Review of the KGHM Ajax Mine Environmental Impact Statement

Submitted to:

Coalition of Concerned Citizens /

Kamloops Physicians for a Healthy Environment Society

Kamloops, British Columbia

Submitted by:

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March 17, 2016

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Table of Contents

Purpose of this Document

Large development projects such as the KGHM Ajax Mine (KAM) have well-characterized effects on biophysical, social and economic environments. They also have the potential to exert a strong influence on health in nearby communities. Many, although not all, of these health effects are secondary to direct changes caused by the project—for example, the placement of project facilities may alter wildlife patterns, changing availability of subsistence foods for local residents. However, the health changes themselves are often a lens through which affected stakeholders view the benefits or costs of the project. As such, appropriately framing project impacts from a community health perspective can be essential in helping all stakeholders understand the trade-offs implicit in the project, through common valued components.

This report has been prepared by Dr. Ken Froese of GatePost Risk Analysis, Calgary, Alberta and Erica Westwood, Ame-Lia Tamburrini, and Marla Orenstein of Habitat Health Impact Consulting, Calgary, Alberta. It is an independent review of the EIS report in terms of the appropriateness of its approach to information presentation, analysis and interpretation of results. The purpose of this report is to provide information to the Coalition of Concerned Citizens / Kamloops Physicians for a Healthy Environment Society (KPHES) about the extent to which the KAM EIS appropriately examines the potential effects of the project on community health outcomes.

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Summary of Main Points

The KGHM Ajax Mine (KAM) Project Application is an extensive regulatory document, meant to demonstrate that the Project plan, its technical design, and operational mitigations will cause minimal or no adverse impacts on valued components (VCs) in the surrounding socio-economic, human, and ecological environments.

The approach taken in the EIS to assessing Project impacts on human health has both strengths and weaknesses. On the 'plus' side, the document attempts to address health in a broad and holistic manner, recognizing the importance of a variety of health outcomes and health determinants. Many of the chapters and sub-chapters begin with a brief, holistic discussion that positions issues relative to key health supports.

However, there are many aspects of the assessment that are deficient, potentially misleading, or incorrect and that undermine the overall assertion that the health of local populations will not be meaningfully impacted.

Some of the main weaknesses include the following:

- Relevant data was not presented in a clear manner. In many cases, data were distributed among several chapters, appendices, and sub-appendices. In addition, there were inconsistencies with data groupings, statistics used in different areas, or lack of sufficient detail to confirm the presented analysis and conclusions. There were also inconsistencies in how the terms of Project Case, Application Case, and Future Case were used among the different assessment areas, making a cross-topic data comparison difficult.
- Some emissions and modeling parameters in the air quality assessment may be unduly biased, specifically with regard to parameters that may underestimate the Project contribution of dust and particulate matter (e.g. tailings beach area and associated seasonal and mitigation assumptions). In order for the EIS to be defensible, these parameters and assumptions must be realistic, as the resulting ground level concentrations of PM and metals, and the mass of metals deposited on soils and surface water are carried through all subsequent characterizations of water quality and human and ecological risks.
- Assuming that the data that went into the HHRA is reasonably representative of an upper-bound operational year, the estimated overall human exposures and resulting hazard quotients indicate that the Project should result in relatively small increases in overall exposures to metals. We concur that for most projected metal contamination arising from the construction and operation of the mine, risks of adverse toxicity-based health effects are very low. The greatest uncertainty and greatest risks are associated with the particulate matter modeling and effects evaluation.
- The HHRA as a fundamental "proof" of the safety of the Project is not in itself a convincing argument. A review of HHRAs from 2000 through 2012 in the Alberta oil sands concluded that despite substantially increased technical sophistication and effort in producing a strong, scientifically defensible risk assessment, people's fundamental concerns about their health and surrounding environment remained the same [1].
- A major shortcoming of the EIS is that the evaluation of Project-related health impacts as a whole does not address the role and influence of psycho-social factors in health. An example is risk perception: The influence of the perception of risk on various determinants of health has been studied extensively since Paul Slovic's discussion of the issue [2]. Risk perception can be as harmful as "real" risks [3]. It includes beliefs and perceptions of negative effects or their likelihood, and can be related in this case to concern about metal

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[1] Intrinsik (2012) South Athabasca Oil Sands Environmental Impact Assessments Review. Intrinsik Environmental Sciences Inc., Nichols Applied Management Inc., and Golder Associates. Completed on behalf of Alberta Environment and Sustainable Resources Development.

[2] P. Slovic (1987) Perception of Risk. Science 236: 280-285.

[3] J. Place and N. Hanlon (2011) Kill the lake? kill the proposal: accommodating First Nations' environmental values as a first step on the road to wellness. GeoJournal, Vol. 76, No. 2, pp. 163-175

contamination, dust, noise, vibration, etc. arising from daily operation of the mine, and to concern about catastrophic events and their consequences for the community. Perception of risk due to the Project can adversely affect key factors in health such as stress, mental health, among others, which influence well-being.

- Although health was defined more broadly than many health assessments included within EIS work in Canada, the assessment of project effects on mental health and well-being and mitigation measures to address these effects was not included. Mental health is a key component of overall well-being and is one of largest potential effects from the Project. Its omission from the EIS is a major shortcoming.
- Input from stakeholders (including community members) and an examination of health effects on vulnerable populations is missing from the assessment of health outcomes. These methodological shortcomings can lead to an inaccurate characterization of effects on health and the development of ineffective mitigation strategies or simply a lack of appropriate mitigation measures.
- Physician shortages are a major concern for residents in Kamloops already and there is evidence to suggest that the mine would exacerbate physician recruitment challenges. The EIS mitigation measures inadequately addresses this issue.

Gaps in the EIS

- Human health risk assessment (HHRA) is absent for a catastrophic scenario such as a dam breach during operations.
- Holistic evaluation of impacts on health and well-being, including an evaluation of the aggregate changes to VCs on overall well-being.
- The *perception of risk* is not addressed in the Application. This includes consideration of the following aspects:
    - Mental health and perceived contamination from KAM. Particularly important considering that mental health conditions are listed as the most prevalent chronic condition in the region based on the baseline.
    - Avoidance of country foods due to perception of contamination.
    - Change in outdoor recreation behaviours due to perceived risks or reduced land access.
- Influence of population influx on the social fabric of Kamloops.
- Changes to crime rates, drug and alcohol misuse, and sexually transmitted infections as a result of population influx is largely unaddressed.
- Blasting and noise effects at sites near mine location are not discussed in the context of community well-being, particularly in the context of stress and mental health.

Recommendations

- Air quality assessment parameters and assumptions need to be confirmed and the models rerun as necessary to update all of the data used in the chemical risk assessments.
- Sufficient mortality/$PM_{2.5}$ data exist that KAM could provide an attributable mortality risk calculation for the areas most affected by the Project (e.g. Aberdeen).
- The KAM Project is not happening in isolation; other mines exist with similarities for evaluating emissions, exposures, regulatory issues, catastrophic events, and individual and community health issues (e.g. Canadian Malartic, Teck Highland Valley Copper, Imperial Metal Mount Polley). Stakeholders have significant

concerns regarding issues, conditions, and events at these mines. KAM should address these concerns with direct discussion of how the Project compares.

- Conduct a health impact assessment to evaluate the Project using a community health lens.
- Document stakeholder consultation activities within Chapter 10 and incorporate stakeholder input as evidence into the assessment of effects.
- Include an assessment of the distribution of effects across different population groups and identify how impacts may or may not be inequitable.
- Literature and known community concerns warrant an examination of the impact of perceived contamination and other perceived risks on a wide range of factors important to health and well-being.

