Comments on the CanWhite Sand Vivian Extraction Project
By

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On Aug. 3, 2021 CanWhite Sands submitted two documents to the Manitoba public registry file # 6119.00 to support CanWhite Sands Corporation (CWS) Silica Sand Extraction Project. The documents are an Environment Act Proposal for the Vivian Sand Extraction Project (EAP) and the Vivian Sand Extraction Project – Hydrogeology and Geochemistry Assessment Report (HGR). The authors of the Extraction EAP are Marlene Gifford, M.Sc. P. Bio, Biologist, Environmental Assessor and Clifton Samoiloff, B. Sc. EP(CEA), Mining Market Sector Lead, Canada. These were the same two authors who prepared the EAP for the CWS Vivian Sands Processing Plant for AECOM Ltd. The contributors to the HGR prepared by AECOM Ltd. include Reuben Dandurand, M.Sc., G.I.T. (BC), Stephen Dickin, P.Geo. (MB, BC) Senior Hydrogeologist / Groundwater Modeller, Kun Jia, M.Sc., P.Geo. (BC) Geochemist/Hydrogeologist, Mehrnoush Javadi, M.Sc., Ph.D. Geochemist/Hydrogeologis, Chris Donnelly, M.Sc., P.Geo. (BC, AB), and Ryan Mills, M.Sc., P.Geo. (MB, BC, AB) Senior Groundwater Modeller Senior Hydrogeologist. Omissions, misinformation and inadequacies in the submitted EAP and HGR are documented here.

We prepared a list of questions supported by references for the CWS Virtual Open House of Aug. 24, 2021. The submitted questions document a series of inadequacies and misleading or incorrect information in the Extraction EAP and HGR that require a detailed technical response. The questions were submitted Friday, Aug. 20, 2021, before the CWS Virtual Open House. C. Samoiloff represented AECOM at the open house. C. Samoiloff gave an introductory dissertation about the Professional Engineering guidelines that AECOM was obliged to follow. C. Samoiloff asserted that AECOM is independent and has no stake in the outcome of the licensing process even though AECOM was hired by CWS to represent their interest.

CWS did not specifically address any of the submitted questions in the virtual open house. The questions submitted to the CWS Virtual Open House are attached in a separate questions document. In the chat box during the open house I submitted five written questions that were "*dismissed by the host*." The chat box was configured such that participants could not see written questions of others. Some oral statements were made by the CWS participants in the virtual open house that seemed to be a partial rebuttal to some of the questions submitted in advance, however no specific advance questions were read out and completely addressed. There is no indication that any proper thorough response will ever be forthcoming to questions submitted before the meeting. The questions may be posted on the public registry along with other public comments. The posting is likely to occur after the Oct. 7, 2021 deadline for public submissions and after responses from the provincial Technical Advisory Committee (TAC) are received. The TAC would not be able to review and respond to the public comments. For the Vivian Sand Processing Project and other projects, the TAC has responded in a siloed fashion, addressing issues only pertaining to their particular narrow jurisdiction. With these procedures the public comments and issues raised will receive no independent qualified technical expert review and response other than from AECOM personnel who are hired to represent the interest of CWS.

The issues raised by the seventeen questions submitted to the open house are summarized and augmented below. The link to an audio recording of the CWS Virtual Open House is; https://onedrive.live.com/?authkey=%21AOulLHJK8APROHw&cid=E787770CDC4A49DD&id=E787770CDC4A49DD%21130&parId=root&o=OneUp

1. Re-injection into the aquifers of excess water from sand extraction

The UV sterilization system specified in the EAP will not be effective in eliminating harmful microbes due to manganese, iron and fine particulate in the water that will scatter UV light. Re-injection to the sandstone of excess aerated water extracted with the sand would carry harmful microbes and oxygen into the aquifer. The oxygen in the re-injected water would react with sulphide in pyrite in the shale aquitard and deeper layers of shale within the sandstone, with marcasite (a form of pyrite) in the sand, with pyritic oolite layers in the sandstone and with pyritic concretions in the sandstone to form acid. The acid formed by oxidation of sulphide would mobilize heavy metals such as arsenic that the HGR report documented in the shale. The geochemistry results of the HGR that reported low or no sulphide in the shale and sand were corrupted because the sand samples and core logs were subject to air and moisture for a long period. These issues are all described with references in question 3 of the attached questions document.

The evidence for ineffective UV radiation given in question 2 of the attached question document is summarized below.

The Government of Australia Department of Health states;[1]

"*UV light will only travel in a straight line so any shadow or obstruction will reduce its efficiency. Water that is not filtered can contain iron, manganese and other particles that can either absorb or scatter UV light reducing the effectiveness of the disinfection system. Microorganisms that are able to pass through protected by shadows created by dirt, debris or other microorganisms may be able to survive treatment.*"

The Water Research Centre of Dallas Texas gives the following conditions for UV sterilization to be Effective.[2]

1. Five to ten micron pre-filtration of suspended solids
2. iron concentration less than 0.3 mg/L
3. manganese concentration less than 0.05 mg/L
4. colour – none.

The concentration of manganese in the water in the sandstone aquifer given in table 4.3 of the HGR is between 24 and 45 ppm (mg/L). The iron concentration is between 0.22 and 0.65 mg/L. Fine particulate would be suspended in the sand by the CWS airlift silica sand extraction mechanism.

There is no data provided that the UV treated water was tested. CWS did not verify if the UV system works. This evidence demonstrates that the UV radiation would be ineffective. Potentially harmful microbes would be introduced to the aquifer. The re-injected aerated water would provide an environment where the introduced harmful microbes could proliferate contaminating the drinking water. The dissolved organic carbon content of the aquifers reported Table 4-7 of the HGR illustrated that microbes introduced would have nutrients plus oxygen from the aerated water to enable proliferation.

Particularly egregious was exposure of silica sand samples to air. According to the HGR sand was sampled from stockpiles. The sand was extracted by air-lift methods that would have exposed the sand to air during extraction. Well Bru 95-3 was completed on June 28, 2019 according to drilling records obtained from MB Groundwater. The sand stockpiled outside was exposed to air and moisture until the time of sampling in November of 2021. Any marcasite in the stockpiled sand as was reported for Winnipeg formation sand from Wanipigow would have long been leached out.[3] Well records obtained from MB groundwater show well Bru 121-1 was completed on Feb. 19, 2019. Well Bru 146 would have been completed at a similar time. Sand samples from wells Bru-121-1 and Bru 146 would have been exposed to air and weathering since the time of well completion.

Question 3 and Reference 9 gives methods to prevent oxidation of pyrite in core samples in the attached questions document. A further reference by Basu et al. (2000) describes methods to prevent oxidation of shale samples including airtight containers and refrigeration at 4 degrees.[4] A reference, König et al. (2000) documents the oxidation pyrite in core samples that are exposed to air during storage reporting, "*Massive Fe(II) to Fe(III) oxidation, which involved between 24% and 45% of the initial Fe(II), occurred within only 6 months of refrigerated storage.*"[5] These references establish that oxidation of pyrite in samples can occur rapidly. Core samples for the shale aquitard and carbonate aquifer were placed in core boxes that were not air tight. The core samples sent to analysis were not in air tight sealed containers and were not kept refrigerated at 4 C. The geochemical results conducted in the HGR would underestimate sulphide concentrations.

Ryan Mills, senior hydrogeologist who helped prepare the HGR admitted at the CWS Virtual Open House the core log samples were exposed to air but stated that the samples were prepared according to standard industry practice. He stated that pyrite oxidation was sufficiently slow, that very little would have oxidized before analysis. This contradicts the evidence by Basu et al. (2000) and Konig et al. (2000) that air oxidizes pyrite in shale or sediment core samples readily. Iron pyrite in quartz or other crystalline ore bodies might oxidize slowly because the crystalline structure prevents ingress of oxygen and moisture. Shale and concretions are porous and would allow air and moisture ingress. A publication by Nolan (2019) states;[6]

"*When iron sulphide is exposed to oxygen it reacts rapidly, releasing large amounts of heat. This exothermic reaction can be an ignition source for any oil or gas that is present.*"

To keep core logs exposed to air in core boxes is standard practice for preserving a record of the extent of an ore body but is not acceptable for geochemical analysis. According to the HGR two of the three core log samples Bru 121-1 and Bru 146 were held in storage in Steinbach for over a year where they would have been exposed to air. The core log from the site near Vivian, Bru 95-8, extracted on Nov.11, 2020 and analyzed Jan.5, 2021, was not in an air tight container nor maintained at 4C. The samples were sent in low density polyethylene (LDPE) bags that allow air ingress. (See question 3, reference 11 of the attached questions document.)

At the CWS Virtual Open House I had the opportunity to ask one question at the end of the meeting. I asked about the sand sampled from Bru 95-3 that would have been corrupted due to weathering in the outdoor sand stockpile from which the sand sample was taken. The response in part was that the sand in the Vivian area was from the Carman sands that are different from the sand at Wanipigow and would have no marcasite. The name given to the sands is irrelevant. To determine the amount of sulphide in the sand a valid sample must be taken that has been protected from oxidation. Figure 4 of the attached question document provides evidence that the Carman sands are south of the Vivian extraction area.

It is essential that sand and core sampling be redone with many more samples taken over the entire CWS project area. The sand must be protected from air during extraction. Air lift extraction of the sand cannot be used. Sonic drilling methods such as were used at Wanipigow may be required.[3] Sand and core samples must immediately be sealed in air tight containers and sent for analysis. The sampling and sealing of the samples must be done by an independent agency or company that has expertise in this area.

Selenium was reported in the geochemistry results of the HGR in the carbonate, shale and sandstone despite the exposure of the samples to air that would oxidize and mobilize the selenium. Shake flask tests and other geochemistry results in the HGR have documented potentially toxic levels of selenium in the carbonate aquifer, shale aquitard and the sandstone aquifer. The concentration of selenium (Se) and arsenic (As) for Bru 1221-1 in the shale was particularly high at 1.64 mg/L Se and 0.0306 mg/L As. The selenium concentration of 0.002 mg/L in the sandstone aquifer for Bru 121-1 was attributed in the HGR report to shale fragments in the sandstone. The reported selenium and arsenic would be expected to be underestimated due to oxidation of the samples that occurred.

