CanWhite Sands – Silica Sand Extraction Project
Environment Act Proposal –
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Public Comments Received From

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Comments re: Manitoba Environment Act Proposal
Public Registry 6119.00
CanWhite Sands Corp. Silica Sand Extraction Project

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[redacted]
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Acronyms and abbreviations

EAP1 = CanWhite Sands Corp. Vivian Sand Extraction Project Environment Act Proposal, Part 1

EAP2 = CanWhite Sands Corp. Vivian Sand Extraction Project Environment Act Proposal, Part 2

AppA1 = Appendix A Part 1

AppA4 = Appendix A Part 4

AppB = Appendix B

AppC = Appendix C

AppE = Appendix E

WDR = CanWhite well drilling records (not in EAP) https://registrydocumentsprd.blob.core.windows.net/commentsblob/project-80974/comment-48101/CanWhiteWellDrillingRecords2020_10_01.pdf

EAPPF = Vivian Sand Facility Project Environment Act Proposal, Public Registry 6057.00

NTU = nephelometric turbidity unit

PAM = polyacrylamide

Acronyms used in citation sources are given in the References section.

Verbatim quotes from proposal documents cited in this text have been highlighted in red.

Declaration

I am **opposed** to the proposed project./Je suis **contre** ce projet.

Disclosure

No remuneration or other compensation/consideration was received or promised from any individual, group or agency in the preparation of this document. Personal observations and opinions herein are mine alone.

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Synopsis

1. The upper Red River Carbonate and the lower Winnipeg Sandstone aquifers of concern in the project area are separated by a relatively impermeable shale aquitard which is of variable thickness, brittle, and in some places degraded to clay.

2. The proposed project initially intends to drill more than 9000 production wells, penetrating the aquitard and spanning both aquifers, over a 24 year period for silica sand extraction from the Sandstone aquifer.

3. Approximately 1500 domestic wells are found within the Regional Project Area (AppA1, p. 16), the majority of which are completed in the Carbonate aquifer and do not penetrate the shale aquitard (AppA1, Figure 1-3).

4. Some drilled project wells will not or cannot be used for sand production for various reasons or other purposes.

5. Artesian conditions will certainly be encountered, presenting potential for site flooding, and requiring special sealing techniques. These conditions bring into question the compatibility of this project with the hydrogeological setting of the project area.

6. The enormous number of wells will unavoidably contribute to interconnections between the aquifers and their intermixing, and increase the risk of contaminant transport from the surface into the aquifers.

7. The boreholes will be 20.3 - 40.6 cm in diameter, much larger than typical domestic wells.

8. The wells will be drilled in circles (clusters) of seven, spanning a 50-60, or 60-70 m diameter: six at the periphery and one in the center. Clusters will be 60 m apart, and will each encompass 0.20 -0.28 ha.

9. All of the wells will be located on private land, on parcels as small as 0.3 ha.

10. Setbacks from homes and domestic wells, and hamlets, will be only 100 m. No setbacks are specified for barns.

11. Some form of air lifting will be used, but the actual design is not disclosed, only an example is given.

12. Water and sand brought to the surface will be subjected onsite to vibrating screens, a dewatering station of undisclosed design and process, an attempt at water disinfection, and reinjection of the water into the aquifer.

13. The proposed ultraviolet light disinfection will not be appropriate because high turbidity levels vastly disqualify this method from this application.

14. The processed sand/water slurry will be pumped into plastic slurry lines and travel along cleared pathways to the processing facility, where the sand will be removed and the water will be endlessly recirculated via return lines to the extraction sites.

15. Some of the water in the slurry line system will contain water from the facility clarifier and thus potentially residues of polyacrylamide, which degrades to toxic acrylamide. Some well grouting agents and borehole linings also contain polyacrylamide.

16. Pumping stations of undisclosed design and configuration will maintain pressure in the slurry lines.

17. Slurry lines, i.e. HDPE tubing of inadequate description and specifications, will be placed on the ground, will be moveable to different locations, and will cross under or over roads.

18. Use of HDPE tubing for this application raises concerns: it is not optimal for high pressure applications, becomes brittle at cold temperatures, withstands less pressure at warm temperatures, it will be continually abraded by silica sand, and it requires gentle handling and protection from scratches. It will be exposed to the rigors of the environment, periodic manipulation, and potential human/animal interference. Risks of leakage or rupture are significant.

19. Drilling will occur year-round, with extraction in warmer months but also in winter. Slurry lines will not be used in winter. The slurry water will be stored. The disposition of the extracted sand in winter is not disclosed.

20. Some drawdown of domestic wells surrounding the extraction sites may/will occur during and after operation activities. Simulation modelling does not match proposed parameters.

21. Sampling methodology for groundwater chemistry is in some cases invalid.

22. Removal of the sand will create void space underneath the extraction wells, which will permanently alter the physical structure and characteristics of the Sandstone aquifer within the project site. Damage to the brittle and fractured shale (or the pliable clay) aquitard, combined with the circular perforation placements of the boreholes, could lead to weakening and collapse in the regions of the well clusters, resulting in large holes between the two aquifers that cannot be sealed.

23. Decommissioning of wells is presented in two separate contradictory protocols: the casing will remain/or it will be removed when the well is sealed. In the version where it will remain, it will apparently be severed below ground and capped, then camouflaged at the surface. People won’t know it is there until at some point it may be eroded or accidentally excavated. There will be many thousands of these abandoned wells.

24. The municipality must keep accurate records of all decommissioned wells, and regulate future uses, building permits and construction at these sites. On agricultural land, spreading

of manure, or pesticide and chemical fertilizer application overtop these wells could provide risks of contamination.

25. Since the decommissioned wells will remain in perpetuity, the seals and casings (decommissioning version 1) will eventually fail on at least some of them, as there will be many thousands of them.
26. Oxygen will be introduced into the Sandstone aquifer primarily with the reinjected groundwater, assuming there will not be additional leakage from the air lift apparatus, which latter design is not fully disclosed. Oxygen will oxidize soluble iron and manganese to form insoluble precipitate. Such untreated tapwater will appear discolored, when otherwise it would have been clear and "turned" later after exposure to air.
27. Oxygen will create favorable conditions for proliferation of iron bacteria and aquatic fungi, should they be introduced into the aquifer with infected tools and equipment, or be already present in nearby infested domestic wells.
28. Access trails for large equipment, smaller trails for slurry lines, and the extraction sites for well clusters will be bulldozed in winter, unless clear access is already available. Since clusters will be 60 m apart, multiple clusters could be located on the same land parcel.
29. While the undescribed onsite dewatering station and the undescribed slurry pumping stations will run on mainline power, no mention is made of where hydro poles and power lines will be routed and the additional clearing required.
30. Woody debris from the clearing activities will be burned, not chipped or shredded.
31. Extraction operations will continue 24/7, possibly even some in winter. Each well will operate 3-7 days and nights (there are several different estimates). Not all seven wells in a cluster may operate at the same time, extending the total duration of operation of a given cluster to weeks.
32. The 24/7 operation will generate continuous noise pollution from all of the various pieces of equipment operating simultaneously, only some of which will be powered by mainline electricity, while the majority will be run by diesel generators. The setback limit from somebody's house is only 100 m. Noise affects health and wellbeing of people, and will disturb farm animals, birds and other wildlife. Noise will also occur during clearing, site setup, and decommissioning. The slurry pumping stations will generate noise as well.
33. The proposal bashfully skirts around the issue of light pollution. Since operations will be 24/7, industrial lighting will be required. There is no information regarding details of the intensity, type and disposition of lighting at the sites. Light pollution affects people and nocturnal wildlife. Birds especially are disturbed by light, and extraction operations will overlap with the breeding season of all bird species. The disturbance from light will be combined with that from noise.

34. Air quality will be a nuisance on days when the site is upwind. Diesel exhaust from all of the heavy equipment and generators can exacerbate respiratory conditions and create stress.
35. The revegetation and restoration plans are deemed inadequate in multiple ways. Most of the restoration appears to be based on allowing areas to "revegetate naturally", i.e. walk away. There is noncommittal nebulous mention of possible reseeding with "native seed mixtures" in some cases. Property owners will replant trees themselves.
36. The proposal ignores or minimizes the role and rights of the property owner. There is no provision for compensation for damaged property such as fences, etc., or other nuisance, or provision in the event a family has to stay at alternate accommodations for the duration of the disturbance, which may extend to weeks.
37. There is no mechanism for adjudication/arbitration by a neutral party in the event of disputes.
38. This project will give rise to only 35-45 jobs, 70-85% of which will be seasonal. There is no indication of how many of these jobs will be Manitoba hires.
39. As admitted by the proponents themselves, the procedures and technology to be used in this project are untried and undocumented elsewhere. The first four years are expected to be experimental learning.
40. Post-closure, any long-term accountability is absent.
41. In the end, the proposal fails to provide substantive information on multiple key aspects of the project, and has not been adequately considered or presented. The public are being asked to buy something in a sack. Even so, the proposed project will impose invasive and permanent changes on the aquifers, mar and scar people's properties, and subject residents to unconscionable inconvenience, intrusion, nuisance, and stress.

Two irreplaceable aquifers

The Municipality of Springfield has been blessed with an enviable supply of quality water. The name itself, Spring Field, evokes the aquatic, once pristine, bounty of this place. It reminds us of the fragility and importance of our finite and irreplaceable water resources, and the need to conserve and protect them. Injudicious decisions made in the pursuit of hasty development and commerce may result in long-term adverse consequences that are irreversible and irremediable. Already a series of unfortunate past planning decisions have affected various regions of the RM, where a variety of excessively aggressive human activities have shown that the capacity of the aquifers to absorb insult is not unlimited. Notable impacts have included aggregate extraction, hog production, inappropriately dense and/or regrettably sited residential developments, deforestation and intensive drainage. Large numbers of wells, including industrial users, have resulted in hydrological changes in both quantity and quality of water. Fabulous artesian springs that I remember from the 1950s have since stopped flowing, beloved wetlands have disappeared. It is sad to look back on what we once had, but it is all the more sobering that we should assess and safeguard what we still have. Responsible planning for the future is now particularly urgent and necessary in the face of undeniable climate change and looming water shortages as rural population increases and demand for water grows. Let us take up our stewardship role seriously, with thoughtfulness and circumspection. We do not get another chance.

Physical extent of groundwater threat

The proposed project in the Municipality of Springfield will affect two important, precious and unique groundwater reservoirs: the Red River Carbonate and the Winnipeg Sandstone aquifers, which overlie each other. "These two aquifers are hydraulically separated by a relatively thin shale which forms the upper part of the Winnipeg Formation." (Wang et al., 2008). The depth at which shale occurs and its thickness vary in the project region, while a number of wells have shown multiple shale layers interbedded with the sandstone (WDR). Information is incomplete: "The shale unit is not well understood as it has not been consistently mapped" (AppA1, p. 60).

Unfractured shale is an effective aquitard (Figure 1). Winnipeg Shale in particular has a reported "hydraulic conductivity of 2.8 x 10^{-8} m/s." (AppA1, p.63), at the upper end of the permeability range for shales in Figure 1.

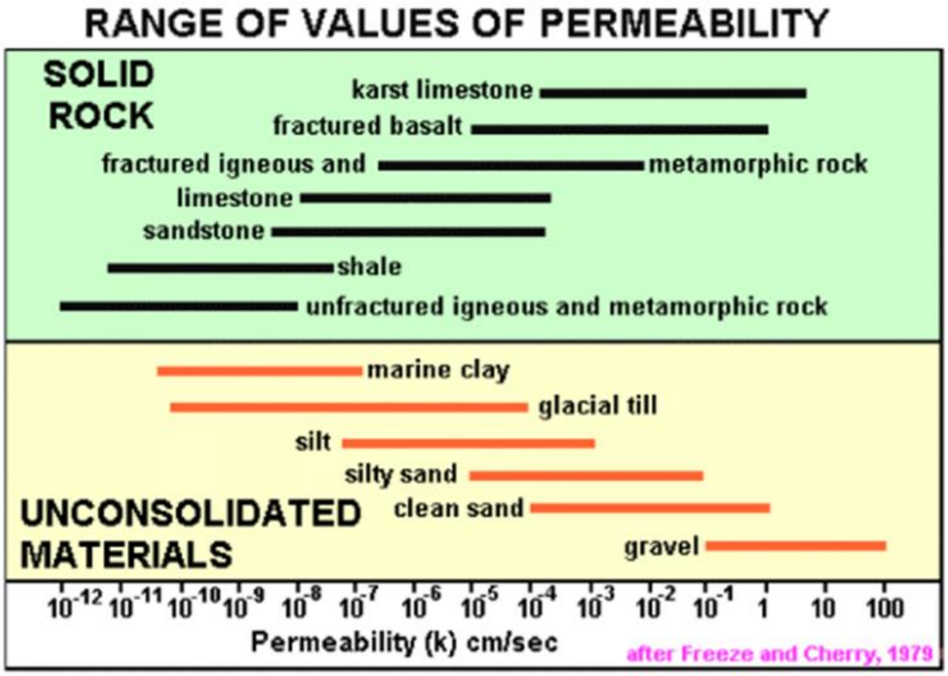


Figure 1. Ranges of permeability of various rocks and unconsolidated media. Source: https://web.viu.ca/earle/geol304/geol-304-b.pdf

One of the greatest concerns with this proposal is the risk, indeed expectation, that the shale aquitard barrier between the Carbonate and Sandstone aquifers will be further compromised and mixing will inevitably occur. For the proposed project, "It is possible that project operations will result in increased hydraulic communication between the Red River Carbonate and the Winnipeg Sandstone within the Project Area due to fractures and borehole annuli that may extend across the Winnipeg Shale aquitard." (AppA1, p. 53). There is the potential of "Degradation of the Winnipeg Shale as a result of project operations resulting in mixing of groundwaters om [sic] the Winnipeg Sandstone and Red River Carbonate with possible impacts on groundwater quality in one or more of the aquifers."(AppA1, p. 79).

A number of mostly domestic wells already span both aquifers (AppA1, Figure 1-3), with associated measurable impacts (Betcher and Ferguson, 2003). The latter authors "reported that these interconnecting boreholes have resulted in localized losses in the naturally softened groundwater from the Winnipeg Formation, and local water quality changes in the carbonate aquifer." (AppA1, p. 66). These changes cannot be reversed.

Water quality in the Red River Carbonate and the Winnipeg Sandstone aquifers differs, and impact will depend on direction of intrusion, as concentrations of many (not all) chemical parameters are lower in the Winnipeg Sandstone (see AppA1, section 3). Also of concern, however, is the potential of the thousands of new boreholes to facilitate the downward migration of pollutants from their surface origins, and thus into both aquifers. According to

Cherry et al. (2004), "Aquitards are critical to protecting water supply wells from contamination". Concerns with this project are further amplified by the large diameter (20.3-40.6 cm (EAP1, p. iv)) of the holes.

The proponent estimates "an initial average of 56 well clusters of seven extraction wells per cluster, annually" (EAP1, p. iv), over a projected 24 year lifespan. This amounts to more than **9400** invasive penetrations of both aquifers. This does not include additional wells that, for various reasons, are unusable for extraction purposes.

This proposed vast number of extraction wells is the **minimum** to be expected: note the word "initial" in the above statement, indicating that this is only a starting number. What the "later" numbers might be is not revealed.

According to the proponent, "When each well is drilled, casing will be installed and grouted in place to isolate the Red River Carbonate and Winnipeg Sandstone aquifers from one another and thereby preventing vertical mixing of waters." (EAP1, p. vii). "After sand extraction is complete at a well, the extraction piping is removed. The well is then sealed in accordance with The Groundwater and Water Well Act using a grout plug with layers mimicking that of the formation using materials such as pea gravel, native material and/or bentonite on top to prevent any vertical movement between aquifers." (EAP1, p. 20).

This does not eliminate the potential for intrusion during drilling and casing manipulation, imperfect sealing, or accidents, more so given the thousands of wells involved. It is almost certain that a number of them will be flawed, and even more certainly over time the integrity of some of the casings will be compromised. Some may have no casings remaining but are otherwise sealed on decommissioning (WDR).

Boreholes

- Some boreholes have already been drilled and extraction has occurred (e.g. Figure 2) under the latitude of Mineral Exploration. According to AppA1 (p. 58) "CanWhite drilled over 40 boreholes between 2017 and 2020". Drilling records can be found for 41 wells at WDR.
- "Additional testing will be conducted to further assess and confirm the limestone and overburden thickness and structure as the Project progresses geographically." This means that test holes will be drilled in addition to the sand extraction holes. **The estimated <9400 number presumably relates only to producing wells**, i.e. non-producing wells and abandoned "duds" are not included. Some wells already drilled are described in WDR as "for monitoring purposes", while some boreholes caved in after drilling (e.g. Well PID 197869, 197923)(WDR), while yet others turned out to be artesian (e.g. Well PID 200824, 200861). Will these **extra wells** be considered supererogatory in terms of **reported production numbers**, yet in themselves also pose (additional) environmental risks?

Figure 2. Silica sand extraction site in Springfield, April, 2021. Image used with photographer's permission.

- "CanWhite Sands Corp. ('CanWhite') is proposing to extract high purity silica sand from the Winnipeg Sandstone aquifer (approximately 61 m, or 200 ft below ground)" (EAP1, p. 1), or "an approximate depth of 51 m to 76 m" (appA1, p. 19). Some test wells already drilled have been in excess of 300 feet, or more than 90 m (e.g. Well PID 197860)(WDR).
- Legal descriptions provided for test wells have not always matched the coordinates. According to the well driller's report, "COORDINATES AND LEGAL ON REPORT DO NOT MATCH" (Well PID 199973)(WDR).
- Each of the thousands of invasive penetrations will present the risk for movement of surface contaminants to the groundwater strata below. It is important to place this number of penetrations in the context that:

a) they will all involve drilling through both aquifer strata,
b) they will be in addition to existing water wells that penetrate both strata, with already documented adverse effects (Betcher and Ferguson, 2003), and
c) they will substantially outnumber existing wells.

According to Cherry et al. (2004), it is of paramount importance to "**prevent well designs that cross connect or breech aquitards**" because of "**vulnerability to contamination**". **Therefore indiscriminate drilling into the Sandstone aquifer is ill-advised, will aggravate already existing issues, and create new ones.**

- "Water well rigs that are the typical size used to install domestic water wells will be used to install the sand extraction wells." (EAP1, p. 14).

  This is misdirection: *of course* the **rigs** may be standard, but **the holes will be much larger**, with diameters of **20.3 - 40.6 cm** (EAP1, pp. iv, 1). Specifically, "Each well is anticipated to be 16" diameter through the Quaternary Sediments, 10" diameter through the Red River Carbonate and Winnipeg Shale, and 7" diameter within the Winnipeg Sandstone (production casing)" (AppA1, p. 23).

  The largest bore is a third greater than the 30 cm (12 in) size of many town water supply wells, and all three bores are larger than typical domestic wells, for which the Canadian standard is 15 cm (6 in). The potential for contamination is thus concomitantly increased.

- The proposal obliquely mentions drainage ditches and "maintaining natural drainage pathways through low areas." (EAP1, p. viii). There are swampy/boggy areas in the project zone. The EAP (section 4.3.1, EAP2, p. 37) minimizes/dismisses consideration of surface water within the project area, although it admits "ditches and low drainage areas" are present. **Will wells be drilled in these conditions**? According to WDR, this has already happened: Well PID 201398 yielded peat moss in the top 1.5 meters. Wet conditions present a potential for direct contamination of wells with surface water. Peatland/bog water is associated with a high risk of introducing organic compounds into groundwater, which may then provide substrates for anaerobic bacterial growth.

- According to Wang et al. (2008), "vertical recharge from overburden material" of the Sandstone aquifer is becoming an increasingly important component of the total recharge, and as demand on the aquifer grows, "vertical recharge will play a bigger role". Therefore **vertical movement of associated contaminants from upper strata will become more significant over time.** This emphasizes the importance of minimizing potential opportunities for contaminant sources and transport, and minimizing activities and development which may present risk.

- The regional project area contains a number of surface watercourses including the Brokenhead River and Fish Creek (AppA1, Figure 1-3), which are likely to be impacted over the 24 year duration of the project. The Brokenhead River is a watercourse of particular and unique ecological importance.
- Water quality and contaminants in the Sandstone aquifer present potential impacts beyond the Municipality of Springfield. According to Wang et al. (2008), "Discharge from the highly confined sandstone aquifer is likely by slow seepage through the upper confining layer near or beneath Lake of Winnipeg." In addition, surface drainage from the eastern portion of the project area discharges to the Brokenhead River, which also subsequently flows to Lake Winnipeg. Surface water from other portions of the project area eventually drain to the Red River (EAP2, p. 37).
- Who will independently monitor/oversee how many wells are actually created and how they are decommissioned?

Extraction process

- While sand extraction will occur primarily in April to November, well drilling will occur year-round (EAP1, pp. 2, 11, 14). Therefore extraction will in many cases not commence immediately on drilling. How will the casings be protected and secured in the interim from vandalism or damage (e.g. farm machinery, recreational and other vehicles, etc.)? Will the cap be welded or removable? Will the casings be mounded to safeguard them from spring runoff?
- The schematic in Figure 2-2 (EAP1), also Figure 2-A (AppA1) showing the components and configuration of the sand well apparatus has the disclaimer "Example Only". Therefore the actual situation will likely be "not as shown". Why is the real design not disclosed, particularly since air lifting has already been conducted at a number of wells (WDR)?
- No information is given regarding a critical component of the air lifting process, i.e. the compressors. What are their pumping capacity and hp? How many wells will be serviced by one compressor? What is the rate of air injection into one well?
- "The water portion of the sand and groundwater slurry that will be brought to surface through extraction wells will be separated from the sand at the extraction site." (EAP1, p. 11). "The sand and groundwater slurry will … move to a dewatering station at the extraction site where the sand will be separated from the groundwater." (EAP1, p. 14, also see p. 18).

"The dewatering equipment is designed to handle large volumes of water and has been sized appropriately to handle fluctuations in water volumes to avoid overflows." (EAP1, p. 23).

Yes, **<u>but what is it</u>? We are not given any information regarding the details of the onsite dewatering operation**, which are left to the imagination. Yet this stage is critical in risk management, as it will be onsite, and the manipulated water will be most vulnerable to contamination during this process. How exactly will it be accomplished? **Will any chemicals be used?** Or is it just a mechanical screening process? Or centrifuging, or …….?

On p. 24 of EAP1 though, we also learn that it is "mobile". Whatever it is, it will be using a lot of power: "It is expected that the dewatering and pump station will require 1460 connected hp to operate." (EAP1, p. 26).

- "The construction method of the extraction well will prevent water that is returned to the sandstone from contacting any potential source of contamination." (EAP1, p. 14).

  It will have contacted compressed air from a compressor, the air line, the production pipe and its joins, vibrating screens to remove overs, a mysterious dewatering station, a disinfection station, a pump and a pipe to return it to the aquifer (EAP1, Figure 2-2). General dust at the surface (presumably the "vibrating screens installed over a sump pit" (EAP1, p. 14) and dewatering station will be exposed to air), lubricants, various machine fluids, oil, diesel fume particulates, machinery metal wear particles, rubber particles, paint particles………… It is an unrealistic overreach to claim no potential source of contamination. The system is not sealed.

