

**CAPTURING VULNERABILITY: TOWARDS A METHOD FOR ASSESSING,
MITIGATING, AND MONITORING GENDERED VIOLENCE IN MINING
COMMUNITIES IN BRITISH COLUMBIA**

by

Alison Marie Stockwell
B.A. (Hons) University of Victoria, 2012

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ABSTRACT

The impacts of the extractive industry (mining, oil and gas) on the health and safety of rural and Aboriginal women are largely unidentified and unmitigated in British Columbia (BC) environmental assessments. In relation to extractive industries, women experience direct and indirect impacts in unique ways. Globally, evidence suggests that extractive industries are associated with increased incidence of substance abuse, prostitution, and violence against women. Rural and Aboriginal women are among the most vulnerable people in Canada. They experience high levels of domestic and non-domestic violence and have limited access to health services. While BC's environmental assessments are increasingly rigorous, health impacts beyond environmental exposures, such as those related to violence in communities, are considered out of scope and the indicators used to assess, mitigate, and monitor them remain undeveloped.

This research, part of a collaborative five-year project on extractive industries and community health in BC, sought to: (1) synthesize findings from the literature on women's health and safety in relation to extractive industry development; (2) identify indicators of vulnerability of rural and Aboriginal women to violent victimization in BC; and (3) develop a mapped composite indicator to identify regions of BC where poor health, substance abuse, and violence are endemic, and where women are at risk of violent victimization. The resulting indicator provides a proposed model for assessing and monitoring population vulnerability in relation to major projects and enhancing the current environmental assessment process. Results indicate that BC's northernmost regions are highly vulnerable, characterized by low health status and access to services, high levels of substance abuse and violent crime, and a high proportion of women at risk of violent victimization. Recommendations are made for extractive industry proponents, regulators and impact assessors, and affected communities to make use of quantitative tools to better capture vulnerability in relation to extractive projects. Subsequently, targeted mitigation measures that address violence and consider the needs of vulnerable populations can be prescribed in regions where extractive industry projects operate. This

work was completed as part of the University of British Columbia Bridge Program with funding from Vancouver Foundation and the Canadian Institutes for Health Research.

PREFACE

This dissertation is the original, unpublished work of the author, A. Stockwell. The research was completed as part of the Ten Steps Ahead project, wherein a community research advisory board first identified the topic as a research priority. All research design, data collection, and analysis are the independent work of the author.

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LIST OF ABBREVIATIONS

UBC	University of British Columbia
BC	British Columbia
EA	Environmental Assessment
LNG	Liquefied Natural Gas
EI	Extractive Industry
EAO	Environmental Assessment Office
CEAA	Canadian Environmental Assessment Agency
MEM	Ministry of Energy and Mines
BCOGC	British Columbia Oil and Gas Commission
NGO	Non-government Organization
STI	Sexually Transmitted Infection
FIFO	Fly-in-Fly-out
NAHO	National Aboriginal Health Organization
VC	Valued Component
AIR	Application Information Requirements
EIS	Environmental Impact Statement
NWT	Northwest Territories
UNDP	United Nations Development Program
HDI	Human Development Index
US	United States
LHA	Local Health Area
HSDA	Health Service Delivery Area
GIS	Geographic Information System
HIA	Health Impact Assessment
OECD	Organization for Economic Cooperation and Development
UN	United Nations
PYLL	Potential Years of Life Lost
PCA	Principle Component Analysis
US EPA	United States Environmental Protection Agency
HHRA	Human Health Risk Assessment
OHS	Occupational Health and Safety
UNICEF	United Nations Children's Fund
CSR	Corporate Social Responsibility
GSS	General Social Survey
NHS	National Household Survey
TSM	Towards Sustainable Mining
IFC	International Finance Corporation
KT	Knowledge Translation

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1. INTRODUCTION

1.1. Ten Steps Ahead: the extractive industry and community health project

This work is part of a collaborative five-year research project on extractive industries and community health in BC entitled *Ten Steps Ahead* funded by the Vancouver Foundation (2010-2012) and the Canadian Institutes for Health Research (2012-2016). The project was started in 2010 when researchers from the University of British Columbia Norman B. Keevil Institute of Mining Engineering and the University of Victoria Department of Geography were approached by health and social service providers from the Nak'azdli First Nation, Tl'azt'en First Nation, and the municipality of Fort St. James. These three communities, situated close to the new Mt. Milligan Copper-Gold Mine, sought to determine how to prevent potential adverse mining related health impacts to their community and; how to maximize and sustain social, economic, and health benefits for community members. Community members were especially concerned that the mine's recently approved Environmental assessment (EA) did not adequately capture baseline health and social conditions in affected communities or mandate a program to monitor possible impacts on the social determinants of health for the life cycle of the mine. Since its launch, the project has produced a baseline study of community health and social services (2012),¹ a monitoring report on impacts to the social determinants of health during the mine construction phase (2014),² and a report on health risks and opportunities associated with Mt. Milligan in Tl'azten First Nation.³ The work of this research project continues to expand, now examining community health impacts on other extractive industry (mining, oil and gas) projects and their surrounding communities across BC.