ALS lab results for solid core samples for Bru 121-1 give high values for heavy metals with 30.4 ppm arsenic, 30 ppm barium, 70 ppm boron, and 13.1 ppm selenium in the shale aquitard. The solid core sample results for Bru 95-8 also had elevated heavy metal content with 24.2 ppm arsenic, 30 ppm barium, and 58 ppm chromium in the shale. The XRD results from Table 1 Appendix A Part 6 in the HGR showed pyrite at 1.3 weight percent in the shale aquitard for well Bru 95-8 near Vivian and 0.6 weight percent for well Bru 121-1 even though much of the pyrite would have oxidized from exposure of the samples to air. These results demonstrate heavy metals including selenium and pyrite are present in the shale.

The well log from Bru 95-7 reports shale layers interbedded with sandstone below the pure sand layer at depth below surface between 72.24 to 74.68 meters. This shale could be extracted with the sand. Figure 1, a picture taken in the spring of 2020 of extracted sand piles south of Vivian, shows shale fragments interspersed in the sand. These pictures provide incontrovertible evidence that shale fragments containing pyrite and heavy metals would be extracted with the sand. The net neutralization potential, NNP, in shale for for Bru 95-8, Bru 121-1, and Bru 146 shale of, 5.0, 3.0 and 3.0 respectively indicates that the shale is potentially acid generating (PAG). The NNP values likely would have been smaller indicating strong acid leaching potential consistent with literature references had the samples not been exposed to air.[8,9]

Figure 1. Photo of shale fragments extracted with the sand near Vivian Manitoba, spring 2020. The photo was taken by a local concerned citizen (name withheld for privacy reasons)

Shale extracted with the sand would oxidize sulphide in the extraction processing tanks to form acid and mobilize heavy metals. Selenium in the shale would oxidize to a soluble form and be released as well. Most of the contaminated water from the processing tanks would be re-injected into the sandstone aquifer. Some of the contaminated water would be directed into the slurry lines. Oxidation of the selenium and pyrite in the small shale fragments carried in the sand would further contaminate the slurry line water. The oxidation of the pyrite and selenium in shale fragments would occur from aerated re-injected water in the sandstone aquifer. The sand grains in the sandstone aquifer may contain marcasite since the geochemical tests for the sand was corrupted due to exposure of the sand samples to air. The oxidation of marcasite would form more acid and mobilize heavy metals and selenium.

A paper by Schrieber and Riciputi (2005) identifies concretions formed in the Winnipeg sandstone as containing pyrite and marcasite.[7] The HGR describes screening out of concretions from the sandstone after extraction of the sand. Oolite nodules described as pyritic by Watson (1985) have been observed in extracted sand piles at Vivian.[8] These concretions and ooilite nodules in the sandstone aquifer would be another source of contamination when exposed to aerated re-injected water. The concretions and oolite nodules have not been analyzed for the presence of sulphide, selenium and other heavy metals. The failure to analyze critical components of the sandstone aquifer system that could be subject to oxidation by re-injected aerated water is another egregious example of negligence and omission by CWS.

The HGR reports mixing of the carbonate and sandstone water would occur due to degradation of the shale aquitard caused by the extraction activities. Mixing of aquifer water is prohibited by the regulations of the Manitoba Groundwater and Water Well Act.[11] CWS has not acknowledged violation of Manitoba Groundwater regulations would occur. An attempt was mad to justify mixing of aquifer waters through geochemical studies that demonstrate that changes to well water quality will be benign. CWS is in no position to override regulations made to prevent deterioration in water quality from mixing of aquifer waters based on geochemical predictions. The unavoidable violation of Manitoba Groundwater and Water Well Act with respect to mixing of aquifer waters should result in termination of the project.

The aerated re-injected water would enter the carbonate aquifer where selenium has been detected at levels that produced toxic concentrations in shale flask tests documented in the HGR. The aerated re-injected water would oxidize and mobilize selenium in the carbonate aquifer. Contaminated water from the sandstone could enter the carbonate aquifer from the mixing. The release of selenium in soluble form directly by oxidation does not depend on formation of acid from oxidation of sulphide.[10]

Groundwater moves relatively quickly in the carbonate aquifer eventually discharging into the Red River, a major fish-bearing water body. The contaminants including selenium introduced and formed in the aquifer by the re-injected aerated water would eventually discharge into the Red River. Selenium is toxic to aquatic organisms above two parts per billion.[12] All the water wells along the flow path would be contaminated.

Rebuttal remarks in the CWS Virtual Open House by CWS personnel that the sandstone and carbonate aquifers already have oxygen are not credible. A paper by Phipps et al. (2008) reported, over a large area of the Winnipeg formation in eastern Manitoba including the Vivian area, that no dissolved oxygen (D.O.) was detected in the carbonate and sandstone aquifers for most samples.[13] In particular Phipps's paper reported:

Carbonate aquifer:
"*Measured pH ranges from 7.0 to 8.1, with a median value of 7.5. Redox and D.O. were measured in 17 sites. The D.O. ranges from 0.03 (oxygen is absent) to 1.14 mgL-1. Only one sample has greater than 1 mgL-1,* ***whereas the remaining samples are almost completely depleted of oxygen,*** *containing less than 0.20 mgL-1. Eh ranges from -223 to 244 mV.*"

Sandstone aquifer:
"*pH varies from 7.2 to 8.2 (median = 7.6). Only one sample, located near the erosional margin, had D.O. concentration > 1 mgL-1 and three other samples had low concentrations >0.1 mgL-1,* ***however, the***

remainder had concentrations of 0.06 and lower (effectively 0 mgL-1 D.O.))*.(n=18) The Eh ranges from -30 to +181 mV.* "

Dissolved oxygen levels are reported in table 4.7 of the HGR for several Bru 95 wells in the carbonate, shale and sandstone ranging from 0.2 to 7 mg/L. These results are high compared to the results from Phipps et al. (2008). The results from Phipps et al. (2008) were over a much broader region and should be considered to be more representative of the generally very low dissolved oxygen concentrations that would be found throughout the Bru area.

The HGR states;

"*the Winnipeg Shale is extensively weathered to clay and shows a strong blue color in the bottom half of its thickness at some locations suggesting limited access to oxygen*."

The blue shale colour confirms lack of oxygen can occur in the shale aquitard layer.

Dissolved oxygen generally decreases with decreasing oxidation reduction potential (ORP or Eh). For example US Environmental Protection Agency (EPA) report EPA/600/s2-86/042 of June1986 for an aquifer in Cuba documented that dissolved oxygen concentration is zero below an ORP of 100 mV as shown in Figure 2.[14]

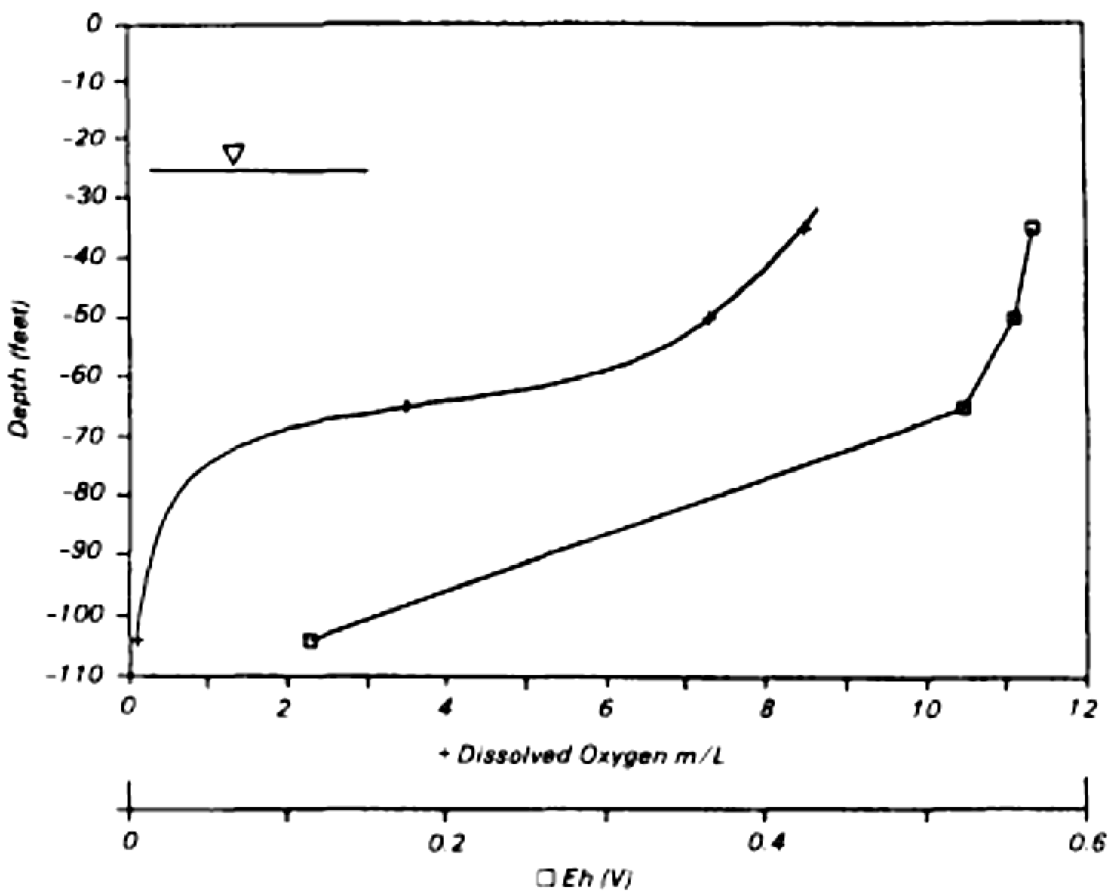

Figure 2. Concentration of dissolved oxygen and Eh (ORP) values in groundwaters of Havana lowlands aquifer, 1985. (EPA, 1986)[14]

B. Bullen in the Virtual Open House referred to an article written by Tom Lewis, the president of the Manitoba Prospectors Development Association, to the MB Winnipeg Free Press on Sept. 23, 2020 that stated;

"*If the groundwater is toxic, it is unlikely to be a good aquifer.*"

In the article the silica sand mining at Beausejour was in the early 1900s was referred to as a benign endeavour.[15] Pyrite would have been oxidized long ago for a surface deposit such as at Beausejour. The carbonate and sandstone aquifers have been shown to have virtually no oxygen content by Phipps et al. (2008). The sandstone and carbonate aquifers are not currently toxic but could become so by re-injected of aerated water that would oxidize known pyrite sources and selenium.

Table 4-7 of the HGR reports significant dissolved oxygen (D.O.) concentrations at negative ORP. For instance the sandstone sample for well Bru 95-7 post test gives a D.O. of 9.09 mg/L for an ORP of -49.1 mV and pretest values for D.O. of 5.60 mg/L for an ORP of -31.3. The reported D.O. and ORP results from Table 4-7 are inconsistent and should not be considered to be accurate.

