Nov. 16, 2021

Via email

Honourable Steven Guilbeault
Minister of Environment and Climate Change
House of Commons
Ottawa, Ontario, K1A 0A6
hon.steven.guilbeault@canada.ca

Barbara Pullishy
Director, Prairie and Northern Region,
Impact Assessment Agency of Canada
1145-9700 Jasper Avenue
Edmonton, Alberta, T5J 4C3
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Dear Minster Guilbeault and Ms. Pullishy:

Re: Request to Designate the PADCOM potash Mining Project in South West Manitoba

The PADCOM potash mining project proposed for southwest Manitoba is now in the licensing and approvals phase under the Manitoba Environment Act. The PADCOM EAP was filed on the Manitoba Public Registry 6126.00 on Oct. 18, 2021. The deadline for public comments was Nov.15, 2021. The PADCOM potash mining project is massive in scale extending over 212 square miles (54,900 hectares) along the western portion of the Assiniboine River Valley in southwest Manitoba near the border with Saskatchewan as shown in Figure 1, reproduced from the PADCOM EAP. The projected project lifetime is in excess of one hundred years.

Potash is to be extracted from an extensive deposit about 800 meters below the surface. The extent of the potash deposit is shown in figure 1. A solution mining method would be used where hot 85 C water from the Hatfield Valley Aquifer would be injected into the formation. Horizontal drilling would be employed for a 1600 meter injection leg in the deposit. Dissolved hot potash brine would be pumped from a horizontal recovery well leg and brought to the surface. The method to return the potash brine to the plant site is not described in the PADCOM EAP. Initially only two injection and recovery wells are planned within the processing plant boundary at Harrowby, Manitoba.

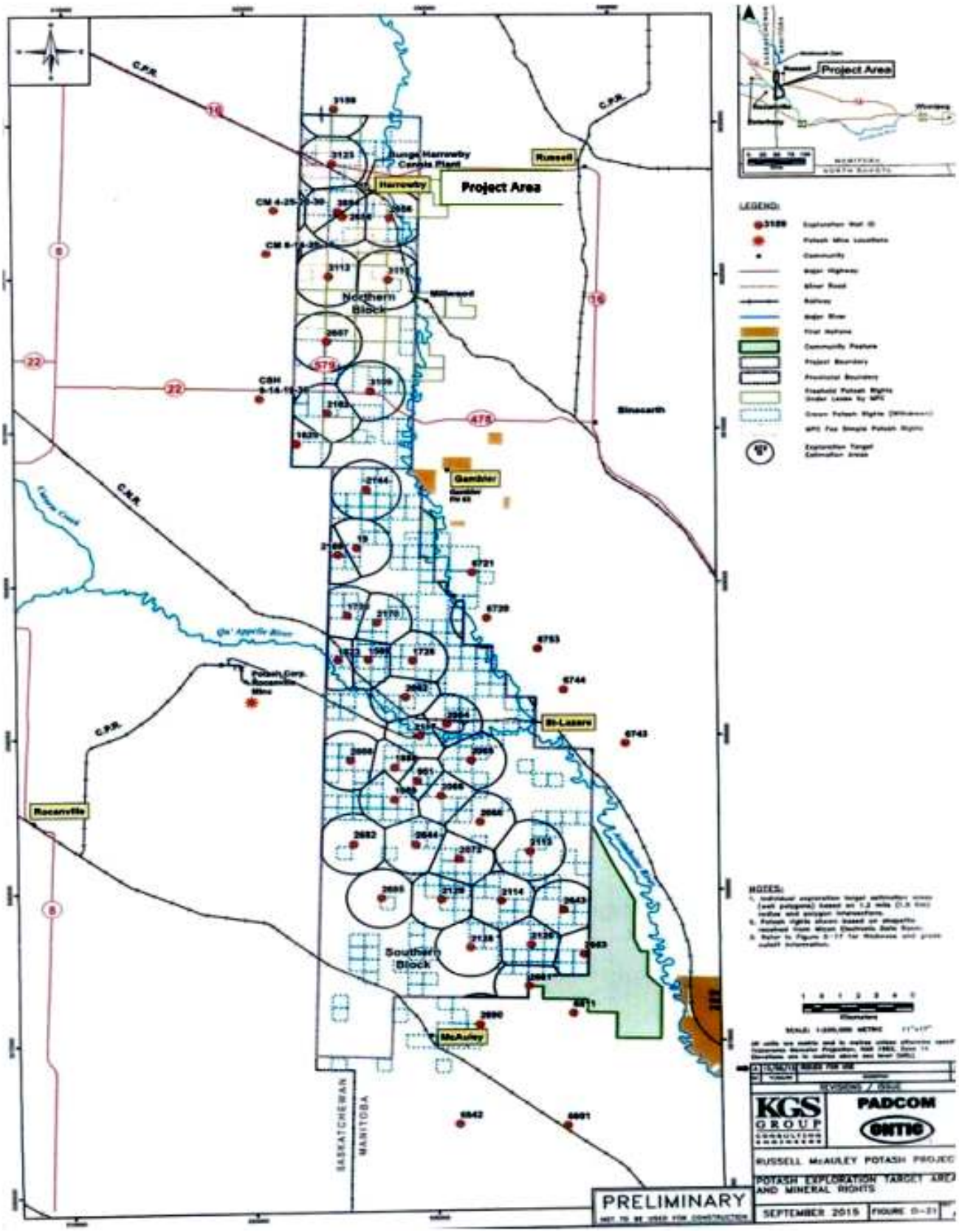

Figure 1. Historical drill holes shown by red dots illustrating the extent of the PADCOM potash resource. Infrastructure and road, rail and river crossings of eventual brine pipelines are shown.

The PADCOM EAP states;

"*There are no overland brine pipelines*."

"*The water to the site will be pumped through a 100 mm HDPE pipeline. Pipe will be buried on the road allowance*."

The plant is planned to operate all winter. To recover extracted hot potash brine over the entire project area shown would require buried pipelines extending throughout the potash project area of 212 square miles. The pipelines carrying hot brine would cross numerous rivers and streams, provincial and municipal roads, CN and CP rail lines and the 230 kV Birtle interprovincial transmission line. The PADCOM EAP omits consideration of required buried pipelines over the entire 212 square mile project area.

Potential effects in areas of federal jurisdiction include;

- adverse effects to fish and fish habitat such as effects of hot brine spills into the Assiniboine River and Qu'Appelle River watershed, and toxins in the fertilizer that could leach into fish bearing waterways,
- changes to the water levels of the Assiniboine River, a navigable waterway under the Canadian Navigable Water Act due to the large water withdrawal from the Hatfield Valley aquifer,
- GHG emissions that do not conform to the requirements of Environment and Climate Change Canada (ECCC) and the Strategic Assessment for Climate Change (SACC)to provide a credible plan that describes how the project will achieve net- zero emissions by 2050, and
- pipeline crossing of federally regulated CN and CP rail lines and the Birtle inter-provincial transmission line that falls under the jurisdiction of the Canada Energy Regulator Act and Transport Canada (TC), and
- lack of Crown led Section 35 indigenous consultation.

The proponent is obligated to contact the IAAC about federally regulated issues to determine if the project should be designated. The proponent must supply information to the IAAC that is missing in the PADCOM EAP such as the extent and locations the brine and hot water pipelines to be built over the duration of the project that may impact fisheries from spills, information on GHG implications, information on effects on water levels in the Assiniboine River, Crown led Section 35 Indigenous consultation and any other information the IAAC may need to asses the project impacts within federal jurisdiction.