This research addresses a key theme arising from the project's 2010 baseline study: the prevalent and persistent issue of domestic and community-level violence in Aboriginal and rural communities in BC. During this baseline study, community members identified that rural and Aboriginal women were particularly vulnerable to violence. While violence is perceived to be closely linked to the intergenerational impacts of the Canadian

residential school system and existing alcohol and drug abuse issues,¹ community members and service providers expressed their desire to prevent any adverse impacts that would exacerbate existing conditions. Some of these conditions, cited in the 2014 construction phase monitoring report, included increased levels of family violence and observations of young women being drawn into prostitution during the first year of Mount Milligan's construction phase.

1.2. Mining, oil, and gas development in BC

British Columbia has a long history of resource extraction, and arguably a significant future in this sector, as the provincial government continues to promote mining and energy as one of BC's 8 key economic sectors included in the nine-year BC Jobs Plan.⁴ Indeed, more than half of Canada's mining exploration companies are based in BC and it is the second largest producer of natural gas in Canada. Since 2001, spending on mineral exploration has grown exponentially, from \$29.1 million in 2001 to \$234 million in 2014.^{5,6} While low commodity prices since 2011 have meant decreases in exploration and development spending and gross revenues, BC maintains a resilient mining economy, with over \$8.2 billion in gross revenues in 2014⁵ and an estimated 30,000 people employed in mining or related sectors in 2013.⁴ The production value of B.C's mines was \$7.3 billion in 2014, up from just below \$7 billion in 2013.⁷ Despite current low metal prices, the BC mining sector continues to move forward. As of the summer of 2015, there are 8 metal and 6 coal mines operating in BC,⁸ and 22 new mining projects in the permitting or EA stages.⁹

Oil and natural gas development in BC is also a high profile, growing economic sector. The province is endowed with enormous unconventional and conventional natural gas resources – an estimated 2,933 trillion cubic feet. In 2013/2014 the BC Oil and Gas Commission issued 2,145 approvals, and completed 4,457 site inspections. During 2014, 697 new wells were drilled in the province, and over 3,000 km of pipeline built.¹⁰ As of 2015, there are 8 major Liquefied Natural Gas (LNG) facilities and 6 oil and gas pipelines in the EA pre-application and application phases of development. Further, according to

the BC Chief Inspector of Mines, there are at least 600 major resource projects worth an estimated \$650 billion planned in Western Canada over the next decade – many of which will be built in BC and intersect with rural and Aboriginal communities.¹¹

The system for regulating extractive industry (EI) projects¹ in BC falls under a number of provincial and federal government jurisdictions, including the Ministry of Energy and Mines (MEM), the BC Oil and Gas Commission (BCOGC), the BC Environmental Assessment Office (BC EAO), and the Canadian Environmental Assessment Agency (CEAA). Primarily, the assessment, monitoring, and mitigation of environmental, health, and social impacts related to projects is regulated by the BC EAO. It is within this process that project proponents are mandated to identify and consult with project stakeholders and Aboriginal peoples through several mechanisms, including: public meetings, open houses or forums; allowing sufficient time for review and comment on Application Information Requirements; and allowing sufficient time for review of the project's EA Application. However, communities and proponents alike still struggle to ensure that community values, concerns, and existing conditions are meaningfully incorporated into the project planning and decision making process.

1.3. Research objectives

Given the needs and research priorities set out in the *Ten Steps Ahead* project, the concerns raised by community partners, and the provincial government's strategy to further develop the BC extractive sector, it is crucial that researchers, communities, and proponents work together to better understand and mitigate the impacts of EI projects on surrounding communities. In addition, it is important that findings be aimed at making improvements to the current process of proposing, permitting, and monitoring EI projects.

This research has three key objectives:

¹ Extractive industry (EI) for the purpose of this research is defined as infrastructure and operations relating to the mining, oil, and gas sectors.