The biological oxidation demand, BOD, is the amount of the initial dissolved oxygen D.O. that can be consumed by biological organisms and the chemical oxygen demand, COD, the amount of initial dissolved oxygen that can be consumed by chemical reaction.[16] The BOD + COD cannot be greater than the initial D.O. For the groundwater samples Bru 95-7 post test for sandstone, Bru 95-9 pretest for shale and Bru 95-9 for shale the BOD + COD is greater than the D.O. suggesting corruption or contamination of the groundwater samples as shown in Table 1.

Table 1. D.O., COD and BOD groundwater results from Table 4-7 of the HGR

Sample name	D.O. mg/L	COD mg/L	BOD mg/L
Bru 95-7 post test sandstone	9.09	<20	11.3
Bru 95-9 pretest shale	0.21	38	<0.6
Bru 95-9 shale	0.28	40	9.3

The HGR states;

"*One water well (Bru 95-7) was drilled and installed by Friesen using a truck mounted dual rotary drill rig. The water well was developed by Friesen using both airlift and cable tool methods. Airlift development was conducted on November 24, 2020 for approximately six hours. On November 26 and 27, the well was developed using the cable tool method for a further six hours. The cable tool method involves repetitively plunging equipment downhole to agitate and suspend the sediments so they can be removed from the well.* "

The airlift completion would have introduced oxygen into the well. Cable plunging could have mixed water from different formations and introduced more oxygen.

The HGR states;

"*Each borehole was completed as a monitoring well, with one (Bru 96-2) completed in the Red River Carbonate aquifer, one (Bru 95-9) completed in the Winnipeg Shale aquitard and two (Bru 95-6 and Bru 96-1) completed in the Winnipeg Sandstone aquifer.*

Only one monitoring well (Bru 96-2) was installed in the Red River Carbonate aquifer. The monitoring well was completed as an open hole monitoring well (i.e. without a well screen) in the carbonate unit by drilling to the target depth and removing the drill rods. Due to the competent nature of the carbonate unit, borehole collapse is unlikely. Therefore, installation of a screen and backfill material was not required.

Two monitoring wells were installed in the Winnipeg Sandstone aquifer (Bru 95-6 and Bru 96-1) and one monitoring well was installed in the Winnipeg Shale aquitard (Bru 95-9). The monitoring wells were completed by using 51 mm (two inch) diameter, flush threaded, schedule 40 PVC standpipe with a 51 mm diameter 0.010" slotted PVC well screen. The annulus of each borehole was backfilled with silica sand around the well screen to form a sand filter pack. Well screens and filter packs were situated entirely within a singular hydrostratigraphic unit to avoid interconnection of hydrostratigraphic units. The remainder of each borehole was backfilled using a bentonite-cement grout mixed according to the Mikkelsen and Green (2003) method."

Water samples were taken from the different formations through these monitoring wells where filter packs were introduced. The filter pack installation could have introduced more air and organics. The monitoring wells are close to the pumping well Bru 95-7 where air completion was used. Introduced air from Bru 95-7 could have migrated to the monitoring wells contaminating the groundwater samples.

The HGR states with respect to the sampling procedure for groundwater from water well Bru 95-7;

"*Groundwater samples were collected from the water well after it was developed using the pumping test equipment by opening a gate valve at the well head. One sample was collected immediately after the 72-hour pumping test commenced, a second sample was collected during pumping, and the final sample was collected immediately before the pumping test ended.*"

Sampling through a gate valve at the well head for the water well with no mention of closed sampling system with specialized tubing does not demonstrate that proper precautions were taken to prevent sample contamination.

Table 4-7 of the HGR shows elevated concentrations of fluoride in all groundwater samples. The HGR states;

"*Fluoride concentrations in all water samples were marginally above FIGQG Agricultural of 0.12 mg/L but below the applicable drinking water guidelines*."

Dissolution of fluorite (CaF_2) and/or fluorapatite (FAP) [$Ca_5(PO_4)_3F$], is thought to be the dominant mechanism responsible for groundwater fluoride (F^-) contamination.[17] Sulphuric acid formation from the oxidation of sulphide in the sandstone, shale, concretions and oolite could release more fluoride into the water by the following reactions;

$H_2SO_4 + CaF_2 \rightarrow 2\ HF + CaSO_4$ and
$Ca_5(PO_4)_3F + 5\ H_2SO_4 \rightarrow 5\ CaSO_4 + HF + 3\ H_3PO_4$.

The HGR has failed to consider and assess the potential source of groundwater contamination from fluoride mobilized by acid dissolution of fluoride containing minerals such as fluorite and fluorapatite.

The HGR states;

"*Uranium: One out of three samples (Sample Bru 121-1_36.57 - 37.00) exceeded screening criteria*."

The concentration of radium, one of the daughters of uranium decay, was not measured. It is well known that high levels of radium can be found in shale. This has been a particular problem in wastes from the Bakken oil production that are so high in radium as to be designated as radioactive waste.[18] Both radium and uranium could be released into the aquifer water by acid formed by oxidation of sulphide in the sandstone aquifer by the re-injected aerated water. Radon gas from the decay of uranium, thorium and radium can contaminate well water. [19] The radon gas levels in groundwater samples were not measured.

Real world evidence for heavy metal contamination of underground mined cavities due to acid formed by oxidation of sulphide from introduced water with dissolved oxygen is found in South Africa. In an abandoned gold mine in South Africa, surface waters with dissolved oxygen migrated into underground abandoned cavities from gold mining. The dissolved oxygen reacted with sulphide in the formation around the cavities to form acid. The acid leached heavy metals into the groundwater in the cavities. The heavy metal contamination migrated to the surface polluting surface water bodies. AECOM was hired to build a processing plant to remove heavy metals from the contaminated water.[20] This demonstrates AECOM has experience with heavy metal contamination of underground mined cavities caused by dissolved oxygen reacting with sulphide bearing formations and should have applied this experience to the Vivian projects.

The geochemical sampling of sand and drill cores was corrupted by exposure to air. Likely sources of sulphide within the sandstone aquifer such as concretions, oolite and interbedded shale layers below the shale aquitard were not sampled and analyzed. The evidence that re-injection of aerated water could oxidize sulphide sources in the sandstone to form acid and oxidize selenium to a soluble form is compelling. The acid formed would mobilize heavy metals and fluoride poisoning both aquifers due the mixing of aquifer waters that would occur from the extraction activities. The ineffectiveness of the proposed UV radiation would lead to microbial contamination of the aquifers. The HGR and EAP have inadequately quantified and dealt with the potential detriment from re-injection of aerated water to the sandstone aquifer.

2. Slurry Line Leakage

A spill from the CWS slurry lines that would carry selenium, fluoride, arsenic, other toxic heavy metals, and harmful microbes could drain into fish-bearing water bodies such as the Brokenhead River and Cook's Creek. The slurry line would be expected to carry the extremely toxic acrylamide monomer from the clarifier tank.[22] The contaminants would be ever increasing in the slurry lines as water is recycled and fresh extracted sand and flocculent is added to the slurry line and the recycled water loop.[23]

The federal guideline limit for selenium in water for aquatic organisms is very small, two micrograms per litre.[12] Mitigation measures for potential selenium and other contaminant leakage into the environment have not been adequately addressed. A precedent has been set with the Grassy Mountain Coal Project[24] where the project was denied by a joint IAAC and provincial review in part because of potential selenium release to the environment.

The potential for spill from the slurry lines affecting fish is acknowledged in the Extraction EAP which states;

"*Accidental releases, depending on the type and quantity of substances released, have the potential to affect air, surface water, groundwater and soils, with consequential effects on vegetation, aquatic resources and possibly human health and safety.*"

In the CWS Virtual Open House mitigation of spill risk was mentioned by CWS personnel who stated that pressure transducers would be installed in the lines that would automatically shut down the slurry lines in the event of a leak. No such automated system is documented in the EAP. No plans or engineering drawings have been provided for such a system. Even if an automated shut down system were installed, pressure transducers would not detect small continuous leaks that may over time release more contaminated water to the environment than a single large slurry line break. The slurry lines are subject to erosion by the sand particles and many other sources of potential leakage as documented in the attached questions (question 9, reference 20).

The EAP never assessed the potential for ongoing small leaks from the six inch feeder slurry lines when they would be emptied into vacuum trucks and moved every five to seven days. The EAP does not reveal if the slurry lines are rigid or flexible, how the lines would be decoupled, and what equipment would be used for movement to prevent spillage of residual slurry and contaminated water in the lines. Considering there would be about 455 wells drilled per year at full production each requiring slurry line movement, the potential for spillage during emptying and movement is significant. CWS has been negligent in its cursory and inadequate treatment of the issue of potential slurry line leakage.

3. Sinkholes and Subsidence

A geotechnical analysis was not submitted for the CWS Extraction Project. The extraction EAP states;

"*Geotechnical aspects of this project are outside the scope of this assessment but have been completed by others… The resource was characterized, and the economics of the project were assessed by Stantec (2019). This involved a geotechnical assessment to inform project design…The pattern of extraction cones is planned to extend laterally by successively extracting from new boreholes across the extraction area in a "room and pillar" style in accordance with the geotechnical model.*"

The geotechnical assessment and geotechnical model by Stantec was not produced. CWS is negligent in not providing an essential detailed geotechnical analysis for the extraction project. This omission is so serious as to constitute professional malfeasance.

In attempt to limit liability for the grievous omission of geotechnical analysis the EAP preamble states;

"In the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time. AECOM shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. AECOM accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time."

Failure to consider variability in geotechnical conditions geographically or over time is absurd. The project covers a very large area where geographical variability occurs. The extraction of sand would form cavities that would affect geotechnical conditions over time. For instance subsidence is known to occur gradually over time.[27] Failure to consider the inherent geographical variation throughout the project and development of geotechnical occurrences over time caused by the project activities is fundamentally negligent.

The Extraction EAP recognizes that subsidence of the extraction holes with design diameter of 54 meters (figure 2-3 of the EAP) may be a problem. The EAP states;

"*Results of a geotechnical assessment based on preliminary exploratory drilling associated with this Project from 2017 to 2021 indicated that the overlying carbonate (limestone) geological layer needs to be at least 15 m thick to minimize the possibility of surface subsidence during sand extraction activities (Stantec, 2019; 2020; 2021).*"

A peer reviewed paper by Waltham and P. Fookes specifies that minimum stability thickness for limestone above a cavity must be 70% of the cavity opening dimension excluding overburden cover.[21] For the CWS standard design opening for a seven well extraction cluster of 54 meters the limestone thickness must be at least 37.8 m.