The power to the project will be provided primarily by diesel generators until such time as a Manitoba Hydro power transmission line to the project is approved and built. The total GHG emissions from the project are not given by the proponent. It appears that even after a hydro line is provided potash will be continued to be dried using propane heating with about 35 kt CO2e emissions per year as documented in the attached Manitoba Public Registry submission.. The energy required for heating of aquifer water for the injection wells, cooling of brine to precipitate potassium chloride and reheating of brine for injection in disposal wells has not been documented by the proponent. The total GHG emissions, should this power be supplied by diesel generators, together with the drying of the potash has been estimated in the attached comments document as 200 kt CO2e per year. Even in if much of this large GHG emission might be avoided by eventual installation of hydro power, that hydro power would not be available for transition to renewable energy in order to meet the 2050 net zero emissions targets. We recommend the SACC initiate a windmill installation plan that would achieve net- zero project emissions by 2050. The intermittency of the wind can

be addressed by increasing the size of the potash stockpiles and by using the large elevation change in the Assiniboine valley to store aquifer water in a reservoir at the top of the valley that can be used to generate electrical power in turbines driven by stored water sent down the valley at times of slack wind.

Many rivers and streams must be eventually crossed by the brine pipelines in the Qu'Appelle and Assiniboine River watersheds. A brine spill in any of these rivers and streams would adversely affect fish and fish habitat. All fish bearing waterways that must be eventually crossed by PADCOM brine and hot aquifer water pipelines must be identified. Fisheries and Oceans Canada (DFO) and the IAAC must be notified of these crossings. To our knowledge the proponent has not consulted with the IAAC, the DFO or the Fish and Fish Habitat Protection Program in order to minimize the risk of pipeline brine spills to fish habitat from this project. Mitigation measures such as use of double walled brine pipelines with leak detection, following consultation with the DFO and the Fish and Fish Habitat Protection Program under the Fisheries Act and Species at Risk Act must be implemented

Fish and fish habitat would be adversely affected by the crude oil used as a dust suppressant and the octadecyl amine used as an anti-caking agent in the potash fertilizer product as documented in the attached Manitoba Public Registry submission. Both crude oil and octadecyl amine are toxic to aquatic organisms and would leach from fertilized fields to fish bearing water courses. Since the fertilizer would be used both nationally and internationally this potential groundwater and fisheries this water contamination issue is of federal and international scope. The IAAC, DFO and the Fish and Fish Habitat Protection Program should ensure that non-toxic dust suppressants and anti-caking agents are used in processing of the fertilizer. The IAAC, DFO and the Fish and Fish Habitat Protection Program should ensure that the potash ore is tested for heavy metals, fluoride, radium and selenium that are toxic to aquatic organisms and determine necessary mitigation measures.

The project should not proceed until the IAAC has made a ruling on project designation, the SACC has approved a credible plan that describes how the project will achieve net- zero emissions by 2050, the DFO has determined the risk to fish and fish habitat and mitigation measures for toxic brine spills, the DFO has ensured that there are no toxic substances in the fertilizer that would leach into fish bearing waterways, and the Government of Canada has ensured that Crown led Section 35 Indigenous consultation has been implemented.

Aboriginal Consultation and Accommodation - Updated Guidelines for Federal Officials to Fulfill the Duty to Consult - March 2011 states,

"*A whole of government approach for Aboriginal consultation will be used in the regulatory review process for major natural resource projects. Consultation will be integrated into environmental assessment and regulatory approval processes. To assist in this approach, each major project will have a Crown consultation coordinator, who will develop and use a consultation plan to integrate the activities of all departments throughout the environmental assessment and regulatory processes*.

Coordination between the relevant federal departments and agencies is essential to ensure that the Crown is responsive and able to relate effectively with the Aboriginal groups involved. Limitations on the mandate of any one department, agency or other federal entity will not limit what is required of the whole Crown in the circumstances."

Some of the government agencies and departments required to engage in ensuring the Crown led Section 35 consultation occurs include the IAAC, DFO, Natural Resources Canada (NRCAN), Environment and Climate Change Canada (ECCC), and the Aboriginal Affairs and Northern Development Canada (AANDC).

There appears to be a deliberate strategy of omission by the proponent to avoid IAAC, ECCC, NRCAN, AACDC, TC, SACC, DFO, CN, CP, MB Hydro, Manitoba Infrastructure and municipal oversight and approval for pipeline crossings of infrastructure and waterways and impacts of project wells. The PADCOM EAP discusses environmental impacts within the processing plant boundaries and omits the potential environmental impacts from all the injection, withdrawal wells and brine disposal wells, brine pipelines and aquifer water pipelines that must be built over the 212 square mile project area.

The PADCOM EAP makes this statement;

"*PADCOM's small pod solution mine is not expected to impact the exercise of Indigenous or Treaty Rights. The project site is private land and only for the purpose of the project, there is a negligible impact on vegetation and wildlife populations and there will be no impact on fish or fish habitat*."

This statement demonstrates the proponent's strategy to limit the scope of the EAP to the private land for the processing plant and ignore the 212 square miles of public and Crown land that will be eventually affected.

An agreement has been made with PADCOM to share 5% of the net profit to be shared with Local First Nation communities and the Manitoba Métis Federation. However no broad-based Crown led Section 35 Indigenous consultation has occurred as required by the Canadian constitution and the Impact Assessment Act.

Attached is the Manitoba Public Registry 6126.00 submission from What the Frack Manitoba.

This deliberate avoidance by the proponent of regulatory, government oversight and required approvals by affected industries and avoidance of Crown led Section 35 Indigenous consultation must not be allowed. It should not fall upon an external public group to bring these issues forward. There is a systemic problem in the approvals process for a project to have advanced to this stage without proper notification by the proponent of the federal regulatory bodies about potential environmental impacts under federal jurisdiction. This problem must be addressed by the appropriate federal authorities in consultation with the Manitoba Licensing and Approvals Branch and the provincial government.

Sincerely,
<Original signed by>

Dennis LeNeveu
On Behalf of What the Frack Manitoba

Comments on PADCOM Potash Mine EAP Manitoba Environmental Assessment and Licensing Public Registry 6126.00

by
D.M. LeNeveu M.Sc. (biophysics)
Nov. 14, 2021

On Behalf of What the Frack Manitoba

1. Introduction

The PADCOM potash mining project is massive in scale extending over 212 square miles (54,900 hectares) along the western portion of the Assiniboine River Valley in southwest Manitoba near the border with Saskatchewan. The projected project lifetime is over one hundred years. About 250,000 tonnes of potash are to be produced per year by a solution mining method. The potential for environmental detriment and significant greenhouse gas emissions far beyond the 2050 target for net zero emissions is very large. The necessary extensive pipeline network to convey hot potash brine to the processing plant from potash recovery wells and waste brine to disposal wells is not included in the PADCOM EAP. The environmental detriment from potential brine spills from the pipelines over the large project area is not discussed. The PADCOM EAP for the potash solution mining project in southwest Manitoba along the Assiniboine River Valley is deficient in many aspects.