1. Synthesize findings from the academic literature and from grey literature - including reports published by international institutions, government, and community-based research reports - on women's health and safety in relation to EI development. A specific focus is on domestic violence, violence against women, prostitution, and street violence, as these were priority areas identified by the project's community partners in the baseline study.
2. Identify indicators of vulnerability of Aboriginal and rural women to violence and violent victimization in BC.
3. Use these indicators to develop a composite indicator to further identify and map Health Service Delivery Areas (HSDAs) where poor health, substance abuse, and violence is endemic and where women are vulnerable to victimization. The resulting GIS tool will provide a model for assessing and monitoring issues related to violence in relation EI projects that can enhance the current permitting and development process.

2. LITERATURE REVIEW: IDENTIFYING THE IMPACTS OF EI DEVELOPMENT ON THE HEALTH AND SAFETY OF WOMEN

This purpose of this chapter is to meet objective 1 of this study by reviewing academic literature to identify key impacts to women's health and safety in relation to EI development. Specifically, this chapter provides, (1) an overview of the current research regarding the impacts of extractive industry development on rural and Aboriginal women's health and safety and (2), how such impacts are identified, monitored, and mitigated in the context of extractive industry project approval in British Columbia, Canada. These findings, from the academic and grey literature - including reports published by international institutions, government, and community-based research reports are synthesized to identify key observed impacts to women's health and safety in relation to EI development. A specific emphasis is placed on impacts related to domestic violence, violence against women, prostitution, and street violence, as these are priority areas identified by the project's community partners.

This review will take the form of a narrative literature review to provide a comprehensive synthesis of previously published information on this topic,¹² identifying key themes and concepts.¹³ While narrative reviews offer a summarized interpretation of current knowledge on a topic and allow for the inclusion of a variety of study types (empirical, theoretical, qualitative, quantitative),¹³ the author acknowledges that such studies, including this one, are vulnerable to bias.¹⁴⁻¹⁶ These biases stem from the author's selection of studies and articles for review based on topic and the author's subjective interpretation of results. However, the aim of this review is to provide a topical overview and point to broad issues as identified by previously published work, and gain an understanding of the state of research on this topic.

The literature reviewed here includes both academic and non-academic sources that employ a variety of qualitative and quantitative techniques. The first databases searched were: UBC Summon, a comprehensive multi-disciplinary search engine including peer-

reviewed journal articles; GEOBASE, multidisciplinary database supplying bibliographic information and abstracts for human and physical geography, ecology, geology, oceanography, geomechanics, and development studies; and Google Scholar. The search included multiple combinations of the following keywords: women's health, women, Aboriginal women's health, Aboriginal women, health, gender, mining, oil and gas, extractives, extractive industry, health impacts, health impact assessment, violence, crime, domestic violence, and violence against women. Research focused on Australia, Sub-Saharan Africa, and Southeast Asia were the sources of a great deal of the peer-reviewed literature on women, health, violence, and EI. The majority of Canadian writings were part of the gray literature. Articles were selected based on relevance and the reference lists of studies selected for inclusion were scanned for additional relevant studies. A final database search was conducted using the same keywords in the Canadian Health Research Collection, a database containing primary research and reports from Canadian research institutes, government agencies and university centres in the area of health and medical research. Results yielded additional gray literature articles.

2.1. Women and extractive industries worldwide

The relationship between gender and EI development are complex and mediated by many external variables.¹⁷ A growing body of literature has examined gendered impacts and implications of extractive industry operations in developing countries. This work stems from academia, non-government organizations (NGOs), and international institutions such as the World Bank.

Several multi-country qualitative studies undertaken by the World Bank and international NGOs have reported broad observations of the impacts of EI development on women, gender relations, and gender equality in countries where mining and oil and gas companies operate. As part of the Gender and EI work program, the World Bank has undertaken a series of conferences and workshops to better understand gender issues and promote gender equality in EI.¹⁸ These initiatives revealed a range of impacts and risks to women including: lack of voice and representation in formal decision-making; loss of

ownership or use of productive land; limited control of productive resources; rise in violence, sexual abuse linked to domestic disputes, alcoholism, drug use, and gambling; rise in prostitution, HIV/AIDS, and other sexually transmitted infections (STIs); poor working conditions and incidence of sexual harassment in the workplace; loss of safety and security due to population influx; and environmental damage such as loss of forest and water sources that impact women's livelihoods.¹⁹