How Health is Presented in the EIS

This section identifies and describes the sections in the Ajax Mine Application / EIS (Application) that deal with impacts related to human health.

In the Application, consideration of effects on health is included in Chapter 10. The paragraphs below summarize how the EIS considers health within specific sections of Chapter 10.

Section 10.1 Air Quality: Defined as a measure of the presence and quantity of constituents in ambient air, including contaminants in the atmosphere. Air quality is a valued component because most of the possible toxicological impacts to human health stem directly or indirectly from aerial emissions from the mine: diesel particulates, dust, fine particulates, and metals as components of any or all of these emissions. The concentration and deposition data generated in this chapter is used in the Water Quality, Country Foods, and Human Health assessment.

Section 10.4 Human Health: This chapter focuses specifically on human health risk assessment (HHRA) – a process that compares estimated exposures to contaminants from air, water, soil, and country foods with toxicologically- and policy-derived toxic reference values (TRv). Various exposure scenarios for people living in various locations in Kamloops and in Knutsford, and First Nations using the land for traditional practices are evaluated.

Section 10.6 Healthy Living and Health Education: Healthy living is defined as "the inter-related and undertaken practices that support, improve, maintain and/or enhance health" (Application, p. 10.6-1). This chapter concentrates on three aspects of healthy living, based on guidance from the Public Health Agency of Canada, namely healthy eating, physical activity, and maintaining a healthy weight. Education is also an important aspect of healthy living, and supports overall community health and well-being (p. 10.6-1).

Section 10.7 Community Health and Well-Being: This chapter defines health as being more than the absence of disease, considering not only individual factors but also the community's social, physical and economic environments. Health determinants that are considered in this chapter of the Application include traffic safety, the provision of health care services, and environmental and societal changes that may affect quality of life.

In addition, health considerations are raised in a number of different sections, including:

Section 11.14 Emergency Response Plan: This plan provides a framework for KAM to manage emergencies that may occur during the Project lifecycle. Some of these emergencies could have direct or indirect implications for individual and community health.

Section 11.21 Access Management Plan: The Access Management Plan (AMP) "manages and maintains access to the Project Site to ensure the health and safety of KAM workers, contractors, the public and social interest groups, as well as addressing safe and effective management of access to Jacko Lake" (Ajax Project Application/EIS, 2016, p. 11.21-1). This plan provides the key mitigation strategies provided in Section 10.6, and thus was included in the review, although in a limited capacity to review mitigations related to healthy living.

Section 17.6 Accidents and Malfunctions: This section outlines major risks that could occur through all project phases, and provides preparedness and management approaches for unplanned events such as accidents or malfunctions. Many of these risk scenarios will have a link with individual and community health.

Review of EIS Health Sections

Section 10. 1 Air Quality

The air quality chapter and its appendix describe the data, assumptions, and results of the methods used to estimate the emissions and dispersion of contaminants from the mining construction and operation. This component is critical in KAMs evaluation of the impacts of the mine, as airborne contaminants affect not only air quality, but also surface water, soil, the aquatic and terrestrial food chains, and country foods that various people may use for subsistence or supplemental food sources.

Modeling: KAM used dispersion modeling (CALPUFF) to estimate concentrations of particulates, metals, and deposition rates at numerous locations in the local and regional study areas. There is concern that the CALPUFF modeling has some significant errors in certain parameter assumptions. One of these that KAM must confirm is the area of tailings beach used in the model, and how this assumption affects the results used in the water quality modeling, and the air- and water-quality data subsequently used in the exposure point concentrations estimates in the HHERA. In Chapter 1 of Appendix 10.1-A, Table E-7 indicates the tailings beach area for the specified modeling years is assumed to be 1,424, 501 m^2 (or 142 ha), whereas in Table E-17, the tailings beach area is given as 14 ha. KAM must confirm the assumed tailings beach area used in their modeling, that it coincides with the latest TSF design parameters, and that if it is based on the inclusion of mitigation strategies, confirmation that these strategies are practically achievable (e.g. 90% dust mitigation from the tailings). Also, further details regarding the conditions under which various emissions occur need to be confirmed and provided: for example, wind conditions, wind anomalies, and seasonal conditions (e.g. is it reasonable to assume there will always be winter snow cover / frozen conditions for the TSF for the number of months designated in the model?).

Blast plumes: There was initial concern that blast plumes were not accounted for in the air quality modeling, however, the KAM report states that dust and explosive byproducts and residues are accounted for in the air quality modeling: Appendix 10-1.A p50, 51, and 55, and 10-1.A Appendix E provide discussions of the blasting included in the model and explosive detonation emissions. Ajax does not appear to have a mitigation plan or emergency response plan in case a blast plume (NO_x) is blown into the Aberdeen area. However, recent information released after reports of blast fumes (NO_x) moving through neighbourhoods near mines in Australia [4] suggests that an emergency plan should be developed together with key members of the community. NO_2 in blast residues can have acute toxic effects such as respiratory distress, eye irritation, which are reversible in most cases. In severe cases, more critical respiratory effects may have a delayed onset.

Project Case: Table 10.1-7 shows results for the Project alone. Tables 10.1-6 and 10.1-9 show air quality results for the Baseline Case and the Application Case, respectively. We require further explanation of how the Project Case is evaluated within the overall KAM application, as it appears that this case is considered only for the air component. Table 10.1-9 shows results for the Application Case, however, the concentrations do not compare with what is obtained by adding the Baseline Case with the Project Case. There is a significant disconnect in the use of the Project Case, why it was modeled, and how it relates to the Application Case in terms of modeling and interpretation. In our view, the Project Case concentrations should be added to the Baseline Case to evaluate the combined effect of the project with background. This issue is discussed further in the review of Section 10.4 Human Health. KAM should provide clarification.

[4] NSW Government Health. Mine Blast Fumes and You. (http://www.health.nsw.gov.au/environment/factsheets/Pages/mine-blast-fumes.aspx) retrieved on 23 February 2016

Section 10.4 Human Health

The fundamental purpose behind doing chemical risk assessment as part of the EIS is to ensure the Project will not expose human or ecological receptors to contaminants at doses that exceed toxicologically- and policy-driven exposure limits. The assessment should help the project proponent build effective exposure mitigations in to their project plans, flag the issues that could become concerns under specific circumstances, and assist the regulatory agencies in setting monitoring requirements for the project. Risk assessments have always been intended to inform risk management decision-making.

There are many variables in a risk assessment, and numerous areas of substantial data variability and uncertainty. The risk assessment framework we use in Canada is based primarily on Health Canada and Environment Canada guidelines for human health[5] and ecological risk assessments[6], respectively. They were developed specifically for contaminated site assessment and remediation: that is, for evaluating risks to human- and ecological receptors at sites with historical contamination to inform remediation and risk management decisions. In the EA process, we continue to use the contaminated site risk assessment approach to evaluate projected conditions for proposed projects. This introduces new uncertainties, or exacerbates those inherent in the exposure estimates used in the HHRA.

More complexity and sophistication in the HHRA itself is unlikely to provide a better prediction of health effects of the project. If we consider a broad definition of health that includes mental and spiritual well-being, individual and community health depends upon many factors (e.g. Health Canada's determinants of health[7]), and exposure to environmental contaminants is only one of those factors. Additionally, aside from factors such as education, employment, social support and culture, concepts such as trust and risk perception play a substantial role in a community's overall sense of well-being.

To provide a general frame of reference for some of the concerns and limitations of the HHRA approach, we have provided a brief discussion of the primary components of the risk assessment.