- The EAP states that no surface pipelines would be used implying all the pipelines to convey hot water, recovered brine and brine disposal would be buried. The location, number of such pipelines and landowner agreements for the pipelines over the approximately 212 square miles of project area is not mentioned.
- The total greenhouse gas (GHG) per year that would be emitted from the propane dryer that is to be used for potash drying is not given directly.
- The energy required to cool hot potash brine to crystallize out the KCL (potash) and then reheat the brine for disposal is not given.
- The CO2 emissions are not given from diesel generators that could be used for heating and cooling the brine.
- The total energy required to heat the aquifer water to 85 C to recover potash is not given.
- The potential GHG from heating water to recover potash if diesel generators are used is not given.
- Leak detection and automatic shutdown for the hot water and brine pipelines is not discussed.
- Potential pollution of surface waters, domestic and irrigation wells, crop and pasture land, and fish habitat from pipeline brine spills is not evaluated.
- Leakage to surface aquifers from the potash withdrawal and disposal wells is not considered. In the original mining proposal by Canamax Resources in 1989 the ground around the potash wells was to be frozen to prevent leakage to potable aquifers.[4]
- Brine spills and leaks are considered only within the plant site area. Potential brine leakage from the pipelines necessary to convey brine throughout the 212 sq. mile project area is not discussed. This is a major omission from the EAP.
- The yearly total draw on the Hatfield Valley Aquifer to supply hot water for potash ore dissolution is not given.

- The Hatfield Valley Aquifer in Saskatchewan is heavily used primarily by the potash industry. No attempt is made to determine the sustainable withdrawal on the Hatfield Valley Aquifer from all uses including the additional use from the PADCOM potash mining.
- Toxic crude oil is to be used as dust suppressant and toxic octadecyl amine is to be used for anti-caking for the potash stockpile inside the processing plant. These toxins would enter the food chain and surface potable water courses when the potash is used for fertilizing. The risk of food chain and biological accumulation of these toxins is not evaluated.
- Use of non-toxic substitutes for dust suppressant and anti-caking of the potash is not investigated.
- The potash has not been analyzed for heavy metal, fluoride and selenium content.
- The potash stockpile in the processing plant could generate harmful levels of PM10 ad PM2.5 particulate. Ventilation measures to minimize particulate exposure to workers are not described nor are monitors to measure dust levels planned.
- The proponent has not communicated with the Impact Assessment Agency of Canada (IAAC) and with Strategic Assessment for Climate Change (SACC) as required under the IAAC guidelines and under Part E of the Information and Management of Time Limits Regulations SOR/2019-283 with respect to potential adverse effects in areas of federal jurisdiction and with respect to the GHG emissions associated with the project.[1,2,3]
- The IAAC, CP Rail, CN Rail have not been notified and permission obtained for PADCOM pipeline crossings of federally regulated railways as required under the Canada Railway Safety Act Standards Respecting Pipeline Crossing Under Railways.[5]
- The IAAC and Manitoba Hydro have not been notified and permission obtained for the PADCOM pipeline crossings of the Birtle interprovincial transmission line as required by the Canada Energy Regulator Act. [6]
- The proponent has identified the PADCOM pipeline crossings of provincial roads and has not notified and obtained permission from Manitoba Infrastructure for the crossing of the provincial roads.
- The proponent has not identified the municipal roads to be crossed by the PADCOM pipelines and obtained permission from the municipalities.
- The proponent has not communicated with the IAAC on any adverse impact the project may have on the rights of the Indigenous peoples of Canada recognized and affirmed by Section 35 of the Constitution Act, 1982.[1]
- The measures to be taken as specified by the Environment Act for a class 3 development are not determined.

These deficiencies are discussed in more detail below.

2. Manitoba Class 3 Project

Under the Environment Act Regulations of Manitoba potash mining and milling is a class three development. The Minister may convene public hearing under that Clean Environment Commission (CEC) for a class three development. The Act states,

"*where the minister receives objections with respect to a proposed development and reasons for the objections, the minister may, within such time as may be set out in the regulations, cause the commission to hold public hearings thereon; but if the minister decides not to hold public hearings the minister shall provide the objectors with written reasons therefore and shall cause a copy of those reasons to be filed in the public registry*."

Reasons for objections not to hold public hearings are given in this submission. If hearings are not held I request the minister provide written reasons why the hearings are not being held as required under the Environment Act. The Manitoba Approvals and Licensing process should not proceed until the minster has made a decision on the CEC Hearings or has provided written reasons as to why hearings are not being held. Considering that the original proposal for a potash mine at Harrowby by Canamax Resources in 1989 required a CEC Hearings it is inconceivable that the PADCOM project would not require CEC hearings.[4]

The Environment Act states;

"*For the purpose of assessing a proposed Class 3 development, the minister, in consultation with the departments may do any or all of the following things:*
(a) require from the proponent additional relevant information"

The additional relevant information in the form of a full environmental impact statement should include all information documented as missing in this and other submissions to the Manitoba approvals process.

3. Effects in Areas of Federal Jurisdiction

Potential effects in areas of federal jurisdiction include,

- adverse effects to fish and fish habitat such as effects of hot brine spills into the Assiniboine River and Qu'Appelle River watershed,
- changes to the water levels of the Assiniboine River, a navigable waterway under the Canadian Navigable Water Act due to the large water withdrawal from the Hatfield Valley aquifer,
- GHG emissions that do not conform to the requirements of Environment and Climate Change Canada (ECCC) and the SACC to provide a credible plan that describes how the project will achieve net- zero emissions by 2050.[2]

The proponent is obligated to contact the IAAC about federally regulated issues to determine if the project should be designated. The proponent must supply information to the IAAC that is missing in the EAP such as the extent and locations the brine and hot water pipelines to be built over the duration of the project that may impact fisheries from spills, information on GHG implications, information on water levels, and any other information the IAAC may need to asses the project impacts within federal jurisdiction. The Manitoba Approvals and Licensing process should not proceed until the IAAC has made a ruling on project designation and the SACC has approved a credible plan that describes how the project will achieve net- zero emissions by 2050.

4. Amount of Water Required to Dissolve the Potash

According to SYSCAD a plant simulation company[7]

"*The solubility of KCl in Potash facilities is a function of temperature and is also influenced by the presence of other species in solution, most importantly NaCl and MgCl2. The curve for KCl solubility as a single species is not valid when other species are present, in this case the saturated value for KCl is lower than the saturated for the solution where only KCl is present*."

A paper by R. J. Bodnar et. al (1997) gives a relationship for the solubility, *S*, in wt% as a function of temperature, *T,* (C) and weight % MgCl2 (*M*) for a NaCl to KCl mixture ratio of 1 to 1.[8] The ore for

PADCOM is 50% KCl corresponding to a ratio of about of 1 to 1 NaCl to KCl for very little magnesium or other species in the potash ore.

From Bodnar et al. (1997),

$$S = a+bM^{1.5} + cT, \quad (1)$$

where a = 24.56279446, b= -0.14535233 and c = 0.165011651.

The temperature to the extraction wells is given in Table 3 of the PADCOM EAP to be 85C

Using equation (1), the solubility of the brine at 85C with no magnesium (MgCl) would be 38.6 wt%
With 5% MgCl the brine solubility would be 37.8 wt%.