The 2013 World Bank report *Extracting Lessons on Gender in the Oil and Gas Sector* provided an in-depth qualitative study of low-income persons in Peru, Azerbaijan, and Papua New Guinea, exploring perspectives of men and women living in areas that are affected by oil and gas development. In general, participants perceived that oil revenues exacerbate inequality in their society. Risks tend to accrue to those who live closest to project sites, with women bearing the majority of risks, while benefits flow elsewhere in the country.¹⁷ For example, the construction of project related roads, power lines, and pipelines in previously isolated areas creates jobs and increases overall economic activity, attracting temporary and migratory workers. This in turn, according to interviewees, is associated with increased prostitution and trafficking of women, accelerated spread of STIs and local prevalence of alcohol and narcotics¹⁷. In addition, interviews gave insight into factors that make women particularly vulnerable to negative impacts of EI projects. Women are vulnerable to the increased pressure on marital relationships that often accompanies EI employment, which may lead to violence, tension, and substance abuse, and they lack of social and financial resources to leave abusive relationships. Women also reported inadequate access to law enforcement to address issues of increased violence, abuse, prostitution, and social disorder, and that calls for action are often addressed with hostility or intimidation of plaintiffs.¹⁷

In the NGO sector, organizations such as Oxfam Australia²⁰ and Mining Watch Canada²¹ similarly identify general impacts for women in communities where mining projects operate. These include a lack of prior consultation that includes women; disproportionate payment of royalties and compensation to men, further increasing women's economic dependence; an increase in domestic workload as males withdraw from traditional

subsistence activities in favour of wage labour at EI developments; the exacerbation of existing social and health problems such as alcohol and drug use, domestic and sexual violence, STIs and HIV/AIDS, and prostitution; and a high prevalence of workplace discrimination and sexual harassment when women are employed in EI projects.^{20,21}

In addition, some research indicates that growth of EI in developing countries can put women at an economic disadvantage as the increasing complexity of EI economies can undercut the value of women's traditional roles. Women from Peru, Azerbaijan, and Papua New Guinea interviewed in Scott et al (2013) perceived that the influx of oil-related money for men decreases women's power and independence within the household, in turn further reducing their ability to participate in decision making.¹⁷ In societies where women are traditionally responsible for meeting the subsistence needs of families, loss of land and resources undermines their ability to provide and increases financial dependence on male partners.²⁰ Similarly, Ross (2008) revealed a correlation between lowered gender equity and oil dependence, concluding that natural resource exploitation leads to a decrease in export-oriented manufacturing – in which women are often employed - in many countries.²² In turn, natural resource development overall decreases women's economic participation leading to weaker women's organizations and political power.

2.2. Substances, sex, violence, and extractive industries

The academic literature delves further into some of the more sensitive issues faced by women in relation to EIs. From this body of research, several negative health outcomes are consistently associated with EI projects, namely: drug and alcohol abuse,^{20,23–28} sexually-transmitted infections and prostitution,^{25,29–32}; domestic violence,^{27,33–42} and violence against women.^{39,43}

The development of EI projects is often linked to increasing levels of drug and alcohol abuse among workers and community members, the impacts of which are experienced differently by men and women. Lightfoot et al (2009) examined the relationship between

HIV and alcohol use in a Namibian mining community, revealing that alcohol use by mine workers fuelled extramarital sexual encounters and visits to sex workers and reduced the likelihood that condoms were used in sexual encounters with either sex workers or partners.²⁴ Further, qualitative interviews revealed the following key drivers of increased alcohol use: miners are emotionally stressed from being away from their families, miners are bored in remote communities with few options for recreation, high mining salaries feel like short-term disposable income to miners living on their own, and finally, the absence of female partners or relatives in mining settlements, who traditionally act as “regulators” of male alcohol consumption. The frequent purchase of alcohol with inflated mining wages and frequent binge drinking by male miners is also an issue raised by research in other parts of Sub-Saharan Africa^{25,26,44} and South East Asia^{28,41}. Papua New Guinea has received particular attention from researchers exploring the social and health impacts of EI development, and such research links beer consumption associated with mine workers with increased incidence of motor vehicle accidents and violence-related injuries.^{27,45,46} Further, alcohol consumption by males in mining communities is seen as a source of male-to-male and male-to-female violence, and is linked to proliferating and encouraging the use of male physical power and force in social situations.²⁷ While the evidence connecting increased alcohol use to EI developments is convincing and the frequency at which it is anecdotally and journalistically cited as a negative impact is alarming,⁴⁷⁻⁴⁹ there is still a need for more studies that focus specifically and longitudinally on alcohol and drug abuse in EI affected communities.