- "When a well is no longer producing sand, the production piping will be removed, the slurry line connection will be disconnected, and the well will be capped. All equipment will then be moved to the next well in the cluster and re-connected. While this is occurring, the other wells (up to seven) will continue to operate so that the slurry loop system continues to supply sand to the facility for processing." (EAP1, pp. 14-15.)

  This cannot be occurring while seven <u>other</u> wells continue to operate: these plus the just disconnected well or the just reconnected well make too many wells when "Maximum of up to seven extraction wells [will be] operating simultaneously" (EAP1, p. iv). We can simplify: either all, or maybe some, wells in a cluster will be operating at any given time.

- "Overs" are concretions and other geological oddments that are 'over' ≈ 840 μ (= 0.84 mm) in size: "These 'overs' that are captured will be temporarily stockpiled in a containment tank on site before being removed off site for disposal at a licenced facility." (EAP1, p. 18). Unless there is something we are not being told about the vibrating screen process, these items are no more toxic than the rest of the extracted sand and can be put to good use in construction, gardening, landscaping, etc. It seems wasteful and unnecessary to truck them to a "licenced facility".

Impacts on water wells

- "The Regional Project Area (Figure 1-2) contains approximately 1,505 domestic water wells (AppA1 (p. 81). Some additional wells are used for livestock watering (54), industrial use, irrigation, air conditioning, municipal water supplies and miscellaneous (AppA1, p. 16). The majority are completed within the Carbonate aquifer (AppA1, Figure 1-3) and do not penetrate the shale aquitard: "most groundwater wells and boreholes terminate before they intersect the shale" (AppA1, p. 60).
- Although pumping will occur from the Sandstone aquifer, both the pumping tests and the drawdown modelling indicate that drawdown will occur in both the Sandstone and the Carbonate aquifers (AppA1, section 7.2.1). A concern with this interconnection is the potential for contaminants to be drawn from upper strata into the aquifers as pumping proceeds.
- For existing domestic wells in the Sandstone aquifer, because of the breached shale, "extracted water would be derived from both aquifers rather than being derived almost entirely from the Winnipeg Sandstone if the Winnipeg Shale remained intact." (AppA1, p. 79). This would be reflected in water chemistry.
- According to simulation modelling (at 50% reinjection of extracted water), "Although the spatial extent of the drawdown is anticipated to be laterally extensive, the magnitude of drawdown impacts is anticipated to be between 1 m and 5 m for the majority of the licensed water supply wells. Because most pumps are installed at depths of 30 m or more, impacts of this magnitude will not likely require any mitigation." (AppA1, p. 5).

  This statement deceives and misleads. It reassures the public that 1-5 m is small compared to 30 m, implying there is 30 m of water above the pump, i.e. the water level is at or near the surface. However it matters not, how deeply the pump is situated *per se* below the surface, but **how deep it is relative to the water table**. If the water level is at 10 m below the ground surface, and the pump at 30 m, a 1-5 m drawdown will not imperil the well. But if the water level is 25 or 30 m below the surface, yes, the drawdown will create a problem. The pump is at 30 m in both cases, and the drawdown is 1-5 m in both cases, but the outcomes are not the same.

  Groundwater elevations in reference to sea level vary in both aquifers (AppA1, p. 64). Superimposed on this variability are variations in surface topography and therefore thickness of the vadose zone above the water table. Groundwater elevations are also dynamic and fluctuate depending on recharge and discharge conditions in different years as well as seasonally. For a given pump located within the zone of natural variation, a given industrial drawdown may be inconsequential one year, but problematic the next. With undeniable climate change already evident, hydraulic regimes will change. In the coming years, if drought conditions are more common, water elevations may regress more frequently, putting many additional wells at risk from intensive pumping operations.

Also, according to the above simulation modelling, ”With the planned re-injection of groundwater, wells beyond 1.5 km from active extraction wells are not likely to be affected. “ (AppA1, p. 5).

Thus “Drawdown effects are largely restricted to the Project Site boundary, but minor effects are anticipated to extend beyond it during and immediately following operation of extraction wells close to the boundary.” (EAP1, p. vi).

Further, “Wells completed in the Red River Carbonate aquifer range from 13 m to 60 m in depth, with groundwater levels generally within 15 m of ground surface.” (AppA1, p. 57). Thus some shallower wells may easily be at risk.

Given the large numbers of extraction wells, and their comprehensive distribution throughout the project area, many private wells may be affected by drawdown to some extent at some point in the proceedings. The buffer from homes and private wells is only 100 m; the closest wells will experience the greatest effects during and for a period after operation. If superimposed on a drought year, effects will be more apparent and numerous. As the project creeps along, new wells will be engaged along its path.

Will potentially affected well owners be alerted regarding these anticipated effects?

- The modelling simulations in AppA1 utilize assumptions and parameters that do not reflect the conditions of the planned operations in the EAP, for example re-injection variables do not agree. This brings into question the purpose and utility of the simulations.
- Drawdown may also affect dugouts and ponds, if these are unlined and depend on the water table.
- “Measures will be developed to avoid and/or mitigate any well interference issues as required by The Water Rights Act of Manitoba.” (EAP2, p. 84). “Appropriate mitigations may include conducting a survey in advance of operations to determine the location, depth, use and configuration of each well, lowering of pumps in advance of sand extraction or providing treated makeup water during periods of time when drawdown impacts may occur.” (AppA1, p. 81).

Who will actually do this, and who will pay? Many pumps are already installed at the bottom of the well and cannot be lowered any further.

Where will the "treated makeup water" come from? How will it be stored at the homeowner's place? Will the water truck be parked at the house, or will the homeowner have to buy a tank or cistern, or will the company supply one? Since the "makeup water" will not be connected to the plumbing in the house, it will have to be transferred manually for the various needs. It will be required for consumption, cooking, washing food and dishes, laundry, flushing toilets, washing hands and surfaces, bathing. There may be animals and a garden to water. Will hot water be provided for washing dishes, laundry, bathtubs and showers, or will it have to be heated on the stove? What if there are children? A senior living alone may not be able to manage. Will the company provide help? Will compensation be available? What about farmers with livestock?

Given that not all wells in the cluster and/or cluster sites will be operating at the same time, or possibly even the same year, how long/often would the property owner be expected to subsist on "makeup water"? Will the company pay for a hotel to house affected families during this tribulation period? Animals will require immediate arrangements. What if the submersible well pump burns out and needs to be replaced – will compensation be provided?

At the CanWhite virtual open house on August 24, 2021, a company official was quoted in the media thus: "If there is an issue with their water, we'll immediately step in…We'll ensure they have water, whether we bring in potable water. (We'll) cease the operation nearby and determine very quickly if it's the result of their well, or whether it's the result of our activities. If it's our activities obviously we'll cease them immediately." (The Clipper, September 2, 2021, p. 5).

Where will affected homeowners or neighbors be able to report the problem? Do they have to go to the work site and find somebody to tell, in the mobile office, maybe? They will have to shout over the noise to make themselves heard. What if they are not allowed on the work site? Do they have to try to look up headquarters in Calgary and try to find somebody to speak to? From EAPPF, Appendix I, a member of the public asked a question and here is the reply (screenshot, question 56):

56	Where is your office in Winnipeg?	Email (1)	There is no CanWhite office in Winnipeg.

In actual life terms, there is a reality disconnect here: the homeowner will require water immediately, but assistance will not be forthcoming in any timely way. Evidence will first be needed that the operations are causing the problem, accompanied by significant delay. How will that process occur and how long will it take? Who will conduct it? The company should not be investigating itself. An impartial third party is required.

In any case, people should not have to deal with the company directly. The Province, which issues the license, must be involved and take responsibility to inquire and enforce a solution: however it will realistically take weeks or months and possibly not give satisfaction in the end. If there is a dispute, the homeowner has to prove her/his case and incur the expense of hiring an engineer and lawyer.

- During the pumping test, "no negative effects were reported by well owners" (EAP1, p. vi). Were well owners alerted prior to the test, and provided with contact information where any well issues could be reported? **Virtually all well owners do not know where to report issues with their wells.** In my own personal experience, even provincial civil servants seldom know, and I can attest that it has taken more than 6 months for a complaint to wend its way to the appropriate person. I also personally know of a recent example in the Municipality of Brokenhead where a rural resident's well failed during a pumping test of the drilled new Beausejour wells, yet the driller's report stated that no complaints were received, which is technically true. In other words, 'no complaints' does not necessarily mean 'no problems'. Pumping tests should not be conducted without the courtesy of letting people know. Much helpful information can be gained that way.
- Section 3.2 of App1 deals with homeowner water well surveys and collection of pressure transducer data. "Homeowner well surveys have not been included in this report due to privacy and confidentially reasons". (App1, p.24). There is a multitude of ways in which data could have been compiled and tabulated without violating individual privacy. Why does the EAP omit this important information? Why was this work even conducted, if the results are secret? Was an impartial outside agency hired to do this work?
- "A Waste Characterization and Management Plan, Groundwater Monitoring and Impact Mitigation Plan, Progressive Well Abandonment Plan, and Water Management Plan will be developed and implemented to protect groundwater quality and guide responses to any potential impacts." (EAP2, p. 84). What **long-range commitment** is there to ensure any aftermath will continue to be addressed after the company has left?

Artesian wells

The EAP has bypassed the topic of **artesian wells**, which present another set of challenges and risks. Artesian wells flow under hydraulic pressure; water cannot be returned to the well and sand extraction is problematic. According to WDR, two of the 41 wells already drilled were artesian, approximately 5% (Well PID 200824, 200861). WDR is ambiguous whether both of these wells have been sealed or not, as there are no sealing records for either.

This matter raises some issues. The flowing well will flood the extraction site (Figure 3). Will the purpose of some of the drainage ditches mentioned in EAP1 (p. viii) be to divert this water before (or even if) the well can be stoppered?

In the course of this project, many more artesian wells will certainly be encountered. This is heartbreaking, as artesian conditions in many other parts of Springfield have declined or disappeared. Figure 4 shows **estimated** extent of artesian conditions in Springfield; the east and south portions of the regional project area are especially vulnerable to indiscriminate drilling. Flowing wells require sealing using specialized and expensive techniques, with possibility of breakthrough hydraulic fractures (BCGWA, 2015). They cannot always be predicted. If allowed to flow, such wells will significantly decrease head and unnecessarily waste valuable water, spilling the lifegiving blood of Mother Earth. This is a treasure that ought to be protected and conserved. Riddling it with masses of boreholes is not the way to do so. It would amount to environmental vandalism. The EAP is silent on this subject, and neither of the well decommissioning protocols (see below) addresses it.

Left

Figure 3. Freshly drilled artesian well. Source: https://www.bcgwa.org/flowing-artesian-water-well-control-methods/

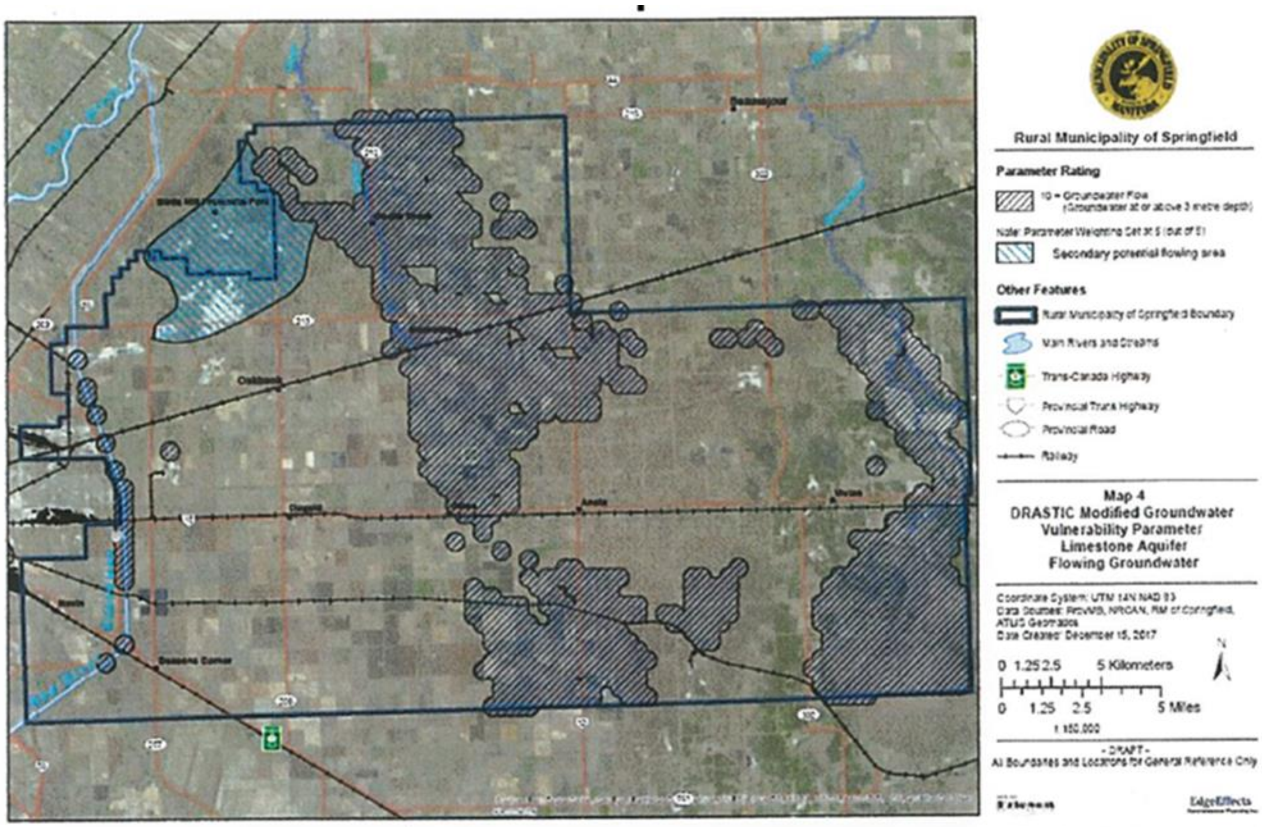


Figure 30 – Flowing groundwater areas in the carbonate aquifer throughout the RM of Springfield; modeled from hydrograph and Lidar topography data; Secondary potential flowing area is based off of topographical data, is approximate and will vary locally. (data source – MSD)

Figure 4. Map of estimated artesian conditions in Springfield. From FD, 2019

Fractures, slumping and contamination

- In EAP2 (p. 83) is the following reference on how the drill locations will be selected: "The locations of annual extraction wells will be determined in consideration of the results of preliminary geotechnical modeling used to predict thresholds of extraction amounts to mitigate adverse effects related to the potential for underground and surface subsidence".

  Potential for subsidence is a big concern. What parameters will be used for prediction of safe threshold amounts of extraction: thickness and consolidation of shale? How will the necessary advance data be obtained – from test boreholes, or from real-time drilling of wells? **Why are the adverse potential effects of subsidence not discussed in the EAP?** Surely this would be of interest to landowners and especially homeowners?

- "Removal of the sand will form a void in the shape of a cone extending from the bottom of the Carman Sand Member to the base of the Winnipeg Shale. The pattern of extraction cones is planned to extend laterally by successively extracting from new boreholes across the extraction area" (AppA1, p. 5).

  In other words, there will be extensive arrays of voids (spaces) created under the shale as the scope of the extraction area expands. According to EAPPF (Appendix H), "LESS THAN 5% OF THE SAND DEPOSIT WILL BE REMOVED". This is an enormous amount, and impacts a wide area.

- Resulting changes will be irreversible: "the removal of sand will permanently increase the effective porosity and storativity of the Winnipeg Sandstone aquifer within the Project Site through the annual extraction of material and resulting creation of void space" (AppA1, p. 81). Further: "Extraction of the silica sand resource will result in a permanent change to the underground geology in the form of horizontal arrays of rooms and pillars in the sandstone geological layer (between 52 m to 76 m), in the Winnipeg Formation aquifer within the Project Site."(EAP2, section 6.2.1 (pages are not numbered)}.

  Note the changes will be <u>permanent</u>. What impacts will these voids have on topographical stability? There will be thousands of them, over a broad area.

- The EAP2 (section 6.2.1) states: "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". Considerable data regarding thickness of the Carbonate stratum are needed **before** comprehensive sand extraction can be undertaken, as subsidence is irreversible. Existing data are not adequate for this purpose.

- Concerns abound regarding the integrity of the shale layer. The Winnipeg shale is variable in thickness and in some places may be quite thin: "Within the Local Project Area, the thickness of this shale was found to be on the order of 3 m thick, but the literature reports the thickness may vary from 1 m to 24 m" (AppA1, p. 60). Indeed, there may no longer be shale remaining, only ductile clay: "the shale is variably weathered and has been reduced to high plasticity clay minerals in some areas." (AppA1, p. 60). This shale (or clay) acts as an aquitard between the Carbonate and Winnipeg aquifers (Wang et al., 2008). In addition, multiple shale layers in the sandstone have been found in some test wells (WDR).

  Shale aquitards are prone to fractures, which in turn facilitate and accelerate contaminant transport between overlying aquifers (Cherry et al., 2004). According to AppA1 (p. 37), "the shale material encountered within the Project Area is characterized as fine-grained, moderate to highly fractured", and "The Winnipeg Shale encountered during the 2020 drilling campaign was friable and deeply weathered to clay minerals in some boreholes."(AppA1, p. 66).

Figure 5 shows the pathway of contaminants originating at the surface into aquifers below. Fractures and openings vastly increase the rate of passage downwards through the aquitard. The contaminants travel in plumes which may impact wells some distance away.

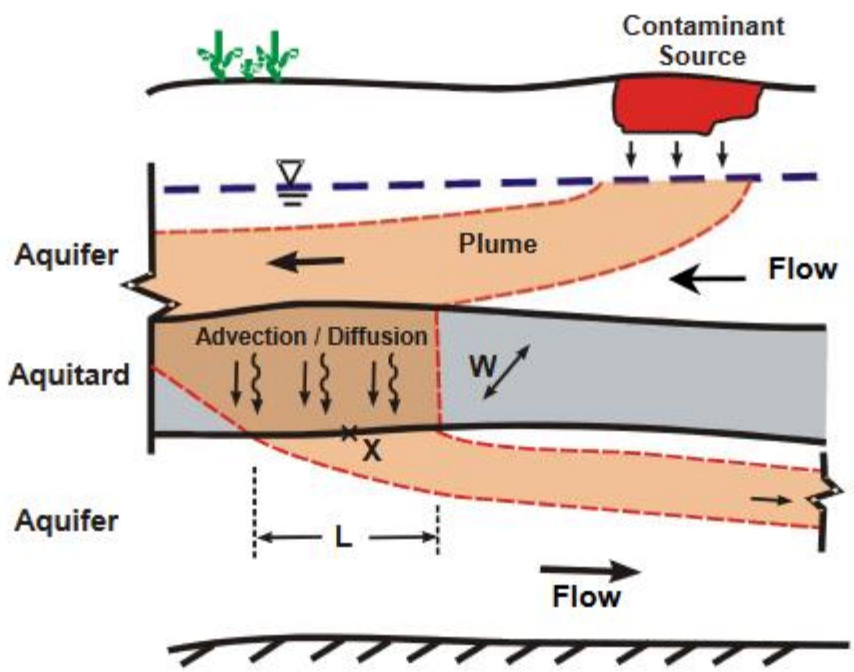


Figure 5. Pathway of contaminants originating at the surface in a stacked aquifer/aquitard system. From Cherry et al. (2004)

Pathogens may also travel in similar pathways from the unconfined aquifer into the confined aquifer below. According to Cherry et al. (2004), "Particulate contaminants very small in size, such as viruses, have the next largest [after certain chemicals] propensity to travel quickly through fractured aquitards". They may remain viable for extended periods of time (Table 1).

Table 1. Human pathogens found as contaminants in groundwater. From Cherry et al. (2004).

Characteristics of biological contaminants in groundwater

Biological contaminant[1]	Typical size	Metabolic state in groundwater	Frequency in unconfined aquifers	Survival time in groundwater
Viruses	27 – 75 nm	Infectious, but cannot replicate without host	5 – 30% of wells in USA	1 – 2 years
Bacteria	0.5 – 2 µm	Infectious, potentially replicating in water	Less frequent than viruses	Months
Protozoa	4 – 30 µm	Infectious, environmentally resistant cyst, cannot replicate without host	Rare, unless surface water influence	Unknown

[1]Refers to human pathogenic forms

In the present proposal, the configuration of the well cluster layout indicates wells are spaced 18 m (Figure 2-3, EAP1) or maybe 22 m (AppA1, p. 22) apart in a circle (+ one in the center), with each cluster spanning a diameter of 50-60 m (Figure 2-3, EAP1), or maybe 60-70 m diameter (AppA1, p. 22). The EAP and AppA1 text do not agree, and the text on p. 22 of AppA1 does not agree with Figure 2-B on the same page.

The conical voids under each well are expected to span the thickness of the sandstone stratum, i.e. "extending from the bottom of the Carman Sand Member to the base of the Winnipeg Shale" (appA1, p.81). The voids as well as drilling vibration may promote and exacerbate fractures in the shale, which according to AppA1 (p. 37) is already characterized as moderately to highly fractured. We also see that some boreholes already drilled have collapsed (WDR), indicating the instability and poor consolidation of strata in some places.

The following question arises: **since in some areas the shale may be thin, or reduced to clay, will clustering this many boreholes so close together in a geometrical pattern create the potential for the entire shale plate underlying the cluster to fail?** In other words, will the tight **circular perforation pattern** induce weakening (in the manner of *déchirez ici*) and **implode** when the sand is removed from underneath? Where there is clay, the clay could sag into the void beneath. This would create a huge opening between the aquifers that would relegate concerns with individual boreholes into comparative insignificance. **This hole would of course be impossible to seal.** Consider the possibilities of even some such failures in relation to the vast number of well clusters that will be drilled.

The EAP1 (p. 3) states: "although up to seven extraction wells may be operating simultaneously in one well cluster at any given time, this maximum number of wells operating simultaneously maybe [sic] spread across two adjacent well clusters". The risk of collapse could be aggravated by the magnitude of the volume of simultaneous sudden sand and water removal from several or all wells within the same cluster: "Each well will operate for four (4) days and will produce from 262 m3/day (40 gpm) to a maximum of approximately 654 m3/day (120 US gpm) of water and sand. Several wells at a given well cluster will operate at any one time, with a combined production rate of approximately 2,943 m3/day (540 US gpm) per well cluster." (AppA1, p. 22). This huge volume is not to be trifled with.

Slurry system

- "A one-time water draw at the beginning of the initial extraction year is needed to prime the sand slurry transport system. After that, the initial one-time water draw remains in the slurry transport loop system while the sand enters and exists the loop system. The water component of the slurry will consist of recycled water that will remain in the system constantly flowing in a loop from the extraction sites to the proposed Processing Facility." (EAP1, p. 11).

On the one hand, additional water will constantly enter the loop system with the wet sand, but on the other hand there may be losses through leaks, spills and general attrition, and there is uncertainty regarding what happens at the processing facility in terms of efficiency of water recovery from the slurry and its re-entry into the slurry system.

In order to maintain an acceptable and consistent range of pressure within the pipes, the system will require constant monitoring and adjustment to balance the total volume in the pipes in order to prevent rupture at high pressure, and to maintain enough flow rate at low pressure. There is no information in the EAP regarding this aspect of the operations. Presumably, remotely continuously reporting pipe pressure gauges and flow meters will be used: how will they be deployed? For safety, pressure gauges should be located in each section between pumping stations. There is no information in the EAP how volumes within the system will be adjusted if the pressure rises or drops outside the optimal or safe range, nor what apparatus will be incorporated into the design for this purpose. Additional water will also be required as the movable slurry pipe system expands with increasing distances (EAP1, p. 18).