Thirty-eight weight percent brine at a ratio of 1 to 1 NaCl to KCl by weight would require 815,750 tonnes of water to dissolve 250,000 tonnes of KCl separated from the brine mixture. At a density of one tonne per cubic meter at least 815,750 cubic meters of water would be required per year from the aquifer. Not all the water injected will be recovered in the saturated brine. The solubility limit (saturation) would not be achieved in practice. Therefore the 3260 litres of water per tonne of KCL produced is the minimum theoretical upper bound. This theoretical upper bound on the water required based on solubility gives a ratio of 3.26 tonnes (3260 litres) of water per tonne of potash produced. The amount of water actually used could be much greater due to incomplete saturation and water loss to the formation. The amount of water drawn from the aquifer per year for 250,000 tonnes of KCl production would be in excess of 815,000 cubic meters per year.

Section 2.8.3 of the EAP states

"*Fresh water for the mine is limited to the water used to produce the brine that remains in the open mined out area. Our calculations indicate this is a maximum of 0.5 tonnes of water (132 gallons) per tonne of product. The actual consumption will be less than this as the mine matures, and closure occurs*."

The 0.5 tonnes (500 litres) of water per tonne of KCL produced contradicts the maximum solubility of a predominately KCl and NaCl brine in water at a weight ratio of 1 to 1 (50% KCL in the ore) in water. At 0.5 tonnes of water per tonnes of potash produced there would be more potassium ore to dissolve than water by weight. To further underscore the underestimate of water required in the EAP, below is a graph of the solubility of pure KCl and pure NaCl is water as a function of temperature. According to the graph 420 grams of pure KCL requires 1000 litres of water or 1 kg of water to dissolve to saturation. One tonne of pure KCl would require 2.38 tonnes of water to dissolve to the solubility limit, far greater than the 0.5 tonnes in specified in the EAP.

This evidence establishes that the estimates in the EAP of 0.5 tonnes of water required to produce one tonne of potash are inaccurate and far below what would actually be required.

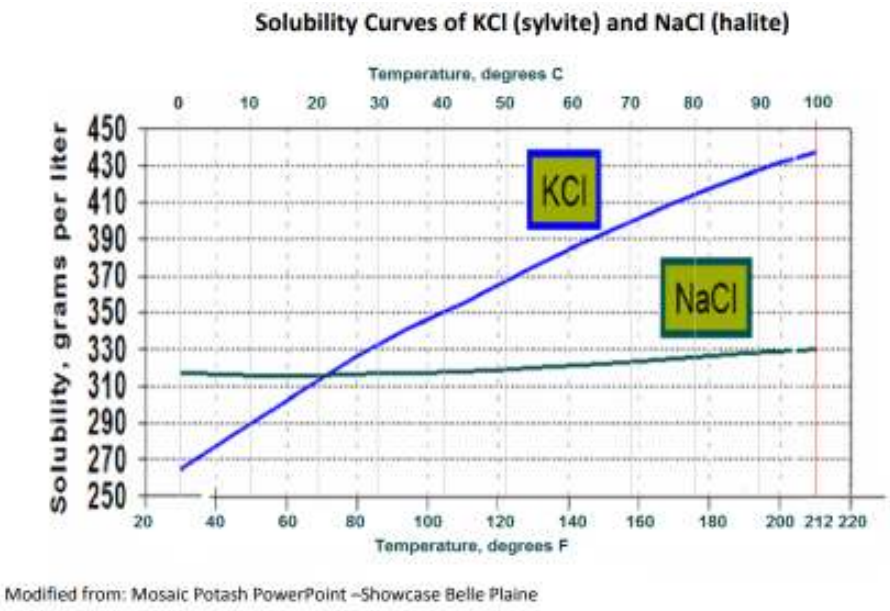

Figure 1. Solubility curves for KCL and NaCL[9]

Table 3 of the EAP gives the flow of water to wells at 5.7 cubic meters per minute for 250,000 tonnes of potash production per year. The available hours per year is given in Table 3 as 8760 (24 hours per day for 365 days per year). The rate of 5.7 cubic metres per minute gives 3 million cubic meters per year for 250, 000 tonnes of potash production. From Table 3 values 12 tonnes of water per tonne of potash produced would be required (not 0.5 tonnes).

The PADCOM EAP states typical Saskatchewan potash mines currently use 900-5000 gallons (4092–22,730 litres) of water per tonne of potash produced. This is 4 to 22 tonnes of water per tonne of potash which is the same range as for the PADCOM Project. The estimates of reduction in water usage for PADCOM process are exaggerated.

5. Aquifer Sustainability

The Assiniboine West Watershed District of southwest Manitoba[10] as specified under the Manitoba Watershed Districts Act[12] and the Saskatchewan Water Security Agency[11] must be consulted to review this project and determine the sustainability of this large draw of water from the Hatfield Valley Aquifer and all other interconnected groundwater resources. The city of Brandon, the town of St. Lazare and other nearby towns must be consulted regarding the potential harm to their drinking water supply from brine spills. Regional groundwater modelling must be done to evaluate the sustainability of the aquifer system and the effect of all the accumulated withdrawals on water resources in the area and on the water levels in the Assiniboine River pertaining to the Navigable Water Act.

6. GHG emissions

The executive summary of the EAP states;

"*Under the current technology, the CO2 per tonne of produced potash ranges from 0.15 to almost 1 tonne per tonne of product based on the Beechy technology an example of 0.25 tonnes of CO2 per tonne of produced potash the technology has the potential to reduce Canada's GHG production by 5,000,000 tonnes*

per year, about 0.5% per year based on current production. As 50% of the world's fertilizers are mineral based and in Saskatchewan, where some of the largest potash mines in the world exist, they typically emit 330-2000 lbs (149.7 – 907.1 kg) C02 for each tonne of potash they produce.

The PADCOM project predicts an emission of. 21 oz (596 g) of CO2 per 1 tonne of produced."

However, table 10 and section 6.1.6 of the EAP gives the CO2 emission as 0.12 tonnes of CO2 per tonne (t) of potash. The EAP gives contradictory information on GHG emission rates. Which value is to be used 0.25 tonnes of CO2, 0.121 tonnes of CO2 or 596 g of CO2 per tonne of potash? Table 10 shows that the factor of 0.12 t CO2 per tonne of product applies to natural gas that would be used for the processing plant. The EAP states;

"*Manitoba Hydro provides gas distribution in the province. They have determined that there is not enough supply at Russell, Manitoba, so a significant capital expenditure is required to supply the mine. The rotary dryer for the initial phase will operate on propane. A decision has to be made for the next expansion, to use some gas or to convert entirely to electricity as an energy source.*"

Based on the natural gas factor of 0.12 t CO2 per tonne of product, eventual production of 250,000 tonnes per year would give 30 kilotonnes (kt) CO2 per year. Propane produces about 1.19 times the GHG per unit of heat energy than natural gas.[13] For propane based heating that would be done initially and very likely for some time after, the GHG from the processing plant would be 35.7 kt CO2.

The Section 2.7 of the EAP states;

"*The heated brine, along with a portion of the production brine that has been reheated, is pumped back to the mine feed injection wells.* At *100,000 tpa the flow to the processing site will be 2 cubic meters per minute at about 90 degrees C*."

A brine flow per year of 2 cubic meters per minute gives one million cubic meters per year for a potash production rate of 100,000 tones per year (tpa). At 250,000 tpa, production the brine flow would be 2.5 million cubic meters per year. The aquifer water flow to the wells from table 3 of the EAP, 5.7 m^3/min for a total of 3 million cubic meters per year from table 3, would be an underestimate since considerable injected water would not be recovered in the brine delivered to the plant.