Exposure Assessment: The exposure assessment requires estimating an exposure dose (i.e. the total amount of contaminant someone could be exposed to per day). Estimating an exposure dose, particularly for proposed projects for which future contaminant concentrations are unknown and must be modeled, is challenging. This is the case even if we could collect biological samples from human, animal, and all known sources of exposure since there is inherent variability and uncertainties in sampling and chemical analysis. The uncertainties rapidly increase when we have few data, and when we need to rely on surrogate species and modeled contaminant concentrations. In all HHRA models developed by Health Canada and provincial agencies, these uncertainties are acknowledged to a large extent by deliberately choosing data and receptor variables that result in an over-estimate of the exposure. Precisely how much of an over-estimate this results in is usually not determined. The policy perspective is that if by significantly over-estimating the exposure and finding that it does not exceed the toxicity reference value, then any risks of adverse health effects would be very low and a more refined exposure assessment is not necessary.

Toxicity Assessment: The toxicity assessment involves identifying the potential toxic effects of COPCs and establishing toxic reference valuess with which to characterize risks. It is important to recognize that the agencies (e.g. Health Canada, US-EPA, ATSDR, IARC) that derive toxic reference values or cancer slope factors use a highly structured, rigorous procedure to evaluate and screen occupational, medical, toxicological, epidemiological, and environmental studies before they are included in the reference dose derivation. Because of this, there is often a substantial lag between medical or toxicity studies being published and their inclusion in derived toxicity references. Further, public health and environmental policy also play a significant role in the reference value derivation,

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[5] Health Canada, 2012. Federal Contaminated Site Risk Assessment in Canada. Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA). Ver 2.0 Health Canada 2010, revised 2012.

[6] Federal Contaminated Sites Action Plan (FCSAP). Ecological Risk Assessment Guidance. Government of Canada. March 2012. (www.federalcontamaintedsites.gc.ca)

[7] Public Health Agency of Canada. "What Determines Health?" (http://www.phac-aspc.gc.ca/ph-sp/determinants/index-eng.php#determinants), accessed 17 November 2015.

particularly with the decisions regarding uncertainty factors for non-cancer outcomes and in establishing the benchmark for what is considered essentially negligible for lifetime cancer risk (e.g. 1 in 100,000 or 1 in 1,000,000).

The toxicity assessment and the procedure followed to set reference values does not explicitly take into account specific factors that are known to increase certain risks – for example, if evaluating the risk of lung cancer from arsenic ingestion or asbestos or radon inhalation, the effect of smoking on increasing the likelihood of developing lung cancer is not explicitly calculated in the arsenic cancer slope factor, even though there is a known interactional or synergistic effect. Uncertainty factors are added to reference doses, in part to account for more susceptible segments of a population. Overall, the HHRA approach is conservative – it generally over-estimates risks so that risk management decisions can be made that would be protective of the majority of the affected population. However, specific groups may be more susceptible to certain health effects – e.g. smokers, immune-compromised individuals, those with respiratory conditions, or those who are obese.

Hazard Quotient: A hazard quotient is the quantitative result of the HHRA. It is the ratio of the exposure dose divided by the toxic reference dose, and provides a measure of whether, and by how much, an established exposure limit is exceeded. The HHRA is an important tool in evaluating whether projected emissions exceed risk-based exposure limits, and understanding the major exposure pathways for different groups of people. However, many of those practicing or using results from HHRAs suffer from both a lack of understanding of what the results of the HHRA mean for health and well-being, and over-interpretation of what the results may indicate. Both of these arise from the same issue – that the output of the HHRA – the hazard quotient (HQ) – does not provide a quantitative estimate of the probability or severity of an adverse health outcome; rather, it indicates whether an "acceptable" exposure level may be exceeded. If not, the interpretation is that health effects are unlikely. If the HQ is greater than 1, it only indicates that health effects "may" occur, not that they "will" occur. The US-EPA definition of the HQ is as follows:

> *The ratio of the potential exposure to the substance and the level at which no adverse effects are expected. A hazard quotient less than or equal to one indicates that adverse noncancer effects are not likely to occur, and thus can be considered to have negligible hazard. HQs greater than one are not statistical probabilities of harm occurring. Instead, they are a simple statement of whether (and by how much) an exposure concentration exceeds the reference concentration (RfC). Moreover, the level of concern does not increase linearly or to the same extent as HQs increase above one for different chemicals because RfCs do not generally have equal accuracy or precision and are generally not based on the same severity of effect. Thus, we can only say that with exposures increasingly greater than the RfC, (i.e., HQs increasingly greater than 1), the potential for adverse effects increases, but we do not know by how much. An HQ of 100 does not mean that the hazard is 10 times greater than an HQ of 10. Also an HQ of 10 for one substance may not have the same meaning (in terms of hazard) as another substance resulting in the same HQ.* [8]

This definition of the HQ, which is the actual risk characterization component of the HHRA, reinforces the perspective that the HHRA is not a full evaluation of risk: the HQ does not provide a measure of the probability or severity of an adverse health impact.

The concept that the HQ is unlikely to be proportional to risk is arguably the most difficult to grasp within the overall exercise of the HHRA. The sense of a good or bad outcome from the HHRA as defined by an HQ less than or greater than the reference point of 1(or 0.2 – see paragraph below) has introduced many challenges in risk communication and in risk management decision-making. Often, the discussion of uncertainties in the HHRA calculations attempts to discount any results above 1, because the common view is that any results above 1 means people are being exposed to unacceptable risks. This view can have a variety of consequences; for example: risk assessors may revise and iterate exposure calculations until they arrive at HQ values less than 1; or individuals and communities and industry critics attribute a variety of observed health outcomes to chemical exposures (most notably cancer). Communication between risk assessors and stakeholders (regulatory, including Health; community) is necessary to ensure that the initial assumptions and any revisions to these assumptions in the exposure calculations are defensible and realistic.

[8] U.S. EPA. *Technology Transfer Networks Air Toxics - National-Scale Air Toxics Assessment*. Air Toxics WebSite, updated Dec 2015. Cited 2016 Feb 17. Available from: http://www.epa.gov/national-air-toxics-assessment/nata-glossary-terms

An important factor in Health Canada's HHRA guidance that is often overlooked or misinterpreted is setting the acceptable HQ to 0.2 for individual exposure pathways[9], or when all exposure pathways including background exposures have not been counted in the assessment. Effectively, this means when we are evaluating a specific project such as the Ajax Mine, an HQ of 0.2 should be the evaluation benchmark unless we also include COPC exposures from as many normal, non-project daily sources as can be accounted for in the primary exposure pathways – inhalation, ingestion, dermal.

Significant Concerns in the Health Effects Chapter

The most significant uncertainty regarding the HHRA arises from the air quality modeling parameters (e.g. tailings beach; wind events) and assumptions (e.g. 90% dust mitigation on the tailings; completely frozen/immobile surface during late fall and winter months). These, and other assumptions in the model, affect the corresponding uncertainty in all subsequent evaluations of the Project contributions to contaminant exposure.

All comments about the HHRA are based on the currently reported results. These will need to be reviewed after KAM confirms their air quality modeling assumptions and provides updated air quality and deposition data, which would then be needed to update the surface water quality modeling, and all of the HHRA calculations. KAM has indicated in their discussion on uncertainty in the risk assessment (Appendix 10.4-A Section 4.5) that data statistics and conservative assumptions have been made throughout the HHRA to ensure conservative exposure estimation.

Selection of Contaminants of Potential Concern (COPC): The screening tables in Chapter 10 Appendix 10.4-A; Appendix D – COPC Selection (p. 852 of 1266) should be provided in the main text in Chapter 10.4, or at least in the main text of Appendix 10.4-A, together with the explanations of the procedures used (Appendix 10.4-A. Section 3.3.2). In the report as it now stands, one needs to search in detail to find the required details. WHY?