Cover collapse sinkholes would occur in the approximately 65 well clusters drilled per year as documented in question 1 of the document submitted for the CWS Virtual Open House. CWS personnel at the open house claimed that literature reports specifying a stable thickness of the limestone larger than 37.8 meters does not apply in the Bru area where the limestone is very strong. The Stantec reports referred to in the HGR specifying a minimum thickness for the limestone of 15 meter thickness have not been produced. The Stantec limit is therefore unverified.

The core log for Bru 95-8 in the HGR report gives the limestone from 32.3 to 35.3 meter depth below surface to be weathered and incompetent. Thus there are 3 meters of incompetent limestone documented. This is followed by 1.6 meters of competent limestone to a depth of 36.9 meters. Next are 1.5 meters of limestone with small vugs which are small cavities. Limestone with vugs would not be competent. Next is a clay rich layer of 1.5 meters to a depth of 39.9 meters, followed by a 1.5 meters limestone with horizontal fractures to a depth of 41.4 meters. The clay layer and the limestone layer with horizontal fractures would not be competent. A final limestone layer 4.6 meters thick to 46 meters depth is reported with no comment as to integrity. In the column of limestone for Bru 95-8 there are at most only 6.2 meters of competent limestone out of the13.7 meters. The Bru 95-8 core log is hard evidence supplied by CWS itself that the limestone in the Bru area is not competent or strong.

The full depth of the limestone for well Bru 95-8 at 13.7 meters is less than the Stantec limit of 15 meters. Figure 1 of the questions document illustrates that none of 37 drill reports give limestone thickness in the Bru area over 37.8 meters. In the eastern area where extraction would begin, most limestone thicknesses are less than the unverified Stantec limit of 15 meters. The figure of limestone thickness from the questions document is repeated here as figure 3.

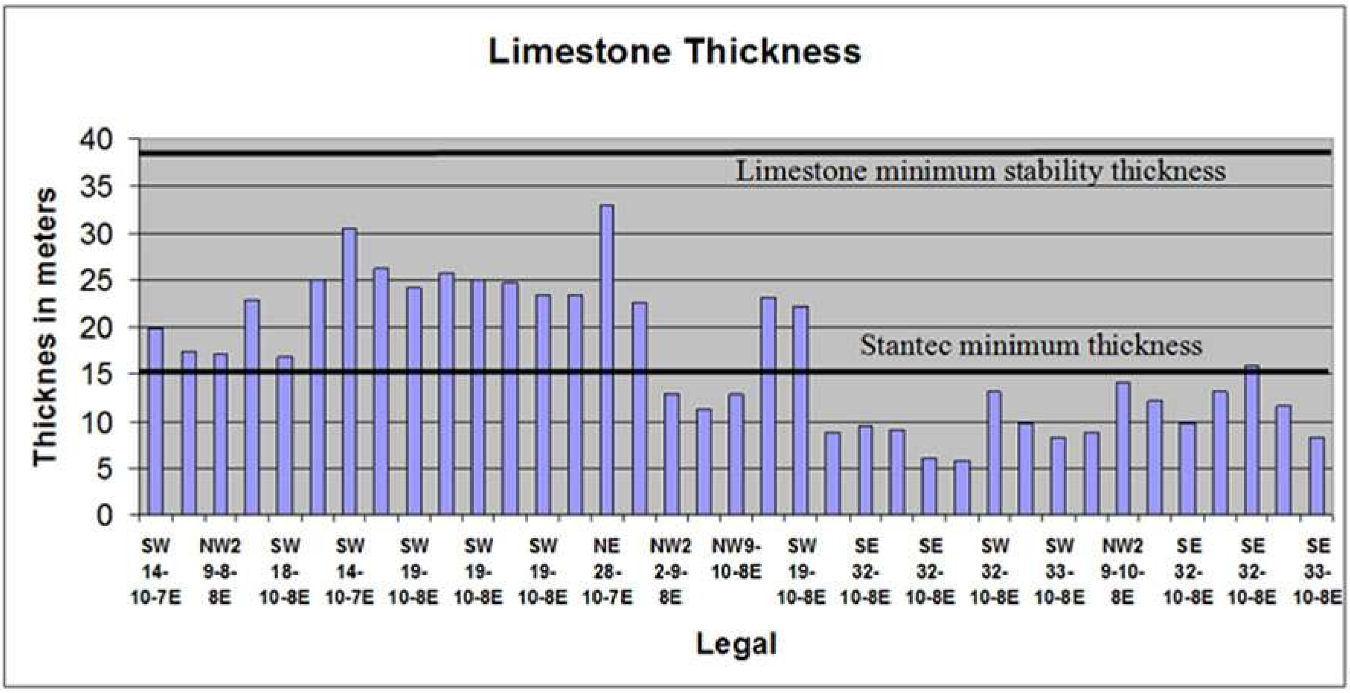

Figure 3. Limestone thickness in the CWS project area taken from drilling reports supplied by Manitoba Groundwater for CWS wells

Forty-two CWS drill reports obtained from Manitoba Groundwater documented many instances of sand collapsing into drill holes demonstrating the sand pillars are not stable. The well log for Bru 95-8 in the HGR report states that the sandstone is fine grained, well sorted, poorly cemented and of low strength and that the borehole would not stay open without drill mud. The core logs for Bru 95-6, 95-7, and 96-1, all state the sand is poorly cemented with low strength. These drill reports and core logs demonstrate the sand pillars would be prone to slumping. The airlift method of extraction would not be viable for strongly cemented sand pillars. Wherever sand extraction occurs with the airlift method, sand must be unconsolidated. The so-called "sand pillars" between clusters would eventually slump and move into the large cavities created by the sand extraction.

According to a recording and a transcript made by local volunteers for the CWS Virtual Open House, Brent Bullen, Chief Operating Officer of CWS stated in response to a question about the cavities;

"*We are seeing indication that the sand will actually move and rest back in. It's a unique sand it has many properties so would actually stand up.*"

This statement indicates that CWS acknowledges the sand pillars would slump into the cavities in the sandstone. However the statement by B. Bullen is nonsensical. How can sand rest back in to fill cavities and stand up to support cavities at the same time?

Sand slumping would enlarge the cavities under the well clusters creating an ever more unstable situation. Figure 4 illustrates the geometry of the well clusters and a unit cell within the clusters.

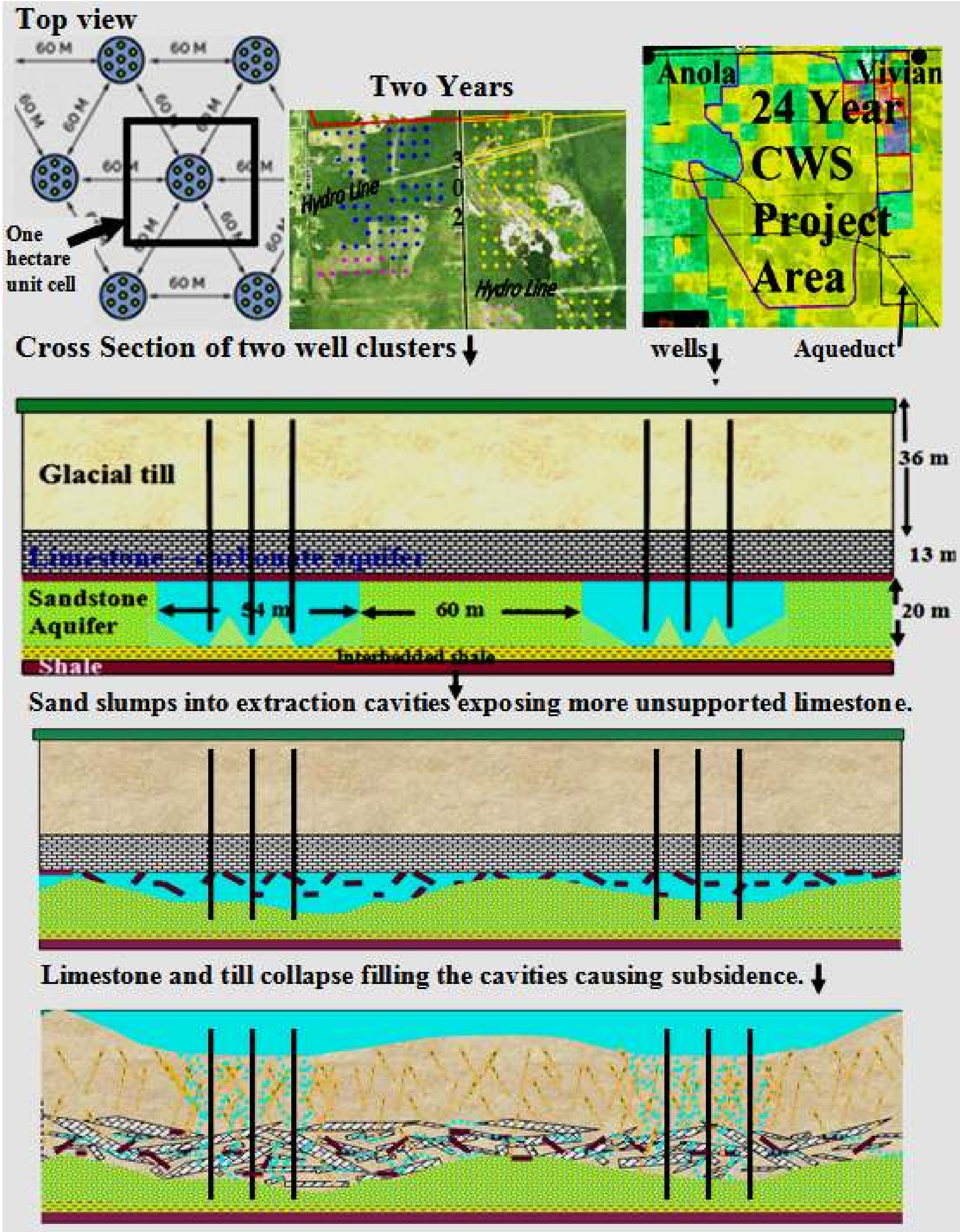

Figure 4. Land Subsidence from CWS well clusters and subsequent aquifer damage and contamination from surface runoff and drainage.