The energy required to reheat the brine is not quantified. The brine in the return pipelines, the brine to the disposal wells and the aquifer water in pipelines to the injection wells must be heated resulting in either electrical energy displaced from GHG mitigation or direct GHG emitted from diesel generators for the heat. The energy required for these operations has not been quantified.

The EAP gives heat required for heating the ore as of the order of 0.5 to 1 gigajoule per hour for a 1600 m potash horizontal recovery drill leg. PADCOM has an application to Manitoba Hydro to access power for the Project site. A 1.0 megawatt transmission line is required. If installation is delayed, the EAP states the project would proceed using a diesel generator until installation can be completed by Manitoba Hydro. The diesel generation would produce an un-quantified amount of GHG. The number of horizontal drill recovery legs required per year is not given. One gigajoule per hour would require 8760 gigajoules of energy per year. The CO2 emission per gigajoule of diesel fuel is 74.1 kg CO2/GJ[14] Thus the CO2 yearly emissions for diesel generation would be 649 tonnes of CO2 for heating the ore for one injection well.

Table 4 of the EAP shows that the volume of ore removed per well is 1600m x 800m x 0.84 m or 1,075,200 cubic meters. At an ore density of 2.0 t/m^3 from table 4, 2,150,400 tonnes of ore would be removed from one well. Table 4 gives a value of 2,000,000 tonnes which after rounding confirms this calculation. At 50% potash in the ore, less than one well per year would be required for a production of 250,000 tonnes potash per year. This appears to be a very optimistic recovery estimate.

Table 3 of the EAP gives the flow of water to wells at 5.7 cubic meters per minute for 250,000 tonnes of potash production per year at a temperature of 85C. Assuming the water in the aquifer is at an average of 10 C, using a specific heat capacity of water of 4.0 kJ/kg/K (at 40 C) [14] and the density of water of 1.0 t/m^3, the energy required to raise the temperature of the water from the aquifer to supply the wells to 85C per year is 898,776 GJ. At 74.1 kg CO2 per GJ,[14] diesel heating would generate 66.6 kt of CO2. The large energy and potential GHG emissions for heating of aquifer water has been omitted from the PADCOM EAP.

The brine in the processing plant is likely cooled to 0 C[9] to crystallize the KCl. The specific heat capacity of saturated brine is about 3.3 kJ/kg/K[16]. To cool 2.5 million cubic meters of brine per year from 85 C to 0 C for a brine density of 1.2 tonnes per cubic meter for about 200 days would require 461,095 GJ of energy. Two hundred days is used considering that cooling would not be required in winter. To heat the brine back up to 85 C for to keep the remaining salt in solution for disposal would require about 841,500 GJ energy for 365 days of heating. The total energy for cooling and reheating the brine at the processing plant would be 1,302,595 GJ. The emissions from diesel generation for the energy required would be 96.5 kt CO2. The emissions from cooling and reheating the brine would be far greater than the emissions calculated for the processing plant for propane heating. It appears, therefore, the propane heating emissions of 35.7 kt CO2 apply only to the drying of the potash.

The EAP does not specify where the heat will be supplied to the aquifer water for the extractions wells. There will be heat energy required to replace heat loss in the water pipes depending on where the water is heated.

Heat will also be required to prevent KCl from precipitating as the brine cools in the pipeline returning brine from the recovery wells to the processing plant. The heat loss for a buried jacketed 6 inch HPDE pipe would be 39 W/m.[17] The heat required to replace the cooling loss per kilometer of pipeline per year would be about 1230 GJ. If diesel fuel were used for this energy the CO2 released at 74.1 kg CO2 per GJ would be 91 tonnes. As the project advances more than 10 km of pipeline would be required releasing 910 tonnes which is relatively small compared to the potential GHG for heating and cooling brine and aquifer water.

The largest amount of energy would be required for heating the aquifer water with the potential releases of 66.6 kt of CO2 per year and cooling and reheating the brine at 96.5 kt of CO2 per year. The third largest emission would be from propane fuelled drying of the potash at 35.7 kt for a total of 200 kt per year. More than 10 kt CO2 emissions requires reporting to Statistics Canada and Environment and Climate Change Canada (ECCC)[18] Manitoba considers emission of more than 50 kt per year to be a large final emitter.[20] The largest final emitter in Manitoba in 2018 was the Koch fertilizer plant in Brandon at 771 kt CO2. According to 2018 data the PADCOM plant would rank as the fourth largest final emitter in the province.[20] This potential large GHG emission cannot be ignored.

The Impact Assessment Agency of Canada (IAAC) guidelines require a proponent to estimate any greenhouse gases (GHG) emissions associated with the project. The proponent must submit the EAP to the IAAC together with estimates of total GHG emissions.[21]

Section 2.9.2 of the PADCOM EAP states;

"*A decision has to be made for the next expansion, to use some gas or to convert entirely to electricity as an energy source (moving the mine to essentially zero carbon). This will require the installation of large heat pumps to cool the crystallizers and reheat the brine, to heat the building and potentially to dry the product.*"

This statement verifies that the energy to heat the aquifer water to 85 C for the injection wells has not been considered. This is in keeping with the strategy employed in the PADCOM EAP to consider only the processing plant and ignore all the potential adverse effects from the injection and withdrawal wells and hot water and brine pipelines over the very large 212 sq mile area outside the processing plant at Harrowby.

In conformance with the SACC requirements to provide a credible plan that describes how the project will achieve net- zero emissions by 2050, the licence conditions for the project should include a stipulation for a deadline to transition from propane to electrical heat pumps for drying the potash. Diesel generators should not be allowed for the large amount of energy required to heat the aquifer water, heat and cool brine and provide power for other plant needs. PADCOM should be required to build windmills to provide the large amount of power required for this mining operation in order to meet GHG targets for net zero emissions by 2020.

The intermittency of wind could be handled by increasing the indoor stockpiles of potash. The large elevation change along the banks of the Assiniboine River Valley could be used to pump and store water uphill and generate power using turbines in downhill return pipes at times of low wind. This is an ideal project to use renewable energy from wind so as not to diminish the available hydro power that could be used for transition away from fossil fuels. GHG emission mitigation strategies for this project should be implemented in conformance to Canadian Net Zero Emissions Accountability Act and the SACC guidelines.

7. Injection wells

One injection wells is documented in the processing plant area that would be used to control magnesium levels in the brine mine feed. The reason for control of magnesium levels is not given. This is another example of missing information in the EAP. It appears that magnesium, prior to treatment in the processing plant, must be removed from the ore as an undesirable component of the potash fertilizer.

The geological formation for brine disposal injection is not specified. The Cretaceous age Swan River Formation (or Manville) or the Devonian Winnipegosis Formation are given as possibilities. The research on the suitability of these formations to accept the large quantities of brine disposal should be done before the project is approved. The quantity of brine that must be disposed per year and locations of the brine disposal wells must be specified. The PADCOM EAP states in section 2.11 the PADCOM mine will inject 378.54 – 757.08 litres of brine per minute for a disposal well. According to section 2.7 of the EAP, 2.5 million cubic meters of brine would require disposal for 250,000 tonnes of potash production per year. Using a 500 litre of brine per minute disposal rate about10 disposal wells would be required. The formation can absorb only a certain amount of brine at a given site. More disposal wells would be required over time.