KAM compared the 95th upper confidence limit of the mean (UCLM) concentrations of metals in the ore dust to soil screening criteria concentrations to derive the list of contaminants that would be assessed in the HHRA. A more conservative approach for screening is to use the maximum concentration, as suggested by Health Canada[10], or the 90th percentile concentration for screening purposes. Using this approach might result in more compounds included as COPCs, and result in a broader assessment. KAM should clarify the validity of using the 95th UCLM for screening rather than the maximum concentration.

KAM further described their four-step screening approach in Appendix 10.4-A, Section 3.3.2. While the four-step approach to compound screening appears to be sound for the most part, it doesn't account for bioaccumulation potential for various metals. For example, cadmium was screened out because, it would account for less than 1% of the overall toxic potential of ore dust to humans and most other receptors. However, cadmium transfers from the dust to soil and plants, and then bioaccumulates in certain organs of organisms that consume the plants[11] – e.g. in the liver and kidney in ungulates. So while direct exposure to cadmium from ore dust may contribute a small proportion of the toxic potential when soil is the primary exposure medium, further assessment is necessary, particularly if organ meats are consumed as part of a country food diet. There may be metals other than cadmium that should be considered regarding their bioaccumulation potential. KAM should include cadmium as a COPC in the HHRA, and evaluate whether other metals should also be included because of their bioaccumulation potential.

As we understand it, the COPC screening was completed using data from ore sample analysis. The ore dust will be one emission source from the mine; however, as the mine develops and the TSF takes form, tailings become another significant emission source. An additional screening using projected elemental concentrations of the tailings should also be considered.

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[9] Health Canada, 2012. Federal Contaminated Site Risk Assessment in Canada. Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA). Ver 2.0 Health Canada 2010, revised 2012.

[10] Health Canada, 2012 Federal Contaminated Site Risk Assessment in Canada. Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA). Ver 2.0 Health Canada 2010, revised 2012.

[11] ATSDR 2012. Toxicological Profile for Cadmium. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. September 2012. http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=48&tid=15

Project Case Evaluation: re: Chapter 10.4, Tables 10.4-5 through 10.4-8: The percent increase calculations in Tables 10.4-5 through 10.4-8 are based on the change from the Baseline Case to the Future Case; they do not consider the Project Case in estimating the relative increase in $PM_{2.5}$ or PM_{10}. Table 1 shows combined data from these three tables in the report and the percent increase if the Project is added to the Baseline – shaded column. This is our understanding of how this data should be evaluated; however, KAM calculated the percent increase between the Future Case and the Baseline Case, and did not evaluate the Project Case. As described in the report, the Future Case is derived from CALPUFF modeling of emissions of the Project together with existing and approved sources. It is counter-intuitive that the Future Case would be less than the additive amounts of the Baseline Case and the Project Case. The Project requires further explanation in terms of how it relates to the Future Case and the Baseline Case, particularly because if we calculate the increased PM the Project appears to contribute, the percentage increases are significantly greater than those described in the report. KAM should provide clarification of the Project case.

Table 1. Data combined from Tables 10.4-5 through 10.4-8, showing percentage increase of Project Case plus Baseline Case

Criteria Air Contaminant	**Averaging Period**	**Concentration Ratios (CR)**			**% Increase BC to FC**	**% Increase Project plus BC**
		Baseline Case (BC)	**Project-alone Case**	**Future Case (FC)**		
Aberdeen						
PM2.5	24 hr	1.16	0.723	1.17	1.1%	***62***
	Annual	0.958	0.0767	0.967	1.0%	***8***
Upper Aberdeen						
PM2.5	24 hr	0.805	0.310	0.869	8.0%	***39***
	Annual	0.829	0.0767	0.855	3.2%	***9***
West End/Downtown						
PM2.5	24 hr	1.24	0.117	1.30	4.6%	***9***
	Annual	0.967	0.00747	0.974	0.7%	***1***
Aberdeen						
PM10	24 hr	1.39	1.44	1.90	36.2%	***100***
	Annual	0.323	0.123	0.337	4.5%	***38***
Upper Aberdeen						
PM10	24 hr	0.85	1.44	1.90	123%	***170***
	Annual	0.231	0.123	0.294	26.8%	***53***
West End/Downtown						
PM10	24 hr	1.57	0.00706	1.59	1.0%	***0.4***
	Annual	0.307	0.000986	0.316	3.1%	***0.3***

KAMs interpretation of the CRs that exceed 1 lacks depth or substance. Their interpretation follows the subjective assumption that an increase of 4% (or significantly greater, depending on a clearer explanation of the Project Case, as shown in Table 1) is "small" and therefore will be insignificant in health outcomes. In a 6-cities study follow-up, Lepeule et al (2012)[12] reported that the concentration-response for annual average $PM_{2.5}$ and mortality is linear down to 8 μg/m^3. Elliot and Copes[13] state that mortality effects of $PM_{2.5}$ have been demonstrated down to 5 μg/m^3. Health Canada considers $PM_{2.5}$ to have no lower threshold of effect. There is sufficient data available for KAM to perform an attributable mortality risk calculation for annual $PM_{2.5}$ as per Elliot and Copes to compare the PM related mortality risks from the Baseline Case and the Baseline Case + Project Case.

Hazard Quotient Reference Point: The HHRA in the KAM Application has accounted for inhalation background exposure, and some aspects of ingestion with the Baseline Case evaluation of soil exposures and home garden produce. However, exposure to metals from grocery store foods or country food from other locations, for example,

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[12] Lepuele, J., Laden, F., Dockery, D., Schwartz, J. Chronic exposure to fine particles and mortality: An extended follow-up of the Harvard Six Cities Study from 1974 to 2009. *Environ Health Perspect* 120:965–970 (2012). http://dx.doi.org/10.1289/ehp.1104660

[13] C. Elliott and R. Copes 2011. Burden of mortality due to ambient fine particulate air pollution ($PM_{2.5}$) in Interior and Northern BC. Can J. Public Health 2011; 102(5): 390-393.

has not been considered as part of the background exposure assessment. KAM's response to this issue is that BC regulations state that the HQ threshold of 1.0 is operable for all exposure pathways, and the only area that may be interpreted using the HQ of 0.2 is if the *difference* in HQ between the baseline case and the project (or future) case is greater than 0.2 – i.e. the Project increases exposures over background by at least 20%.

As discussed earlier, Health Canada recommends using a reference point of HQ = 0.2 when the assessment does not include full background exposure sources and pathways. KAM has used HQ = 1 as a reference point for all aspects of the HHRA. The most significant sources of COPC that have, to our knowledge, not been included in the overall exposure assessment are commercial food sources. The exposure parameters for each age range and receptor location or type were adjusted in the assessment to account for between 10% to 100% of foods acquired from the land – either country foods from the mine site, or beef from local ranches. However, the remaining fraction of food that would normally be sourced from grocery stores or other places has not been included in the assessment. Health Canada has published data on contaminants and daily exposures in the Total Diet Study[14] – data to approximate Kamloops adult exposures to COPC in market food may be taken from either the Vancouver study or could be taken as an average of the main Canadian cities over several years.

