of 680,000 cubic metres of silica sand. When a bulking factor and in-situ density are applied, it will be possible to estimate the dimensions of "cavities produced from the mining" every year, and for each borehole."*

b) See the response to MBEN/OLS-IR-018(a).

IR Number:	**MBEN/OLS-IR-019**
Submitted by:	MBEN/OLS
Date Submitted:	November 25, 2022
Subject Matter:	Heterogeneity of Aquifers and Aquitards
Reference:	i) "Technical Review: Sio Silica Corporation's Environment Act Project Proposal", 19 September 2022, prepared by Dr. Hartmut Holländer and Dr. Allan Woodbury at pages 8, 19.
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.
Request:	a) Please file the sources referenced by the CEC Technical Advisors documenting material heterogeneity in the aquifers and aquitards on the record of this proceeding.
Response:	a) Sio declines to provide the requested information on the basis that Sio has not relied on this information as part of its evidence.

IR Number: **MBEN/OLS-IR-020**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Hydraulic Properties of the Sandstone Aquifer

Reference: i) "Technical Review: Sio Silica Corporation's Environment Act Project Proposal", 19 September 2022, prepared by Dr. Hartmut Holländer and Dr. Allan Woodbury at pages 8-9.

Preamble: In their report, Holländer and Woodbury found that "…all of the conclusions listed in the model simulation discussion all rely on an assumption that the mining operation does not affect the hydraulic properties of the sandstone aquifer and hence cannot be viewed as being conservative."

Request: a) Please provide an explanation of the reliability of the assumption described by the CEC Technical Advisors as noted in the Preamble.

Response: a) As stated in the Responses to the Technical Expert Reports – Hydrogeology, filed November 29, 2022 issue 6:

"See the response to Issue #3 above. The project proposes to remove a very small proportion of the sand contained within the sandstone aquifer. While hydraulic properties may be locally affected on the scale of tens of metres, each extraction well void will be separated from other voids by intact aquifer materials at the scale of the Representative Elementary Volume that is being modelled. Models are routinely utilized to evaluate the impacts of future conditions and are by definition intended to be a representation of reality, rather than an exact replica. The sensitivity analysis approach is routinely applied to understand the influence of uncertainty on modelling results. Further, scenario analysis also informs the influence of alternative parameter values on simulation results. Both approaches were applied for this assessment. Changes to aquifer storage will affect both the time of drawdown and the time of rebound following cessation of pumping. Based on the project operation procedures, the hydraulic properties of the Winnipeg Sandstone aquifer are not anticipated to change significantly at the scale of the model. The modelling and accompanying sensitivity analysis evaluated the influence of variability in model parameters in both directions, which is a conservative approach and aids in improving the understanding of model sensitivities."

See also issue #7 in the Responses to the Technical Expert Reports – Hydrogeology, filed November 29, 2022.

IR Number: **MBEN/OLS-IR-022**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Hydraulic Testing

Reference:

i) "Technical Review: Sio Silica Corporation's Environment Act Project Proposal", 19 September 2022, prepared by Dr. Hartmut Holländer and Dr. Allan Woodbury at page 8.

Preamble: In their report, Holländer and Woodbury found at page 8 that "Calibration to an existing data set for hydraulic heads has been attempted. However, there is insufficient detail given in the text to assess if an appropriate calibration has been achieved."

Request:

a) In response to the above-noted finding by the CEC's Technical Advisors, please provide the analysis underlying the calibration undertaken.

Response:

a) As stated in the Responses to the Technical Expert Reports – Hydrogeology, filed November 29, 2022 issue 19:

> *"Regional scale modelling assessments require use of information collected by multiple parties over an expansive area and over an extended period of time. This is a known limitation of any regional modelling assessment and was documented as a limitation in Section 7.4 of the Hydrogeology and Geochemistry Assessment Report. However, this can also be considered a strength of the calibration as it is more likely that temporally and spatially averaged conditions are captured rather than point in time, point in space measurements.*
>
> *An acceptable match between simulated and observed groundwater levels was quantitatively assessed through calculation of residuals, the residual mean, root mean square error (RMSE), normalized root mean square error (NRMSE), and the correlation coefficient (r), with results considered reasonable in accordance with several groundwater modelling guideline documents. Other assessment approaches, such as a map of hydraulic head residuals, were also presented in the calibration effect evaluation (see details in the Section 5 of the Hydrogeology and Geochemistry Assessment Report).*
>
> *See the response to Issue #5 for more information on the calibration of the model and an explanation for differences between one local scale measurement of hydraulic properties and the values assigned in the regional scale numerical groundwater model."*