Figure 4 illustrates the progressive slumping of sand pillars into the excavation cavities and the subsequent collapse of the limestone layer. The subsidence and collapse would open the remaining carbonate aquifer to contamination from surface water runoff.

The unit cell in figure 4 is 114 meters wide by 98.7 meters high covering 1.12 hectares with a central cavity of 54 meters in diameter. The extraction EAP states that a cone of sand would be extracted around each well and that the wells in each well cluster are separated by 18 meters. According to the extraction EAP 3,000 tonnes of sand are to be extracted from each well in a well cluster. The actual volume of material extracted from each cluster would be greater due to the waste in terms of concretions and other over sized particles that are screened out a the extraction site.

A right circular extraction cone with the base at the top, a depth of 20 meters, a sand fraction of 0.8, and a dry sand density of 1.65 t/m^3, would have a base radius of 10.4 meters ignoring the wastage.

The details of the calculation are as follows. The volume V of a right circular cone is $V = \pi r^2 h/3$ where r is the radius of the base of the cone and h is the height of the cone (depth of sand extracted). Using a dry sand density of 1.65 tonnes/cubic meter, the volume of sand extracted plus water extracted per well would be 3000 t/(1.65 t/m^3)/0.8 = 2272 cubic meters. Using the formula for the volume of a right circular cone, for a sand depth of 20 meters radius would be10.4 meters.

The extraction cones around each well would overlap such that the entire 54 meter diameter well cluster would be open at the top. The extraction ratio for the cavity for the unit cell shown in figure 4 would be 0.203 (~20%). The unit cell and the 20% extraction ratio in the sand layer repeats as the well clusters expand. The extraction ratio quoted in the EAP for the processing plant of 5% would include the layers of limestone and glacial till above the sand layer thus giving a much smaller extraction ratio.

At the CWS Virtual Open House Brent Bullen stated;

"*We look at global sustainability we actually will take on average 1% of the resource in the global space that's in the Winnipeg formation.*"

The global ratio in the entire global space of the Winnipeg formation is not relevant to subsidence for the room and pillar configuration in the excavated area of the well clusters. To determine subsidence the extraction ratio within the sand layer is required only in the area of the extraction well clusters. The thicknesses of the limestone and till layers are relevant to determine the stability of the limestone and the total unsupported weight of overburden above the cavities but not to determine the extraction ratio relevant to sand slumping. In fact the thicker the layers above the extracted layer, the more unsupported weight that would contribute to subsidence and formation of sinkholes even though, if included in the extraction ratio, thicker layers of limestone and till would decrease the extraction ratio.

As the sand slumps into the cavities the unsupported cavity area would increase as the extraction proceeds. Eventual collapse of the limestone and till and subsequent subsidence would be inevitable over the entire area of the well clusters. A huge ever growing depression from subsidence would result that could fill with surface water. The depth of the depression would vary depending on the residual sand left after extraction in each well cluster and the degree of slumping from the surrounding sand.

Individual sinkholes could form for a well cluster to a depth of 20 meters, the total depth of the sand layer. Sinkhole formation around each well is documented in a report I wrote for What the Frack Manitoba of

February 2021 reviewed by Dr. Ingraffea of Cornell University a world renowned expert on well fracture mechanics.[25] The general subsidence area covered by all well clusters could be punctuated with these deeper sinkholes.

An example of subsidence has occurred in Sheridan, Wyoming for an underground coal mine abandoned in 1921.[27] The mined coal cavities were under a solid supporting coal layer covered by overburden analogous to the CWS sand extraction cavities under solid limestone covered by glacial till at Vivian. At Sheridan the cavities were supported laterally by solid coal pillars. At Vivian the cavities would be surrounded by unconsolidated sand that would not be supporting. Thus subsidence at Vivian would therefore be more likely than has occurred at Sheridan. The general subsidence is punctuated by deeper sinkholes at Sheridan as shown in Figure 5 taken from the Geological survey professional paper describing subsidence at Sheridan in the Powder River Basin.[27] Figure 5 foretells the future landscape at Vivian.

Figure 5. Subsidence and sinkholes at Sheridan,Wyoming from an abandoned underground coal mine[27]

The carbonate and sandstone aquifers would be exposed to contamination from agricultural chemicals, animal fecal matter, septic tank seepage and surface that would runoff into the subsided depression and sinkholes. This contamination would migrate in the carbonate aquifer exposed by subsidence. The contamination would eventually discharge to the Red River contaminating all the wells along the flow path. There may be hydrogeological connections between the aquifers and Cook's Creek and the Brokenhead River causing discharge of contaminants into these fish-bearing waters. The large and ever growing area of subsidence and sinkholes would disrupt the local surface runoff patterns and may create permanent swamps that could drain into the Brokenhead River and Cook's Creek carrying contaminants. The fish-bearing waters of the Red River could also be contaminated.

4. Waste Disposal

According to the HDR oversized particles, mainly sand concretions, would be screened out at the extraction site and sent for disposal at a licensed facility. The licensed facility is not named nor is the volume of screened waste material quantified. A paper by Schrieber and Riciputi (2005) identifies concretions formed in the Winnipeg sandstone as containing pyrite and marcasite.[7] Figure 6, a photograph of extracted sand south of Vivian taken by a nearby concerned citizen in the spring of 2020, shows that the concretions can be large and significant in volume. Note in the second panel of figure 6 the reddish colour indicating oxidation of pyrite.

Figure 6. Concretions potentially containing sulphide in pyrite and marcasite in sand piles extracted near Vivian, Manitoba in the spring of 2020.

Pyritic oolite nodules described by Watson in the Winnipeg formation [8] have also been observed in the extracted sand piles at Vivian. These oolite nodules could be screened out and added to the pyritic waste at the extraction site. Such concretions and oolite nodules were not analyzed for sulphide and heavy metal content nor subject to acid base accounting. These concretions and oolite nodules would likely be acid generating and would require specialized storage on site and disposal as acid generating waste. It is essential that the concretions and oolite be independently sampled and analyzed by acid base accounting and heavy metal content to determine the potential for acid drainage and heavy metal mobilization.

Drill cuttings would require disposal. The HGR identifies the shale drill cuttings as potentially acid generating, (PAG), which would require protective storage. Some of the larger shale fragments could be screened out and require specialized disposal for PAG waste. The volume of such screened out shale fragments has not been considered.

The HGR states regarding the small volume of PAG drill cuttings;

"*Therefore, this very small volume of waste material will need to be managed in a manner that is protective of groundwater quality. This will require additional characterization and mitigation measures which may include blending/co-deposition of potentially acid generating (PAG) or uncertain materials with Non-PAG materials in a designated area at surface to create a blended material with sufficient buffering capacity, use of organic matter to control redox conditions or construction of a temporary waste storage facility designed to safely contain waste materials.*"

The volume of PAG tailings, CWS terms "overs", is essential to determine the size and feasibility of storage or other mitigation measures. At other mine sites such as Snow Lake, PAG tailings are crushed and immediately transported by pipeline for disposal at the bottom of Anderson Lake.[28] Such a potential disposal location for acid generating tailings is not present in the Vivian area.

CWS has been negligent in not analysing the "overs" and concretions for acid generation potential and not determining the volume of all screened out tailings as the extraction site. CWS has given only a brief vague description of potential mitigation measures for PAG waste. The entire treatment of PAG waste has been glossed over and inadequately addressed. Potential major sources of PAG such as concretions, interbedded shale, and oolite have not been quantified and are ignored. The sand samples that were corrupted by extensive weathering in stockpiles could contain significant quantities of marcasite that contains sulphide as documented at Wanipigow.[3,7] Large amounts of acid generating tailings from the extraction facility without an adequate disposal location such as Anderson Lake would cause the project to be untenable.

5. Unrealistic Groundwater Model Simulations

The groundwater model simulations using the finite-element code FEFLOW v.7.3 were unrealistic. Only zero and fifty percent re-injection of water was modelled. The fifty percent re-injection scenarios were actually drawdown simulations with about ½ the withdrawal pumping rate of the zero percent re-injection. No water re-injection actually occurred either in the modelling or in the field tests.

CWS has explicitly stated that no discharge of water to the environment would occur from the extraction operations. Thus virtually all the water extracted with the sand would be re-injected. The extraction EAP states that only 10 US gallons per minute (gpm) would be directed into the slurry line recycle water loop. The remainder of water in the sand would be re-injected. The maximum rate of water plus sand extracted per well cluster is given in the HGR as 540 gpm. The amount of water extracted with the sand would vary according to the HGR from about 30% initially to 80% by the end of the 5 to 7 days of extraction. Thus nearly 100% of the water extracted with the sand would be re-injected. The 10 gpm water in the sand sent to the slurry loop would replenish the water lost to wet the sand stockpiles at the processing plant.

The finite element model and the field tests did not examine the actual intended operating conditions of near 100% re-injection of water. Modelling and measuring the fate and quantity of re-injected aerated water is essential. Re-injection of water would create a local high water pressure (head). It is recognized in the HGR that the shale aquitard would likely be compromised by excavation activities leading to mixing of aquifer waters. In the far field the groundwater pressure (head) in the carbonate would be lower than in the local high groundwater pressure region around the point of aerated water re-injection. Groundwater flows from high pressure to low pressure.[29] Some aerated re-injected water would enter and migrate in the carbonate aquifer. The amount of water that would enter the carbonate aquifer during re-injection at operational rates should have been modelled. Contaminated water would move much more quickly though the fractures in limestone than through the sand matrix of the sandstone aquifer.[13] The contamination could include harmful microbes, acid, and heavy metals including arsenic and selenium. It is essential to determine movement of the re-injected water through the carbonate to determine the contamination potential for the aquifer. The critical and essential analysis of re-injected water flow to the carbonate aquifer was not done. The fate and amount of the aerated re-injected water in the sandstone should also have been determined.

The amount of heavy metals released to the aquifers is likely to be oxygen limited. It is essential to know how much oxygen would be introduced to the aquifers and the movement of the oxygen through the aquifers. Not only dissolved oxygen could be re-injected but gaseous oxygen in air bubbles entrained in the water during the airlift process. Gaseous air could also enter the aquifers directly from the air injection tube in the extraction wells. F. Somji, President and CEO of CWS, stated in a Sept. 11 letter of to the IAAC that the air injection tube is shorter that the sand recovery tube so that the air would not directly enter the aquifer.[30] However, especially during initial priming of the system and during operation, some leakage of gaseous air to the aquifer could occur. It is essential to quantify the volume, rate and fate of all sources of oxygen introduced into the aquifer by the extraction process including from air injection. This has not been done in the groundwater modelling.