The number and location of such brine disposal wells must be given. A Theis solution should be carried out using the properties of the aquifer used for brine disposal to determine the pressure build up and feasibility of injection over the long term.[19] The pressure from brine injection should not exceed the fracture pressure for the aquifer caprock.

Safe brine injection rates must be established for the formations to prevent over pressurization. Any abandoned or active exploration or oil wells that penetrate to the brine injection formation wells, that could

act as upward conduits to potable aquifers for injected brine, must be identified and avoided. Considering that there are two active oil fields nearby the project area, the Manson and Birdtail, there will likely be numerous abandoned deep wells. These wells are typically sealed with cement only at the hydrocarbon pay depth. The open annuli around well casings and the interior of corroded casings are known to provide a route for pressure or buoyancy driven contaminants.[22]

As required in the CEC hearings for the Canamax original potash mine proposal of 1989, the ground around brine disposal and withdrawal wells should be frozen to prevent leakage to potable aquifers near the surface.

8. Leak Detection

At the Bethune solution potash mine in Saskatchewan, more than 100 km of brine water pipeline between wells and the processing plant are monitored for leak detection using fiber optics technology.[23] Such leak detection measures should be a licensing condition for the PADCOM Potash Mine.

Gradual leaks that would not be detected by a leak detection system could be more environmentally damaging in the long term than a large detected leak. Accurate real time volume measurements of the amount of brine entering the pipeline system and the amount leaving, together with an automated mass balance check that shuts down the pipelines when a volume discrepancy is recorded must be installed.

Groundwater and brine transport modelling for different leakage scenarios including a large spill and gradual ongoing undetected smaller leaks should be done to quantify the risk and detriment from leakage.

9. Toxins in the Potash

In the processing plant, crude oil at 2 litres per tonne of potash is to be used as a dust suppressant. Crude oil is known to contain carcinogens such as benzene and PAH's and other toxic organic compounds. A representative value for benzene content in crude oil is 0.52 weight%. [24] Thus 0.11 kg crude oil per tonne could result in 57.2 grams of benzene per tonne of potash or 57.2 parts per billion. The allowable concentration of benzene in water is 5 micrograms per litre or 5 parts per billion.[25] Clearly a non toxic substitute must be used for a dust suppressant.

Octadecyl amine is added to potash to prevent caking 0.11 kg per tonne of potash. According to the European Chemicals Agency octadecyl amine

" *may be fatal if swallowed and enters airways, is very toxic to aquatic life, is very toxic to aquatic life with long lasting effects, causes serious eye damage, may cause damage to organs through prolonged or repeated exposure and causes skin irritation.*" [26]

The extreme toxicity of octadecyl amine to aquatic organisms would violate the Fisheries Act under federal jurisdiction. The risk to the fisheries must be reported to the IAAC. Use of a non toxic anti-caking agent must be a licence condition for this project. Octadecyl amine should not be allowed.

Toxic heavy metals and selenium are often found in subsurface mineral deposits. Elevated levels of chromium and lead have been found in potash fertilizer in Bangladesh.[27] The conditions in the Bangladesh study may not be applicable to the PADCOM mine however the evidence from Bangladesh establishes that heavy metals can occur in potash. Ore samples from the PADCOM potash deposit must be analyzed for heavy metal, fluoride, radium and selenium content.

Hydrogen sulphide (H2S) contamination of potash ore has been reported in Saskatchewan.[27] The H2S develops as a result of the mining process. Organic material introduced from aquifer water that can be used as a food source by sulphate reducing bacteria that release H2S. The levels of H2S in the recovery brine should be monitored. One mitigation scheme that should be investigated is the removal of organic content from the aquifer water.

10. Exposure to Airborne Particulate

A potash stockpile in the processing plant could generate harmful levels of PM10 ad PM2.5 particulate. Ventilation design to minimize particulate exposure to workers and PM2.5 and PM10 and particulate level monitors should be specified in the EAP.

11. PADCOM Pipeline Crossings of Critical Infrastructure and Water Courses

The PADCOM EAP has omitted the critical infrastructure that the brine and hot water pipelines for the injection and recovery wells and the brine disposal wells. As shown in figure 3 of the EAP the project potash mining area covers 212 square mines where much critical infrastructure exists but has not been identified. The EAP deliberately omits the requirement for buried pipelines to convey hot water and brine over the entire mining area and does not show the eventual route of the required pipelines.

The map in figure 2 from the Birtle Transmission Line planning study illustrates some of the rail, road and transmission line infrastructure that would be affected by the PADCOM project.[28] A reproduction of figure 9 in the PADCOM EAP shown in figure 3 shows the extent of the potash resource with respect to infrastructure, and potential eventual brine pipeline crossings of rail, road and river crossings.

The Canada Energy Regulator Act states,

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

Permission must be obtained from MB Hydro for PADCOM pipelines to cross the Birtle Transmission Line.

An application specifying the engineering drawings and plans for the pipeline crossing of the rail lines must be submitted to CN and CP and approval obtained. Manitoba Infrastructure and relevant local municipalities must be notified of all eventual road crossings by the PADCOM pipelines and permission obtained.