In Tables 10.4-12 – 14, 10.4-16, 10.4-20, and 10.4-24 a number of HQs are above 0.2. Exceeding HQ 0.2 does not mean an adverse effect will occur. It indicates only that exposures may exceed the risk-based reference dose for a particular exposure pathway. Most of the exceedances are for arsenic, lead, manganese, and thallium. The drinking water exposure for toddlers in Knutsford shows the greatest increase from Baseline Case to Future Case for arsenic and manganese, based on modeled project impacts on groundwater. The increase in arsenic exposure should be evaluated carefully, because a single well is used for domestic groundwater use data in the Knutsford area, therefore, substantial uncertainty is associated with the contaminant concentrations. With respect to the projected increase in arsenic and manganese in the groundwater in Knutsford, additional discussion is warranted. For the Aboriginal toddler, fish consumption accounts for the majority of lead exposure. This is with the assumption that only 10% of the fish consumed comes from Jacko Lake. As far as we can tell, the remaining 90% of fish in the assumed diet is not accounted for in the HHRA.

Particulate Matter (PM) Concentrations: The estimated concentration ratios (CR) are greater than 1 in some cases for PM_{10} and $PM_{2.5}$ (page 10.4-31). The authors suggest that it is appropriate to attenuate (reduce) the CR based on a "reasonable" time people are outdoors (they give examples of 12 hrs/day or 3 hrs/day). They state that the guidelines (for PM_{10} and $PM_{2.5}$) are based on 24-hour exposure, and therefore they should adjust the "real" exposure of the receptors to account for the fraction of time actually spent outdoors. This definition or interpretation of the PM guidelines is incorrect. The PM_{10} and $PM_{2.5}$ guidelines are <u>not</u> based on calculated exposure or dose over 24 hrs (which would be a toxicity-based dose response determined from total daily exposure). Rather, they are based on epidemiological studies (the Six Cities study and follow-up studies) showing associations between regional PM concentrations and morbidity and mortality on a population basis. These associations are based on the health responses of populations living in those cities under the studied ambient PM conditions. Therefore, attenuating the CR based on the estimated time spent outdoors is inappropriate.

<u>Other specific concerns</u>

Surface water at Jacko Lake and Peterson Creek

- The application used *annual weighted average* for data from 2012-2104 for Baseline Case exposure point concentrations and *maximum predicted annual average* for Future Case. These are still *average* concentrations, not an estimate of an upper confidence interval. KAM should explain the reasoning for using these values and whether they are sufficiently conservative for the HHRA. The 95th UCLM is generally considered to be appropriately conservative but was not used in this case. KAM should provide clarification.

[14] Health Canada, 2011. Total Diet Study, Dietary intakes of contaminants and other chemicals for different age-sex groups of Canadians. http://www.hc-sc.gc.ca/fn-an/surveill/total-diet/intake-apport/index-eng.php

- We could not locate corresponding modeled concentration data in Chapters 6 vs Chapter 10. Statistics, case designations, or data groupings are different and confusing. It appears that most (all?) of the water data used in the HHRA was more conservative (higher concentration based on statistical value selected) than in the water quality evaluation. While conservative estimates are expected in the HHRA, we are concerned about the difference in the data used in one part of the EIS vs another. KAM should comment on why the evaluation data differ.

- Recreational and traditional lifestyle receptors were assumed to use Kamloops water, not surface water. This differs from HHRA scenarios in other jurisdictions (e.g. Alberta) where the assumption is approximately six months of residency at the traditional lifestyle location and consuming all food and water from that location. The concern with assuming that only Kamloops water is ingested is whether this is sufficiently conservative for all possible exposure scenarios.

Groundwater

- This pathway is only relevant in Knutsford (semi rural and rural) where residents obtain their drinking water from wells. KAM used the elemental concentrations from a single active well as representative of all domestic groundwater for those receptors in the Knutsford area. Because drinking water is a significant source of certain compounds of concern, such as arsenic, we are concerned about the substantial uncertainty a single data point introduces to this part of the exposure estimation. KAM should comment on this uncertainty.

Soil

- Appendix 10.4-A Section 3.3.3.2 - Soil samples were collected in the project area and at the boundary: baseline soil concentrations for these areas were calculated as the 95th UCLM or maximum concentrations if there were fewer than 10 detectable concentrations. This seems reasonable. However, the baseline soil concentrations for the city areas were defined as the mean concentration in soils from garden sites, school grounds, parks, etc. KAM uses the 95th UCLM or maximum concentrations for soils on the site, so we recommend consistency in use of these statistics for the city areas.

- Future case concentrations: KAM used the deposition rate at the location at which the maximum annual <u>average</u> dust deposition was predicted. This number was used to predict deposition and subsequent metal accumulation over the operating years in all community areas. The basis is an average annual deposition: KAM should comment on the use of the average or mean concentration, rather than using the 95th UCLM.

Country Foods

- With respect to country foods, KAM specifies that they are only evaluating possible impacts arising directly from exposure to chemical contaminants from mine emissions. While this scope limitation is perhaps sufficient to estimate the contribution of contaminants from country foods, it is insufficient to respond to concerns over habitat disruption and loss as a result of the mine construction, operation and closure, which also can affect well-being.

- Samples were collected from local cattle (4 samples), therefore, KAM should use maximum concentrations for calculations due to small sample size. For wild game no samples were collected, therefore, data were assumed to be the same as cattle, or they were modeled from vegetation, soil, and surface water. Further clarification of the data is needed, as it is unclear to what extent cattle data were used as surrogates for other ungulates. Potential uncertainties introduced by using cattle as surrogates include the differences in forage between cattle and deer, particularly in the fall/winter when deer switch to browse and cattle may be supplemented with hay and grain. These limitations need to be clearly stated in the application or accounted for.

- KAM used an uptake model for deer to estimate the concentrations of contaminants from soil or vegetation, however, a discussion of the uncertainty or accuracy of the uptake model is not apparent in the report. Teck / HVC contracted a study on metals in moose and deer near the HVC mine – these results could be useful to check the model results used for Ajax. We suggest that KAM formally obtain access to the Teck HVC study results and provide a comparison of the projected contaminant concentrations in deer to those reported in the HVC study.

Section 10.6 Healthy Living and Health Education

The healthy living and health education section focuses on changes to healthy living via reduced opportunities for outdoor physical activities.

This section has both strengths and weaknesses in its overall approach and content. The strengths of this section include:

- Separating outdoor recreation impacts into sub-topics of Access, Experience and Resources, which is a useful way to distinguish the unique issues related to this category.
- The rationale for including Healthy Living integrates the community's desire for strong outdoor recreational opportunities, which is a local value that was strongly expressed by residents.
- Secondary data sources utilize reputable sources from federal and municipal government (e.g. Statistics Canada and municipal documents), as well as for specific sub-populations (e.g. publically available documents from Aboriginal Groups).