What is the thickness of the plastic tubing walls? It is not even clear in the EAP whether the lines will be flexible tubing or rigid pipe. What will the pressure be in the slurry lines? What will the flow rates be? How soon will there be a round-the-clock response to a cut or ruptured line? Will this necessitate suspension of extraction activities until repairs are made, and extend the duration of the extraction window?

- There will apparently be tremendous variability in the proportion of sand in the slurry. "Early in the extraction process for each well, the slurry will consist primarily of solids (est. 70%) and will slowly reduce to approximately 20-30% near the end of well production." (AppA1, p. 22). But according to EAPPF (Appendix H), "Slurry from the well are [sic] as high as 90% sand".

- There are few details on how exactly the slurry lines will be deployed, other than that they "will be positioned at ground level" (EAP1, p. 23) i.e. lying exposed on the ground. They will be "diverted underground at road crossings" (EAP1, p. 13), although it is not known where the diversions will start relative to the road allowances and edge of the travelled surface. Figure 2-5 of EAP1 appears to show the lines running in existing hydro transmission corridors and between quarter sections. Since the polyethylene plastic pipes run between quarters, they impinge at the middle of the intersecting roads when they emerge from private property, not at Mile Road intersections. Apparently they will "go temporarily below the road and trails using existing culverts where possible" (EAP1, p. 23), although most culverts across roadways are found near intersections except in low places with drainage issues. Maybe they will even be "elevated over crossings" (EAP1, p. 23), although how this would be constructed or allowed is hard to imagine.

  Routing the pipes "using existing culverts where possible" presents numerous problems:

  1. The pipes are 35.6 cm in diameter (EAP1, p.18)(assuming outer diameter), and there will be two of them, requiring more than 70 cm of width inside the culvert. This would require a culvert that would be large enough to accommodate this width.

  2. This amount of space occupied by the pipes would occlude the culvert and affect drainage.

  3. The corrugations in the culvert, combined with the weight of the pipes and pressure fluctuations, could initiate cracks in the pipes. The pipes would have to be padded, increasing the amount of required space (see HDPE section below).

  4. Ditch water from rain events would carry debris that could damage the pipes. If the pipes are left in place during winter, the pipes could be damaged by ice in the spring.

  5. Leaks would be very difficult to detect underwater.

  6. Where no culvert is available, or it is too small, a culvert of large enough size would have to be installed across the roadway. Will it create a subsidence trench across the road surface?

7. When the pipes and installed culvert are finally decommissioned from underneath the roadway, who will repair the gap left behind, since roadway work falls under the jurisdiction of municipal or provincial departments?

8. At the road crossing points, will the exposed portions of the pipes be affected by municipal maintenance activities on the road allowance, for example mowing of road shoulders, grading, spraying, ditch clearing?

The other proposed option, where the pipes are "elevated over crossings" would require them to be securely contained in a metal sleeve or pipe, as overhead rupture could spew sand slurry over vehicles passing underneath, and present the potential for road crashes and fatalities.

- One of the legends in both Figures 1-1 and 1-2 of EAP1 refers to "slurry pipe right-of-ways". Note: the correct term is "rights-of-way". Under what legal provisions/licences will these become "right-of-ways", and what legal rights do these confer? The term "right-of-way" means "taking precedence over other uses/needs". The municipal and provincial road allowances are rights-of-way. So is the Manitoba Hydro corridor. Will the slurry pipe rights supersede those of the utility and public roadways?
- The slurry trails will be ≈ 2 m wide (EAP1, p. 23). How will they be maintained throughout the season to control vegetation? They cannot be mowed because of the pipes. **Will herbicides be used** on private land or municipal/provincial/railway/hydro rights-of-way?
- Since the proponent indicates some extraction could also occur in winter (EAP1, p. 11, 14), how will the extracted water be returned to the aquifer onsite, specifically, **how will screening, dewatering and disinfection work at freezing temperatures?** Will some sort of heated shelter be erected over and around the worksite, maybe?
- "Sand will be wet and will either be contained within the extraction well lines or the slurry line" (EAP1, p. vii). In winter the slurry pipes will not be used as they are not heated and will freeze. Where will the sand be contained during extraction in winter, since it won't be conveyed to the processing plant at this time? Will it be stockpiled at the extraction site until spring?
- There is confusion regarding the actual months of extraction. On p. 11 of EAP1, we see: "Sand extraction activities will occur 24/7 from April through November (and winter, weather dependant)", and on the same page as well as p. 15 we see: "In the winter months, the water in the system is stored on site in tankage". What sort of tankage and how secure will it be? How much tankage will be required, especially as the volume will eventually increase with extension of the slurry pipe system?

Yet in Table 1-2 (EAP1, p. 10), **slurry operation is clearly linked to winter as well, in** contradiction to the above. Here is a screenshot of the relevant portion of the table (highlight is mine):

Operation	
Pumping of sand and water slurry via slurry lines to the sand Processing Facility and return of water from the Processing Facility to the aquifer at the extraction sites.	Q3/Q4 2021 for initial production extraction year, then April through November (and winter, weather dependant) for each extraction year thereafter. Activities will occur 24/7.

- According to Figure 2-5 in EAP1, some of the slurry pipes will be routed along a Manitoba Hydro transmission line corridor. Manitoba Hydro conducts weed and brush control on its rights-of way using spraying and/or brush cutting/mowing. How will these maintenance activities ensure that the slurry lines are not damaged? Is an easement required?

  What happens if power lines are damaged in storms and fall onto the pipes?

- The EAP1 (p. 23) indicates: "visually [sic] monitoring will occur 24/7 while slurry lines are in use". Since it is visual, this suggests 24-hour patrols. How often? Will staff travel on noisy ATVs or dirt bikes day and night? Flashlights/spotlights and vehicle headlamps will disturb wildlife at night. They won't be able to see leaks when it is raining, unless there is spouting.

  In any case, visual inspection of the lines will only detect leaks that are already underway and a spill has occurred. Visual inspection will not detect weakness and cracks that could be mitigated to prevent a spill from happening. How will sections diverted under roadways be assessed?

- Section 2.4.2 of EAP1 makes no mention regarding how the pipe system will be made **secure** from farm equipment accessing/working fields, recreational vehicles, vandals, hunters' target practice, stubble burning, wildfire and other misadventure.

- "An accidental release of slurry or return water may also occur if a break or crack occurs in the slurry and/or water return line." and "If leaks or breaks in the line are detected, appropriate spill containment and clean-up measures will be applied as soon as feasible and the line will be repaired or replaced" (EAP2, section 6.9.2, no page numbers).

  Over the 24 year span of the proposed project, spills are virtually certain. Containment and clean-up will be "as soon as feasible", why not "immediately"? And what are these "appropriate spill containment and clean-up measures"?

  A rupture or spill will require clean-up of sand and fluid. The sand at this stage has been contaminated by the fluid and is no longer environmentally innocuous. Normally, this would require a vacuum truck, loader, dump truck, etc. The slurry trails will only be 2 m wide. Furthermore, the slurry and return pipes will occupy part of the trail. Furthermore again, the pumping stations (see below) will obstruct the trails (that is, if they are located on the trails, this is conjecture). Unless the pipes and spill are located in the open where they are readily accessible, how will it be possible for the above vehicles and equipment to reach the spill site?

In such an event, will wooded access trails {either new or the existing path) have to be cleared or widened to reach the spill location, involving more destruction? And, of course, serious delay in starting clean-up? By then the spilled fluid will have percolated into the ground or drained into the surrounding area, and will not be recoverable. The sand will eventually dry and present risks of inhalation. In realistic terms then, in all likelihood spills will not be cleaned up, unless they are in an accessible location, and when "feasible".

- Another place where spills and leaks from the slurry system could cause particular risk is the extraction site itself, where the slurry pipe system comes into proximity with the open wells. Apparently, feeder pipes will service the slurry pipes; how far are the slurry pipes from the wells, and from the processing components, such as the secret dewatering station, that handle water which will be directly returned to the aquifer? Are these components contained and enclosed? If an onsite rupture occurs, a geyser would spew the pressurized slurry over a broad area and could directly contaminate the open well(s) with slurry fluid. How will the open wells be safeguarded during operation from spills or flooding?
- "Prior to the mobile slurry lines being moved between extraction well sites, the slurry line segments are emptied via periodic access points in the slurry line to eliminate any spills or leaks of water onto the ground." (EAP1, p.18). The pipes are on the ground. How will slurry line segments be emptied: by some sort of vacuuming device into drums, on wagons or pickup trucks? Into a tanker truck? But the trails are only 2 m wide, the pipes occupy part of the trail, the pumping stations (if they are on the trail?) present obstacles to traffic……
- The pipes are moveable, and they are "fused together to create one continuous line" (EAP1, p. 18), or rather "Slurry lines are fused for sectional length and flanged together through the length of the system" (EAP1, p. 23).

  Dismantling will occur at the flanges: "Dismantling and relocating the above-ground slurry and water return lines and pumping stations, as needed, to the subsequent annual sand extraction area"(EAP1, p. v).

  First of all, are the pipes flexible or rigid? Are the sections fused onsite on the slurry trails? How large are the resultant sections and how far apart are the flanges? Will they be moved with machinery or person-power and coiled (if flexible) or piled (if rigid) onto a flatbed truck? But the slurry trails are "approximately two meters wide." (EAP1, p. 23), while a standard semi or flatbed truck is 2.6 m wide (https://www.summittruckgroup.com/blog/by-the-numbers---standard-dimensions-of-a-semi-truck--26281). It would be a tight fit. They require gentle handling and are easily damaged, they cannot be dragged (GET, 2021). This also raises the question of how they were deployed in the first place. How will sections that are diverted underneath roadways be moved without damaging the tubing?

Pumping stations

- What will the **unattended pumping stations** look like? What equipment will they include besides the pumps? What is the size/capacity of the pumps? Will they be enclosed to protect against weather, misadventure and interference, in a locked structure?

  Information is scant, other than: "The footprint area for the pumping stations along the slurry line is small (approximately 63 m^2)."(EAP1, p. 18). Actually, this is not "small", it converts to almost 700 square feet: there will eventually be a number of them. More specifically, what will be their **dimensions?** "The trails to accommodate the slurry lines will be approximately two meters wide." (EAP1, p. 23). If any of these stations are located on the slurry trails, they will have to be awfully long and narrow even if they occupy the entire width of the trail (2 x 30+ m, or more than 100 feet long). Or will clearings be required along the trails to accommodate the stations? If they are not on the slurry trails, where are they?

- Since the pumping stations will presumably service both the slurry and the return lines, they will be pumping simultaneously in both directions, as flow will be opposite in the two lines. Presumably this will require two pumps at each station.

- There will be multiple pumping stations: "Pumping stations will be installed as necessary along the slurry line and water return line trails to facilitate transport of the sand and water slurry" (EAP1, p.13). As the slurry line system expands, more pumps will be added: "When the slurry line increases in length during subsequent years of operations, a pumping station will be needed approximately every 450 m to 550 m along the length of slurry line."(EAP1, p. 18). "Extraction activities will gradually progress further from the Processing Facility each year within blocks of land adjacent to previous year extraction activity land areas over the anticipated 24-year life of the Project." (EAP1, p. v).

  The **maximum reach of the slurry system from the processing facility is reported as 3.5 km** (EAP1, p. 23). This translates to approximately six eventual pumping stations (with two more at the ends). Distances between pumps may need to be shorter where the slurry travels upwards along an incline, or maybe just even bigger pumps.

Table 2-1 (EAP1, p. 27) indicates that sixteen slurry pumps will be required during the extraction phase, enough to service eight stations, or one slurry line. They are all grouped together in Table 2-1, implying that they will all be the same. However half of them will pump return fluid only, while the other half will sustain a greater load as they will be pumping slurry which will be denser, heavier and will offer more resistance. The load will be inconstant as the proportion of sand in the slurry will vary greatly (AppA1, p. 22; EAPPF, Appendix H). They will also sustain more wear from sand abrasion. What types of pumps will be used? How durable are the interior components to constant 24/7 sand abrasion?

- When the system starts up and when it shuts down, all of the pumps must be synchronized to turn on and off at the same time. This will require a main switch at the mobile office and electrical supply to all of the pumps.
- "The pumping station will be powered by an extension of a local power line" (EAP1, p. 24), and "Back-up power will be supplied by an onsite diesel generator if necessary" (EAP1, p. 24). Presumably the generator will be triggered automatically when the electrical supply fails, or will it need to be started manually? There will eventually be a series of pumping stations, each with its own generator, which will run both of the pumps at each station.

  The generators will require a stored fuel supply, i.e. tanks: what will be their capacity and how will they (and fuel) be **secured from tampering and spills**? Will they be inside the pumping station structures, if there are such? Will they constitute risk in the event of wildfire?
- Since the pumps will operate 24/7, they will heat up. What measures will be taken to ensure that wildfires are not triggered by hot machine parts and exhaust ports during dry conditions? Are the machines enclosed, but if so, are they adequately ventilated and cooled? Repeating the same question asked for slurry trails, will herbicides be used to kill grass and other encroaching vegetation around the pumping stations?
- **What happens when one of the pumps within the series fails?** The generator cannot power a broken pump. Will the buildup of unrelieved pressure in the upstream portion of the line cause a **rupture**? Will there be an integrated safety mechanism to shut all of the pumping stations down automatically in the event of emergency?
- Presumably pressure in each pipe section between stations will be monitored remotely. Will the mobile office control centre be staffed 24 hours a day? Will an alarm be triggered?

High density polyethylene (HDPE)

The slurry and return water lines will consist of high-density polyethylene (HDPE): "The slurry loop system is a temporary line made of high-density polyethylene (HDPE) tubing fused together to create one continuous line that is 35.6 cm (14-inches) in diameter which transports sand to the facility site." (EAP1, p. 18). Is this the inner or outer diameter? There are no further specifications: is it flexible or rigid, what is the thickness of the HDPE, is it translucent or opaque, what pressures can it sustain, is it reinforced or coated (externally or internally) in any way? We do, however, learn that the HDPE feeder lines at the extraction sites are "thick-walled" (EAP1, p. 18). As for flow rate specifications of slurry in the tubing, we learn that flows will be "at an optimal and manageable rate" (EAP1, p. 3).

The pressure in the slurry system is not stated: according to a plastics industry source, **HDPE is "not well-suited for high-pressure applications."** (Fast Radius, 2021). In the present application, pressures will also fluctuate: the inconsistent stress will fatigue the walls sooner and age the plastic. Furthermore, the slurry tubing will be exposed to **constant abrasion from sand under pressure and velocity**, which will erode the tubing walls. According to EAPPF (Appendix H), "Slurry from the well are [sic] as high as 90% sand", although AppA1 (p. 22) indicates 20-70%. Yet according to a HDPE pipe supplier, "**the pipe should be protected against scratches**" (GET, 2021).

The lines will apparently or possibly remain in place through the Manitoba winters. They will also apparently be used year to year, and be exposed to high pressures (unspecified in the EAP) when in use. The question arises concerning the **durability of HDPE at low temperatures**, particularly when subjected to subsequent and repeated strain. According to Poly (2021) cracking of HDPE may occur around -45°C. However Szklarz and Baron (1995) found that at lower temperatures for HDPE, "The changes are gradual and over a wide range of temperature with no sharp cut-off temperature at which brittle behavior will occur." Therefore integrity at lower temperatures can be unpredictable, even more so when other components in the formulation of the plastic are introduced, for example stabilizers, plasticizers, pigments, and other additives.

The HDPE lines, whether in use or not, will be exposed to sunlight. According to Sahu et al. (2019), "The Ultra Violet (UV) rays present in the natural environment degrade HDPE materials", causing loss of mechanical properties. Martinez-Romo et al. (2015) found that after 30 days of exposure to UV-B radiation, "physical properties such as stiffness, dissolution resistance, and dimensional stability" of HDPE were affected. These workers concluded that UV-B radiation has "a crucial influence on the physical properties of the polyethylene." These authors even went further and proposed that UV-B pre-treatment was a way to make this plastic more readily degradable in the environment after it was discarded: "HDPE pretreated with the correct dose of UV-B radiation, before its commercial uses or after its final disposition, may be an option of biodegradable material".

To confer UV resistance, HDPE for outdoor use often has additives and stabilizers. Most often, carbon black is added to the plastic for this purpose: “The particle size of carbon black used and its type determines the resistance to degradation” (Sahu et al. 2019). According to the latter authors, UV resistance increases with percentage of carbon black; however increases in carbon black beyond 3% reduce “the mechanical properties due to the development of stress concentration and crack propagation.” Nonetheless, commercial HDPE pipe suppliers recommend that “It is preferable to cover the pipes while transporting them over long distances involving exposure to the sun,,,because irregular heat distribution on the pipe circumference may result in kinking or distortion.” (GET, 2021). The EAP does not specify what type of HDPE plastic will be used.

Carbon black HDPE tubing is black in color and will heat up in the sun. **Higher temperatures decrease the maximum working pressure of HDPE tubing**, making it more prone to failure (Figure 6). Therefore “When operating a pipeline above 20°C it is important to allow reduction in the strength of the material at elevated temperatures.” (GET, 2021).

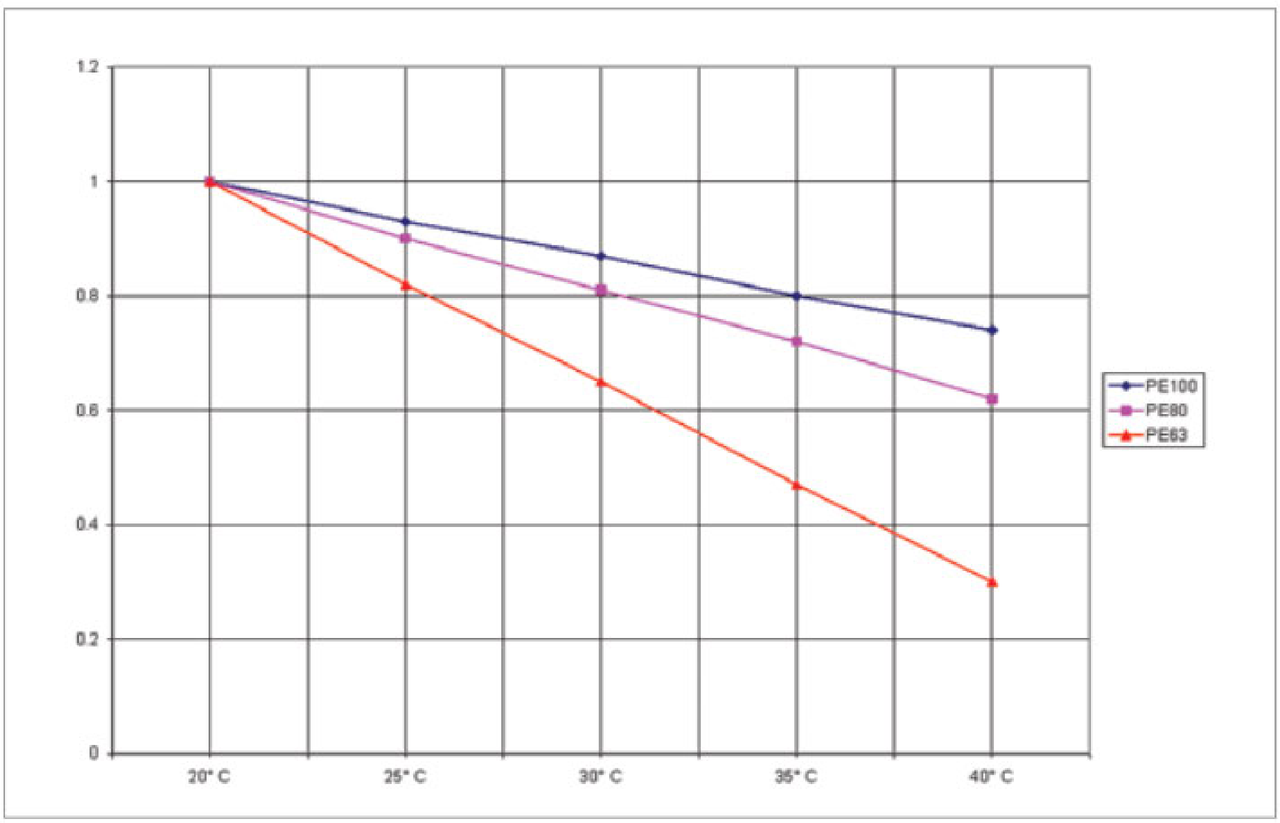


Figure 6. Pressure reduction factor vs. temperature of different pipe grades of HDPE. A baseline factor of 1.0 was used for 20ºC. Source: https://gulf-eternit.com/wp-content/uploads/2019/03/HDPE-Product-Information-GET-2019.pdf

The concern is that the slurry and return lines are planned to be exposed not for months, but reused for years. The mechanical effect of handling and moving the lines periodically will further exacerbate degeneration initiated by thermal, UV and pressure influences and predispose them to mechanical failure.

"During the winter months and prior to start up of the slurry line each season, a full inspection for wear of seals and connections will be conducted. Slurry lines will be replaced based on a maintenance schedule or early wear." (EAP1, p.24). It is not known whether the lines will be stored indoors in winter, or will they remain outside? **Visible** early wear can only be eyeballed on the outside of the line, at which point it is serious, but abrasive damage and cracks on the interior will not be observed, particularly if carbon black tubing is used.

At the road crossings the adjacent exposed portions may be vulnerable to road salt, dust control chemicals, and municipal spraying for weed control on road shoulders and in ditches, as well as gravel flung by passing traffic. Recreational vehicles and snowmobiles favor road shoulders: the pipes would need protection from being ridden over. The sections at road crossings that are diverted underground beneath the roadway will be subject to constant vibration from road traffic. How will this affect their durability and resistance to leaks and rupture? There is no information in the EAP on how the subterranean diversions will be configured relative to roadways.

The pipes are intended for use underground. HDPE pipe suppliers stress the importance of handling them with gentle care. For example, if flexible, "Coils should be stored horizontally just as they are normally delivered by the factory, if it is necessary to transport them vertically care should be taken to avoid any overloading or excess movement which may result in the deformation of the pipe". If rigid, "Straight lengths should be stored on a flat, clean surface without being allowed to bend in any direction", with the stacks not exceeding 1 m in height (GET, 2021). "The HDPE pipes should not be dragged, thrown or stacked on uneven surfaces. Whenever Loading or unloading is carried out, it is recommended to use cotton or nylon (synthetic) belts to avoid damage to the pipes. If at all metal slings are used, the pipe should be protected against scratches." (GET, 2021).

Yet these pipes will be left exposed to the vagaries of what the environment will offer: getting stepped on and ridden over by people, horses, recreational vehicles, machinery; the attentions of wildlife (bears are attracted to hoses and tubing (personal observation)); fallen trees; the pipes will be dismantled and moved and relocated multiple times. And **they will be continuously bombarded (sandblasted) from the inside by hard silica sand**. If sandblasting with silica sand has been used to etch and carve granite, how will plastic fare?

Thus the proposed use and reuse of HDPE tubing as described in the EAP is associated with significant risks of leaks and rupture.