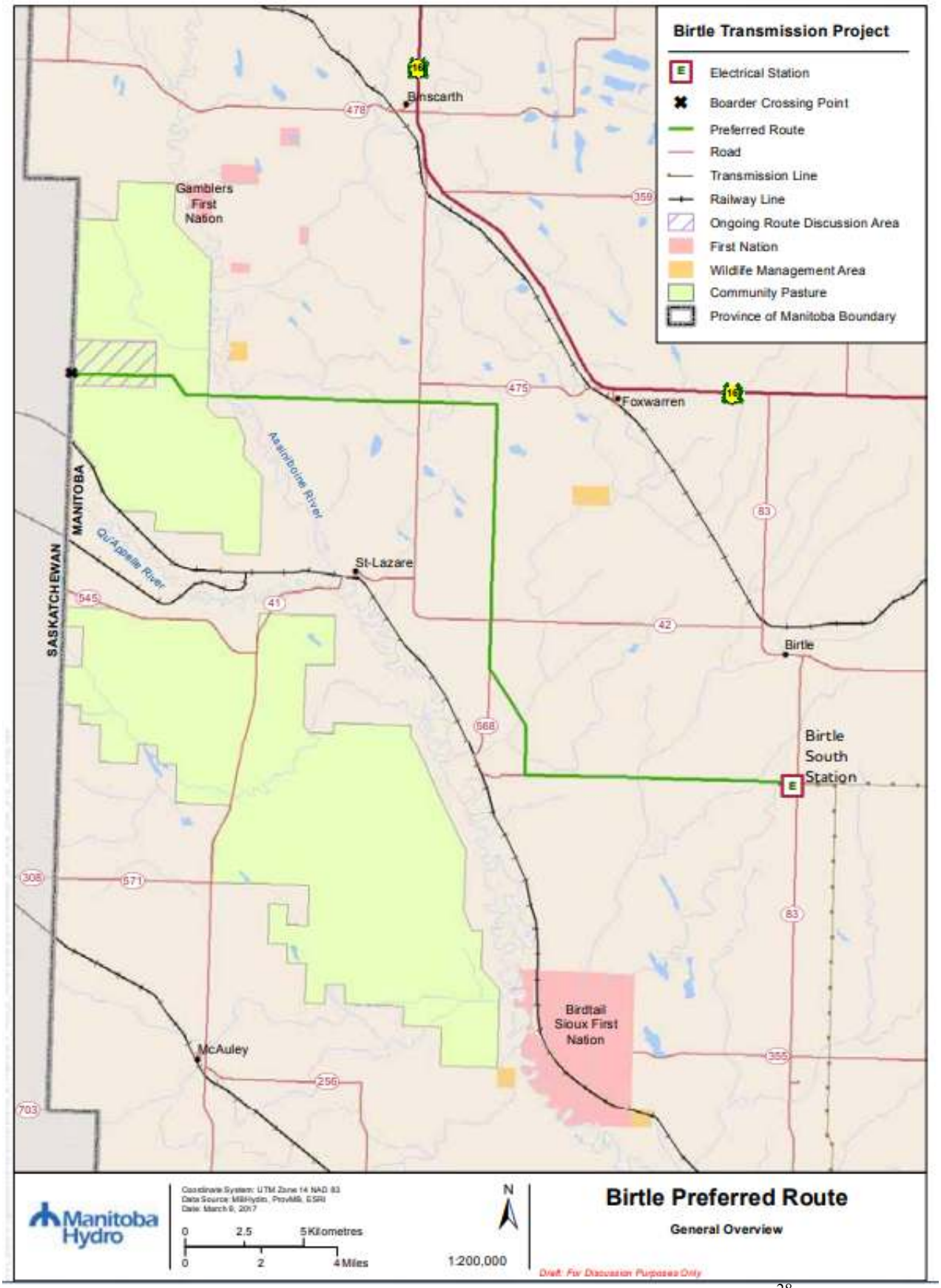

Figure 2. Some of the critical infrastructure in the PADCOM potash mining area [28]

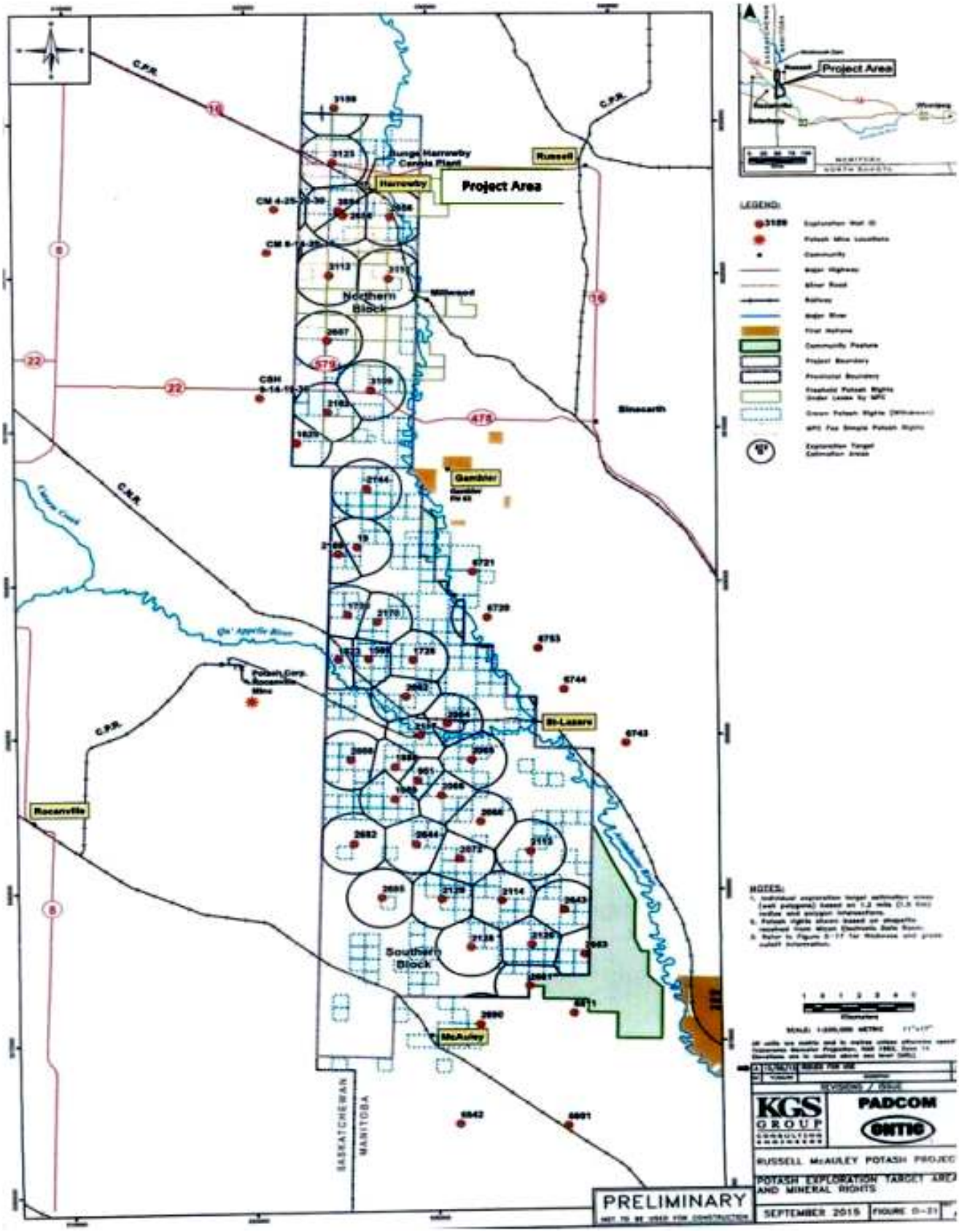

Figure 3. Historical drill holes shown by red dots illustrating the extent of the PADCOM potash resource. Infrastructure and road, rail and river crossings of eventual brine pipelines are shown.

Many rivers and streams must be eventually crossed by the brine pipelines including the Qu'Appelle River. A brine spill in any of these rivers and streams would adversely affect fish and Fish habitat. All fish bearing water courses that must be eventually crossed by PADCOM brine pipelines must be identified and the Fisheries and Oceans Canada (DFO) and the IAAC notified of these crossings. Mitigation measures to minimize the risk of brine spills and detriment to fish habitat in consultation with the DFO and the Fish and Fish Habitat Protection Program under the Fisheries Act and Species at Risk Act must be implemented.[28]

There are 12 units of The Upper Assiniboine Wildlife Management Area stretching from north of St. Lazare, south to Miniota and southeast to the Oak Lake area. According to the Manitoba Use of Wildlife Lands Regulation, M.R. 77/99;[30]

"*No person shall engage in (c) quarry mineral exploration or (d) any other activity that significantly and adversely affects habitat*."

The project infringement on these wildlife management areas must be determined and avoided.

There appears to be a deliberate strategy of omission by the proponent to avoid DFO, CN, CP, MB Hydro, Manitoba Infrastructure and municipal oversight and approval for pipeline crossings. This avoidance of regulatory, government oversight and required approvals by affected industries must not be allowed. The Manitoba Approval and Licensing Branch must ensure all the proper federal regulatory authorities, including the DFO, the IAAC, SACC, CN, CP and MB Hydro have been informed about this project and supplied with additional information required to assess the risk to the environment and infrastructure and to specify necessary mitigation measures for this project.

12. First Nation Consultation

Section 4.3 of the PADCOM EAP states;

"*PADCOM's small pod solution mine is not expected to impact the exercise of Indigenous or Treaty Rights. The project site is private land and only for the purpose of the project, there is a negligible impact on vegetation and wildlife populations and there will be no impact on fish or fish habitat*."