However, we find this section of the Application to have the following shortcomings:

- There is a lack of clarity in how the assessors link project activities to proposed effects on healthy living and education. A logic diagram (pathway diagram) may improve understanding of these linkages.
- The connection between the project attributes, baseline data and the assessment of effects is extremely unclear. Baseline information focuses on existing social supports and services (e.g. Public Health Centres and the Community Food Action Initiative), healthy living factors such as healthy eating, smoking rates, alcohol consumption, and also describes provincial health-related school curriculum. The majority of information presented in the baseline is not carried forward into the assessment, and is not placed into context of the overall Proposed Project. This leaves the baseline and assessment disjointed and confusing. It is not clear if the Application is proposing that these lifestyle factors and education programs will be affected by the mine.
- The limited information provided on physical activity in the baseline is not sufficient to inform the assessment on outdoor recreation for the local population.
- Stakeholder input is not included in the assessment, nor is there a description of the consultation activities that took place. As a result, the assessment lacks important data required to draw conclusions about the potential impacts. Changes in land use behaviors are based off personal preferences and risk perception, therefore it is very difficult to understand how personal use, enjoyment and experience of recreational opportunities will be affected without having engaged potential users in the region. If these users were engaged, the results were not clearly incorporated into the assessment.
- The methods section (p. 10.6-5) is extremely brief. Better explanation of qualitative methods (e.g. interviews) and other methodological approaches to this section would help the reader to determine whether or not the methods were rigourous.
- First Nations input and concerns are excluded from the healthy living assessment. Considering the importance of land access and land use for well-being among First Nations populations, this topic should have been explored, with better First Nation input being integrated into this section.
- There is also no data discussing current usage of Goose Lake and Jacko Lake in high or low season. Without this type of information, in addition to an overall lack of stakeholder input, this assessment provides no concrete understanding of how many people could be influenced by restricted or altered access to these lakes and surrounding areas.
- Mitigations are largely concerned with allowing access to Jacko Lake. While this is important there remain several flaws with the mitigations: 1) There is no understanding as to whether current users will still want to spent time at Jacko Lake with active mining occurring in the immediate region, 2) The mitigations provided in this section are essentially repeats of those in the Access Management Plan and Section 8.6 Outdoor Recreation, and 3) There are areas such as Jacko Lake Prayer Tree and Goose Lake road that will have

restricted access as a result of this project, and access to these areas are not mitigated.

- A major shortcoming of this section is that it neglects to examine effects to healthy living among vulnerable populations. There is no discussion on how impacts could be experienced differentially, and which populations might be more strongly affected either positively or negatively.

Overall, this section and the rationale for its inclusion within Section 10.6 is confusing. There are two central reasons for this comment. First, this section introduced a range of healthy living factors (e.g. smoking, diet, alcohol consumption and obesity/overweight) in the baseline, but does not tie these baseline characteristics back to the assessed effects on outdoor recreation. Second, it is unclear why outdoor recreational opportunities became the main focus related to impacts on healthy living, when it is directly related to community health and well-being.

It should be noted that health education was considered for the assessment within this chapter and then removed. Table 2 includes the rationale for the removal of health education, which is given in the EIS. The table also provides our own critique of the appropriateness of the removal from further assessment in Section 10.6.

Table 2: Appropriateness of Health Area Scoped out of Healthy Living and Health Education

Health Area	KAM's reasoning for its removal	Appropriateness of removal
Health education	KAM will be implementing several programs to promote healthy living and health education among workers, which are expected to have only positive impacts.	It is appropriate to exclude health education from the assessment in Section 10.6 since the section only focuses on education programs for workers.

Section 10.7 Community Health and Well-being

The community health and well-being section focuses on the following health areas:

1. Traffic changes leading to collisions and safety issues
2. Project workforce effects on community health services
3. Changes to community image and quality of life of residents due to proximity of Project

The following summarizes a review of Section 10.7 Community Health and Well-being. The strengths for this section include:

- An attempt at broadening the definition of health beyond chemical or contaminant exposure pathways.
- There is use of reputable secondary data sources from government and non-government sources that cover the range of sources that would be expected in a health baseline. The addition of local surveys and qualitative data is also useful.
- Quality of life baseline section (p. 10.7-24) does a good job of integrating qualitative information to represent community values and perceptions. The relevance and importance of this baseline section is clear and supports the assessment of effects.
- The effect characterization is justified based off information provided throughout the section, as well as the definitions provided in the characterization. However, considering an existing doctor shortage in Kamloops, it would be worth considering if the resiliency of the "Increased demand for physicians and emergency room could affect the availability of community health services" should be characterized as low, and not neutral for residual effects in Table 10.7-15 as well as cumulative effects in Table 10.7-19.

Overall we find this section of the Application to have the following shortcomings:

- Baseline data provided for community health and well-being are not sufficient to understand the health vulnerabilities in the affected population, nor is it enough to understand general characteristics of the community (e.g. employment rates or age distribution, among other possible data). In order to assess health effects and identify population groups that are most at risk it is important to first identify who is within the affected area by providing population demographics. The baseline section does not achieve this.

- Baseline data that are provided are not utilized in the assessment of effects, and so the rationale for the indicators selected is unclear. For example, there are data describing potential years of life lost due to suicide, natural causes and accidents but there is no indication of how this information informs the assessment of effects of traffic safety, quality of life or health care service capacity. Also, there are data missing that would inform the assessment. For example, a description of the population that may be impacted by Project traffic and identification of vulnerable population groups that would be more susceptible to health effects being examined is not included in the baseline. Overall there is poor selection of community health indicators, and the baseline would greatly benefit from interpretation of data presented.
- A major shortcoming of this section is that is neglects to examine effects to community health and well-being among vulnerable populations. There is no discussion on how impacts could be experienced differentially, and which populations might be more strongly affected either positively or negatively.
- There is a lack of information included in Section 10.7 to fully understand the assessment of effects. The reader is often sent to lengthy appendices to obtain the information required to make a judgment of the effects. This is especially true for *Project-related Traffic* and two omitted health areas: *Changes to the Biophysical Environment,* and *Noise and Vibration*.
- It is stated that key person interviews and public engagement were used to validate data collected (p. 10.7-8); however no information is given as to how many interviews or public meetings took place, and it is unclear who was engaged. A table of stakeholder engagement activities, or a more detailed description of these activities is needed.More than once, it is noted that a non-significant effect for another VC in the Application means that no health effects will occur. This argument does not hold true, especially for *Changes to the Biophysical Environment,* but also for *Outdoor Recreation Activities*, two areas that were omitted from the assessment. The original VC effects are often characterized as "Non-significant (moderate)", which according to the definition provided means that "residual effects on the VC may be distinguishable at the population, community and / or ecosystem level" (p. 5-21); therefore the possibility remains that health effects could result. This would also merit an investigation of perceived health effects in the community, which could emerge whether or not the exposure risk is high, and could have health implications (e.g. for outdoor recreation or mental well-being).
- Table 10.7-11 recognizes that the interaction between income and both mine staffing and contracted employment during construction and operations are characterized as "potentially moderate interaction requiring unique active management/monitoring/mitigation; warrants further consideration". However, interaction between project-related income change and health have not been carried into the assessment. This is a well known interaction in mining projects, that can have impacts on individual and community health, in both positive and negative forms, and thus should have been further assessed to understand anticipated interactions for this specific mining project.
- Impacts to stress and mental well-being may be one of the largest health effects stemming from this project for both First Nations and non-First Nations communities. A discussion of the pathways of effect and mitigation strategies is required.
- There is a good recognition of the project workforce, and how it could affect current capacity in the health system. However, there are additional issues related to population influx of a temporary workforce that were not covered, such as housing (e.g. Location of where the workers will be housed is not included. If KAM will rely on current housing, the impact on rental prices/availability and hotel availability needs to be assessed. Influx of a temporary workforce could also influence the social fabric of the community and affect social cohesion of community members (e.g. there is evidence to suggest that large resource development projects can create divisions within communities and amongst people based on those who benefit and those who do not benefit from the developments. These divisions can lead to changes in health and quality of life).
- There is a lack of clarity in how the assessors link project activities to proposed effects on Community Health and Well-being. A logic diagram may improve understanding of these linkages and make clear the

assumptions being made in each assessment pathway.