The literature on increased incidence of STIs in mining communities commonly associates this phenomenon with increasing demand for commercial sex work. Migrant labour has long been associated with simultaneously increasing the market for commercial sex work and the transmission of HIV and other STIs.²⁹ This outcome is particularly concerning for women, as they are more likely to work in the sex trade or casually exchange money for sex.⁵⁰ Desmond et al identified that women in South African mining settlements are at risk of contracting HIV or other STIs in this context due to their participation in sex work, their relative economic disadvantage compared to

men, and their often young age compared to male mine workers.²⁵ Women in turn, have little control over these risk factors as they are governed by their financial and sexual relationships with high earning male mine workers. Like alcohol abuse, the notion of increased prostitution and STI incidence in relation to EI projects is well documented worldwide.^{25,29-32} However some research in the mining industry suggests that female commercial sex work is not as widespread in EI communities as assumed, and that women participating in sex work are not necessarily “victims” of mining.³¹ Rather, sexual relations in mining communities undergo rapid sociocultural changes involving men and women making a variety of sexual, material support, and cohabitating arrangements. Bryceson uses the example of “mining wives” – extramarital partners of miners – in Tanzanian mining settlements, who are employed outside of the sex trade and exchange their company and domestic labour for financial and material support just as much as they exchange sex.³¹ While this can involve multiple partners, increasing the risk of STI transmission; or abuse, putting women’s safety and health at risk; these arrangements do not always result in negative health outcomes or economic disadvantage for women.

Increased levels of domestic and community violence are one of the most commonly cited impacts of EI development in both the academic and gray literature. Women are affected by, and concerned with increasing incidence of violence in both the developing and developed world,³³ so much so that this impact, and the idea of women as “victims” of EI has become a staple in the literature.³⁴ The authors acknowledge the inherent flaw in this position, as it mistakenly homogenizes women into a single category without exploring important elements of ethnicity, class, or social relations.³⁴ However, it is important to review how these literatures have employed a broad gender lens to identifying community-level impacts in order to design appropriate mitigation strategies that do indeed consider the diverse ethnic, socio-cultural, and economic needs of women in rural EI communities. Violence in EI communities effects men, women, and families, with studies pointing to increased incidence of male-to-female domestic and intimate partner violence,³⁵⁻³⁸ community-level male to female sexual assaults^{39,40}, and male-to-male street violence and assaults.^{27,41,42}

Domestic violence perpetrated by males towards females is a recurring topic in the academic literature, and is commonly connected to substance abuse, women's financial dependence on male partners, and women's rigid role in some societies as domestic and subsistence labourers.²⁷ Women, according to Scheyvens and Lasiga (1998) experience exclusion from land-use decision making and are controlled by their partners through domestic violence as a deterrent for becoming involved in the planning and distribution of benefits processes of mine development.⁵¹ Qualitative research based on interviews with miners and female community members in the mining sector in Papua New Guinea reveals domestic violence as a serious community and women's health issue.^{27,41,51} While such violence is partially a product of existing gender relations, socio-economic and cultural status in rural Papua New Guinea society – described by MacIntyre (2008) as a “mundane part of social life in [Papua New Guinea]” – research strongly suggests that domestic violence is fuelled by increased alcohol consumption by male mine workers.^{27,39,51} In fact, women's exclusion from mine wage labour and the direct control of wage earnings by male workers is linked to increased spending on alcohol and drugs and extramarital sex and resulting conflicts between male and female partners over household finances and relationships.^{39,41} Similar conditions are observed in Central Kalimantan, Indonesia,⁴² the South African platinum belt,⁵² and India.^{40,53} The work of D'Souza et al (2013) that compared mental health and well-being in women in mining vs. agricultural-centred villages in India demonstrated that communities reliant on EIs such as mining may even be associated with poorer health outcomes than other rural communities. Women in mining communities reported higher levels of domestic violence and mental health conditions and poorer physical health than their counterparts in a nearby agricultural community. Age, marital duration, poverty, existing gender inequalities, and partner's employment status emerged as risk factors in women's exposure to domestic violence.⁴⁰ Although strong links between domestic violence and involvement in EI are difficult to draw at the population level, collecting observations from women who live and work in EI communities gives valuable insight into how women experience impacts from EI development.

Research from Australia regarding mining operations in Western Australia and the Bowen Basin also exemplifies domestic and intimate partner violence as a key issue for women in EI communities located in high-income countries. Rural resource-based communities in Australia are historically associated with high rates of violence-related morbidity and mortality, irrespective of the current gold and coal mining booms.⁵⁴ Aside from being associated with massive influx of mainly male workers, overwhelming of social services, and increased cost of living,^{55,56} the boom is correlated with increased incidence of domestic and intimate partner violence,³⁵⁻³⁷ increased male on male street violence,^{54,57} and a perception of increased crime and deterioration of public safety.^{43,58,59} Interview-based qualitative research in remote Australian mining communities reveals that women who have a partner in the mining industry are more likely to experience intimate partner abuse or domestic violence.^{36,37,60} In these instances, a partner in the mining industry is a predictor of a women experiencing domestic violence or abuse. However, other covariate predictors include alcohol and drug use, the male partner's level of education, age, relationship status, and smoking status. Factors and socio-cultural settings influencing such high prevalence of violence and abuse include: stress from fly-in-fly-out (FIFO) or 12-hour "block roster" shift work affecting relationship well-being;^{38,60} changing socio-demographics that disrupt gender dynamics and social structure,^{55,61} and individual and family stress and coping strategies.³⁸