Polyacrylamide and acrylamide in the slurry system

The fluid in the lines may potentially contain residues of **polyacrylamide** (PAM) from the processing plant. The companion Environment Act proposal for the processing plant (EAPPF) indicates that the clarifier at the facility will utilize polyacrylamide as a flocculant for water from the dewatering process. The EAPPF (p.3) refers to "using food grade biodegradable flocculant (anionic polyacrylamide)". We also see this cruelly devious phrase in EAPPF, Appendix I, question 29. There is no hint from this reassuring pronouncement that polyacrylamide biodegrades into highly toxic acrylamide, which is where the problem lies.

PAM and its breakdown product, acrylamide, are NOT ever added intentionally to any food because of the risk to health from the breakdown product (Health Canada, 2019). Acrylamide is an **objectionable toxic contaminant** in some starchy foods, resulting from processing or cooking at temperatures in excess of 120^{o} C. (e.g. Tepe and Cebi, 2019). It may also occur as a contaminant in some food packaging. Health Canada (2019) is engaged in monitoring programs and reduction strategies to lessen unwanted incidental acrylamide levels in Canadian food. While PAM has been used in some domestic water treatment plants in some countries, the presence of resulting acrylamide residues has prompted the World Health Organization (WHO, 2011) to caution this use. According to the latter, "Conventional treatment processes do not remove acrylamide." On the other hand, if acrylamide that is already present in raw water enters a drinking water treatment plant, chlorination may create N-nitrosodimethylamine, a nitrosamine which is extremely toxic at very low concentrations (MEQB, 2013).

Polyacrylamide, a polymer, degrades into monomeric acrylamide, which poses serious health risks: it is a neurotoxin, causing acrylamide encephaloneuropathy in humans (Igisu et al., 1975; Charoenpanich, 2013), characterized by "hallucinations, drowsiness and numbness in the hands and legs" (PubChem, 2021). It is also a genotoxin and probable human carcinogen (EPA, 2000; King and Noss, 2016). It is absorbed through "unbroken skin, mucous membranes, lungs, and the gastrointestinal tract." (Charoenpanich, 2013).

Thus "**inorganic acrylamide contamination into environment is a big threat and has potential hazards for public health.**" (Tepe and Cebi, 2019). According to Xiong et al. (2018), "**applications of PAM can result in significant environmental challenges, both in water management and in contamination of local water supplies after accidental spills.**"

"Acrylamide has high risk of contamination into surface and ground water supplies due to its rapid solubility and mobility in water" (Tepe and Cebi, 2019), because "the adsorption of AMD [acrylamide] onto particles is very low, which could favor its transfer in surface waters and groundwater" (Guezennec et al., 2014). According to Tepe and Cebi, 2019), its main route of breakdown in *surface* water is bacterial degradation, where it is metabolized as a nitrogen source.

Groundwater contamination with acrylamide has been reported where PAM flocculants are used in sand mining operations (e.g. WHO, 2011; Touze et al., 2015). PAM may also be used as an aid in drilling to reduce friction at the drill bit (Charoenpanich, 2013). While it does degrade, in rivers the half-life of acrylamide ranges from weeks to months (Brown et al. 1980 in Guezennec et al., 2014). Unlike surface water, degradation of PAM in groundwater is more limited because of factors such as cold temperatures (Nawaz et al., 1998 in Guezennec et al., 2014), with poor degradation below 15^{o} C. (Labahn et al, 2010 in Guezennec et al., 2014), and lack of appropriate bacteria and photolytic pathways. Contamination is particularly an issue where ongoing acrylamide release is occurring.

According to the EAPP (p. 13), the water from the processing plant "may be reused in the slurry system loop" (EAPPF, p. 13). The EAPPF (p. 13) claims that "The levels of flocculant remaining in the water after leaving the clarifier will be virtually undetectable.": what does "virtually undetectable" mean? **On what data is this statement based?** This dismissive declaration indicates that levels will not be monitored or even considered.

The slurry water will be endlessly recirculated in the lines, added to, and recycled year to year. PAM degradation into monomer (acrylamide) can be enabled by "chemical, mechanical, thermal, photolytic, and biological processes."(Xiong et al., 2018). All of these mechanisms (including photolytic, if the lines are somewhat translucent or the water is exposed at some stage) will be available for the fluid in the slurry and return lines. Furthermore, **a wide variety of bacteria, a number of them pathogenic to humans, can grow on PAM in water** (see Xiong et al., 2018), and may potentially grow in the slurry and return lines. Thus risks of leaks and spills are of concern. Aside from the processing facility itself, this is especially important at active extraction sites, where slurry water and open wells will be in close proximity, and accidents and carelessness can happen, given the thousands of extraction wells. The methodology is experimental and wobbly. How will the endlessly recycled slurry water be eventually disposed of?

Yet another risk from PAM must be considered. Human acrylamide poisonings have been reported from **grout used in water well installations**, as some grouting agents used in well and borehole linings may contaminate the water with acrylamide (Igisu et al., 1975; WHO, 2011; UKgov, 2021). Livestock poisoning has also been attributed to PAM grouts in water wells in pastures (Godin et al., 2002). In Canada, PAM grouts are used as groundwater infiltration sealants because of their extended functional **half-life**, calculated as more than 360 years (Gentry and Magill, 2012). This long lifespan presents the potential for long-term contamination. **Will the grouts used in the thousands of boreholes contain PAM?**

Decommissioning

- The proponents indicate that the wells will be sealed on decommissioning (EAP1, section 2.2.6). Sealing "will occur sequentially over the April to November timeframe with all wells being sealed (i.e. decommissioned) sequentially" (EAP1, p. 13). Does this mean that the wells will be sealed individually as they are abandoned? How soon afterwards? Or will all of the wells in a cluster or block be sealed at the same time?
- "Usage (of coarse overs material) for well sealing activities will only be for approved cuttings" (EAP1, p. iv). What are the criteria for "approved cuttings"?
- In the Progressive Well Abandonment Plan (EAP2, section 8.3), the following procedure is stipulated, reproduced verbatim below:

  "The following procedures will be used to abandon or seal Project wells:

  1. A mechanical plug will be placed at the predetermined depth to isolate the movement of water within the already cemented casing between the sandstone and limestone aquifers. Then a bentonite plug will be placed prior to cementing to ensure the cement does not dilute or leak into the water prior to setting.
  2. Above this plug, a several foot-thick cement plug will be placed and allowed to set. Cement will be pumped into place using a tremie grout system. The cement plug will be confirmed by manual contact prior to proceeding to the next step.
  3. Once set, layers of bentonite and pea gravel will be used, or a benitoite grout to 5 feet (1.5 m) within surface.
  4. Where pea gravel and bentonite are used, no more than 15 feet (4.6 m) of pea gravel will be used before another layer of bentonite. In addition, careful attention will be paid to the layering of bentonite across any interfaces between aquifers (e.g., the limestone to the till interface) to prevent vertical mixing of the aquifers.
  5. A 5 feet (1.5 m) thick cement cap will be placed at the very top, allowed to set and then the topsoil/organics are replaced on top of the cement to allow for vegetation regrowth/remediation of the surface land to occur.
  6. Detailed logs will be kept of the well abandonment and depths of each layer, in addition to the GPS coordinates of each well.

  This procedure will be used in all extraction wells and wells that exceed 2 inches (5 cm) in diameter."

  [Note: The text was not proofread: Step 3 is using "benitoite grout".]

  This description, which will apply to all wells, raises the following concerns:

  1. According to this plan, the casing will be left in place. Yet according to wells already drilled, **in numerous instances the casing has been removed** (WDR).

  2. Step 5, i.e. "the topsoil/organics are replaced on top of the cement to allow for vegetation regrowth/remediation of the surface land to occur.", indirectly indicates that the casing will be severed below ground level and covered over (camouflaged) with soil, but this is not admitted as such in the plan. This "cut-and-cap" approach is an issue

because of **lack of visible evidence at the surface for abandoned wells.** Furthermore, the concealed wells will be in clusters, the clusters will be in blocks.

Future excavations, construction, farming activities or trenching for utilities may compromise the hidden plugs or damage the casings. They also provide future risk in the event of flooding, or future risk in the event of soil erosion which could bring the plugs to or just below ground level. The soil overtop may subside to form a depression which collects runoff. Since "cut-and-cap" is not mentioned, neither is the depth below ground level at which the casing is severed. However in wells already drilled and abandoned, this depth has not been consistent, but has been up to 1.2 m, although usually less (WDR).

3. Casings of already drilled wells are in some instances at ground level or protrude above the ground (WDR).

Therefore, will the above stipulated abandonment protocol be followed in all subsequent cases henceforth when thus far a spectrum of well sealing strategies has been applied? If the latter multiplicity of methods will continue to occur, the plan needs to be revised, and criteria for choosing which method shall be applied in each instance be clearly laid out.

- The above Progressive Well Abandonment Plan in EAP2 conflicts with the protocol given in the Hydrogeology and Geochemistry Assessment Report (AppA1, p. 20) which explicitly states as the last step in the well decommissioning process: "Remove casing and progressively rehabilitate well clusters and other temporarily disturbed areas". Thus according to this version of events, casings will not remain. It is a head scratcher, all right.

- If we accept version 1 above, or some portion thereof, thousands of decommissioned and capped well casings will remain **permanently** after the 24-year life of the project has expired. Each well cluster will be 50–60 m (or 60-70 m) in diameter, and the clusters will be 60 m apart (EAP1, Figure 2-3). Some larger properties will have several of these clusters (see EAP1, Figures 1-2, 2-3), while small properties may have a substantial part of their parcel affected. The integrity of the casings and seals may be compromised at any time, and provide direct routes for contamination.

- Where abandoned casings protrude above the ground, they are vulnerable to damage from recreational vehicles, farm machinery, vandalism, and sundry mishap.

- Incomplete sealing is also an issue (e.g. Figure 6). See Reference number 49, Impact Assessment Agency of Canada, Canadian Impact Assessment Registry, Vivian Sand Processing Facility Project and Vivian Sand Extraction Project. https://iaac-aeic.gc.ca/050/evaluations/exploration?projDocs=80974

- The question arises regarding future land use for decommissioned areas **in perpetuity.** According to protocol version 1 above, if the casings will remain, **future excavation** for purposes such as foundations, landscaping, ponds, dugouts, etc. will be incompatible at these sites because of the risk/certainty of wellhead and casing damage, and disturbance of soil around the casing. Regulations will need to be enacted to deny building permits or septic/ejection fields on top of decommissioned sites. Residential housing tracts, livestock operations, and industrial uses will also be incompatible at these sites.

- **The locations of these abandoned wells must be permanently marked and documented in perpetuity by the municipality**. Municipal development plans and zoning must reflect the locations of these sites. This is especially important if the land is sold, and even more so if the land is later subdivided into smaller parcels where development might occur.

- Abandoned well sites on agricultural cropland and hay fields will present another series of permanent problems, as agricultural chemicals and manure can travel along the exterior of the casings to the groundwaters below. The bentonite plug at the top may be dislodged by farm machinery or earth moving equipment. Over time, the seals around and within the casing may deteriorate, or seals may be inadequate from the start (Figure 7). Subsequent soil erosion may reduce the distance of the cap from the soil surface, or eventually expose it. Some wells already decommissioned have not been mounded to direct surface water away, but have depressions instead which collect runoff that will percolate down and along the casing, these depressions being the only evidence that a well is concealed underneath (Figure 7).

- "Levelling and grading will occur upon Project decommissioning to return the landscape to elevations typical to the surrounding area" (EAP1, p. v).

  Within what time frame will this occur? A concern with this step is that heavy earth moving equipment will be rehashing the soil covering and surrounding the wells, and damage to casings and seals may occur.

Figure 20 a and b Surface expression of abandoned sealed CanWhite borehole near Ross Manitoba in a slight depression (no mounding) with clay sealing on top of the cut off borehole.

Figure 21 shows inspection of the borehole sealing.

Figures 21 a and b Showing inspection by Dennis LeNeveu and Tangi Bell of the sealing of an abandoned CanWhite borehole near Ross Manitoba.

Figure 7. Lack of surface evidence of decommissioned Can White borehole near Ross, MB (top), and problematic sealing of the well (bottom). Source: https://www.gov.mb.ca/sd/eal/registries/6057canwhite/20200824_errata_public6.pdf

- The EAP1 (p. x) states: "Use of the land for other purposes will not be available in the locations of annual Project activities. However, due to the progressive annual reclamation of extraction sites and other Project-related disturbed areas, parcels of land used for Project activities during any given year of Project operation will be available for other uses the following year or once the activities are complete." Whatever uses these might be, they will be limited henceforth by the abandoned wells.

- Will the areas be properly cleaned up, including removal of all litter on the ground as well as in the surrounding bush, such as we too often see left behind at water well and construction sites once the workers have left: discarded coffee cups, cigarette butts and packaging, plastic water bottles, beer cans, plastic packaging and gloves, styrofoam containers, straws, foil, wire, broken glass, metal parts….(e.g. Figure 8)? Or will it be surreptitiously incorporated into the levelling and grading? Sharp metal scrap may injure children, horses, cattle. Wildlife may succumb from ingesting plastic and aluminum food wrappings, while other trash may not biodegrade. Gimcracks such as seen in Figure 8 at an abandoned sand well can pose a tripping hazard or create an expensive jam for farm machinery. People's properties deserve some respect.

Figure 8. Discarded gimcrack left behind at an abandoned test sand well. Source: https://ourlineinthesandmanitoba.ca/?fbclid=IwAR2DUPHPfOu6vP7oqEmVI_hFJjJb9INrmYe2GyEfi_bBJBm7uXRwOCsdo68

- There will be no inspection program to monitor the abandoned wells for the vast lifetime of their existence.

Oxygen introduction into groundwater

Source

Groundwater is typically devoid of oxygen. This condition is particularly evident in the sandstone stratum and aquitard, and has remained that way for a long time: "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." (AppA1, p. 62). In the proposed project, oxygen and other atmospheric gases will enter the sandstone aquifer primarily as dissolved gases via the reinjected water that has been exposed to air at the surface. It is not known whether any leakage of air will occur from the particular air lift process in this project: Figure 2-2 in the EAP is labelled "Example Only", therefore an undisclosed well design will be used. A number of wells previously drilled have been air lifted already (WDR), but the equipment used is unknown and is not revealed in the EAP. Air leakage would present serious problems with air pockets against the shale ceiling, but will not be discussed here until there is more information about the project.

Solubility of oxygen in water varies inversely with temperature (Figure 9). Manitoba groundwater typically averages $4^{o}C$. **Oxygen readily dissolves in groundwater on exposure to air and can achieve relatively high saturation concentrations at cool temperatures.** In the present project, ample opportunities for aeration of groundwater will occur while it is processed through the various stages at the surface, then it will be returned to the aquifer. Flows and plumes within the aquifer will carry the **introduced oxygen to areas beyond the sand extraction sites**. This is important because oxygen in groundwater **promotes chemical oxidation reactions, and enables survival and growth of organisms which otherwise would be absent.**

According to AppA1 (p. 53), "pe values in existing groundwater samples were calculated based on field measurements of ORP and ranged from 2.44 to 3.2. Under future operating conditions, simulated pe values were greater than 13, indicating oxidizing conditions in groundwater." ""Pe" is parameter used to measure redox potential. Higher pe values usually indicate oxidizing conditions and lower pe values are indicative of reducing conditions." Thus modelling concurs that return of oxygenated water to the aquifer will increase oxidizing conditions therein. This has implications for **changes in water chemistry. "**Oxygenation of groundwater during sand extraction and groundwater reinjection was simulated to result in groundwater that is more alkaline and oxidizing " (AppA1, p. 54).

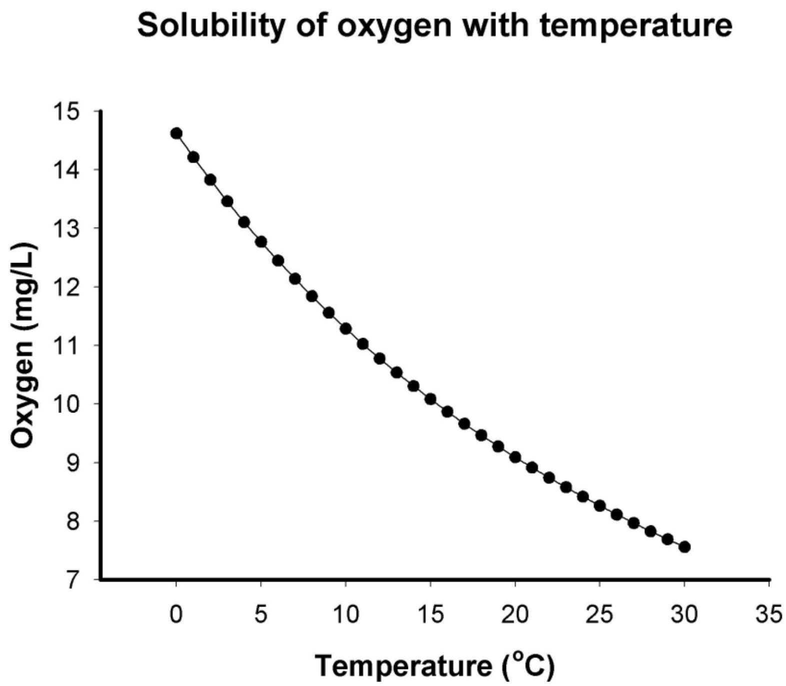


Figure 9. Oxygen solubility in water as a function of temperature. Source: https://www.esf.edu/efb/schulz/Limnology/Oxygen.html

Iron and manganese

The proponent indicates (EAP1, p. vi) that "For some constituents, the impact was simulated to be positive due to reduction of concentrations of iron and manganese when oxygen (air) is introduced into the aquifer or is allowed to mix with water containing lower concentrations of those elements." Also, "the increasingly oxidizing conditions will tend to further reduce iron, manganese and aluminum concentrations" (AppA1, p. 82).

In the anoxic conditions of groundwater, iron is present in the divalent, soluble, ferrous form. The water appears clear. On exposure to oxygen, ferrous iron is oxidized to the insoluble trivalent form. The water appears turbid and bloody (Figure 10).

Figure 10. Iron-containing well water without (left) and with (right) oxygen.

https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.idahowatersolutions.com%2Fwell-water-problems-and-treatment&psig=AOvVaw1uJPBxAql32VsfDFHA7xjQ&ust=1629817223462000&source=images&cd=vfe&ved=0CAcQjRxqFwoTCMD4i8K0x_ICFQAAAAAdAAAAABAE

Similarly, oxidized manganese can also discolor well water (Figure 11).

Figure 11. Unoxidized (left) and oxidized (right) manganese in well water. Source: https://www.google.com/url?sa=i&url=https%3A%2F%2Ftheberkey.com%2Fblogs%2Fwater-filter%2Fmanganese-removal-from-the-drinking-water&psig=AOvVaw0YIUOdDgfEeJBDVyRNMKg7&ust=1629818062453000&source=images&cd=vfe&ved=0CAcQjRxqFwoTCNDy98i3x_ICFQAAAAAdAAAAABAE

The above quoted statements from the EAP, that concentrations of iron and manganese will be reduced on introduction of oxygen into the aquifer, need clarification – they are true only for the **dissolved** forms as they are converted to insoluble compounds. Thus the statements should read: “dissolved concentrations…will be reduced”. The iron and manganese are still present: their valency is altered and **they will now be in visible form** as precipitate particles in the well water. Oxidation will have already occurred before the water is pumped to the surface, whereas in the natural course of events, the water would “turn” following a lag period after being exposed to air, subsequent to being pumped to the surface. In the aquifer, while some of the precipitated compounds may adsorb onto clay particles, raw untreated tapwater will appear as in Figure 12: in practical consumer terms this does not constitute an “improvement” in water quality. Neighboring well owners proximate to sand extraction sites may notice this change if they do not have iron filters. Since plumes containing oxygen can travel some distance, in unpredictable ways, well owners farther away may also be sporadically affected.

Figure 12. Untreated iron-containing well water that has been exposed to oxygen prior to emerging at the tap. Source: https://www.idahowatersolutions.com/water-problems-solutions/iron-in-water-is-it-harmful

Fungi and Iron Bacteria

Dissolved oxygen in the reinjected groundwater will enable the growth of obligatory and facultative aerobic organisms that are not normally found in anoxic groundwater, including bacteria, fungi, protozoa and even some heterotrophic algae that can survive in darkness.

Fungi can easily contaminate groundwater and result in both aesthetic and public health concerns. A number of fungal and yeast taxa have been isolated from contaminated groundwater, some of which are human pathogens (Oliveira et al., 2016). Fungi can block pipes, cause undesirable tastes and odors, cause allergies, create infections, or produce toxins (mycotoxins)(Babic et al., 2017). For example Taylor et al. (2001, **in** Oliveira et al, 2016) reported 307 fungal species out of 1415 infectious organisms occurring in drinking water known to be pathogenic to humans. Arroyo et al. (2019), reported that "wells were shown to be potential reservoirs of many types of fungi, including filamentous fungi and yeast. Many of these may become opportunistic pathogens when they infect immunosuppressed individuals." Groundwater contamination with fungi can result from well drilling and inadequate sealing (DEFR, 2011).

Iron bacteria such as *Gallionella* and *Sphaerotilus* are **aerobic** aquatic procaryotes which can create significant problems in water systems and pipes. According to Cullimore and McCann (1978), these bacteria cause "corrosion of water pumps, pressure tanks, galvanized pipes and fittings; the clogging of metal and plastic pipes (Figure 13); the reduction of water flow and water pressure and the coating of the resin beds of water softeners with slime, reducing efficiency and imparting unpleasant tastes and odours to the water". According to the latter authors, infestations are common in the southern Canadian Prairies, and are frequently the result of infected drill bits, tools and repair equipment.

The bacteria proliferate in the presence of iron and oxygen. The amounts of oxygen need not be significant as these bacteria can be **microaerophilic** and subsist on very small concentrations: huge growths of iron bacteria have been reported in wells containing less than 5 mg/L of dissolved oxygen (see Cullimore and McCann, 1978). Maamar et al. (2015) found Gallionellaceae at less than 2.5 mg/L of dissolved oxygen in groundwater.

The introduction of oxygen into the aquifer at large numbers of sites in the proposed project presents the potential of promoting iron bacterial growth, whether such bacteria have been introduced through the drilling and extraction process, or by facilitating the spread of existing local infestations. Considering that only small concentrations of oxygen are enough for iron bacterial proliferation, **this presents the potential for growth of these bacteria in the aquifer and the fouling of wells.** Once a well is infested, the problem is notoriously hard to eradicate. It often recurs after attempts at control because the bacteria easily spread outside the treatment zone (Cullimore and McCann, 1978). In the present instance, the large numbers of boreholes that will be drilled over 24 years provide the potential for spreading the problem over a wide area if drilling or extraction equipment happens to become contaminated. There is no mention of this issue in the EAP.

How will the proponent **ensure that no iron bacteria are introduced into the aquifer** during drilling, casing and pipe manipulation, grouting, and during extraction and decommissioning?

Figure 13. Iron bacteria in water pipe. Source: https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.h2oequipment.com%2Fwater-problems%2Firon-bacteria%2F&psig=AOvVaw2GyT9i6uCKfiUHWsEhpRqK&ust=1631293466840000&source=images&cd=vfe&ved=0CAYQjRxqFwoTCNi8m_2v8vICFQAAAAAdAAAAABAd

Water quality analysis

A concern regarding water sampling methodology is raised by the following: "Groundwater samples from select residential water wells were collected from a point of consumption within the house (e.g. tap in kitchen). Samples could not be collected directly from the residential water wells because downhole equipment and wiring obstructed sampling equipment." (AppA1, p. 46). Evidently these systems had no drain valve between the well and the captive air tank (Figure 14). This is the 'next best' sampling option. A hose can be attached at this point, but this is not recommended as it will add potential contamination to the sample.