Spills from the brine and hot water pipelines over the very large 212 square mile mine area could affect fish and fish habitat and wet lands used by migratory birds and moose. Land based spills could result in soil salinity that could adversely affect all local wildlife. PADCOM has entered in agreements with Gambler and Birdtail Sioux First Nations however it appears no grass roots community based consultation under the auspices of the Crown was undertaken with the First Nations as required according to Section 35 of the Constitution Act**.** Traditional land of First Nations and Métis could be adversely affected by this project.

An agreement has been made with PADCOM to share 5% of the net profit to be shared with Local First Nation communities and the Manitoba Métis Federation. The Birtle Transmission Project Métis Land Use and Occupancy Study identified Métis traditional harvesting areas such as the Spy-Hill Ellice Community Pasture north west of St. Lazare that are in the PADCOM project area.[32] There is no mention of consultation with the Métis concerning their traditional harvesting areas within the 212 square miles of the PADCOM project area such as the Spy-Hill community pasture. Many Métis landowners in the PADCOM project area are identified in the Birtle Transmission Line Report with whom there is no record of communication or consultation. A community based Crown led Section 35 consultation should be conducted before this project

proceeds. The Section 35 consultation should communicate with all Métis landowners in the area. Such landowners would be directly affected by injection and withdrawal wells and pipelines on their lands.

The Métis people in the area should be consulted at the community level concerning traditional harvesting areas such as the Spy-Hill Ellice Community Pasture. First Nations in the area should be consulted at the community level about the traditional lands in that could be affected by the PADCOM project.

13. Broad Based General Public Consultation in Nearby Communities

The only public consultation mentioned in the PADCOM EAP was this statement;

"*PADCOM has a certificate of approval from the Tri-Roads Planning district to proceed with this project, which was obtained through a public hearing where participants were invited, and the public notified through local advertising*."

The Tri-Roads Planning District does not contain the Southern Block PADCOM development area or important rural towns such as St. Lazare and Miniota. Well publicized community meetings must be held to cover the entire north and south block areas in St. Lazare, Miniota, Brandon and other nearby towns. The community meetings must provide comprehensive information on the project and explain how the risk of brine contamination of groundwater, local drinking water supplies and agricultural land, would be mitigated. Brandon must be involved because the city's drinking water is sourced from the Assiniboine River which could be affected by a brine spill.

14. Recommendations

Recommendations based on the information and evidence provided here are;

- The Manitoba Licensing and Approval Process should not proceed until the proponent consults with the IAAC and the SACC on a plan for the PADCOM project to achieve net- zero emissions by 2050.[1,2]
- Windmills should be used for the large energy consumption for this project as part of the net zero emissions plan.
- Aquifer water storage atop the Assiniboine Valley should be implemented to provide energy to the Project at times of slack wind.
- Plans for mitigation of potential adverse effects within federal jurisdiction including prevention of fish habitat, agricultural land and groundwater detriment from brine spills should be formulated in consultation with experts from the IAAC and DFO.
- Real time detection, volume balance measurements with automatic brine pipeline shut down should be installed.
- Non toxic anti-caking and dust suppressants should be required as a mandatory licensing condition to replace crude oil and octadecyl amine.
- Laboratory testing for heavy metal, selenium and radium concentrations in the potash ore must be done.
- Toxic species in the potash ore must be removed.
- Air monitors should be installed in the processing plant where the potash stockpile is located, to measure PM2.5 and PM10 particulate levels.
- Ventilation should be provided in the processing plant to keep the PM2.5 and PM10 levels below allowed limits.

- Organic content in the aquifer water supplied to the hot water injection wells must be removed to prevent souring of the potash ore body.
- Brine disposal injection wells must not be drilled within an injection pressure envelope of any abandoned or active wells that penetrate to the injection depth.
- The ground around the potash wells should be frozen to prevent brine leakage to potable aquifers.
- The project should not proceed without scientific evidence that the water withdrawal for the project does not exceed the sustainable limit for the Hatfield Valley Aquifer and other interconnected ground water resources.
- A comprehensive interprovincial water modeling study for the Hatfield Valley Aquifer and interconnected groundwater resources must be done that incorporates all groundwater users of the aquifer system in both Manitoba and Saskatchewan.
- The Assiniboine West Watershed District of southwest Manitoba[10] under the Manitoba Watershed Districts Act[12] and the Saskatchewan Water Security Agency[11] must be consulted to review this project and determine the sustainability of the large draw of water from the Hatfield Valley aquifer and all other interconnected groundwater resources.
- Manitoba Hydro must be notified and permission obtained for the eventual PADCOM pipeline crossings of the Birtle transmission line
- CN and CP rail must be notified and permission obtained for the eventual PADCOM crossings of the railway lines.
- The provincial and municipal road crossing of the PADCOM pipelines must be identified and permission obtained from Manitoba Infrastructure and the relevant Municipalities.
- The road, rail and hydro line permissions must be obtained before the licensing approvals process is allowed to proceed as the project viability depends on these crossings and on any restrictions imposed regarding the crossings.
- Restrictions and conditions imposed on the road rail and hydro line crossing must be included in the EAP and measures to fulfill these conditions must be documented.
- All fish bearing water courses that must be eventually crossed by PADCOM brine pipelines must be identified and the DFO and the IAAC notified of these crossings.
- The project infringement on the twelve units of the Upper Assiniboine Wildlife Management Area must be determined and avoided.
- Mitigation measures to minimize the risk of brine spills and detriment to fish habitat in consultation with the DOF and Fish Habitat Protection Program must be implemented.
- Regional groundwater modelling must be done to evaluate the sustainability of the aquifer system and the effect of all the accumulated withdrawals on water resources in the area and on the water levels in the Assiniboine River pertaining to the Navigable Water Act.
- Brine transport modelling for different leakage scenarios including a large spill and gradual ongoing undetected smaller leaks should be done to quantify the risk and detriment from leakage.
- The Manitoba Approval and Licensing Branch must ensure the all proper federal regulatory authorities, including the DFO, the IAAC, SACC, CN, CP and MB Hydro have been informed about this project and supplied with additional information required to assess the risk to the environment and infrastructure and to specify necessary mitigation measures for this project.
- The city of Brandon, the town of St. Lazare and other nearby towns and communities must be consulted regarding the potential harm to their drinking water supply from brine spills.
- In addition to the agreements made with First Nations and Métis in the area, formal broad-based community based Section 35 consultation must be undertaken by the Crown with all the First Nations people in the project area and with the Métis in the communities of St. Lazare and nearby.

- Section 35 consultations must be completed before the Manitoba licensing approval process can proceed.
- Broad based public communications and meetings regarding the project must be held in the surrounding communities including St. Lazare, Miniota and Brandon.
- Considering the extensive missing information in the PADCOM EAP, the large area affected by the project and that CEC hearings were held for the original Canamax potash mine at Harrowby, CEC Hearings should be held for the current PADCOM potash mine project.
- In the event that the minster decides CEC hearings will not be held the Minister must give written reasons for the decision.
- As specified under the Environment Act the Minister and/or the Direct of Environmental Approvals should require additional project information in the form of a full environmental impact statement from the proponent. The public and the provincial Technical Advisory committee, the CEC if convened, the IAAC, the SACC and the DFO must be allowed to comment on new information provided to fill the missing information gaps.

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