Outside of the home, some evidence demonstrates that some of the same factors that fuel domestic violence (alcohol and drug abuse, demographic gender imbalance, inequitable gender relations) are linked to increased incidence of sexual assaults and rapes on women in EI communities.^{39,53} A prime example of this is Barrick Gold's North Mara property in Tanzania, where members of private security forces and police guarding mine assets raped and assaulted 14 local women.⁶² Cases like these receive heavy media attention, as do community perceptions of increased risk of sexual assaults on women in EI communities.⁴³ However, due to the sensitivity of this topic there is little empirical data to support this, and few studies have attempted to track incidents of sexual assaults in EI communities over time.

The perception of community crime and safety is also related to the presence of EI developments, particularly in arrangements involving FIFO workers. Rapid population growth due to EI workers in Australian mining towns shows not only a rise in local crime rates, but also a change in the perception of crime and safety by male and female residents.^{63,64} This, according to Carrington et al (2012), creates a sociocultural transformation, where residents perceive their community as changing from a “rural” to “mining” town, characterized by a masculine frontier culture⁵⁷ that erodes perceptions of community safety and makes women, children, and youth feel more vulnerable to violence and crime.^{43,54} This in turn, creates social divides where public violence is associated with certain groups – in the case of Scott et al (2012) and Carrington et al (2012), FIFO workers, non-resident workers, and Indigenous people. Interestingly, these “visible” forms of violence are often male on male assaults related to alcohol-fuelled bar brawls and street assaults and the presence of work camps.^{54,63} While Carrington (2010) asserts that these incidents are closely linked to cultures of masculinity and how male residents perceive their place in them, they appear to also impact the way that female residents perceive their own safety.^{54,63} As discussed in the following section, this is a key finding of many reports in the gray literature, through which women in EI communities have long voiced their concerns on health, safety, and family life.

Even considering that women in EI communities are at higher risk of experiencing violence, that they identify it as a key concern, and that they perceive their personal safety to be at risk in relation to EI workforces, there is still a lack of empirical and longitudinal studies in the academic literature to support these contentions. Further research exploring how women experience violence over the lifecycle of EI projects is required to truly detangle how and why women are at risk and what mitigation measures should be implemented.

2.3. Women and extractive industries in Canada

Literature on the impacts of EI on women in Canada is sparse. In fact, within the academic literature, there are almost no studies that specifically focus on health and

safety impacts of EI development for women living in communities surrounding EI projects. One exception to this is a 2013 project undertaken with the Pauktuutit Association of Inuit Women and academic partners at the University of British Columbia (UBC). This quantitative participatory study, *The Impact of Resource Extraction on Inuit Women and Families in Qamani'tuaq, Nunavut Territory* is one of the first participatory academic studies on the impacts of EI development on Aboriginal women.⁶⁵ UBC researchers facilitated participatory action research led by women from Qama'ni'tuaq, collecting and analyzing both qualitative and quantitative data with the overarching goal of better understanding the impact of the Meadowbank Mine in Nunavut on Inuit women in three capacities: as mine employees, partners of mine employees, and community members. The key impacts identified were family stress and the erosion of interpersonal relationships due to shift work, increases in domestic violence, increased alcohol consumption and spending on alcohol and, that these issues and the lack of services to address them, negatively effected women's ability to participate in mine employment. Baseline health data indicated that these issues were already prevalent on a regional level, a common narrative in the Canadian north where rates of violent crime, domestic and family violence, drug and alcohol related abuse are far higher than national or provincial averages.⁶⁶ However, as in many other jurisdictions discussed below, participants perceived that these issues would become worse. In fact, examination of vital statistics for Qama'ni'tuaq demonstrate that between 2009-2011, a period covering the peak construction phase and beginning of operations, permits issued for importing alcohol increased by 100%.⁶⁵ A key observation underpinning many of the findings was the importance of funding community services designed to deal with arising social issues before or in anticipation of negative social and health impacts of mining operations. Results indicate that retrospectively designing and implementing support services after issues arise forces these services to have to "catch up" with demand very quickly, resulting in the exhaustion and overextension of services and providers. In essence, this project reveals that remote Aboriginal communities are under existing stress; when confronted with EI developments that bring further change, already stressed resources cannot appropriately respond.