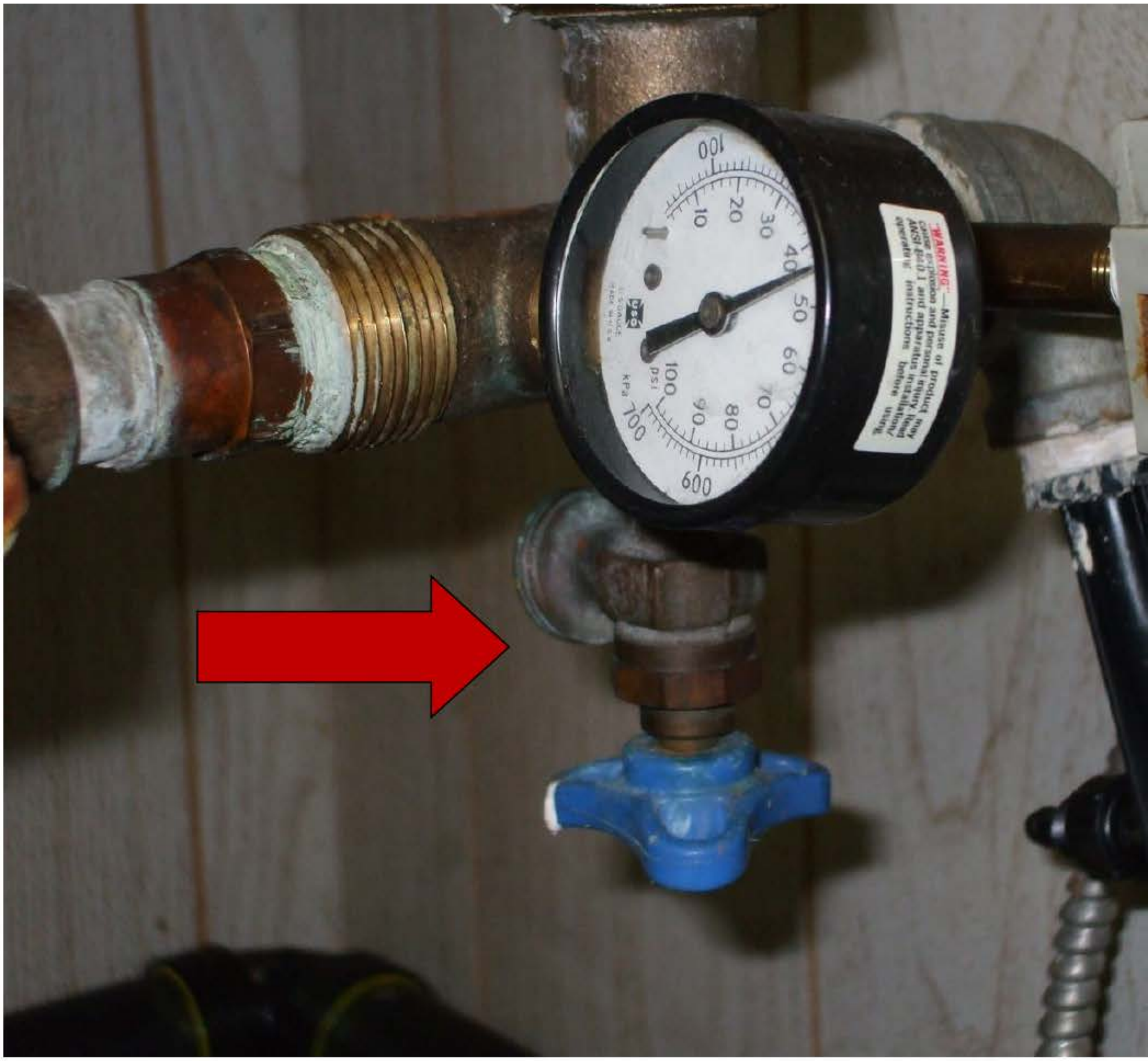


Figure 14. Drain valve between well line (on right) and captive air tank on 40 year old plumbing. Photo: E. Pip

The above quoted statement regarding sampling at point-of-consumption is remarkable, as many changes and interventions can occur between well and tap, for example:

- leaching from the interior of captive air tanks and pipe
- water softeners and conditioners
  These systems are used to **reduce hardness**. The cation exchange resins in water softeners **adsorb calcium and magnesium, and substitute sodium ions from the softener salt (sodium chloride) instead.** Other cations such as iron, manganese and barium may be affected as well. Associated changes in alkalinity, conductivity and pH also occur.

  Softener salt is not regulated for purity or suitability for consumption and may contain a variety of impurities and trace elements, for example boron, depending on the source of the salt and the manufacturing method. These impurities will appear in the finished water.
- iron filters (aerator type)
  Air stripping oxidizes iron and magnesium and other reduced elements, and displaces dissolved gases such as hydrogen sulphide, carbon dioxide, methane and radon.
- home reverse osmosis systems
- activated carbon or ceramic filters
- leaching from copper plumbing pipe
  Presence of manganese in the water further increases rate of copper leaching from plumbing systems.
- leaching from lead solder plumbing joints in houses built before the 1989 Manitoba Plumbing Code mandated plumbing solder of no more than 0.2% lead
- some pre 1950s houses may have lead pipe
- certain types of PVC pipe may contain lead- or cadmium-based stabilizers
- galvanized pipe and components may contribute zinc
- brass plumbing fixtures may contribute lead and zinc
- corrosion-resistant fittings may contribute cadmium
- fixtures and tap aerators may leach chromium and other plated metals
- tap screens/filters may leach accumulated organic matter from bacteria, and other foreign materials

- leaching of many materials, including petroleum hydrocarbons and PAHs, from rubber seals, washers, O-rings, plumber's tape
- Since the tap carries both hot and cold water, scale in the tap components includes the many substances leached from hot water tanks and pipes. Elevated temperatures greatly increase leaching rates of copper, lead, zinc and cadmium, which may be redeposited elsewhere in the system.

- Source: Pip Water Quality lectures, University of Winnipeg

Consider the following statements in light of the above:

"Private wells (23901 and 66124) were screened in the Red River Carbonate, and water quality is characterized by higher sodium (i.e. 134-138 mg/L) and low calcium and magnesium (<0.2 mg/L) concentrations" (ApA1, p. 49).

"The elevated sodium and low calcium/magnesium concentrations are likely due to the use of a water softener (i.e. water softener salt), which is primarily composed of sodium chloride." (AppA1, p. 49).

"Dissolved copper and zinc concentrations exceeded CCME for aquatic life."

The **purpose** of water softeners and conditioners is to alter the water chemistry, *substantially*. The results "are likely due to the use of a water softener"? "Without application of the water softener, groundwater in these two private wells would likely be similar to water samples from the carbonate or sandstone units" (AppA1, p. 49). It would "likely be similar"? These are the data? Why were sampling and analysis even conducted, when it could have been just said what the results "likely" are?

Some homes have a dedicated tap for consumption in the kitchen which bypasses the water softener. However even in these instances leaching from the various components of the plumbing system still occurs, and the water is usually also treated for iron. Therefore **water from point-of-consumption taps is not representative of the original raw groundwater, and results obtained in this way are invalidated**.

- Similarly, with respect to the well pumping samples, "It is AECOM's opinion that the sample collected prior to the end of the pumping test was influenced by grouting during well installation. Grouting can impact water quality temporarily in the area around the borehole until the grout has set." (AppA1, p. 50). How many of the other samples may have been contaminated in this way?
- Another concern (AppA1, p. 46) is that pH was analyzed in the laboratory rather than measured in the field. Since pH is dependent on factors such as temperature (which

affects solubility of carbon dioxide), pH *in situ* virtually always varies from pH measured after the sample has been bottled, transported and stored. Given the importance of carbon dioxide in groundwater, it is important to retain original conditions in order to obtain accurate results.

- On pp. 46-47 of AppA1, "The following additional parameters were also analyzed at the water well:
  Biological oxygen demand (BOD); Chemical oxygen demand (COD)
  Polycyclic aromatic hydrocarbons (PAHs)
  Phenols
  Petroleum hydrocarbons (i.e. benzene, toluene, ethylbenzene and xylenes)"

These parameters are separate from those described as "submitted for analysis". This indicates that these parameters were analyzed in the field (i.e. "analyzed at the water well"). What methodology and instrumentation was used?

Ultraviolet light irradiation

Details of the proposed ultraviolet light treatment in the EAP are significantly lacking. According to EAP1 (p. 11), "The water portion of the sand and groundwater slurry that will be brought to surface through extraction wells will be separated from the sand at the extraction site. This groundwater is then returned to the aquifer via the sand producing well after being treated with UV light." Therefore onsite UV treatment is proposed.

The EAP1 (pp. 18-19) neglects to disclose any actual information: a simple generic diagram of a UV lamp is provided, but specifics intended for this project are completely absent: the type of mercury arc lamp, the primary wavelengths (200-300 nm are required (McElmurry and Khalaf, 2016)), the radiation intensity, collimated beam or other, and the configuration and size of the reactor chamber. According to the latter workers, flow rates are important because different pathogens vary in their response to UV light and may require threshold exposure times. How will the unit be powered onsite: what failsafe features will be available in the event of power interruption or failure? However these questions are moot, as is explained further below.

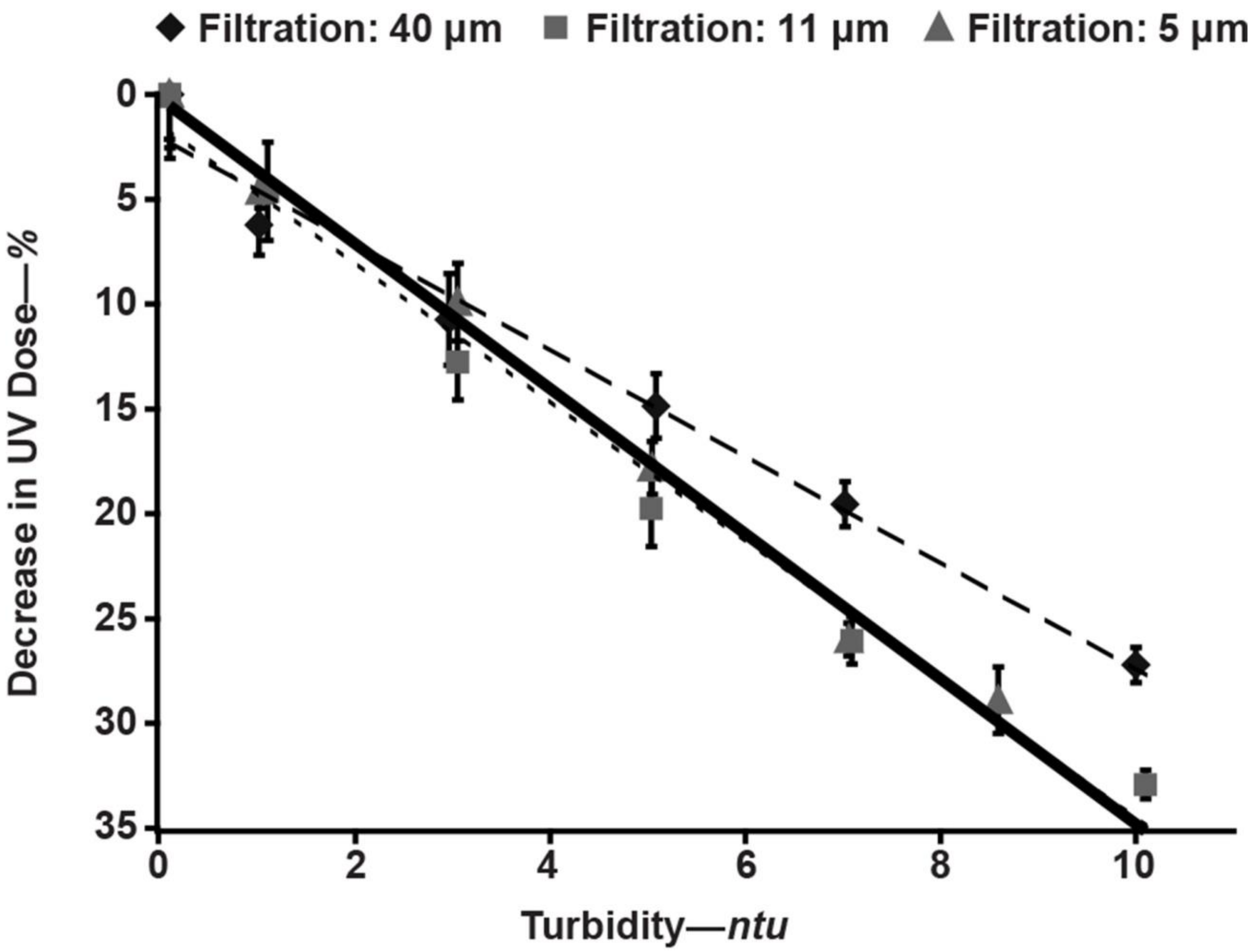
UV lamps have a limited, rather short, effective lifespan and must be monitored to ensure they are replaced when output starts to decline. For hard waters, such as the present case, UV light can cause carbonate precipitation on the quartz tube and lead to significant declines in effectiveness, therefore the lamp needs to be continually cleaned (USEPA, 1999).

On p. 19 of EAP1 we see the comforting statement: "UV light acts very rapidly by rending [sic] any bacteria, viruses or protozoa that may be present inert when they are exposed to the UV light". Yes, **provided conditions are met**. **BUT the <u>very first prerequisite</u> is: the water must be clear and colorless**.

In the present application, the untreated water destined to be irradiated will be **highly turbid.** The groundwater in itself is already of high turbidity: the consultant's report found that "The field turbidity values were generally above 20 NTU, and well above the treatment limit ranges (0.1 to 1 NTU). (AppA1, p. 48). However the agitated and manipulated and vibrated groundwater will contain **an even greater burden of suspended particles:** not only calcium carbonate and various other minerals (as detailed in AppA1), but also oxidized particles of ferric iron and manganese compounds resulting from exposure to oxygen. A further impediment to UV treatment efficiency is that turbidity will not be constant (McElmurry and Khalaf, 2016), and therefore irradiation dosage cannot be calibrated.

Suspended particles cause UV attenuation and **reduce penetration of the light beam** (Christensen and Linden, 2003), decreasing its disinfection capacity (Figure 15). Note that Figure 15 terminates at 10 NTU, at which point there is a 35% decrease in UV dose. In the present application, reported turbidity values in the raw unmanipulated Sandstone aquifer water (see above) exceeded 20 NTU, well beyond the limit shown in the graph.

Also note that differences in particle sizes (at a given NTU) had minor effects on attenuation: the end result in dose reduction was similar regardless of particle size. Filtration through a 5 µm filter showed that the dose reduction of turbidity consisting of small particles was similar to that caused by larger particles (at a given NTU). Thus filtration through a 5 µm filter would still result in some objectionable turbidity in the filtrate.



UV exposure times were determined from applied (incident) UV irradiance. Target UV dose of 30 mJ/cm² was delivered to each sample. Error bars represent standard deviations, n = 3. UV—ultraviolet

Figure 15. Relationship between effective UV dose and turbidity in water. Source: https://awwa.onlinelibrary.wiley.com/cms/asset/94d857ed-e575-4a88-9413-945a83ec1a52/awwa10344-fig-0004-m.jpg

Pathogens such as **bacteria can escape irradiation** by being **shaded** from the UV light by the particles, or **shielded** if the organisms are attached to them (i.e. tailing). A single particle may shield multiple organisms, depending on its and the organisms' size (Emerick et al., 2000). The size of the majority of bacteria ranges from 1 to 10 µm; that of *Escherichia coli* is 1-2 µm (Riley, 1999). According to Christensen and Linden (2003), "particles entering a UV reactor, if not adjusted and accounted for, may compromise lethal delivery of UV energy".

Farrell et al. (2018) found that *Escherichia coli* and *Enterococcus faecalis* showed the **strongest affinity for attachment to ferric iron**, **followed by calcium carbonate particles, resulting in the poorest disinfection rates**. Both of these materials are in abundance in the present situation.

While UV dose reduction increases with turbidity irrespective of particle size (Figure 15), when bacteria are added to the system, particle size becomes important: disinfection efficiency **declines** with decreasing particle size at all UV dose intensities (McElmurry and Khalaf, 2016)(Figure 16):

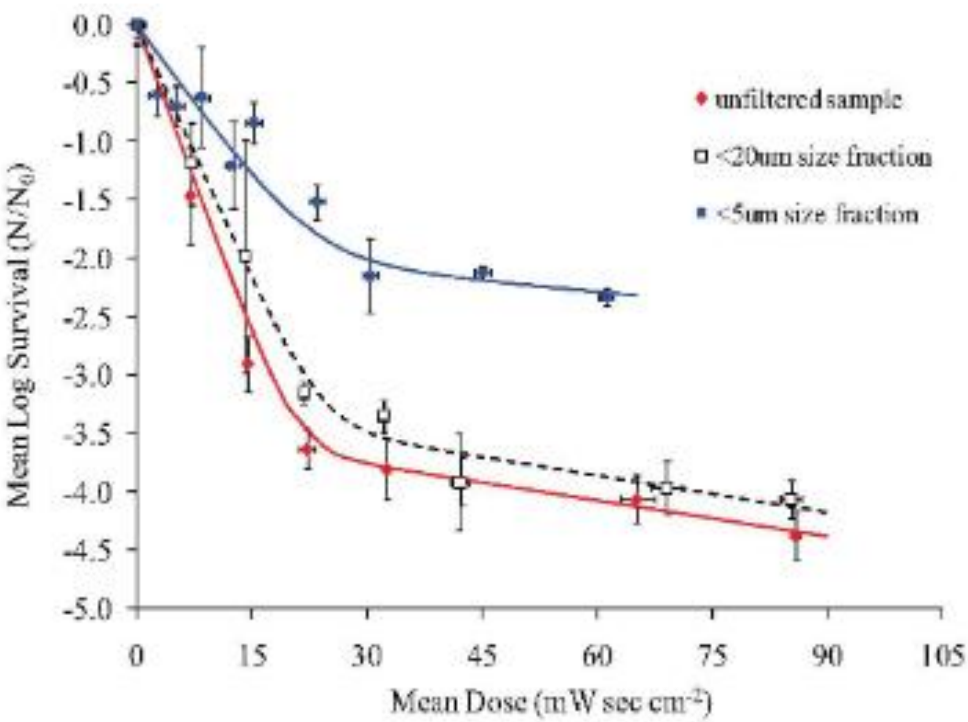


Figure 16. Exponential survival of *E. coli* irradiated with different UV doses associated with two different particle sizes. From McElmurry and Khalaf (2016).

Thus particles less than 5 µm are associated with comparatively **greater** bacterial survival than <20 µm sizes (McElmurry and Khalaf, 2016). Therefore **turbidity associated with smaller particles requires more disinfection**. In the present application, filtration to remove larger particles will still leave smaller particles that favor bacterial survival.

In a water treatment plant, turbidity can be addressed by chemical flocculation using iron, magnesium or aluminum salts and removal of the agglomerated flocs, but obviously chemical treatments are not an option here. Although some silica sand processing facilities utilize flocculants to remove clays during washing, this water is not suitable for return to the aquifer because of contamination with acrylamide and other carcinogens and neurotoxins (MDH, 2019;

Pruser and Flynn, 2011). Ultrafitration, on the other hand, for example with ceramic filters, is not practical given the huge volumes of water involved. Sedimentation by allowing the water to stand in settling tanks or ponds is also not feasible because of the volumes and the lengths of time required for smaller particles to sink (Peterson, 2001).

Water clarity can also be measured in terms of suspended solids concentrations. USEPA (1999) does not recommend UV disinfection at total suspended solids levels above 30 mg/L. The suspended solids data presented in Table 4-8 of AppA4 show that values in the Sandstone aquifer substantially exceed this threshold as well, again **disqualifying this water from UV treatment for disinfection.**

Thus the ultraviolet treatment process (as described (section 2.2.5, EAP1) **is not suitable for this application.** Ozone treatment, which is an effective and benign disinfection method, is also unfortunately not an option here, as it will only introduce even more oxygen into the aquifer. Neither is chlorination an alternative, for obvious reasons.

Another unsettling question intrudes: since some of the wells already drilled have been air lifted (WDR), what happened to the extracted water? Was it returned to the aquifer undisinfected, or was it dumped on the surface, or….?

Respect for property and environment

The proponent indicates that access trails will be required for transport of equipment, materials and personnel, and for slurry pipes. Well cluster sites will need to be stripped. With the vast numbers of proposed wells, this will in many cases necessitate the destruction of trees and vegetation. There is a proposed **minimum** of 1344 cluster drill sites over the proposed life of the project (56 annual well clusters x 24 years (EAP1, p. iv, v)).

Setbacks

- The proponents have indicated setbacks of only 100 m for residences and water wells. It is not clear whether this distance applies to the nearest **extraction well**, or to the **extraction site boundary**.

  The only other features identified for setbacks are Manitoba Hydro infrastructure, hamlets and property boundaries (EAP1, p. 4). There is no mention of setbacks for barns and farmyards, hog or poultry operations, lagoons, cattle and horse enclosures. On agricultural land, will extraction wells be situated on manure spread fields, or in or beside feed lots and pastures? Near fuel or agricultural chemical storage sites? Presumably “communal living” colonies would be classified as hamlets.

  While some of the above possibilities might not be currently extant within the project zone, they may arise within the next 24 years of the projected operation.

- Clearing activities (bulldozing) of trails and digging of drainage ditches (EAP1, p. viii) may encounter various underground utility lines. The EAP does not mention setback policies regarding buried electrical lines, telephone or cable service lines, or natural gas lines on private property.
- Two railway lines are material to the project area (EAP1, Figure 1-1). In the 24 year life of the project area, a small but real possibility of derailments and spills of hazardous goods does exist. What are the setbacks for extraction wells from rail lines?
- The project area is gridlined with municipal roads, and a provincial trunk highway intersects it. What are the setbacks for this infrastructure?

Disturbance

- "Project components will be located on previously disturbed land to the extent feasible." (EAP1, p. ix). Some of this previously disturbed land may be in the process of rehabilitation and may contain planted trees. Some of it may be abandoned gravel pits from which overburden has been removed, facilitating transfer of surface contaminants. In any case, land which has sustained previous insult should not be regarded as reason to assault it some more.
- "measurable disturbances will be imposed on topographic features during Project construction and operation" (EAP1, p. v). "Temporarily disturbed areas include areas to accommodate the extraction wells, drilling rig access trails, equipment laydown areas (within well cluster areas) and trails to accommodate the slurry lines and water return lines." (EAP1, p. 13). Also a mobile office, worker parking, fuel storage, supply depot, pumping stations, portapotties….
- "Project activities will setback a minimum of 100 m from nearest residences" (EAP1, p. viii), or "100 m from a dwelling and the dwelling's drinking water well", **even 100 m from a hamlet!** (EAP1, p. 4).