- It is not clear where stakeholder input was integrated into this section, or if qualitative data relies largely on pre-existing data. Stakeholder engagement on issues pertaining to the Project and impacts to community health are necessary to accurately characterize impacts on changes to health such as quality of life or community image. There are few cases where stakeholder input was clearly integrated.
- Overall, the majority of the three assessment sections draw on limited data, and make few conclusions that help to understand the expected health outcomes. For example, the assessment of project-related traffic impacts (p. 10.7-41) would benefit from estimations in the increase in project-related traffic, as well as the type of vehicles (i.e. heavy truck traffic). Without this quantitative information, it's not possible to understand the magnitude of impact on community health nor is it possible to calculate changes to risk of collisions leading to injury or mortality as a result of traffic changes. While it is recognized that data limitations would make it difficult for assessors to draw conclusions for all health areas, there could have been a better use of the *Traffic Impact Assessment* and the *Socio-Economic Baseline* within Section 10.7, and furthermore increased stakeholder input in the Application would also strengthen the assessment.
- Traffic mitigations provided are good for controlling volume, however there is limited information on mitigations that will promote safe driving behavior. Possible measures could include speed control measures, strict policies to prevent drinking and driving, in addition to driver training for employees.
- The organization of Section 10.7 is confusing, has little flow between sections, and does not follow a logical order. This ultimately makes it hard for the reader to understand how each sub-section informs the next, and prevents a good understanding of the potential health effects.
- Ultimately, there are a range of possible health issues that have not been adequately addressed, specifically related to mental well-being and effects of perceived contamination. Without additional stakeholder input in addition to assessing the Proposed Project using a wider health lens, there could be concerns and issues that have not been properly recognized and mitigated.

In addition, the following effects were considered in the EIS and then scoped out of the assessment of community health and well-being:

1. Changes to the biophysical environment
2. Noise and vibration
3. Changes in income generation
4. Changes to outdoor recreation activities

Table 3 includes the health areas that were removed from detailed assessment and characterization, including the rationale for removal that was provided in the EIS. Authors of this review have added commentary on the appropriateness of the removal of the health area.

Table 3 Appropriateness of Health Areas Scoped out of Community Health and Well-being

Health Area	**KAM's reasoning for its removal**	**Appropriateness of removal**
Changes to the biophysical environment (air, water, country foods)	The HHERA concluded that inhalation exposure resulting from the Project, and Project-related changes in water and country foods would result in negligible changes in human health risk to those living in the vicinity of the Project.	This approach ignores the effects of perceived contamination, which are known to affect community health and well-being. The removal may result from lack of inclusion of stakeholder input around this issue.
Noise and vibration	Predicted Project effects are well within noise and vibration guidelines and no	The noise and vibration assessment is located in an appendix (10.5-A), therefore

	residual adverse effects are anticipated.	the health and well-being section lacks sufficient detail for the reviewer to critically examine this information. Relevant information (e.g. receptor locations, predicted noise level increases and air blast levels) should be included in this section.
Income generation	Project effects relating to income generation are likely to contribute to improved community health and well-being, no adverse effects are anticipated and this effect is not considered further.	This section is not grounded in local data and lacks sufficient evidence to back the conclusion that only positive effects will occur. More evidence is required to provide confidence in the predicted effects, especially given the literature and lived experiences that exist in resource development communities that suggest that many negative impacts also result from income generation.
Outdoor recreation activities	Since the assessment on outdoor recreation concludes that no significant adverse effects on outdoor recreation will result from the Project it is concluded that no potential effects to community health and well-being will result.	Moderate impacts are expected on Outdoor Recreation, as characterized in the Section 8.6 Outdoor Recreation. While these are not seen as significant, it warrants an investigation as to whether the potential exists for community health impacts related to changes in outdoor recreation.

Section 17.6 Accidents and Malfunctions

There are both strengths and weaknesses in Section 17.6 Accidents and Malfunctions, in terms of how this section addresses public health. Strengths of this section are summarized below:

- The assessment of severity looks at three areas of concern: environment, community, and human health and safety. Community includes "public mistrust consequences", while human health and safety includes "community and public but not occupational consequences" (p. 17.6-5). This separation is appropriate to address community health issues.
- The section on environmental effects of Case #5 (p. 17.6-78) recognizes that a dam breach would impact the land quality in areas where land is used for traditional purposes. KAM's plan to communicate with Aboriginal groups about the dam failure is extremely important, and while it needs more detail, shows a positive initial step.

Overall, this section has the following weaknesses for the consideration of public health:

- It is stated that off-site events are considered for Failure Modes and Effects Analysis (FEMA) (p. 17.6-5). However, the majority of FEMA Risk Profiles are concerned with events on site, and do not consider the range of potential situations that have health and community-wide impacts off-site. The application should identify the possible off-site failure situations as well as the mitigations and plans for response.
- Risk characterizations in the FEMA Risk Profiles for health and safety, and community include an assessment of likelihood and severity, but do not provide further discussion or analysis into what expected impacts could actually result for health and safety or the community, nor are there any further plans provided for these failure situations. There is a need for better follow-up and planning for these scenarios. Examples of these FEMA Risk Profiles, where health and community have a severity characterization that is "major" or higher, but do not include further discussion of possible impacts and response include;
    - Open pit high wall failure (operational), ID-01

    - Overloading blast holes, ID-03
    - Jacko Lake Water Retention failure, ID-06
    - Slope failure of SMRSF (2), ID-08
    - Fuel Truck Accident and Spill, ID-15
    - Hazardous Goods Truck Accident and Spill, ID-16

- There are several FEMA Risk Profiles where the severity of health and safety consequences is "low", however the community consequences are characterized in the profiles as "serious" or "major". Better planning for these scenarios is necessary. Without this, it is unlikely that community members concerned about accidents and malfunctions will feel secure or have trust that KAM has their interests, values and safety in mind.
- The VC interaction matrices for all FEMA Risk Profiles fail to recognize any interaction with the Community Health and Well-Being VC. This is surprising, considering the range of recognized risks to the community, as were mentioned in the list of FEMA Risk Profiles above where both health and community have the potential to be affected with varying degrees of severity. This is partially explained by the limited scope of Community Health and Well-Being, which fails to address issues of stress, anxiety and mental well-being, which could be affected in the case of a failure situation. Furthermore, in cases where accidents and malfunctions could affect Jacko Lake, among other areas where the land is used for recreation, subsistence activities, and has spiritual importance, there could be interactions with both the Healthy Living and Health Education VC, in addition to the Community Health and Well-being VC. These interactions are not recognized, meaning the potential health effects are unacknowledged in response planning.
- This section identifies two extreme cases, Case #5 and Case #1 (p. 17.6-68), of dam breach that are discussed in more detail. Overall, the management and response planning for either case needs to include better stakeholder consultation. There may be individuals or groups, particularly First Nations, who view this land as irreplaceable and although the damage could be small, there needs to be an approach for compensation among those most affected, as well as a response plan that has been developed alongside end users.
- Mitigation responses for Case #5 need to explicitly state the public protection measures that will be implemented. Section 17.5, as well as the Emergency Response Plan (Section 11.14), the focus is towards on-site precautionary measures but not off-site measures.
- A communication plan is needed. In the case of any accident or malfunction, whether or not it will have impacts outside of the project boundaries, there is potential for significant perception of risk in the community that could manifest in behavior changes and impacts to well-being. These perceptions could be managed with a strong communication plan. The communication plan should be developed in concert with relevant municipal agencies as well as First Nations groups.

Management Plans

Section 11.14 Emergency Response Plan

Positive aspects of the Emergency Response Plan are outlined below:

- Overall, the Emergency Reponses Plan appears to be developed alongside BC MEM guidelines.
- The plan states that engagement will take place between the Emergency Response Plan Coordinator and Aboriginal Groups, as well as other interested community groups throughout the life of the mine (p. 11.14-5), which will include presentations on the current plan, and will provide opportunity for responses to be integrated into updates.