Although there are few peer-reviewed studies that focus on health and safety impacts of EI development for women in Canada, several studies address health and safety impacts that are relevant to women without specifically employing a gender lens. Research on EIs in BC in particular suggests that while positive economic benefits such as employment and small business opportunities may be realized at the community level, economic dependency makes communities vulnerable to adverse impacts during periods of rapid industrial growth (“booms”) and downturns (“busts”).⁶⁷ The work of Shandro et al (2011) examined community health impacts during boom and bust periods in a northern coal mining community in BC.⁶⁸ In general, both boom and bust periods were associated with increases in family violence, stress, violence towards women, and addictions. During boom times, women experienced increased rates of STIs, a lack of adequate maternity services to address an increase in pregnancies, as well as increased violence against women. Family well-being was especially strained during bust periods, characterized by increased violence, stress, divorce, and separation. The work concluded that in times of rapid industrial changes both in a positive and negative direction (i.e., during both booms and busts) industry, impact assessors, and policy makers should focus on improving family counseling services; ensuring women have access to adequate health care; enhancing drug and alcohol policies; and guaranteeing that the company’s presence does not overburden local health systems.

Communities associated with EI in Canada have been identified as particularly susceptible to substance abuse issues due to their isolation, income disparities and social inequality, highly transient populations that have difficulty accessing social and health services, and high levels of disposable income.⁶⁹⁻⁷¹ A number of historic and contemporary studies have examined increasing alcohol and drug abuse in communities associated with EI development. In the late 70s Mucha⁷² explored drug and alcohol related impacts of the proposed Alcan Pipeline that followed in 700m stretch of highway from northeastern BC. The study indicated that rapid growth of large scale industrial projects were indeed characterized by increased alcohol consumption in the community in general and the introduction of illegal drugs brought in by the incoming workforce, and that this in turn increased demands for health and social services that providers could

not meet. Thirty years later, BC's Chief Medical Health Officer conducted a similar qualitative study interviewing public health officials in Fort Nelsen, Chetwynd, Tumbler Ridge, Dawson Creek, and Fort St. John to determine population health issues associated with the oil boom.⁷³ Similar results were revealed, including that health incidents in the community as a whole related to alcohol and drugs, particularly cocaine and methamphetamine, were on the rise and posing a serious public health and safety challenge. These can be an issue where multiple projects have a cumulative effect on services, as is demonstrated in the case of Fort McMurray, Alberta.⁷⁴

A number of other Canadian studies have drawn attention to the impacts of EI developments on community-level sexual health. Increased incidence of STIs, commercial sex work, and "risky" sexual behaviours are identified as key impacts associated with the influx of EI workers.^{75,76,77} These are related to the unique set of socio-cultural conditions associated with boom towns, such as presence of a highly mobile workforce, binge partying, high levels of disposable income, and resulting gendered power dynamics are shown to exacerbate existing sexual health inequalities between males and females and between youth and mature adults.^{75,65} For example, young women can lack power in negotiating safe sex practices with older and wealthier male partners. Conversely, the presence of few women in towns with burgeoning populations of male workers and jobseekers can also be a source of sexual power for women, who may be involved with multiple partners and be able to negotiate the conditions of these relationships in their own favour.⁷⁵ These works concluded that there is a need to further identify sexual health implications of EI in remote Canadian communities, that socio-cultural conditions in remote boomtowns are linked to negative sexual health outcomes, and that sexual health outreach and programming should specifically target the EI workforce.

Finally, there is evidence that, similar to the international context, Canadian communities associated with EI also demonstrate elevated levels of violence. A survey-based study on gendered violence in Fort St. John⁷⁸ demonstrated a shockingly high prevalence of women and girls who had experienced violence in the community – over 90% of female

Aboriginal respondents said they had experienced violence in the past. In particular, Aboriginal women, women who consumed drugs and alcohol, women living in poverty or geographic isolation, and teenaged girls were identified as “most at risk” of violence. In addition, the study identified that Fort St. John’s current health and social service system had severe service gaps for at-risk women and for men who commit violence. As part of a community plan for addressing these findings the study recommended that furthering education and increasing services would help to prevent violence against women.

Some research links elevated levels of violence in EI communities with the “social disruption proposition”;⁷⁹ the premise that growth and rapid economic and industrial change disrupts normal patterns of interaction and the conduct of newcomers is less likely to be influenced by informal social control.⁵⁹ The type of growth experienced by resource-based towns is described as fundamentally different than population growth in other rural communities, as it is characterized by the “influx of young men with little stake in the community, [and] is likely to have significantly higher levels of crime.”^{57,59,80} This boomtown narrative has long been criticized that scholarship is based on journalistic and anecdotal accounts rather than crime and policing data.^{81,82} Ruddell (2011) addressed this in a study of Fort McMurray, Alberta and noted that between 1986-2009, the first 20 years of the oil boom, criminal code offences increased substantially, putting strain on police resources.⁵⁹ The rates of crime in Fort McMurray per police officer were three times the national average by 2009, while ratio of police officers to residents was below the national average for 20 years. This study, however, is one of few in Canada that quantitatively examine crime data in relation to EI development in rural communities.