  This is an ineffective distance for disturbance, heavy equipment noise, and diesel/exhaust odors. Does this setback apply only to the drill sites, or **does it also include access trails** (to prevent heavy equipment and traffic and portable toilets and a mobile office and all manner of paraphernalia from trundling beside somebody's house)? Visitors are also mentioned (EAP1, p. x). Does the setback distance also include slurry trails? Are there extra setbacks for pumping stations because of the length of time they will remain in place?
- "Project staff will be limited to approximately 35 to 45 personnel during Project operations with staff arrivals and departures being staggered daily to accommodate the 24 hours, seven days/week (24/7) operation schedule." (EAP1, p. xi).

How many people will be at the site per shift? Are these 8 or 12 hour shifts? If 8 hour shifts, this means 12-15 individual vehicles x 2 (coming and going) x 3 shifts = 72–90 passes per day (and night), plus any additional trips for lunch, supplies, or other purposes.

Incidentally, "Project staff will be limited to approximately 35 to 45 personnel" (above) is also the total workforce for the entire project (EAP1, p. 25), thus they can't be limited to this number when there aren't any more.

- According to AppC, some of the mining claims have **land areas of less than 2 ha**. No information is given whether there are homes on these parcels. Apparently there is no **minimum** size of the property that can be occupied. There seems to be no protection to ensure that small-acreage plots will not suffer what amounts to major damage and loss of the small amount of cover they have. One parcel (in Bru 92)(EAP1, Figure 1-2; AppC) is 0.3 ha in size, but it seems adjacent to a larger claimed piece; yet the existence of a claim on this crumb of land indicates that mining is planned for it. Thus this parcel will be denuded almost in entirety, because: "The footprint area of each well cluster [will be] 0.20 ha to 0.28 ha" (EAP2, section 6.5.1).

- The EAP repetitively stresses the ephemeral and transitory nature of the disturbances, claiming that extraction activities at a well will span only a matter of days: 5-6 days (EAP1, p. 3) or maybe 5-7 days (EAP1, pp. 2, 14), although AppA1 (p. 22) states categorically "Each well will operate for four (4) days". But wait, "A CanWhite well is produced for only 3 days" (EAPPF, Appendix H).

  Whatever the situation, how long an individual well operates is irrelevant, as "All wells within a well cluster may not be operating at the same time." (EAP1, p. 3). This prolongs the duration of inconvenience, disturbance and stress for the homeowner.

- On p. x of EAP1 we see: "Sand Extraction activities occur over weeks in one area rather then [sic] months, with individual wells over days."

  The EAP repetitively minimizes the extent of disturbance and impact of each well cluster. However from Figures 1-2 and 2-3 in EAP1, it is evident that, since clusters are 60 m apart, **multiple clusters may be located on the same land parcel.** No information is given regarding what the maximum number might be on an individual parcel.

- The clusters are arranged in blocks, which will require some time to process. Furthermore from Figure 1-2 it appears that activities on the same parcel could straddle different years. This raises the level of impact for the property owner to an entirely different level, affecting duration of disruption and ability to use her/his own property.

Noise

- All aspects of the proposed operation will be associated with unwanted intrusive noise. This noise will occur on private properties, where frequently people are living, and/or where adjacent neighbors are living. In winter, clearing and drilling will occur. The rest of the year massive unrelenting noise will emanate from extraction sites, with their generators, pumps, compressors, vibrating screens, a clandestine dewatering station, heavy earth moving equipment, worker and supply traffic, sundry clanging and banging, shouting and swearing. The workers will require hearing protection. There will also be more drilling in summer, as well as pumping stations, slurry line patrols, and whatnot. There will be other noise when slurry lines are relocated, and other noise during decommissioning. While it appears a few of the equipment items might be powered by mainline, that powered equipment itself will still make noise. There will be noise when hydro poles and power lines are installed and removed.

- The EAP1 document (p. 11) states that "Sand extraction activities will occur 24/7 from April through November (and winter, weather dependant) while extraction well drilling will occur year-round". Apparently there will be no let-up on Sundays and statutory holidays. How considerate for the residents: perhaps they would best vacate their homes and move to a hotel.

- All of the wells in the cluster may or may not operate simultaneously (EAP1, pp. iv, 3). Either option is disheartening – if operation is simultaneous, the level of noise, smell, disturbance and traffic is correspondingly additive and superimposed; if operation is staggered, so is the misery for the people living there. Furthermore, this time window **does not include** time involved in the preliminary activities of destroying property, drilling, movement and setup of extraction equipment and associated impedimenta, and dismantling the site and other sequelae such as levelling and grading.

- The "power for all the extraction equipment will either be supplied by a generator on site or the equipment will have its own power generation, such as the water well rigs or light plant. A diesel generator will be used to power the slurry pumps, vibrating screens" and mobile office (EAP1, p. 26). This is a confusing statement: there will be a "generator on site", or/but some equipment will have its own generated power, also on site, and then the slurry pumps and vibrating screens will have a diesel generator.

  It would be useful to provide a table which sorts out which is powered by what. In any case, according to this, multiple generators will run simultaneously. However, Table 2-1 (EAP1, p. 27) lists only two diesel generators required during the extraction phase. Why the discrepancy?

  Regardless, will they have exhaust silencers? **Generator noise will be superimposed on the noise of the equipment that they power.**

- An exception to generator power will be: "The dewatering and pump station will be powered via direct mainline from Manitoba Hydro" (EAP1, p. 26). Since there will be a mainline, why won't it be used to power more items, rather than using generators that produce noise, noxious exhaust fumes, and greenhouse gases?

  The proponent's website claims "***It is our mission to continue to evolve our environmental program to reduce our carbon footprint.***" **(**https://www.canwhitesands.com/environment/**).** How about starting here?

- "up to seven extraction wells may be operating simultaneously in one well cluster at any given time" (EAP1, p.3). However in section 6.5.1 of EAP2 (no page numbers), we see: "with only seven well clusters active any one time".

  Which is correct? Is this a typo? Will wells from seven different clusters operate at the same time?

- "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." (EAP1, p. viii).

  Operation will occur 24/7, so will the noise, only at times it will be even worse. The setbacks from houses are only 100 m, which is a negligible distance for noise that will be heard more than a kilometer away (this is the distance that gravel pit noise travels (personal observation)).

  A preliminary example of the type of noise that will occur can be accessed at https://www.dropbox.com/s/0hfqzckgv68f61o/img_0623.mov?dl=0
  This video was recorded in Springfield on 24 August 2021 at 8:45 P.M., at the stipulated setback distance of 100 m. Note that not all machinery would be operating at this time, since slurry lines are not in use. It is unknown where the extracted water is going.

- "Additional noise mitigation measures will be applied (e.g. portable noise barriers) as required" (EAP1, p. viii).

  What sort of "portable noise barriers"? Who will determine when it is required? Does the resident have to complain? To whom? How long will it take to get a response? Will it be taken seriously? Does a provincial mining inspector have to be involved?

- Figure 17 shows the relationship between decibel levels and perception of loudness. Noise perception increases rapidly and disproportionately exponentially as decibel levels rise. **At higher decibel levels, even small increments have a huge impact on nuisance and discomfort.**

- **"Noise is a source of stress."** (GQ, 2021). **Noise pollution** is associated with multiple adverse health effects: disrupted sleep patterns, altered quality of sleep, mental health issues, irritability, reduced ability to concentrate, high blood pressure, cardiovascular disturbances, hypertension, hormone disruption, stress; children are especially susceptible (Goines and Hagler, 2007; GQ, 2021). Immediate effects of sleep disturbance and deprivation can persist into the following day (GQ, 2021).

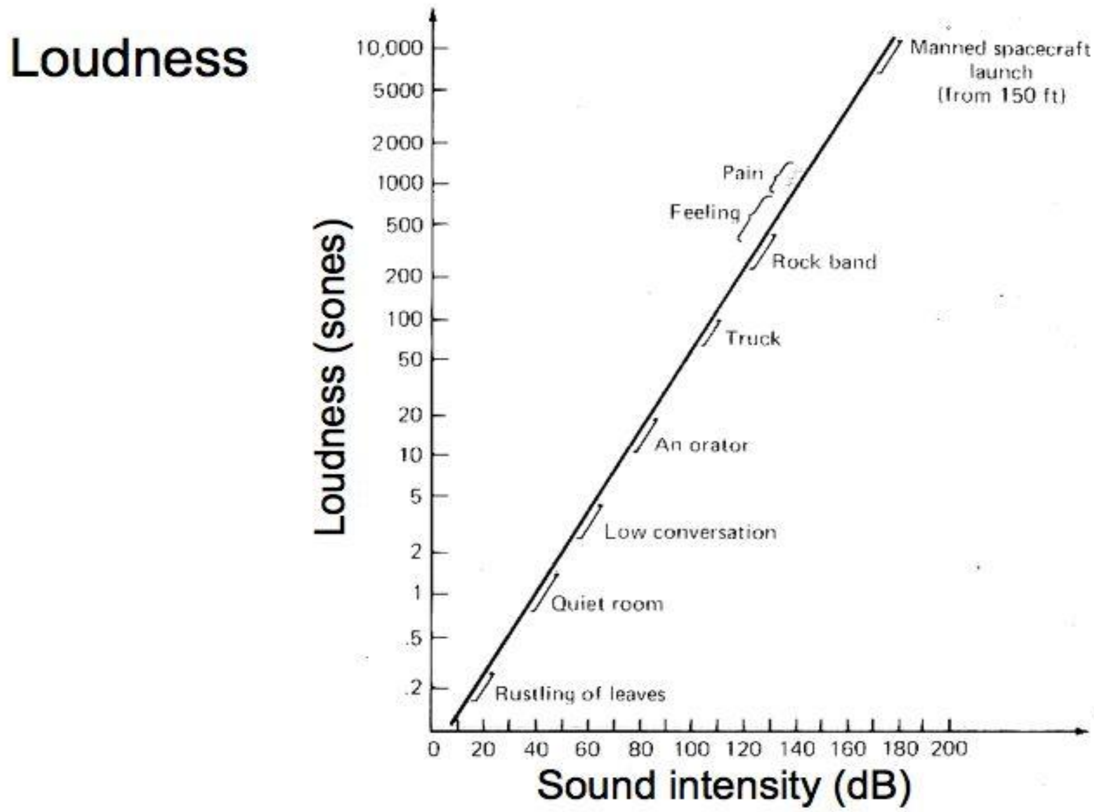


Figure 17. Sound intensity and perceived loudness. Note that sound intensity is shown as a linear scale, while corresponding loudness is exponential. Source: http://www.cns.nyu.edu/~david/courses/perception/lecturenotes/loudness/loudness.html

- **Will decibel readings be taken**? According to WHO (https://www.who.int/docstore/peh/noise/Comnoise-4.pdf), continuous daytime residential noise levels should not exceed 50-55 dB, which should not exceed 16 hours per day, and not exceed 45 dB at night. Above these levels adverse health effects start to manifest.

  While noise level thresholds are higher in daytime, the assumption is that people are sleeping at night. However shift workers, or people (including young children) needing rest in the daytime will have their sleep disturbed at these daytime thresholds. According to GQ (2021), “sleep can be disturbed by an outdoor noise of 40 dBA.”

  As sound intensity increases, the percentage of residents highly annoyed rises (Figure 18). While these data relate to continuous noise, “bangs that can provoke a "startle effect" are increased 13 dBA over their measured values" (Everbach, 2001). In the proposed project, bangs will be superimposed on the continuous noise levels.

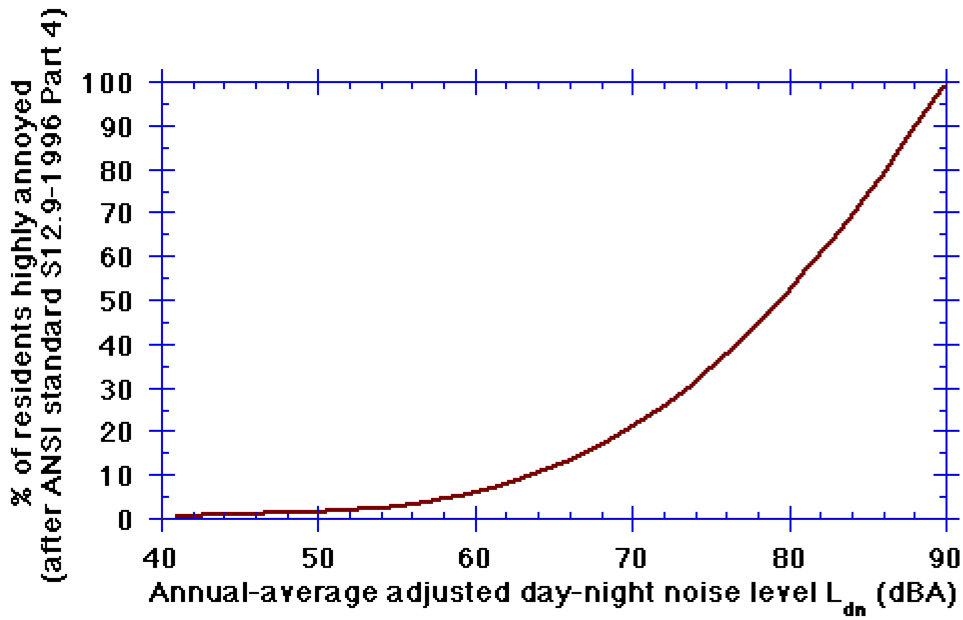


Figure 18. Percentage of highly annoyed residents in relation to noise decibel levels. From Everbach, 2001.

- **Springfield By-Law 19-11** has been enacted "to regulate and prohibit unnecessary and harmful noise within the RM of Springfield" (https://www.rmofspringfield.ca/Home/DownloadDocument?docId=74b2170f-02b3-4a07-82e6-72e7ead2bf74).

- Worker safety is paramount, as these people will be exposed to the noise maximum during every shift, and will accompany the noise as it moves from well cluster to cluster. In Manitoba, the maximum permitted exposure level for an 8 hour shift is 85 dB (Workplace Safety and Health Act [R.S.M. 1987, c. W210]
Workplace Safety and Health Regulation (Man. Reg. 217/2006) Part 12) (CCOHS, 2021).

- With respect to diesel generators, for example, "A fairly small generator could have an output of 50 kW and might generate…about 85 decibels. In contrast, 1,500 kW models may emit about 105 decibels, which you could compare to the sound of a jet airplane flying about 1,000 feet over your head." (WPP, 2021).

  At the working sites, several generators will operate at the same time, in addition to the other equipment. The sizes of the generators to be used are not divulged.

- Noise has been shown to have **adverse effects on farm animals**: cattle, pigs, chickens and horses (Broucek, 2014). “Animals have a different spectrum of audible sounds with maximum sensitivity at frequencies that are inaudible to humans” (Voipio, 1997 in Broucek, 2014). Cattle and pigs hear high-frequency sounds much better than people (Heffner, 1998 in Broucek, 2014), with discomfort in cattle starting at ≈ 90 dB (Phillips, 2009 in Broucek, 2014). Noise stress includes impacts on reproductive performance, feeding, milk yield, egg laying and brooding, hormonal cycles, blood cell counts, heart rate and behavior (Broucek, 2014). Continuous noise at 90-95 dB induces immobility and convulsive behaviors in chickens (Algers et al., 1978 in Broucek, 2014).

  In the present situation, sustained round-the-clock noise could impact farm livestock, poultry and dairy cows, especially animals housed outdoors, as well as livestock and pets owned by rural residents. Setbacks of 100 m from animal enclosures will be inadequate because of greater hearing sensitivity of animals. How will this issue be mitigated?

- The EAP takes pains to reiterate and emphasize that clearing activities will proceed in winter to minimize adverse effects on birds. “Clearing of natural vegetation to accommodate the establishment of sand extraction well cluster sites, temporary access trails, temporary trails for slurry lines and water return lines and area for pumping stations will occur outside of the peak breeding bird season for the Project area (i.e. April 25 – August 15) to avoid contravening the federal Migratory Birds Convention Act, 1994.” (EAP1, p. 13).

  This statement is laudable but in fact disingenuous. While clearing activities are traumatic enough, they do not compare in terms of noise levels and disturbance duration with the extraction sites, which latter will **operate during breeding and nesting times of all bird species**. Furthermore, unlike clearing activities, extraction sites will operate round-the-clock, and be of several weeks+ duration, as likely operation of wells at a site will be staggered over a period of time. Sites will also generate other additional nuisances that will affect birds (see below).

  Just as one example, continuous 24/7 **compressor noise** at the extraction sites will affect birds in the area. Ortega and Francis (2012) found that the detection threshold where no birds were found within 60 m was approximately 45 decibels(A) of compressor noise. Although 45 decibels seems not very much in itself, it is the **type of noise** (amplitude, frequency, pitch, etc.) that is also important. The extraction sites will generate far greater decibel levels.

  Once disturbed, the parents will not return to an abandoned nest. Furthermore some species use the same nest each year, therefore disturbance may have longer term consequences. There will also be associated reduced opportunities for food and cover because of the injured landscape. The problem is exacerbated by the fact that the disturbance will not be confined to one location, but the entire vicinity will be riddled with pockets and corridors of disturbance and destruction.

- Noise pollution has also been found to negatively affect a **majority of wildlife taxa**, both vertebrate and invertebrate (Kunc and Schmidt, 2019). "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 (e.g. agriculture activities, residential areas, roads and aggregate quarries)." (EAP1, p. ix).

  None of these listed settings are associated with diversity and abundance of wildlife. Aside from agricultural land, for entirely different reasons extraction sites will hopefully not be located in residential areas, roads, or aggregate quarries……..But wait: sadly in gravel pits they already are (Figure 19). Quarries carry a particularly high risk of groundwater contamination because protective overburden has been removed. Here is pollution from oil and mechanical fluids from machinery and recreational vehicles, dumping of garbage, partying without portapotties and other insults. Boreholes may channel this material directly into the aquifers beneath.

  There will be significant invasion of woodlands and other natural areas, which constitute refuges for wildlife. **Extraction activities will be concentrated during breeding seasons of all wildlife.** Operation will be continuous 24/7. Noise will be just one stressor of many, which will work together to exert a combined synergistic effect.

Figure 19. Silica sand extraction operating in a gravel pit in Springfield, April, 2021. Image used with photographer’s permission.

- The **pumping stations will generate noise:** aside from the pumps themselves, the generators that might at times run them (as backup) will produce additional noise. The noise will occur 24/7, be continuous, and prolonged over weeks or months, depending on how often the slurry system is moved, during the April through November extraction window. Presumably the 100 m setback from residences will apply to the pumping stations as well, but this is inadequate for continuous, prolonged, round the-clock, intrusive, oppressive nuisance.

  Figure 2-5 of EAP1 indicates that the slurry pipes, with attendant pumping stations, will often be routed through normally undisturbed forested lands, which traditionally provide cover and breeding habitat for birds. Ample research has shown that birds are adversely impacted by chronic noise, resulting in reduced reproduction and impeded chick development (e.g. Schroeder et al. 2012). Birds and frogs are particularly sensitive to generator noise, resulting in negative patterns of distribution relative to these sources (Slabbekoorn, 2019). **Therefore pumping stations are expected to be disruptive for wildlife**.

The EAP1 (p. 24) indicates that pumping stations "will be buffered by sound barriers for noise suppression if required". Therefore they will not all be buffered as a matter of course, but only "if required". Again, the same questions arise as above for extraction sites: Who will determine if this is required? What will the criteria for action be? The wildlife will have no ability to complain and nobody to intercede on their behalf.

Light pollution

On p. 26 of EAP1, we see a reference to a "light plant" for the first time: no further elaboration is provided. Does this refer to mobile industrial light towers with banks of excruciatingly powerful lamps? How much lighting will there be? Whatever this item is, Table 2-1 (EAP1, p. 27) indicates there will be an alarming eight of them.

The nuisance of **light pollution** is mentioned only in passing with respect to wildlife, but no reference is made to human health: "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" (EAP2, section 6.5.2). Since activities will occur round the clock, and drilling year-round, January through December, need for substantial lighting is anticipated.

Light pollution is a recognized adverse impact on human health (Holker et al., 2010), where it may enable cancers (especially breast cancer (Chepesiuk, 2009)), may interfere with hormonal regulatory mechanisms and chronobiology (circadian rhythms), and create stress and psychological/behavioral issues. Not just the intensity of artificial light is important, but also its quality (primary wavelengths). Health effects can occur not just within the lit area itself, but also from peripheral unwanted glare and light bleeding around the lamp (Figure 20).

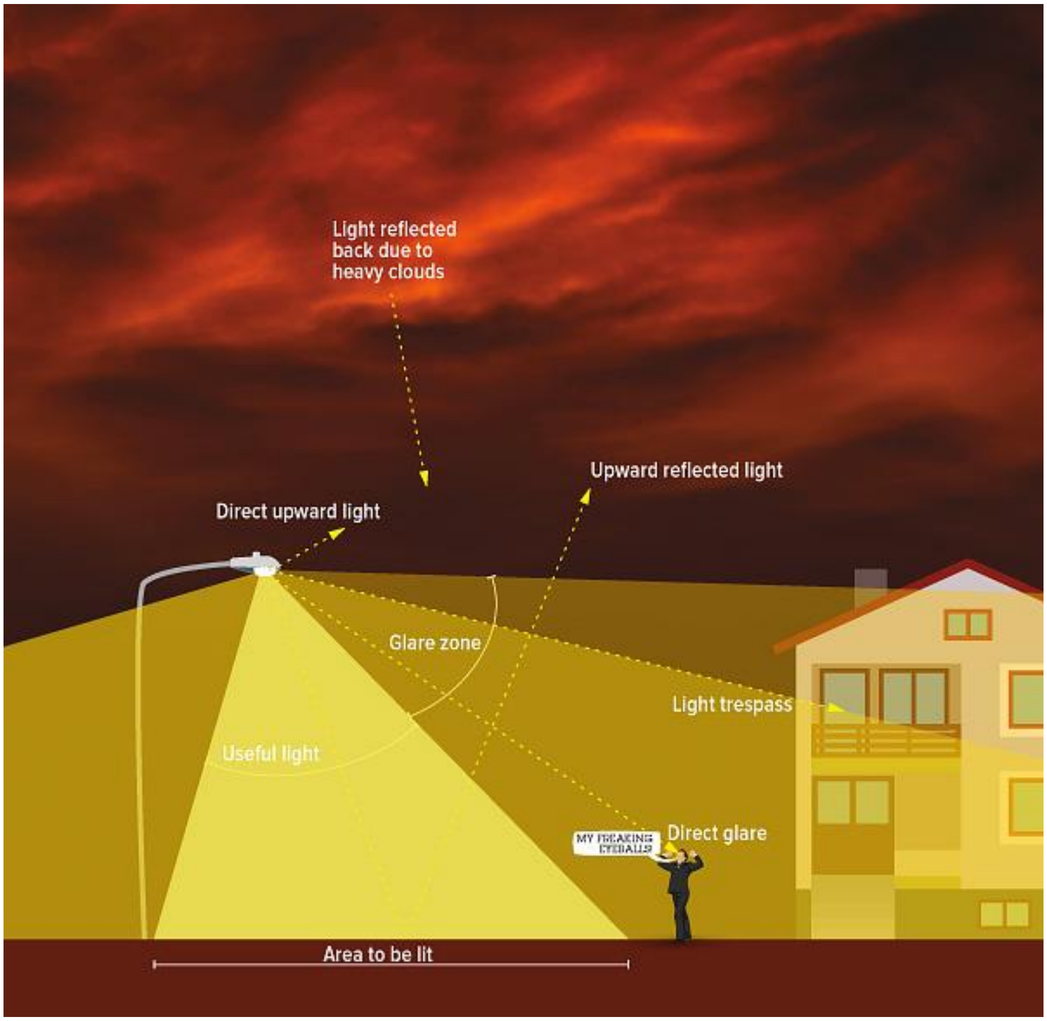


Figure 20. Zones of light pollution from an artificial light source. Source: https://www.darksky.org/light-pollution/

Artificial light also affects ecology and environment (Bashiri and Hassan, 2014), and disrupts the behavior of nocturnal wildlife (Chepesiuk, 2009), interfering with mating and feeding behaviors. At the extraction sites, activities will overlap the bird breeding season. It is known that night time illumination alters bird behavior and causes disorientation, dehydration and exhaustion in hatchlings (Chepesiuk, 2009). Light and noise intrusion may cause nests and young to be abandoned, resulting in wasted reproductive effort.