Overall, this management plan has the following weaknesses regarding the consideration of public health:

- KAM plans to establish an emergency operations centre that will consider ease of communication and access, which is important in emergency planning; however, it is unclear if this will be accessible only by workers. This centre should also include community communications and accessibility.

- First responder consultation will be important. However, KAM should consult with local emergency services to understand what capacity already exists, and where the Ajax mine could overwhelm existing services. Emergency services and capacity provided by the mine should be clearly identified.
- Emergency communication is well thought out in terms of means of communication, but what is not clear is who communications will be targeted toward. In some cases it may only be necessary to communicate to workers; while in other emergency situations it could become imperative to have a communication plan that extends to the wider the community. A communication plan considering both community and worker communications would make this clear, and would be extremely useful in the event of an emergency.
- In the case of a fatality KAM will be offering counseling among other services to the family (p. 11.14-13). Counseling should also be offered to coworkers in this situation.

Commentary on Cumulative Effects

Cumulative effects are defined in the Application as any effects of the Project remaining after mitigation actions (residual effects) plus similar residual effects from overlapping projects (planned and approved) that have not already been considered within the Baseline. This is a development- and time-based (longitudinal) definition of cumulative effects and is an important aspect of understanding how the KAM Project may contribute to the overall projected impacts on people and the environment in the planned future.

For health concerns, the cumulative effects assessment is mostly limited to overlapping contributions to air contaminants from the additional projects or activities. KAM's analysis suggests that no additional projects beyond those already accounted for in the Baseline Case would influence air contaminants; therefore, there would be no cumulative effects and any further assessment is unnecessary. KAM provides some analysis of potential additions of other projects on traffic-related concerns, and on physician- and community health services capacities. In all examined components related to health, whether the projected magnitude of effect is low or moderate, KAM concludes that the effects are not significant. Given the current shortage of physicians, the challenges for physician recruitment in Kamloops, the evidence to suggest there would be out-migration of physicians and recent evidence from the Abitibi mining region in Canada, we question whether this conclusion is accurate.

A fundamental weakness of the longitudinal definition of cumulative effects is that it reinforces the silo-like nature of the EIS approach. This is not unique to KAM. Defining the cumulative effects assessment term is a policy matter, and should be revisited. A definition of cumulative effects that also encompasses an evaluation of the aggregate impacts on ecological/environmental components and holistic human well-being is likely to resonate more meaningfully with all stakeholders of major industrial projects, including KAM, and more adequately address cumulative impacts. We consider the methods used to address cumulative effects assessment in this application to be inadequate and they do not meaningfully address the range of issues that affect well-being.

Holistic Considerations

The KAM environmental impact assessment is based on an empirical approach that examines each valued component (VC) separately for effects of the Project – this is standard practice for environmental assessments in Canada. The outcome of this approach is that if the project related change in each VC is deemed 'not significant', the overall conclusion is that as a whole, the project will have a negligible or insignificant adverse impact. A fundamental weakness of this approach, and therefore this application, is the lack of a holistic evaluation of the *aggregate* impact of the changes on the VCs that relate to human health and community well-being, particularly in the broader definition of health that includes mental and spiritual well-being.

The regulatory EA model depends on the HHRA as the fundamental measure of the health impact of a project. A review of 12 years of HHRAs (from 2000 - 2012) in the Alberta oil sands showed in each case that health risks from each project were negligible [15]. The review also showed that, despite substantially increased technical sophistication and effort in producing a strong, scientifically defensible risk assessment, stakeholders' fundamental concerns about their health and surrounding environment remained the same; people were concerned about effects on their health, on whether game was safe to consume, and on overall environmental integrity. Clearly, the HHRA and overall EA approach is not effective in assuring people of the safety of the proposed project.

Health and overall well-being depend on multiple social and environmental determinants, some of which may be directly influenced by the KAM project (e.g. $PM_{2.5}$ concentrations; a job at the mine) and some indirectly (e.g. sense of belonging; 'agency' or sense of control; community image). One of the aspects of health that is critically missing, and which has important ramifications for Kamloops neighbourhoods, is a holistic assessment that includes overall quality-of-life considerations. An example is risk perception: the influence of the perception of risk on various

[15] Intrinsik (2012) South Athabasca Oil Sands Environmental Impact Assessments Review. Intrinsik Environmental Sciences Inc., Nichols Applied Management Inc., and Golder Associates. Completed on behalf of Alberta Environment and Sustainable Resources Development.

determinants of health has been studied extensively since Paul Slovic's discussion of the issue [16]. It includes beliefs and perceptions of negative effects or their likelihood, and can be related in this case to concern about metal contamination, dust, noise, vibration, etc. arising from daily operation of the mine, and to concern about catastrophic events and their consequences for the community. Risk perception can be as harmful as "real" risks [17], and it can influence mental health and perceived quality of life [18]. Perception of risk due to the project can adversely affect key factors in health such as stress, mental health, and sense of place, which influence well-being.

Overall, the KAM application lacks appreciation of this holistic approach to assessing community health and well-being, and therefore fails to accurately capture the impacts of the proposed Project on the community.

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[16] P. Slovic (1987) Perception of Risk. Science 236: 280-285.

[17] J. Place and N. Hanlon (2011) Kill the lake? killKill the proposal: accommodating First Nations' environmental values as a first step on the road to wellness. GeoJournal, Vol. 76, No. 2, pp. 163-175

[18] K. Bickerstaff (2004) Risk perception research: socio-cultural perspectives on the public experience of air pollution, Environment International, 30:827-840;
G. Fleury-Bahi, M. Préau, T. Annabi-Attia, A. Marcouyeux & I. Wittenberg (2015) Perceived health and quality of life: the effect of exposure to atmospheric pollution, Journal of Risk Research, 18(2): 127–138;
M.L. Lima (2004) On the influence of riskperception on mental health:living near an incinerator, Journal of Environmental Psychology 24:71-84;
L. Downey and M. Van Willigen (2005) Environmental Stressors: The Mental Health Impacts of Living near Industrial Activity. Journal of Health and Social Behaviour, 46(3):289-305.

Final Concluding Statements

The KAM EIS report is an extensive, complicated document. There are numerous aspects of its evaluation of human health and community well-being that are done well and clearly documented. There are also many components in the assessment that lacked clarity and transparency, which led to an incomplete assessment or uncertainty in the findings.

Accuracy and credibility in the HHRA is a requirement for the EIS as a whole to be viewed as credible by those who would be affected by the mine. Aside from a number of technical concerns, the HHRA appears to be reasonably conservative – that is, for all of the contaminants of concern apart from particulate matter, it over-estimates the risks from exposure to contaminants from the mine and from background. The single major caveat on the HHRA is the uncertainty introduced by assumptions in the air quality modeling, specifically dust emitted from the tailings storage facility and the likelihood of projected dust mitigation efficiency being consistently met. Re-visiting these parameters will necessitate re-calculation of the risk estimates.

Exposure to contaminants is only one factor in human health and community well-being. KAM acknowledges in various parts of the assessment that health and well-being are influenced by many factors. What is missing is a holistic analysis of the aggregate impacts on health from the overall mine project that is also grounded in stakeholder input, and considers inequitable distribution of effects among the population. This could identify a wider range of factors that influence quality of life in a much broader sense than simply lack of illness or disease. Although KAM recognizes a sub-set of community health and well-being impacts, we identified the *perception of risks* as a significant factor in stress and mental health as a particular aspect of such a holistic analysis.

It is this holistic aspect of evaluating a project such as the Ajax Mine that, combined with credible discipline-specific assessments, has the chance of addressing many issues that affect people's lives in the broadest sense.