During CWS sand extraction operations simultaneous sand plus water extraction and re-injection of surplus aquifer water would occur. At no time would only water withdrawal occur during sand extraction. It is mystifying why so much effort was spent on irrelevant well drawdown studies that would never occur during production operations. The essential studies to determine the amount of oxygen in re-injected water, the amount of gaseous air introduced into the aquifer, the quantity of the re-injected water, the flow path and ultimate fate of the re-injected water and gaseous air together with the magnitude potential geochemical reactions that could occur with this aerated re-injected water and gaseous air were not done.

The 50% re-injection scenario modelled was in fact done by simply decreasing the well pumping rate by ½ from the 0% re-injection scenario as shown in the following statements from the EAP.

"*One production well (representative of the Project) was specified since at any moment in time production is occurring at one well cluster. Well cluster number 213 (Figure 6-5) was arbitrarily chosen as the location for the well boundary condition for the steady state predictive scenarios (Scenarios 1 through 3). The extraction rate assigned to the pumping well in the Scenarios 1 through 3 was scaled according to the injection rate as follows:*
- *Scenario 1 (0% re-injection): Pumping Rate = 2,998 m3/day (550 US GPM)*
- *Scenario 2 (50% re-injection): Pumping Rate = 1,526 m3/day (280 US GPM)*
- *Scenario 3 (0% re-injection): Pumping Rate = 2,998 m3/day (550 US GPM)*"

Thus for the 50% re-injection scenario the pumping rate was reduced by about one half rather than injecting 50% of the water and with drawing 100%. In other words in the modelling study water was never re-injected, the pumping withdrawal rate was simply reduced.

In finite element modelling discretization must be very fine around a withdrawal well. For an injection point nearby another very finely discretized area would be required for the water injection.

The HGR states;

"*Element size near the model boundaries are approximately 400 m, refined to approximately 60 m near stream boundary conditions and approximately 5 m around production wells. The groundwater model is also refined to approximately 50 m over the footprint of the project and increases to 75 m and 100 m within a 1 km and 4 km radius respectively. The groundwater model consists of 167,760 elements (84,423 nodes) per model layer for a total of 1,174,320 elements… Well boundary conditions act to remove water from specified grid cells at a specified extraction rate.*"

Rather than going to the time and expense of discretizing very finely with very small element sizes for water withdrawal and again for water injection, the same model was used for the 50% scenario as the 0% scenario with the withdrawal pumping rate decreased by about one-half.

Having a model with two very finely discretized regions very close together might not result in good resolution of the complex head distribution and groundwater flow pattern that would result. Simultaneous re-injection and withdrawal of water very close together is a difficult modelling challenge and was never done. The withdrawal rate of water was simply reduced for the water well Bru 95-7 to attempt to simulate re-injection. The net water input for 50% re-injection and 100% water withdrawal would be 50% water withdrawal. The actual production scenario would be almost 100% water re-injection and 100% water plus sand withdrawal. The net water change rate in the aquifer would be much smaller than the water withdrawal and water re-injection rate. For the model used in the hydrogeological study for a100% water re-injection and 100% water withdrawal scenario the net withdrawal pumping rate would be zero and there would be nothing to report for well drawdown. The scenario of 100% water (plus sand) withdrawal and nearly 100% water re-injection scenario that would actually occur was never modelled nor field measured in the hydrogeological study.

The drill records obtained from Manitoba Groundwater show Well Bru 95-7 used for the pumping tests for the hydrogeological study was constructed with no outer well pipe for re-injection of water. Well Bru 95-7 was designed for water withdrawal pumping tests only. All the field tests and modelling results were done for water withdrawal pump tests that have no relevance to the sand extraction process that the hydrogeological model was purported to support.

In reality the CWS airlift extraction operation would inject aerated water near the top of the sandstone aquifer that would increase the groundwater pressure around the injection point. This higher pressure zone above the bottom of the well would override the pressure drawdown around the deeper sand extraction point so that nearby domestic water wells in the carbonate would experience pressure (head) increase rather than decrease or drawdown. Fine silica sand injected could migrate across the degraded shale aquitard and enter into domestic wells in the carbonate turning the well water cloudy. Brown discoloured well water was reported in the public review of the CWS Vivian sand processing plant project by a resident nearby the CWS sand preliminary test sand extraction activities at the CWS Centre Line Road site. The brown discoloured water occurred in the well water only at the time of CWS sand extraction and had never occurred previously. This evidence of discoloured well water confirms that pressurization and turbidity effects could be experienced by nearby well owners during CWS extraction activities rather than drawdown. Accompanying contamination of the well water by heavy metals, fluoride and radon gas would not be so readily evident without water analysis. Ill effects of such potential contamination such as organ failure, loss of hair and teeth, fluorosis and cancer would take longer to manifest.

The results from the well drawdown tests quantifying the drawdown effect on nearby domestic water wells are misleading. Rather than temporarily drying up nearby domestic wells around the sand extraction, wells could back up from the re-injection pressure and return cloudy water high in file silica particles.

The re-injection point of the CWS sand extraction system would be according to the Manitoba Groundwater and Well Water Act, an injection well requiring a permit from the Water Director.[11] To our knowledge CWS has not obtained such a permit. CWS has not recognized and quantified the pressure effect of re-injection in their misleading hydrogeological study.

It appears that meaningless drawdown studies were a deliberate tactic to deceive reviewers, the regulator and the public into believing that an extensive comprehensive hydrogeological study was done that would support and verify the feasibility of the extraction project. We have not fallen for this deception.

6. The Winnipeg Aqueduct

As shown in figure 4 and figure 9 the Winnipeg aqueduct traverses the entire CWS project area. The slurry lines and return recycled water loops would eventually have to cross the aqueduct likely multiple times. The aqueduct is known to have cracks that allow infiltration of surface water.[26] Slurry line spills near the aqueduct could contaminate Winnipeg's drinking water supply with harmful microbes, arsenic, selenium, other heavy metals and the highly toxic acrylamide monomer. A major break of the slurry line would leak at a rate of up to 24 cubic meters per minute as documented in the CWS processing plant EAP. The aqueduct could be submerged with a volume of about an Olympic sized swimming pool in two hours. A gradual undetected leak could infiltrate the aqueduct undetected for a long time. The land subsidence and wetlands created by the well clusters on either side of the aqueduct could destabilize the aqueduct and adversely affect drainage around the aqueduct. Flooding of the aqueduct from subsidence wet lands could occur.

CWS is applying for a licence up to 2025. The excavations are not planned to reach the aqueduct by 2025. Project alterations after 2025 such as crossing of the Winnipeg aqueduct could be approved by an alteration request under the Environment Act with no consultation with the City of Winnipeg or the federal government. CWS has failed to consider the potential detriment of the extraction project on the Winnipeg aqueduct. CWS has failed to notify the City of Winnipeg of this eventual disturbance of the aqueduct and has not participated in or initiated a legal agreement with the City of Winnipeg for the CWS slurry operations to cross or be in the vicinity of the aqueduct. Failure to consider the eventual risk to the Winnipeg aquifer and to devise a method to avoid notification and approval by the City of Winnipeg for aqueduct crossing is deliberate avoidance of responsibility by CWS.

7. Section 35 Consultations

The large land disturbance from clearing slurry lines and well cluster drill pads would cause long term damage to the traditional lands of First Nations and Métis in the area. The land subsidence and sinkholes would have a devastating impact on traditional lands and wildlife and likely the fish-bearing water bodies of Cook's Creek, the Brokenhead River, and the Red River. The entire extraction project is on treaty one lands. Crown land where the indigenous people have harvesting rights would be adversely affected by the extraction project. There has been no Section 35 consultation undertaken by the provincial crown and as specified in the sections 155 (b) and (i) and other provisions of the Impact Assessment Act[32] and by the Constitution of Canada. The extraction EAP states;

"*The Project is not expected to adversely impact the exercise of Indigenous or Treaty rights.*"

No consultation is planned. CWS should ensure that the province carry out consultations. CWS must provide full and complete information for the consultations and comprehensively reply to all questions and concerns of First Nations would raise in the consultations.

8. Noise and Light disturbance

CWS has not adequately quantified the light disturbance from 24 hour drilling and slurry line operations and has not measured the noise levels.

The EAP states;

"*The impact of the Project on noise levels at nearest points of reception (e.g. nearest residences) is assessed as minor to moderate with intermittent duration and short-term frequency. Example noise sources associated with Project activities include mobilization of extraction well drilling equipment, drilling of wells and operation of pump stations. The following measures will be implemented to reduce noise generated from Project activities: • Vegetation clearing will be minimized to the extent feasible. • Project activities will setback a minimum of 100 m from nearest residences. • Mobile equipment and vehicles will be kept well maintained and will be fitted with mufflers, and other noise mitigation equipment as required. • Unnecessary idling and revving of engines will be avoided. • Additional noise mitigation measures will be applied (e.g. portable noise barriers) as required. In consideration of the above measures to minimize noise levels due to Project activities, it is anticipated that noise levels will be adequately attenuated.*"

Mitigation measures such as, setbacks, mufflers, portable noise barriers are vague and the effects of such mitigation have not been quantified. Additional noise mitigation measures are not specified and are meaningless.

Residents in the town of Vivian have complained about noise levels from CWS sand extraction activities in the LSL quarry pit about two kilometres south west of Vivian that have occurred since the spring of 2021. The noise was from one drill rig and sand extraction from one well, not several operating at once as would occur for the CWS operational well cluster extraction. This is definitive evidence that a 100 meter setback and intervening bush would be ineffective noise attenuation of CWS extraction activities. Figure 7 illustrates the CWS quarry drilling activities.

Figure 7. CWS drilling activities in a quarry southwest of Vivian Manitoba commencing in the spring of 2021.

The EAP states;

"*Fully shielded directional lighting fixtures will be used to focus light specifically to work areas to minimize the dispersal of light to the surrounding Project Site.*"

This appears to be the only reference to light pollution and mitigation of the effects to residents. The drilling rigs would be lit 24-7. Slurry lines and equipment with lights are to operate day and night. There is no quantification of the amount of light disturbance that would occur or any determination of the effect of this minimal mitigation measure of focus light. Focus light may not be feasible for drill rigs. Residents have witnessed intense yard night time lighting occurring at quarry sand extraction activities carried out near Vivian by CWS.

Below is a link to a clip of CWS night time silica sand extraction from the LSL quarry about 2 km southwest of Vivian. Both the penetrating noise and the extremely bright light pollution are evident.