As is the case for humans, wildlife sensitivity to light pollution is also dependent on light quality, with outputs weighted in the blue part of the spectrum being the most disturbing (Figure 21). Low pressure sodium lamps appear to be the most ecologically benign, while LED lights are the worst choice (Longcore et al., 2018). The EAP ignores this topic entirely.

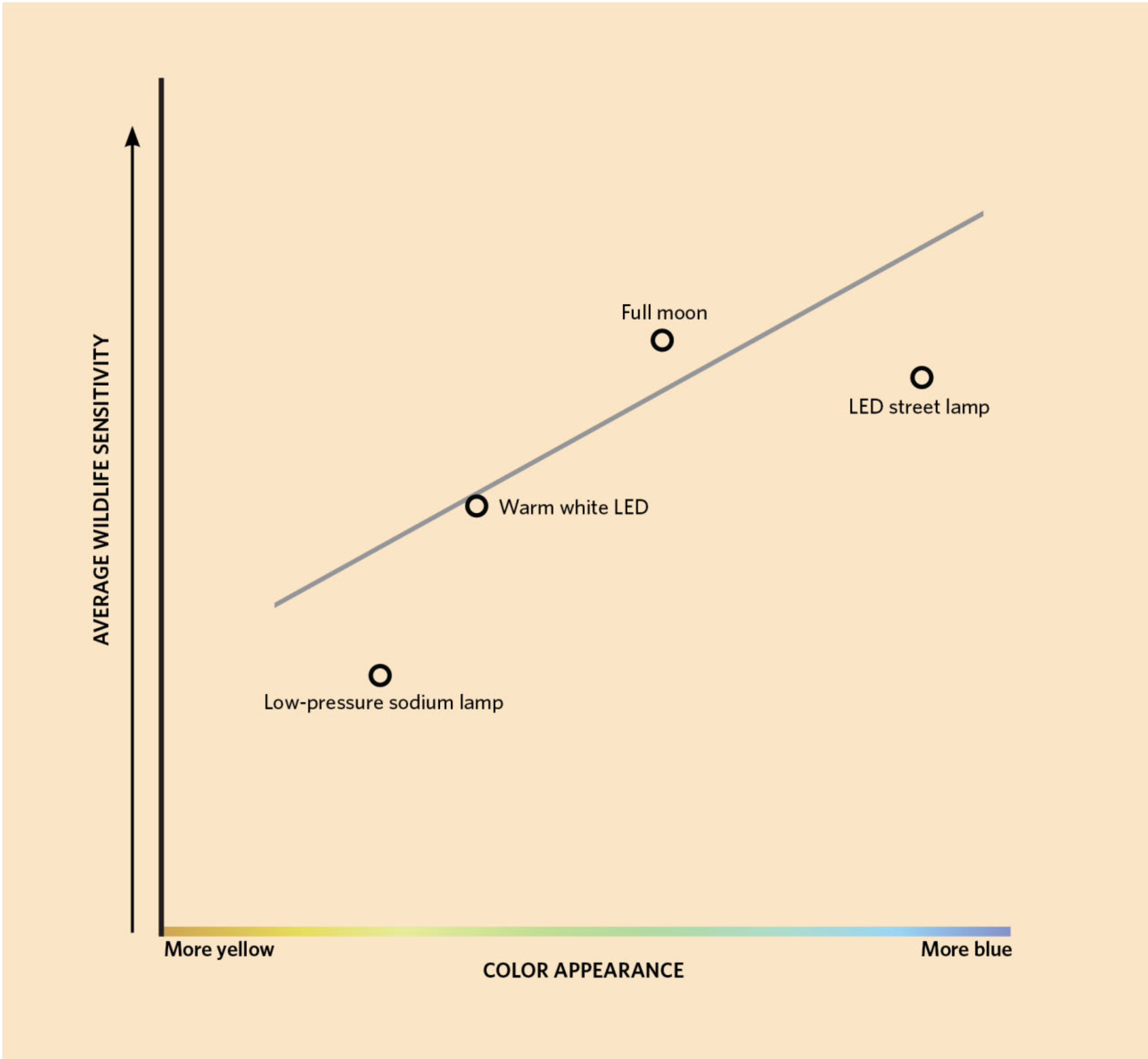


Figure 21. Wildlife sensitivity to nocturnal light increases with proportion of blue light in the output spectrum. Source: https://www.the-scientist.com/features/the-vanishing-night--light-pollution-threatens-ecosystems-64803

- The EAP2 (section 6.5.2) 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."

  From the video at https://www.dropbox.com/s/0hfqzckgv68f61o/img_0623.mov?dl=0 , it is apparent that the light is not shielded (Figure 22). This video was recorded at an extraction site in Springfield on 24 August 2021 at 8:45 P.M., at the stipulated setback distance of ≈ 100 m. Eight "light plants" are planned (Table 2-1, EAP1, p. 27), but how they will be deployed is unknown.

Figure 22. Springfield silica sand extraction site on 24 August 2021 at 8:45 P.M. at ≈ 100 m setback. Sunset at 8:28 P.M., still twilight. It is apparent that the light is not shielded. Source: https://www.dropbox.com/s/0hfqzckgv68f61o/IMG_0623.mov?dl=0

- There is **no further information** on the type, intensity, horizontal arrangement and vertical placement of lighting at the extraction sites, nor how it will be powered. **What kind of lighting will be used and how will it be deployed?** Will it be powered by diesel generators? **Will pumping stations be illuminated?**

Air quality

- "Project activities are expected to have a negligible effect on air quality… due to exhaust emissions including nitrogen dioxide (NO_2), carbon monoxide (CO) and sulfur dioxide (SO_2)" (EAP1, p. vii).

  Activities will occur 24/7 and exhaust may be a nuisance if upwind. On these days, residents will keep windows closed and remain indoors. It will be more unfortunate when the direction is that of the prevailing wind.

  Diesel exhaust is especially unhealthy: besides carcinogenic particulates, "It contains more than several hundred different organic and inorganic components, including many chemicals that have been designated as toxic air pollutants." (Kagawa, 2002). According to the latter author, diesel emissions aggravate asthma, allergies and inflammatory respiratory conditions. This will pose a nuisance on some days for families with children, the elderly, and persons with health challenges. The meager 100 m setback will not be adequate when these emissions travel hundreds of meters.

- "The measures that will be applied to minimize adverse effects on air quality and noise …….are expected to adequately mitigate adverse effects on human health both on and off the Project site."and "Therefore, the risk of adverse impacts on human health is determined to be negligible." (EAP1, p. x). **What about STRESS?**

Land clearing and revegetation

- According to the EAP1 (p. ix), 56% of the project area is neither agricultural nor developed. However this figure does not consider natural vegetation and trees on residential land which is deemed "developed", nor on pastureland, which latter would be deemed agricultural, nor on other "developed" categories of land use. According to Figure 4-6 in EAP2, the project area is blessed with woodland cover in various phases of maturity. Thus it is anticipated that many trees will be in the way – trees which are private property.
- In some cases, the trees will have been planted and cared for by landowners.
- The Corporation does not own or have rights to the trees. Lost trees will be associated with concomitant reduction in property value, esthetic/spiritual value and enjoyment of one's property.
- While the proposal states: "Effects on topography will be minimized by using existing roads, trails and other previously disturbed areas to the extent feasible to minimize disturbance to the natural topography." (EAP1, p. v), in the majority of cases, it is unlikely that locations of existing corridors on private property will conveniently

coincide with access to the extraction sites without significant further damage. If they do, they will still require adjustment and enlargement for heavy equipment width and turning radius. Hydro pole rights-of-way on the property cannot be used. Besides trails, substantial and comprehensive destruction will occur at the extraction sites.

- On parcels with multiple well clusters, besides clearing of the primary access trails and the cluster sites themselves, and widening of existing trails, additional pathways will be needed to interconnect the clusters for the movement of equipment between clusters, amounting to additional damage and scarring.
- Each cluster of 50-60 m diameter (or 60-70 m, see above) will encompass 0.20 - 0.28 ha, and clusters will be 60 m apart. It is unclear whether the latter distance is well-to-well or site edge-to-edge. The clusters will be arranged in blocks; it is not known whether there will be a maximum block size. According to this description, it follows that nearly half of the area occupied by a block will be denuded in a patchwork pattern, not including the interconnecting access and slurry trails. This will amount to major damage affecting a large area, and will substantially alter ecological balance and habitat integrity.
- The proposal indicates that the onsite "dewatering and pump station will be powered via direct mainline from Manitoba Hydro" (EAP1, p. 26). Since mainline power will be required at the extraction sites and pumping stations, and since power lines cannot be laid on the ground, this will require the **installation of hydro poles** to service this equipment. A number of issues arise:
  - Mainline power will presumably be tapped from the hydro service lines running along the property frontage, and metered accordingly.
  - **Rights-of-way for Manitoba Hydro (MH) poles and lines will have to be cleared** on private property to bring them to the extraction site and the pumping stations.
  - Access trails for extraction sites will likely not be suitable for running hydro poles and power lines unless they are very wide and meet MH specifications, and caution will be needed for the transportation of large and heavy equipment to prevent accidental contact with power lines.
  - In agricultural fields, hydro poles and power lines would inconvenience the farmer; for example modern farm equipment is guided by GPS, and these obstacles would create additional annoyance and loss of usable acreage. Special care would be required for operating large farm equipment nearby.
  - Power for the pumping stations will be problematic as the slurry trails will be only 2 m wide and hydro poles cannot be installed, unless these trails as well are greatly widened, adding to the amount of property damage.

- As the operation proceeds from cluster to cluster and block to block, additional poles will be needed to extend the power line, requiring additional clearing.
- Will these extensions cross property boundary lines between neighboring parcels?
- What is the maximum distance that will be achieved before a new hydro pole corridor will be established?
- The rights-of-way for hydro lines on private property would require temporary easements.
- All power infrastructure is owned by MH and **can only be handled by MH staff**.
- Since there is usually a wait time of up to several months for MH hookups, the schedule would have to be firmed up well in advance. Should there be a delay or other unforeseen issue at an extraction site, this would create a problem for MH.
- Hydro poles and all related infrastructure will need to be removed by MH staff when no longer required, and moved to the next location.
- This project would place a substantial burden on MH resources for 24 years.
- The results of consultation with MH cannot be found anywhere in the proposal. Has any such consultation even taken place?

- "Burning permits to dispose of woody debris will be sought" (EAP1, p. 9). Burning is nowhere indicated in the EAP. The landowner owns the firewood from her/his trees. Chipping and shredding of unseasoned woody debris rather than burning is far more environmentally responsible as it creates much less air pollution and greenhouse gases, and provides useful mulch for gardening and landscaping.
- The estimates of greenhouse gas emission (EAP2, section 6.3.2) omit contributions ensuing from removal of trees and vegetation, and burning debris.
- Clearing of access and other trails will make the property vulnerable to trespassing: ATVs, dirt bikes, snowmobiles, hunters, woodcutters, berry and mushroom pickers, miscellaneous "tourists". Will decommissioning include closing the entrances to trails, or will this be left to the landowner?
- "Drainage ditching will be constructed along Project access trails and at disturbed areas, as required, to assist in directing runoff flow from rain and snow and maintaining natural drainage pathways through low areas." (EAP1, p. viii). In addition to clearing, there will be digging. Do the proponents have the right to construct **drains on private property**? This is substantial habitat disruption. There is nothing in the EAP regarding filling in the ditches afterwards. Is this left to the property owner?

- Some residents may be affected by destruction of wild foraging foods such as berries, mushrooms, edible roots and herbs and traditional medicinal and ceremonial plants, which are important resources for many residents and Indigenous harvesters. These items will not be included in the restoration plans.

- The proponents estimate that 31% of the impacted area consists of agricultural lands (EAP1, p. ix). On cropland, how will the Corporation compensate farmers for loss of crop at the cluster sites and access routes? Will sites of abandoned well clusters be suitable for future tilling, fertilizing and other farm practices?

- Regarding sites situated within pastures and paddocks, how will livestock owners be compensated if they require alternate arrangements for pastured livestock? Will damage/destruction of enclosure fences be repaired? Will dugouts destroyed or impacted by the operations be replaced?

- The proposal indicates that the decommissioning process will "minimize soil erosion" (EAP1, p. vi). In the BMP for the Erosion and Sediment Control Plan (EAP2, section 8.5), soil replacement is mentioned. Will this soil consist of **restored topsoil**, which has been **saved**, or simply be a mashup of the bulldozed material and other waste left over from the drilling and extraction? If the area is to be reseeded with native species, they must have the appropriate soil to expect much success. They will not grow in graded sand and gravel.

- Further (EAP1, p.vi), "disturbed areas will be revegetated as quickly as feasible, and will be augmented using an approved native seed mixture and native plantings if required." (EAP1, p. ix). Who will determine if it is "required"? What does "as quickly as feasible" mean – within the month, the year, never? Does "disturbed areas" mean ALL disturbed areas including trails, or just the extraction sites? Who will approve and conduct the reseeding process? Will there be dedicated staff in charge of the rehabilitation process?

  What is an "approved native seed mixture" – is it native **to the specific area/ecozone**, or a generic commercial mixture from outside the province or even the country? It should not contain any invasive or exotic species. To illustrate, Purple Loosestrife, a highly invasive species in Manitoba, was at one time a component of some native seed mixtures because of the ease with which it revegetated barren soils.

- The BMP for the Erosion and Sediment Control Plan (EAP2, section 8.5) states that restoration will occur "using an appropriate seed mix or fast-growing cereal crops for late fall or spring germination." Why and where would cereal crops be planted – not in natural areas, not in agricultural fields where it would conflict with the existing crop?

- In contradiction to the above two text bullets, "disturbed areas [will be] allowed to revegetate naturally" (EAP1, p. ix). This means "walk away". If the hapless property owners want something more, they will undertake the expense and travail of replanting trees and other vegetation themselves.

The EAP1 dismisses the vegetation impacts as "minor and temporary" (EAP1, p. ix), and "it is expected that most natural vegetation will be very well established after approximately four years, with reestablishment of trees and shrubs expecting to be evident within five to 10 years following closure" (EAP1, p. ix).

The reestablishment of trees is only expected to be "**evident**", not complete, or even advanced, after these many "temporary" years: unless the landowners are very young, they may not live to see those trees mature. In the meantime, they just have to put up with it. Greene et al. (1999) have compiled an extensive review of regeneration of boreal tree species such as are found in the project area, and factors that contribute to regeneration failure in disturbed areas.

A drawback of both natural revegetation and tree replanting of clearcut areas is that the resulting forest will be composed of trees of the same age, unlike the original stands, which have developed and staggered growth over a long period of time (FPB, 2021). Thus the ecosystem which will replace the original will not be the same.

Figure 23A-C. Natural poplar forest regeneration with no supplemental planting or seeding. Beausejour area, 20 km North of Vivian project area.

Left (A): Mature**, undisturbed** forest, with thick shrub understory and tall tree canopy.

Next page, two pictures (B and C): **Adjacent disturbed areas after 30 years** with no intervention. The trees are 2-3 m tall. Understory is absent.

Photos: E. Pip

- Natural, unassisted regeneration rates of woodland can be very slow. Figure 23A-C shows natural regeneration of a poplar forest 20 km North of the Vivian project area on private registered conservation land in the Beausejour region. The site was cleared but top soil and tree roots remained intact, and was adjacent and contiguous with mature, undisturbed forest. The site was allowed to revegetate by itself without any replanting, reseeding or other intervention. Human traffic was excluded.

  Figure 23A shows undisturbed forest immediately adjacent; note the thick impassable shrub understory and high tree canopy. Figures 23B and C show the contiguous disturbed area within 20 m of the undisturbed boundary edge, **30 years later**. The trees are 2-3 m tall and understory is absent. It is obvious that in situations such as these, spontaneous revegetation can occur very slowly. Thus we cannot be overly optimistic about how quickly damaged sites recover: it depends on a variety of site-specific factors, as well as the plant species involved.

- Yet further on this topic, contradictory again to the two preceding text bullets, a company official was quoted in the media as having said, at the CanWhite virtual open house on August 24, 2021: "Most of the areas we work in, within 30 days you can't tell we'd even been there." (The Clipper, September 2, 2021, p. 5).

  The quoted statement is deeply insulting to the public. The official obviously had not read his own EAP report. Any landowner who has ever planted and cared for trees knows how slowly trees grow. Similarly natural revegetation takes many years. Seeding with native plant mixtures will show only **some limited germination** after 30 days; many native herbaceous species take months or even years to germinate. Some places never recover, and the scars are still evident decades later: look at any abandoned gravel pit.

  The proponent states: "A Revegetation Monitoring Program will be implemented to determine the success of the revegetation program and determine if follow-up reseeding or replanting is required. " (EAP1, p. ix). In this program (EAP2, section 8.7), "The revegetation monitoring program will include monitoring during the growing season until the seedlings appear to be established." What criteria will be used to determine success or failure? Who will determine if reseeding/replanting is required? Who will run this program? Will there be a mechanism in place for appeal?

- The issue of **soil compaction** on the trails and damaged areas by the passage of heavy industrial equipment and other traffic will set back revegetation and regeneration rates, and reduce plant diversity.

- Similarly **compaction of living tree roots** by vehicles is an important factor that promotes poor performance and regeneration failure of boreal tree species, particularly those which produce suckers (e.g. poplar)(Greene et al., 1999).

- "No land cover considered rare for the regional area was observed in the Project site during terrestrial reconnaissance of the Project site. Vegetation species at risk are not expected to occur within the Project site." (EAP1, p. ix). This statement is contradicted in EAP2 which does identify "Plant 'Species at Risk' that may occur within which [sic] the Project Site" (pp. 44-45, and AppE).

  Contrary to the information presented in EAP2 and AppE, the proponent states that species at risk **are not expected.** "Expected" and "actual" are different things. Who conducted the reconnaissance, and how extensive was it? Species at risk and rare species are designated thus because they are, well, **rare.** By definition, they are unlikely to be identified in a cursory eyeballing of the general area, especially when they are not in flower. Assumptions do not equate to actual assessment (by qualified botanists) of the actual places where disturbance and destruction will occur. I have observed for example, that there are several species of rare native orchids, rare herbaceous species such as Indian Pipe, rare ferns and clubmosses (*Lycopodium*) and liverworts within the project area, yet the "reconnaissance" apparently did not see any "land cover considered rare for the regional area".

- Since reconnaissance of the project site was done (EAP1, p. ix), why is the report not included, or a link provided?

- Similarly the beginning of Section 4 (EAP1, p. 32) lists a number of environmental studies and surveys that are relevant to the project area: why are these links not included? Except for fish, there are no references or literature citations, or indication of who conducted this work, so that it is not possible to access it.

- While section 4.4.4 of EAP2 identifies **public** ecological reserves and wildlife management areas in the surrounding region, **how will lands that are legally designated as conservation or ecological reserves but are in private ownership** be handled? Even if there might not be any now (**do we know?**), there well might be within the next 24 years. Have inquiries been made of agencies such as the Manitoba Habitat Heritage Corporation, which enters into binding agreements with private landowners? Would extraction activities still take place on such protected lands? What is the legal precedence in such cases?

Heritage

- Old gravesites from settlement times (as well as Indigenous burials) may occur in the RM of Springfield, particularly on old homesteads and in the bush. According to pioneer seniors now passed (personal communications), during early settlement in the Springfield area cemeteries were either not yet organized, or bush burials were necessary due to isolation, lack of religious affiliation, poverty, or contagious disease; frequently the deceased were infants or children and the graves are small. Any grave markers are now mostly obliterated. According to the EAP1 (p. xi), "If heritage resources are discovered within the Project site, work will be stopped" (EAP1, p. xi). These resources should be ascertained beforehand, as it would be extremely disrespectful for human remains to be disturbed by a Corporate bulldozer. Will a staff member who is able to distinguish human from animal bones monitor the clearing activities, as the bulldozer operator will be unable to do so?

Respect for the property owner

There is virtually no information or even acknowledgement regarding the landowners. What are their rights, and how shall the company deal with these stressed human beings throughout the entire process? Throughout the report there is a disheartening disregard of potential human impacts and concerns, which are either not mentioned, or summarily dismissed as "minimal" and "negligible" and "minor" without supporting data.

- "Land agreements will be issued in advance of any work occurring on private property." (EAP1, p. 3). Do these "agreements" mean: A) there is informed consent of both parties, or B) one party (i.e. the proponent) "agrees" to occupy the property, in which case it is a notice to the property owner? What is the emolument offered to the landowner per well or cluster and for any related property destruction? In the interests of transparency, **a copy of this landowner agreement form should be disclosed.**

  A curtain is drawn over what happens if a landowner refuses to agree/sign, yet the company has the mineral rights. The only inkling we get is: "Mineral rights permit use and occupation of the land for the purpose of prospecting, exploring for, developing, mining or production of minerals on, in, or under the land." (EAP1, p. 3). No landowner's rights are mentioned. This is not good public relations and sets the stage for many unhappy situations. In an extreme scenario, if the landowner obstructs entry, will the RCMP physically remove him from his own property and charge him with a crime?

- Many landowners have profound attachments to their land, which may have been in the family for generations, and which may often contain areas of particular aesthetic, spiritual or sentimental value. There may be places which are used for picnics, recreation, family gatherings, or meditation and prayer; there may be dedicated memorial areas for buried pets, or spots frequented in life by departed loved ones. There may be scattered ashes of cremated family members. Will there be a mechanism where property owners can beg the company to leave such areas alone?

- Will access points to properties perforce need to utilize parts of people's driveways, as new access created across municipal rights-of-way and municipal drainage ditches (and installation of temporary culverts) may require municipal approval. If so, how much will the activities of movement of heavy machinery and 24-hour traffic interfere with people's use of their driveways?

- What are the policies regarding damage to people's fences, gardens, sheds and other landscaping features and installations? Will the company repair and restore damaged items?

- "Use of the land for other purposes will not be available in the locations of annual Project activities." (EAP1, p. x). Will the property owner be excluded from entering the site, even with a hard hat? What will be the legal mechanism and repercussions?

  Further, "parcels of land used for Project activities during any given year of Project operation will be available for other uses the following year or once the activities are complete."(EAP1, p. x). According to this statement, does this mean that the **entire parcel** will be unavailable to the property owner?

- A set timeline should be required and adhered to within which decommissioning, site levelling, grading and revegetation shall occur. Property owners must be notified of a firm time within which the work will be completed, so they are not subjected to the stress of waiting indefinite periods of uncertainty and delay, for a conclusion which may or may not ever arrive. Throughout the report, we see the recurring phrase "progressive annual reclamation of extraction sites" (e.g. EAP1, p. x), but nowhere is its meaning clarified. Does it mean that each site will be addressed in stages, stretched out over a year after it is abandoned, or does it mean reclamation of all the yearly sites will occur annually as a block at the same time within the same year?