IR Number: **MBEN/OLS-IR-023**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Hydraulic Efficiency

Reference:
i) "Technical Review: Sio Silica Corporation's Environment Act Project Proposal", 19 September 2022, prepared by Dr. Hartmut Holländer and Dr. Allan Woodbury at page 16.

Preamble: In considering the proponent's site investigation methodology in section 3.2 of their report, Holländer and Woodbury found that "the proponent did not attempt to determine hydraulic efficiency of the well." The CEC Technical Advisors went on to cite relevant literature setting out a "recommended procedure" for conducting this testing.

Request:
a) Please explain why Sio Silica did not follow the "recommended procedure" identified by the CEC Technical Advisors on page 16 of their report.

b) Please confirm that the "recommended procedure" identified by the CEC Technical Advisors is consistent with best practice as identified in relevant literature. If this cannot be confirmed, please provide an explanation with references to relevant literature that the approach taken by Sio Silica was consistent with best practice.

c) Please provide an explanation justifying the reliability of Sio Silica's findings from the relevant test and analysis in light of the finding of the CEC's Technical Advisors noted in the Preamble.

Response:
a) As stated in the Responses to the Technical Expert Reports – Geotechnical, filed November 29, 2022, issues #4, #16 and #45:

> "*As a point of clarification (and as discussed in detail in Section 3.7.2 of the Hydrogeology and Geochemistry Assessment Report), it is acknowledged that the pumping well would have benefited from additional development efforts to improve its hydraulic efficiency. It is also acknowledged in the report that the aquitard separating the carbonate and sandstone aquifers is leaky. However, several methods were used to analyze the pumping test data, many of which do not rely on a hydraulically efficient connection between the pumping well and the aquifer. The pumping well was pumped at a rate that was judged to be representative of an operational scenario, and responses were measured in several observation wells completed in the Red River Carbonate, Winnipeg Shale and Winnipeg Sandstone aquifers and several distances from the pumping well. The solution that was selected for determination of aquifer properties was able to simultaneously fit drawdown measured in several wells and at a variety of distances. The data from the pumping well was not relied upon for determination of aquifer properties, placing focus on the observation well data. Additional analysis of pumping test results could be completed using alternative analytical solutions, but it should be recognized that the testing protocols*

and assumptions invoked to allow for use of multilayered aquifer systems are very limiting (e.g., isotropic aquifers) and may not be suitable for application to the study area. Therefore, this is not deemed necessary or reasonable at this time.

Also refer to Issue #4 and #16 for additional information."

b) The "recommended procedure" identified by the CEC Technical Advisors is an appropriate method for determining hydraulic efficiency of a well. However, determining the hydraulic efficiency of a temporary well was not the objective of the pumping test, nor is it important that a pumping well be hydraulically efficient to produce useful information.

As described in detail above, water levels measured in observation wells combined with the measured pumping rates can be used to obtain arguably more reliable aquifer properties than those derived from a single well response test in a well that is hydraulically efficient. Methods employed in this study analyzed drawdown and recovery data using industry standard methods including Theis (1935) and Cooper and Jacob (1946) to estimate aquifer properties.

c) As noted in response b), "*determining the hydraulic efficiency of a temporary well was not the objective of the pumping test, nor is it important that a pumping well be hydraulically efficient to produce useful information*".

Rather, it is important that pumping rates and groundwater elevations be measured in a series of wells at various distances from the pumping well, and in each aquifer during pumping and recovery phases to enable use of the alternative methods employed in the Hydrogeology and Geochemistry Assessment Report. It is very common for observation well data rather than pumping well data to be utilized for pumping test analysis as observation wells avoid near-field turbulent flow effects associated with wellbore skin effects and hydraulic head losses as water enters the well screen. Additional turbulent head losses may occur as water travels upward through the narrow annulus between the pump body and the pump, and then turns sharply to enter the pump intake. This is especially important for relatively small diameter wells installed in relatively productive aquifers as is the case within the Project Site Area.