"https://www.dropbox.com/s/0hfqzckgv68f61o/img_0623.mov?dl=0"

The lack of quantification and recognition of the detrimental effect of light pollution from the extraction project by CWS is extremely negligent.

9. Greenhouse Gas Emissions

The total greenhouse gas (GHG) emissions summarized in Table 6-3 of 6.8 kt of the Extraction EAP were not combined with the GHG from the processing facility of 34 kt given in the processing plant EAP. The projected GHG from all users of a new gas line to be constructed to serve the CWS processing plant were not included in the total GHG impact for the CWS projects. The GHG emissions from the plant and extraction project might not extend beyond the 2050 target for zero net emissions according to the project's 24 year stated lifetime. However the project start date could be delayed or production could continue beyond 2050 through submission of project alterations as described in the executive summary of the extraction EAP. The new natural gas line planned for the CWS processing plant would continue operation beyond 2050. There are no plans provided by CWS to meet 2050 GHG reduction targets that would be required by the new Canadian Net-Zero Emissions Accountability Act (Bill C-12). The mitigation measure of geothermal electrical heating for the CWS processing plant sand dryer may be required to conform to the new federal legislation. CWS has not considered such mitigation measures.

The HGR states;

"*Pumping stations will be installed as necessary along the slurry pipe to facilitate transport of the sand and groundwater slurry to the Processing Facility. This method of silica sand extraction will minimize above-ground disturbance and eliminate the need for trucks to transport the sand. As new extraction well locations and associated piping are established in the sequential progressive sand extraction process, pumping stations will be dismantled and relocated to optimal locations to facilitate movement of the sand and groundwater slurry through the slurry pipes to the Processing Facility*."

The Extraction EAP states;

"*The dewatering and pump station will be powered via direct mainline from Manitoba Hydro to reduce diesel consumption. It is expected that the dewatering and pump station will require 1460 connected hp to operate*."

The cost to provide hydro lines and hydro power to the pump stations is not documented. The movement of the pumping stations would require new hydro lines and hook-ups as the extraction progresses. This continual movement of hydro power installation is likely to be far more expensive than providing the power via diesel generator. CWS has not made this essential cost comparison. Manitoba Hydro might not be willing to dismantle and reconnect power every year to the moveable pump stations. Such an operation would add to the project land disturbance and require expensive rehabilitation. CWS has not determined the additional land disturbance, cost and methods of required rehabilitation for the movement and installation of new hydro lines as the pump stations are moved.

Table 6-3 of the extraction EAP gives the GHG emissions of 394,712 kg/CO2/yr for diesel generators that would provide power for slurry line pumping. The GHG for the pumping stations is given as only 12,432 kg CO2 per year. The low GHG for the pumps stations is not explained but according to table 6-3 of the CWS Processing Plant EAP would be indirect GHG attributed to hydro usage.

We can only assume that the diesel generator GHG of Table 6-3 of the Extraction EAP would be for the six inch HDPE slurry feeder lines that would be moved every five to seven days. The hydro power for pumping stations would be used for the fourteen inch HDPE slurry lines. If diesel generators would be required in lieu of hydro the GHG emissions for the14 inch slurry lines are bound to be comparable to the slurry feeder lines. Every year as the pump stations would become further from the processing plant the energy required and GHG emitted from the pump stations would increase. The 1460 hp given for the operation of the pumping station is equivalent to 1 Mw. Table 6-3 gives the pumping hours per year as 8784 hours. One Mw of energy for 8784 hours is 31.6 TJ of energy per year required for the pumping station. A diesel generator is only about 35% efficient.[34] The GHG per GJ of energy in diesel fuel is 74.1 kg/CO2e/GJ.[33] Using this information a pump station using diesel generators would release 6.7 kt CO2 per year.

The total GHG given in Table 6-3 is 6.8 kt including the small emission of 0.012kt for the hydro powered pump stations. The initial GHG release would be about double, 13.5 kt per year for diesel powered pump stations. By the end of the project lifetime the pumping stations would be at least 6 times the initial distance from the processing plant. The GHG released could increase to more than 40 kt per year for diesel powered pump stations. The 6.8 kt per year fixed GHG from table 6-3 would give a total of 46.8 kt GHG per year assuming the feeder slurry line length would remain the same as the project extends. To this must be added the GHG from the processing plant of 34 kt per year. The total GHG for the project would be at least 80 kt per year by the end of the project. The total GHG would be 47.5 kt at the beginning of the project for diesel powered pump stations. Even with hydro supplied pump stations which seems to be extremely unlikely, the GHG for both the extraction and the processing plants would be 40.8 kt per year.

Emissions over 50 kt per year are large final emitters and must be reported to Statistics Canada. In 2018 Manitoba had eight large final emitters. For diesel powered pump stations by the end the 24 year project period the GHG for both CWS projects would be about the same as the Summit Road landfill at number 6 amongst the large final emitters for Manitoba.[35]

Contrary to the assertions in the EAP that;

"*the impact of the Project on Greenhouse Gas contributions to the atmosphere is assessed as negligible,*"

the GHG for both CWS projects would be substantial and among the largest single emitters in the province. This is another example of CWS deliberately under-representing project detriment. CCWS has also failed to account for the cumulative effects of GHG emissions from other users of the natural gas line to be brought to the processing plant, has failed to substantiate that hydro power can be used for the pump stations and has failed to comply with federal regulations of Canadian Net-Zero Emissions Accountability Act.

10. Infrastructure Disturbance

The CWS slurry lines and return recycling water lines would cross two Manitoba Hydro transmission lines one of which is an international 500 kV transmission line falling under the federal jurisdiction of the Canada Energy Regulator Act (S.C. 2019, c. 28, s. 10).[36] CWS well clusters would be drilled on either side of the transmission lines as shown in figure 8. The well clusters may cause ground disturbance of the transmission lines. CWS vehicles, equipment and slurry lines would cross the transmission lines.

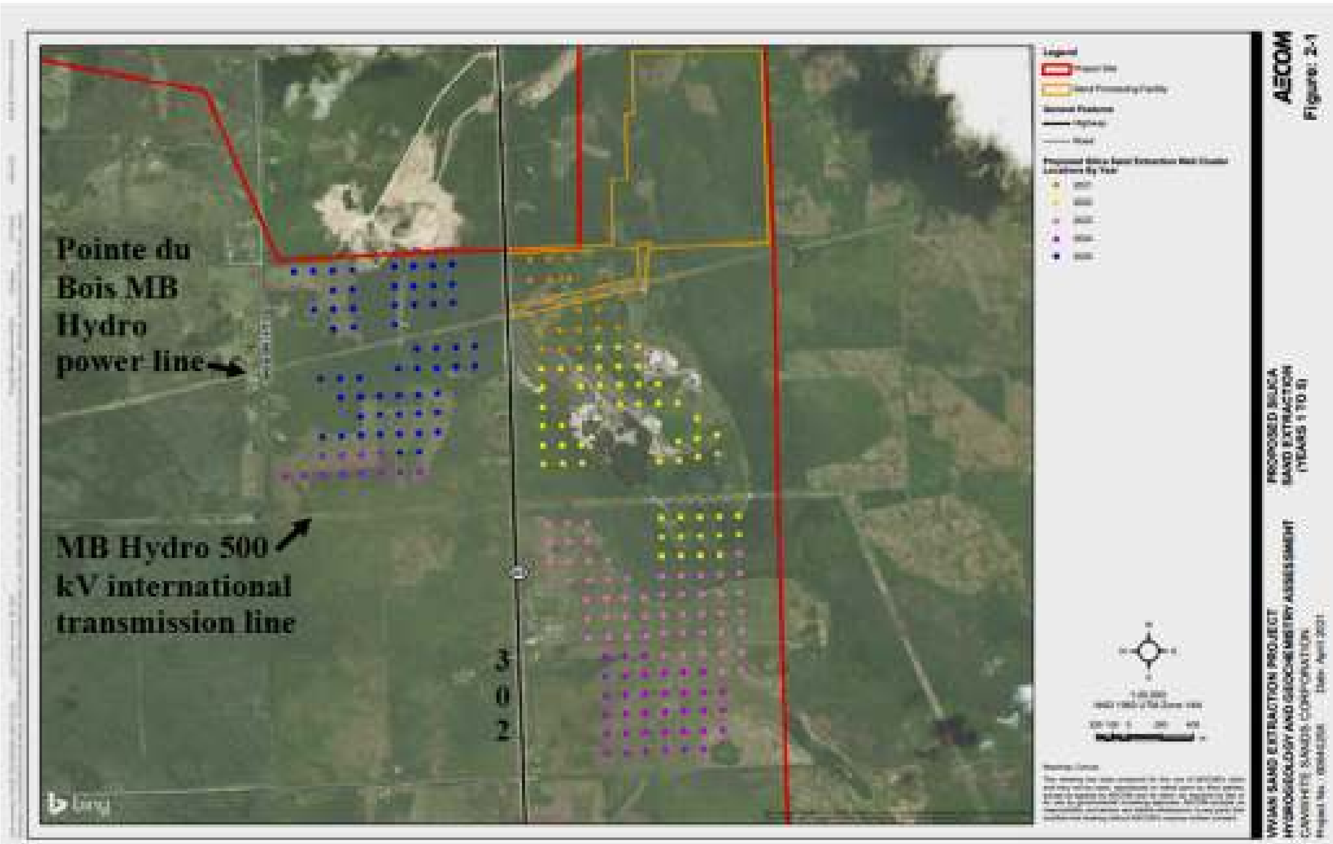

Figure 8. Planned location of CWS well clusters up to 2025 from the CWS HGR

Section 273 of the Canada Regulator Act states;[36]

"*Prohibition — construction or ground disturbance*

273 (1) It is prohibited for any person to construct a facility across, on, along or under an international or interprovincial power line or engage in an activity that causes a ground disturbance within the prescribed area unless the construction or activity is authorized by the orders or regulations made under section 275 and done in accordance with them.

Marginal note:Prohibition — vehicles and mobile equipment

(2) It is prohibited for any person to operate a vehicle or mobile equipment across an international or interprovincial power line unless
(a) that operation is authorized by orders or regulations made under section 275 and done in accordance with them;

Orders
275 (1) The Commission may, by order, give directions
(a) governing the design, construction, operation and abandonment of facilities constructed across, on, along or under an international or interprovincial power line;
(b) prescribing the area for the purposes of subsection 273(1);
(c) authorizing the construction of facilities across, on, along or under an international or interprovincial power line;
(d) authorizing ground disturbances within the prescribed area;

(e) governing the measures to be taken in relation to
(i) the construction of facilities across, on, along or under an international or interprovincial power line,
(ii) the construction of an international or interprovincial power line across, on, along or under facilities, other than railways, and
(iii) ground disturbances within the prescribed area;
(f) authorizing the operation of vehicles or mobile equipment across an international or interprovincial power line and governing the measures to be taken in relation to that operation;"

The location of the MB Hydro Pointe du Bois power line and the 500 kV International Transmission Line to Minnesota as well as the Winnipeg aqueduct and the CN mainline railway are shown in figure 9.