- Will there be a dedicated contact person available where people can take their questions and concerns?

- How will disputes be resolved and what mechanisms for appeal will be available and enforceable? Will there be access to an **independent, neutral** adjudicator/arbitrator/conciliator, or will litigation be the only option?

- What will be the role of the Province in monitoring and oversight? What legislation will have to be adapted to this unprecedented situation?

- How will the community be kept informed as the project proceeds?

- There is a discouraging tone of disregard and disrespect for the people whose wells may be affected. They seem to be a disposable collateral annoyance. Even the peer reviewers (AppB, p. 8) noticed this: "Throughout the report, the treatment of private water wells/private water well resident concerns throughout the course of the project is inadequate."

- It must be recognized that the entire intrusion will be highly stressful and disruptive for many landowners and families, and that this stress will have to be endured over an extended period of time. For many, it has already started with anxiety regarding what the future will hold, and a feeling of injustice, powerlessness and violation. There will be, and already is, a need for support.

Jobs and economy

- The extensive "variety of markets" listed for silica sand (EAP1, p. iv, also p. 3) accidentally omits fracking, a major consumer of this commodity. This use enables two environmental transgressions to be perpetrated by the same sand: the mining of the sand, and the fracking.

  At the CanWhite virtual open house on August 24, 2021, a company representative was quoted as saying that "the silica would not be used for fracking" (The Clipper, September 2, 2021, p. 5), although this intent is absent in writing from the EAP. Yet at the same time, the EAP has stressed the high purity of the Springfield area deposits: 99.85% (EAP1, p. 3). According to Benson and Wilson (2015), "Premium frac sand is greater than (>) 99 percent quartz or silica (SiO_2)…although a great deal of sand used as frac sand falls within the range of 95–99 percent silica content." Since the purity of Springfield sand renders it eminently suitable for this purpose, and the company is free to market wherever it likes, and the market is lucrative, public distrust of statements like this brings into question whether company officials will honor the things they say.

  In contrast, in the companion EAPPF (Appendix I), question 44 from the public was answered thus (screenshot, highlight is mine):

Project Description - Sand Product Market Use	44	By using rail as your main transportation source, are you shipping the silica sand to be used in the oil industry outside of the province and/or country?	Email (1)	Sand will be shipped within Canada, the United States and internationally through ports on either or both the east coast and west coast of Canada. Although some of our sand may be sold to the oil and gas industry, it is of high enough silica purity that our target markets are other industries such as the medical glass industry, renewable energy industry (e.g., solar panel production), electronics (e.g. cell phones, computer chips) and telecommunications (e.g., fibre optics). Until such time that these target markets have operations in Manitoba, the sand will be shipped to established markets within Canada, the United States and internationally.

Also question 46:

46	What percentage of your sand product will be sold to markets other than the oil sector?	Virtual Meeting (2)	We forecast that at least 60% of the sand product will be going to various industries outside of the oil and gas industry. Also see responses to #44 and #45 above.

- For the sake of an embarrassingly paltry number of jobs **(35-45 staff), 70-85% of which will be only seasonal** (EAP1, p. 25), the land will be subjected to widespread, extended scarring, the aquifers will be subjected to potential irreversible impacts and long-term risk, and the residents will be subjected to inconvenience and stress, diminished quality of life, and blemished property values. Elsewhere in EAP1 (p. 25), the word 'limited' is used for the size of this workforce.
- The proponent does not indicate how many of these sparse staff will be local or Manitoba hires, and how many will be existing out-of-province company employees. How many of these hires will be minimum-wage jobs?
- Will Manitoba contractors conduct all of the well drilling, or will the proponents bring in their own crews from Alberta?
- "The need for local suppliers and other business to support Project activities is likely to provide an additional 100 to 120 indirect employment opportunities." (EAP, p. x). These people are employed by somebody else. Suppliers and businesses are unlikely to create this many new jobs just to service this project. How much procurement of goods will be within Manitoba?
- As this is an out-of-province company, other than some taxes and license fees, the profits will accrue neither to the municipality nor the province. The residents of Springfield, and of the province, will bear the long-term consequences and costs of any adverse effects. How many of the company officers or executives or Board members will be moving to Springfield to reside permanently and raise their families?

Where are the testimonials

This is new technology that still requires development. According to an HD Minerals 2019 open house, there is a need "to develop a new extraction methodology that has never been done before" (Figure 24):

Figure 24. Storyboard from an HD Minerals Open House in April, 2019. Highlight is mine. Source: https://steinbachonline.com/local/mining-discussion-draws-response-from-local-reeves

"CanWhite is currently applying for an Environment Act Licence for extraction activities up to and including 2025 because advancements in extraction methods and operations are expected to increase efficiency and reduce overall footprint after 2025. This will be explained in a subsequent Environment Act Proposal for the future potential extraction years." (EAP1, p.2).

On p. 13 of EAP1 we see: "The first four years of sand extraction activities are expected to result in improvements and efficiencies to this proposed new sand extraction method." These statements are frightening because they acknowledge that extraction methods and operations still need to be worked out after more learning experience and experimentation. The project area will be the practice ground. Some things probably won't work out. It will all occur on somebody's private lands.

The first four years will be trial and error of a novel procedure, for which industry operational parameters have not been standardized, and for which specific regulation/legislation has not been enacted. There is a complete absence of any reference to other places where this method has been tried/used and what impacts it has had. Based on the content of the EAP, its contradictions, and its incomplete and uncertain planning and design, licensing is here sought for a project that apparently will in large part be made up as it goes along. How can such an endeavor proceed **without fully defined and proven methodologies**, and without fully developed and committed associated strategies in place for accountability, response, mitigation, rehabilitation, compensation, and long-term responsibility?

As for jobs, in most industries as efficiency and technology improve, the number of jobs decreases. Thus with future streamlining, the estimated relatively small number of jobs could be even less significant in the future.

Therefore is it not prudent that we should demur? If this extraction method is proven to be sound and safe, other jurisdictions will be using it, and we can learn from them and their mistakes and successes, rather than being the disposable test ground that gambles with very high and permanent stakes, indeed with the future. Our already battered environment is just too precious and in need of our stewardship, vigilance, and care.

Additional remarks

- The text document of the EAP is endlessly repetitive, replicating the same statements in multiple places, while inconsistent information is presented in different sections. Apparently the EAP was prepared by various people who did not consult or coordinate with each other.
- Although there is a complete Table of Contents, it is useless after page 63, for subsequent pages are not numbered (EAP2).
- Many wordings in the consultant's text suggest a bias in favor of, and promotion of, the proponent's application, leading the reader to question the objectivity and completeness of the documentation presented.
- The EAP is frustratingly nebulous, uncertain, even obfuscating on numerous technical aspects of the proposed operation, with disconcerting gaps in information for several key procedures in the system, for example the air lift system design, dewatering plant, slurry system, pumping stations, and many, many others. There are numerous outright

contradictory statements. This makes it difficult to respond cogently to the proposal when we do not know what it actually is.

- The EAP and the Hydrogeological Assessment Final Report (AppA) do not agree on several fundamental topics, for example planned reinjection rates of water, or decommissioning protocols for abandoned wells. Simulation models in AppA do not match the planned parameters in the EAP. At times one has the feeling that they are for different projects altogether, and there is no guidance regarding which version is correct, or perhaps neither is. This makes one question the validity or even pertinence of commenting at such a disorganized and muddled stage.
- The proposal seems very dismissive and trivializing in the tone of its treatment of a very serious issue. For example: "The potential risks to groundwater are assessed to be minor, seasonal in duration and reversible." (EAP1, p. vi). Groundwater impacts unfold over long periods of time, contamination cannot be reversed, mistakes can affect large numbers of people, into future generations, and risks will persist long after the company is gone. Not minor, seasonal, reversible. Even their own EAP acknowledges that aquifer changes will be permanent.
- With respect to previous historical silica sand mining in Manitoba, particularly Black Island, "There have been no significant environmental impacts attributed to silica sand presence or mining at any of these locations." (AppA1, p. 14). Similarly, the following peer reviewer's statement is presented in AppB (p.2) "This background is very important, as it presents silica mining as a concept that has previously occurred in Manitoba, without any significant environmental effects." (AppB, p. 2).

  Previous silica mining, using an additional example (not mentioned in the EAP) at the old glass factory in Beausejour, did not involve the invasive subterranean methodology currently proposed, and was largely open pit mining of near-surface deposits, confined to the same limited circumscribed area. <u>Of course</u> environmental impacts would have been lesser and different, as they did not implicate aquifers.
- The peer reviewer has been employed by the proponent thus far (see WDR), which creates a conflict of interest.
- "It is recommended that mitigation measures, follow-up plans, and monitoring programs described in this report be implemented to avoid or minimize potential environmental effects and/or identify any unanticipated adverse effects early so that appropriate adaptive management action can be undertaken." (EAP1, p. xi). Recommended, not required?
- Long-term accountability is absent. In the future, a company may no longer exist, it may declare bankruptcy, or reorganize under another name and structure. There are many such mining legacies in Manitoba, where the taxpayer is left to deal with the problem,

which is at that stage irreversible. Consider the extreme case of thousands (170,000 (AER, 2021)) of abandoned and orphaned oil wells in Alberta, and stranded landowners, many of whom have waited decades for restoration of their land, that has, and never will, come in their lifetimes, if at all. This is what comes when we place greater value on the quick over the enduring.

- "the tax revenue that will be realized with the proposed Project being located in the RM of Springfield" (EAP1, p. xii). The tax revenue that will accrue to Springfield will primarily derive from the processing facility, which, if approved, will operate for 24 years. After this term has expired, the surrounding resources within functional distance of the slurry lines will have been exhausted, and the processing facility will have to move to a different area, which may or may not still be in Springfield.

  The proponent has reportedly secured mineral rights in several additional municipalities besides Springfield, including Reynolds, Tache, Hanover and La Broquerie (The Clipper, August 19, 2021, p. 1), as well as others. Hanover and La Broquerie are particularly glutted with industrial hog operations. Manitoba is Canada's primary hog producer, and Manitoba hog farms are the largest in the country (https://www.gov.mb.ca/agriculture/markets-and-statistics/livestock-statistics/pubs/ag-sector-hog-accessible.pdf). Contamination potential in such regions is enormous.

  The existing facility will likely be sold and repurposed. Let us weigh this amount of revenue (for the municipality) against all of the concerns and liabilities expressed in this document as well as by Springfield residents, in addition to depressed property values, the inevitable perception that Springfield will be a place to avoid, and other ramifications not yet identified. People have no shame.

- We cannot conclude without identifying the root which makes such situations possible: our regressive and unjust mining legislation. Much is permitted under the gray schmutz of our provincial Mineral Exploration laws, and much is permitted for all of the other phases of operation and abandonment. The legacy of hundreds of unremediated/irremediable places in Manitoba proves it. Our Goddess of Mining is outdated and decrepit, she neither sees nor hears, and she cares only for herself. Perhaps one day we will change which things we value, when they are no longer there.

*   *   *

In the end, especially disheartening is the short shrift given to the fact that there are decent people living in these places, with a right to enjoyment of their own unscarred property without interference, a right to a healthy and harmonious environment, a right to unmanipulated and unthreatened water, a right to live out their lives without anxiety and stress as God has ordained. Who speaks for them? Is this really worth it? For whom?

References

AER. 2021. How are wells abandoned? Alberta Energy Regulator. https://www.aer.ca/regulating-development/project-closure/suspension-and-abandonment/how-are-wells-abandoned

Arroyo, M.G.; O.P. Frota and 8 others. 2019. Wide diversity of fungal species found in wellwater for human consumption: an analytical cross-sectional study. Sao Paulo Medical Journal 137: https://www.scielo.br/j/spmj/a/bXRBrC48rztnMfzPjyMkbck/?lang=en

Babic, M.N.; N. Gunde-Cimerman and 8 others. 2017. Fungal Contaminants in Drinking Water Regulation? A Tale of Ecology, Exposure, Purification and Clinical Relevance. International Journal of Environmental Research and Public Health 14: 636: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5486322/

Bashiri, B. and C.R.C. Hassan. 2014. Light pollution and its effect on the environment. International Journal of Fundamental Physical Sciences 4: 8-12.

BCGWA. 2015. Flowing artesian water well control methods. The British Columbia Ground Water Association, March, 2015. https://www.bcgwa.org/flowing-artesian-water-well-control-methods/

Benson, M.E. and A.B. Wilson. 2015. Frac Sand in the United States—A Geological and Industry Overview. U.S. Department of the Interior, U.S. Geological Survey, Open-File Report 2015–1107.

Betcher, R. and G. Ferguson. 2003. Impacts from Boreholes interconnecting multiple aquifers: a case study of Paleozoic aquifers in south-eastern Manitoba. 4th Annual Joint CGS-IAH Conference. Winnipeg, Manitoba.

Broucek, J. 2014. Effect of noise on performance, stress, and behaviour of animals. Slovak Journal of Animal Science 47: 111-123.

CCOHS. 2021. Noise – Occupational exposure limits in Canada. Canadian Centre for Occupational Health and Safety. https://www.ccohs.ca/oshanswers/phys_agents/exposure_can.html

Charoenpanich, J. 2013. Removal of Acrylamide by Microorganisms. In: Applied Bioremediation - Active and Passive Approaches, Y.B. Patil and P. Rao, eds. IntechOpen. DOI: 10.5772/56150

Chepesiuk, R. 2009. Missing the dark: health effects of light pollution. Environmental Health Perspectives 117: https://doi.org/10.1289/ehp.117-a20

Cherry, J.A.; B.L. Parker, and 5 others. 2004. Role of Aquitards in the Protection of Aquifers from Contamination: A "State of the Science" Report. AWWA Research Foundation, Denver. https://cluin.org/download/contaminantfocus/dnapl/Chemistry_and_Behavior/Aquitard_State_of_Science_Reportfor_AWWARF_draft_of1-3-05.pdf

Christensen, J. and K.G. Linden. 2003. How particles affect UV light in the UV disinfection of unfiltered drinking water. Journal of the American Water Works Association. 95: 179-189.

Cullimore, D.R. and McCann, A.E. 1978. The identification, cultivation and control of iron bacteria in ground water. In: Aquatic Microbiology, Skinner and Shewan, Eds., Academic Press, N.Y. 32 pp. https://www.dbi.ca/Books/PDFs/Water-Paper.PDF

DEFR. 2011. April 2011. A review of fungi in drinking water and the implications for human health. Department for Environment Food and Rural Affairs. http://dwi.defra.gov.uk/research/completed-research/reports/DWI70-2-255.pdf

Emerick, R., Loge, F., Ginn, T., Darby, J., 2000. Modeling the inactivation of particle-associated coliform bacteria. Water and Environmental Research 72: 432–438

EPA. 2000. Acrylamide. https://www.epa.gov/sites/default/files/2016-09/documents/acrylamide.pdf

Everbach, E.C. 2001. Noise quantification and monitoring: an overview. http://www.swarthmore.edu/NatSci/sciproject/noise/noisequant.html

Farrell, C.; F. Hassard, B. Jefferson, T. Leziart, A. Nocker and P. Jarvis. 2018. Turbidity composition and the relationship with microbial attachment and UV inactivation efficacy. Science of the Total Environment 624: 638-647.

FD. 2019. Aquifer Variablity and Groundwater Vulnerability in the Rural Municipality of Springfield. Friesen Drilling, Edge Effect Environmental Planning Inc., Steinbach.

FPB. 2021. Alternatives to conventional clearcutting. Forest Practices Branch, Victoria, BC. https://www.for.gov.bc.ca/hfp/publications/00217/atcc.htm

Gentry, J. and D. Magill. 2012. Acrylamide Grouting: Successfully Controlling Groundwater from Canada to South America. Proceedings of the Fourth International Conference on Grouting and Deep Mixing February 15-18, 2012. New Orleans, Louisiana.

GET. 2021. High density polyethylene (HDPE) pipes product information. Gulf Eternit Trading. https://gulf-eternit.com/wp-content/uploads/2019/03/HDPE-Product-Information-GET-2019.pdf

Godin, A-C.; B. Bengtsson, and 4 others. 2002. Acrylamide and N-methylolacrylamide poisoning in a herd of Charolais crossbreed cattle. Veterinary Record 151: 724-728.

Goines, L. and L. Hagler. 2007. Noise Pollution: A Modem Plague. Southern Medical Journal 100: 287-294.

GQ. 2021. The Effects of Environmental Noise on Health. Gouvernement du Québec. https://www.quebec.ca/en/health/advice-and-prevention/health-and-environment/the-effects-of-environmental-noise-on-health/definition-environmental-noise

Greene, D.F.; J.C. Zasada, and 5 others. 1999. A review of the regeneration dynamics of North American boreal forest tree species. Canadian Journal of Forest Research 29: 824-839.

Guezennec, A.G.; C. Michel, and 5 others. 2014. Transfer and degradation of polyacrylamide-based flocculants in hydrosystems: a review. Environmental Science and Pollution Research 22: 6390-6406.

Health Canada. 2019. Acrylamide and food. Health Canada. https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/chemical-contaminants/food-processing-induced-chemicals/acrylamide/acrylamide-food-food-safety.html

Holker, F.; T. Moss et al. (14 others). 2010. The dark side of light: a transdisciplinary research agenda for light pollution policy. Ecology and Society 15: 11 pp.

Igisu, H.; I. Goto, Y. Kawamura, M.Kato and K. Izumi. 1975. Acrylamide encephaloneuropathy due to well water pollution. Journal of Neurology, Neurosurgery and Psychiatry 38: 581–584.

Kagawa, J. 2002. Health effects of diesel exhaust emissions—a mixture of air pollutants of worldwide concern. Toxicology 181-182: 349-353.

King, D.J. and R.R. Noss. 2016. Toxicity of polyacrylamide and acrylamide monomer. https://www.degruyter.com/document/doi/10.1515/reveh-1989-1-403/html

Kunc, H.P. and R. Schmidt. 2019. The effects of anthropogenic noise on animals: a meta-analysis. Biology Letters http://dx.doi.org/10.1098/rsbl.2019.0649

Longcore, T.; A. Rodríguez, B. Witherington, J. Penniman, L. Herf, and M. Herf. 2018. Rapid assessment of lamp spectrum to quantify ecological effects of light at night. Journal of Experimental Zoology A 329: 511–521.

Maamar, S.B.; L. Aquilina et al. (8 others). 2015. Groundwater isolation governs chemistry and microbial community structure along hydrologic flowpaths. Frontiers in Microbiology 22: https://doi.org/10.3389/fmicb.2015.01457

Martinez-Romo, A.; R. Gonzalez-Mota and J.J. Soto-Bernal. 2015. Investigating the degradability of HDPE, LDPE, PE-BIO, and PE-OXO films under UV-B radiation. Journal of Spectroscopy 2015: Article ID 586514. https://doi.org/10.1155/2015/586514

McElmurry, S. and N. Khalaf. 2016. UV treatment efficiency for E. coli in storm water containing different size fractions of suspended solids. Proceedings of the 13 International Conference on Modelling, Monitoring and Management of Water Pollution (WP 2016). https://www.witpress.com/Secure/elibrary/papers/WP16/WP16020FU1.pdf

MDH. 2019. Crystalline Silica in Air & Water, and Health Effects. Minnesota Department of Health. https://www.health.state.mn.us/communities/environment/hazardous/topics/silica.html#ground

MEQB. 2013. Report on silica sand. Minnesota Environmental Quality Board. https://www.eqb.state.mn.us/sites/default/files/documents/March%20Final%20Silica%20Sand%20report%20with%20award%20sticker.pdf

Oliveira, H.M.B.; C. Santos, R.E.M. Paterson N.B. Gusmao and N. Lima. 2016. Fungi from a Groundwater-Fed Drinking Water Supply System in Brazil. International Journal of Environmental Research and Public Health 13: 304: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4808967/

Ortega, C.P. and C.D. Francis. 2012. Effects of gas-well compressor noise on the ability to detect birds during surveys in northwest New Mexico. Ornithological Monographs 74: 78-90.

Peterson, H. G. 2001. Rural Drinking Water and Waterborne Illness. *In*: Maintaining Drinking Water Quality, Lessons from the Prairies and Beyond. Proceedings of the Ninth National Conference on Drinking Water. Regina, Saskatchewan, Canada. May 16-18, 2000. Canadian Water and Wastewater Association. W. Robertson (Editor).

Poly. 2021. What is the coldest operating temperature for HDPE sheet? https://www.ipoly.com/faq/what-coldest-operating-temperature-hdpe-sheet

Pruser, K.N. and N.E. Flynn. 2011. Acrylamide in health and disease. Frontiers in Bioscience S3: 41-51.

PubChem. 2021. Acrylamide. National Library of Medicine. https://pubchem.ncbi.nlm.nih.gov/compound/Acrylamide

Riley, M. 1999. Correlates of smallest sizes for microorganisms. In: Size Limits of Very Small Microorganisms: Proceedings of a Workshop. National Research Council (US) Steering Group for the Workshop on Size Limits of Very Small Microorganisms. National Academic Press (US), Washington DC.

Sahu, A.K.; K. Sudhakar and R.M. Sarviya. 2019. U.V light effect on the mechanical behaviour of HDPE/Carbon black composites. IOP Conf. Series: Materials Science and Engineering 788 (2020) 012054. https://iopscience.iop.org/article/10.1088/1757-899X/788/1/012054/pdf

Schroeder, J.; S. Nakagawa, I.R. Cleasby and T. Burke. 2012. Passerine birds breeding under chronic noise experience reduced fitness. Plos One https://doi.org/10.1371/journal.pone.0039200

Slabbekoorn, H. 2019. Noise pollution. Current Biology 29: R957-960.

Szklarz, K.E. and J.J. Baron. 1995. Considerations for cold weather construction using high density polyethylene for corrosion control systems. Conference: Corrosion `95: National Association of Corrosion Engineers (NACE) international annual conference and corrosion show, Orlando, FL (United States), 26-31 Mar 1995.

Tepe, Y. and A. Cebi. 2019. Acrylamide in Environmental Water: A Review on Sources, Exposure, and Public Health Risks. Exposure and Heath 11: 3-12.

Touze, S.; V. Guerin, A-G. Guezennec, S. Binet and A. Togola. 2015. Dissemination of acrylamide monomer from polyacrylamide-based flocculant use--sand and gravel quarry case study. Environmental Science and Pollution Research International 22: 6423-6430.

UKgov. 2021. Acrylamide – Guidance for Local Authorities. https://dwqr.scot/media/9724/pws-parameter-information-acrylamide-1.pdf

USEPA. 1999. Wastewater Technology Fact Sheet. Ultraviolet Disinfection. EPA 832-F-99-064, United States Environmental Protection Agency, Washington, DC.

Wang, J.; R.N. Betcher and G.C. Phipps. 2008. Groundwater resource evaluation in southeastern Manitoba. GeoEdmonton ’08. https://members.cgs.ca/documents/conference2008/GEO2008/pdfs/202.pdf

WPP. 2021. Noise Pollution in Diesel Generators. World Wide Power Products. https://www.wpowerproducts.com/news/diesel-generator-noise-pollution/

Xiong, B.; R.D. Loss, D, Shields, T. Pawlik, R. Hochreiter, A.L. Zydney and M. Kumar. 2018. Polyacrylamide degradation and its implications in environmental systems. NPJ Clean Water 1: https://doi.org/10.1038/s41545-018-0016-8