IR Number: **MBEN/OLS-IR-024**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Groundwater

Reference:

i) "Technical Review: Sio Silica Corporation's Environment Act Project Proposal", 19 September 2022, prepared by Dr. Hartmut Holländer and Dr. Allan Woodbury at page 29.

Preamble: At page 29 of their report, Holländer and Woodbury find that "the [Proponent's Environment Act Proposal] does not discuss the proponent's understanding of regional groundwater flow."

Request:

a) Please confirm that this information was excluded from the Sio Silica's Hydrogeology report. If confirmed, please provide an explanation.

b) If assessment of groundwater flow was conducted by Sio Silica, please provide it.

c) Please explain the uncertainty introduced to Sio Silica's understanding of the potential risks and impacts of the Proposed Project that may result from failing to consider groundwater flows.

Response:

a) AECOM disagrees with the statement that regional groundwater flow information was excluded from the Hydrogeology and Geochemistry Assessment Report.

b) Please refer to Section 5.8 of the Hydrogeology and Geochemistry Assessment Report for a discussion of regional groundwater flow, including a discussion of groundwater recharge, groundwater elevations and gradients, groundwater flow directions and groundwater discharge. This information is complemented by extensive discussion of groundwater flow in the literature references provided in Section 1.3 of the Hydrogeology and Geochemistry Assessment Report.

c) AECOM disagrees with the statement that the Hydrogeology and Geochemistry Assessment Report "failed to consider groundwater flows". See response b) above.

IR Number: **MBEN/OLS-IR-025**

Submitted by: MBEN/OLS

Date Submitted: November 25, 2022

Subject Matter: Aquifer characteristics

Reference: i) "Technical Review: Sio Silica Corporation's Environment Act Project Proposal", 19 September 2022, prepared by Dr. Hartmut Holländer and Dr. Allan Woodbury at page 37.

Preamble: Holländer and Woodbury found at page 37 of their report that "it is assumed by the proponent that water levels would re-equilibrate after 20 days but it is noted that removal of solids will change the aquifer properties and recovery may take 4 times as long, but no data is given to support this conclusion and is counter intuitive if K is increased as a result of mining."

Request: a) Please provide a detailed explanation, including underlying data and analysis, supporting the assumption described in the Preamble.

Response: a) During the 2020 pumping test, a pumping well was operated at a rate of approximately 380 US gpm, which is much higher than that proposed during operations (i.e. 270 US gpm). As shown on Figure 6-4, after approximately 62 hours of pumping, approximately 85% of drawdown recovered over a period of one (1) day, with full recovery occurring approximately two (2) days after pumping ceased.

The time for groundwater recovery following operation of each extraction well cluster was estimated from Figure 6-8 which illustrates drawdown and recovery at select observation locations as simulated by the numerical groundwater model over the duration of the Project. The numerical modelling results were utilized because the operating wellfield is spatially and temporally complex with several wells cycling on and off over time, and an estimation of the time for full recovery is not easily achieved using analytical solutions. As shown on Figure 6-8, groundwater elevations recover relatively rapidly following cessation of pumping due to the relatively permeable nature of the Winnipeg Sandstone and abundant recharge from the Sandilands Glaciofluvial Complex and the overlying aquifer system.

As stated in Section 8.1 of the Hydrogeology and Geochemistry Assessment Report, "*approximately 80% recovery was observed approximately two (2) days following the end of production at each well cluster. Groundwater levels are anticipated to return to static water level conditions approximately 20-80 days after production ceases at each well cluster.*" Porosity of the Winnipeg Sandstone is estimated at 25% under existing conditions, and the localized zone around each extraction well will achieve a porosity of 100% following mining (i.e., 4 times increase). It is recognized that there is some uncertainty with the recovery rate due to transient changes in aquifer storage that will result from mining of the sand, and hence the recovery rates were conservatively extended by a factor of 10 (factor of safety) to 40 (100/25 x 10) to produce estimates of 20 days (observed 2 day recovery multiplied by

10x factor of safety) to 80 days (direct changes in porosity of 4x times multiplied by 10x factor of safety) for complete recovery.