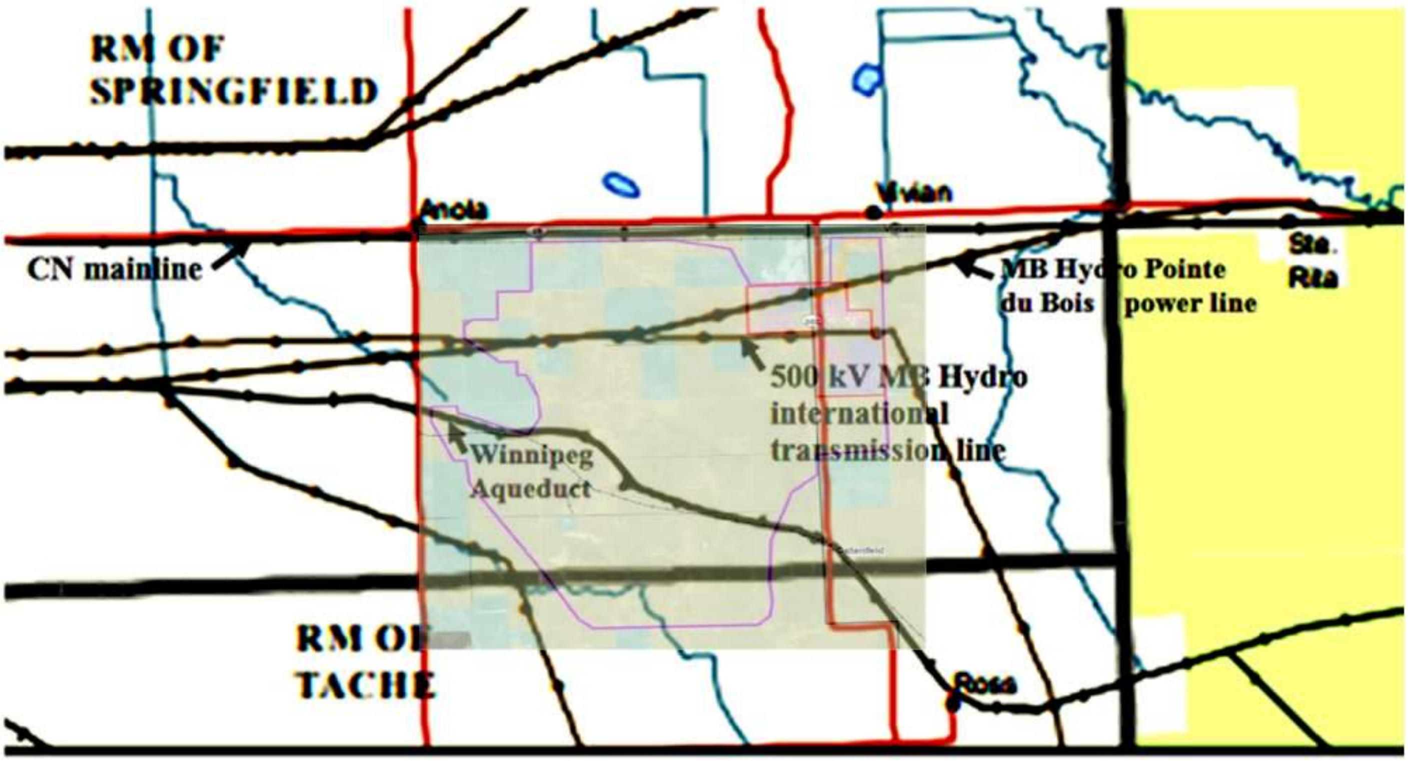

Figure 9. Location of MB Hydro Pointe du Bois power line, the MB Hydro 500 kV international transmission line, Winnipeg aqueduct and CN mainline.[37] The CWS project boundary is shown by the purple line

Fourteen and six inch diameter HDPE slurry lines that would carry the extracted sand to the Vivian Sand Processing Plant and recycled return water lines would cross the Hydro lines multiple times. The six inch sand slurry HDPE lines would be emptied into vacuum trucks and moved every five to seven days each time crossing the hydro lines anew when extraction is in that vicinity. The fourteen inch main slurry line and the return recycle water lines would have to be moved, crossing the hydro lines repeatedly in different locations.

Figure 4 illustrates the land disturbance that would affect the international 500kV transmission line and the Pointe du Bois power line due to land subsidence. The unconsolidated sand around the cavities would slump into the cavities gradually enlarging the area of the unsupported shale and limestone above. The limestone is not thick enough to support the cavities that would increase in size as the sand slumps. The land subsidence could cause the formation of swamps or wetlands around and crossing the hydro corridors.
The subsidence would cause land depression and instability within and adjacent to the corridors and transmission lines.

As shown in figure 8 the CWS well clusters up until 2025 would be on either side of the provincial highway 302. CWS slurry lines and heavy equipment such as vacuum trucks and drill rigs would be required to cross highway 302. To our knowledge CWS has not notified Manitoba Infrastructure nor obtained permission for the disturbance to highway 302. The land subsidence that could occur from the well clusters could destabilize the road bed and would affect road drainage. CWS should have identified these engineering issues and documented the risks and planned mitigation.

11. Property Damage and Devaluation

The large project footprint of over 130 CFL football fields per year with extensive damaging land clearance for drill pads, pump stations and well clusters and slurry lines would be slow to rehabilitate and cause loss of property value and recreation opportunities. Land subsidence and sinkholes would cause permanent land disruption and change to drainage patterns that would damage and devalue private property. Aquifer damage could render the area uninhabitable and cause large outward population migration from the affected areas.

12. Wildlife and Bird Disturbance

The extensive subsidence and land disturbance from slurry line and drill pad clearance and project noise and light disturbance continuing for 24 years or more would have serious detrimental effects on birds and wildlife habitat and behaviour. Rehabilitation would take many years and not be feasible for such major disturbances as subsidence and sinkholes.

The extraction EAP states;

"*The types of naturally vegetated land cover (wildlife habitat) that will be cleared (i.e., forest, meadow and willow/alder) are common within the regional area. The amount of naturally vegetated area that will need to be cleared for the Project during each year of operation is minor considering approximately 44% of the Project site is previously disturbed land cover due to human development such as agriculture, roads and aggregate quarries. Project components will be located on previously disturbed land to the extent feasible*."

This is an absurd understatement of wildlife disturbance. What about the 56% undisturbed portion that is the home to many birds and wildlife? CWS has made no realistic effort to quantify the wildlife disturbance and to specify mitigation measures.

CWS has not surveyed the wildlife present and quantified the habitat disturbance that would occur. Only vague statements are made in section 4.4.2 of the EAP on the presence of such wildlife as bear, white tailed deer moose, grey squirrel, red squirrel, smaller rodent species, snowshoe hare, red fox, coyote, American woodchuck and striped skunk. The risk to some birds is vaguely specified in Table 4-5. No mitigating measures for bird and wildlife habitat loss are given.

The EAP states;

"*Light pollution emanating from the well cluster/work areas within the Project Site can also disturb wildlife and alter natural wildlife behaviour for wildlife that may be present within the zone of influence of site lighting*."

There is no quantification of this light disturbance or any mention of mitigation of this detrimental effect on wildlife.

The extraction EAP states;

"*Wildlife species present in the vicinity of the Project are anticipated to be accustomed (habituated) to some level of noise due to the presence of existing developments.*"

There is no supporting evidence for this statement. It is baseless conjecture deliberately dismissing the issue of detrimental noise effects on wildlife and birds. Such unsupported dismissal of project detriment is inexcusable.

13. Conclusion and Recommendations

CWS has deliberately provided misleading information and omitted essential information in the EAP and the HGR used to support the CWS Vivian Sand Extraction Project. The project detriment includes;

1. re-injection into the sandstone aquifer of excess water from the sand extraction that could lead to acid, heavy metals, selenium, fluoride, and microbial contamination of the both the carbonate and sandstone aquifers, water well poisoning and prohibited mixing of aquifer waters,
2. slurry line leakage that could pollute surface waters and the Winnipeg aqueduct with acid, heavy metals, selenium, fluoride, and toxic acrylamide monomer,
3. extensive land subsidence and sinkholes covering at least the equivalent of 130 CFL football fields per year that could destroy the integrity of both the carbonate and sandstone aquifers in the extraction area, provide a vector for surface contamination including fecal matter to enter the aquifers, cause extensive property damage and land devaluation, infrastructure damage to provincial road 302 and other roadways, disturbance of the Pointe du Bois power line and the international 500 kV MB Hydro line to Minnesota, and damage to and potential poisoning of the Winnipeg Aqueduct,
4. creation of uninhabitable land, altered drainage, damage to fish- bearing waters and outward population migration from land subsidence and sinkhole formation,
5. acid drainage from extensive tailings including pyritic concretions, oolite, interbedded shale in the Winnipeg formation, "overs" shale fragments, and from marcasite coating of the extracted sand,
6. contamination from the slurry line spills of dissolved contaminants including the highly toxic acrylamide monomer that must be eventually removed as they continually build up due to slurry loop recycling,
7. unquantified stress, hearing damage and other detrimental psychological project effects from noise and light pollution,
8. extensive irreversible unquantified wildlife and bird habitat and behavioural disruption,
9. irreparable damage to First Nation traditional lands with no Section 35 consultations as required by the constitution of Canada,
10. large GHG emissions as much as 80kt tonnes per year from the combined processing plant and extraction activities and unaccounted GHG emissions from other users of the natural gas line extended to serve the CWS processing facility, and
11. violation of the Canadian Net-Zero Emissions Accountability Act.

In the light of these egregious effects inadequately documented in the EAP and HGR submissions to support the licensing application for the CWS Vivian Sand Extraction project we recommend that al full Clean Environment Commission Hearing be convened. We recommend that a full and transparent section 35 indigenous consultation be undertaken by the province and CWS. The current licensing process should be suspended until the CEC hearings and the section 35 indigenous consultations are complete.

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