2.4. Linking Aboriginal health to land use change and extractive industries

The peer-reviewed literature is thin on the topic of Aboriginal women’s health and EI developments in Canada. However, there is ample evidence demonstrating that the health of Aboriginal people is greatly impacted by environmental and socio-economic change at the community level. The well-being of Aboriginal communities is linked in part to what

is referred to by Angell and Parkins⁸³ as “cultural continuity” - a unique set of beliefs and practices that sustain Aboriginal people physically, socially, and spiritually. In general, research on this topic recognizes that rapid, large scale landscape changes are associated with cultural discontinuity and can result in elevated rates of depression, substance abuse, suicide, and violence. For example, the work of Chandler and Lalonde shows that suicide rates in Aboriginal youth and adults are lower in BC’s Aboriginal communities that have retained access to their traditional culture.^{84–88} However, few studies have been done on the link between EI development and cultural continuity in impacted Aboriginal communities. In one of the few studies undertaken of this kind, Gibson and Klinck (2005), assert that the mining industry in particular can negatively effect mental stress, addiction, substance abuse, hunting and diet, family integrity, gender equity, and maintenance of traditional culture in Aboriginal communities. Many of these factors, according to the author, are mediated by individual and community resilience, and those factors that effect resiliency require greater attention in the EA process.⁸⁹

Aboriginal people’s health is also strongly impacted by social and cultural characteristics of their communities.^{90,91} For example, access to cultural sites and traditional diets and regulatory changes in land use are demonstrated to profoundly affect health outcomes such as mental and sexual health and well-being in Aboriginal people.⁹² Further, the capacity of indigenous people to heal from intergenerational health impacts of colonialism such as community and family violence, abuse, substance abuse, and addiction, are closely tied to relationships with traditional lands and the quality of indigenous land bases.⁹³ Australian researchers similarly identify that indigenous health outcomes are closely linked to land use and environmental change. Environmental degradation is linked to psychological stress and poor mental health,⁹⁴ while indigenous participation in traditional natural resource management is perceived to improve community health and well-being.⁹⁵

EI impacts on Aboriginal health have also been explored at the institutional level by the now disassembled National Aboriginal Health Organization (NAHO). In a report on the disruption of community dynamics in Inuit communities as a result of large-scale

resource extraction projects, NAHO recognized that EI projects are linked to mental health issues, homicide, increased STI incidence, fetal alcohol spectrum disorder, and violence. In relation to women, NAHO asserted that EI project development can exacerbate existing issues of substance abuse and crime, youth prostitution, and violence against women.⁹⁶

2.5. Capturing and addressing violence, poor health, and substance abuse in environmental assessments

Since the implementation of the Canada-British Columbia Agreement on Environmental Assessment (EA) Cooperation in 2004, proponents for projects requiring both provincial and federal EAs have been able to submit a single EA application that meets the requirements of both federal and provincial EA agencies.⁹⁷ This means that proponents are permitted to submit a single document to both agencies, but it must meet the Terms of Reference outlined by CEAA and the Application Information Requirements outlined by BC EAO. Both federal and BC provincial EAs use a Valued Components framework for assessment of potential impacts. Valued Components (VCs) are components of the natural and human environment that are considered by the proponent, public, Aboriginal groups, scientists and other technical specialists, and government agencies to have scientific, ecological, economic, social, cultural, archaeological, historic, and other importance.⁹⁸

In accordance with the BC *Environmental Assessment Act* (2002), an assessment is required to consider the environmental, economic, social, heritage, and health effects of a reviewable project, using VCs to gauge the project's overall impacts.⁹⁸ Once a project is determined to be reviewable under the requirements in the *Environmental Assessment Act*, the EA process is triggered. For most new mining, oil, and gas projects in BC, a federal assessment under the CEAA is also required and a harmonized provincial-federal process is triggered. This means that federal and provincial agencies agree to carry out a single cooperative environmental assessment but each maintains its own decision-making powers. For BC, the process consists of a pre-application stage where scope and application information requirements (AIR) are determined and the application is

submitted; a review stage where the BC EAO reviews the application, writes a report on their findings, and forwards it to the Provincial Minister of Environment for decision; and a decision stage where the minister either approves the project and prescribes conditions or rejects the project.⁹⁹ The provincial process and its basic timeline are outlined below in Figure 1.

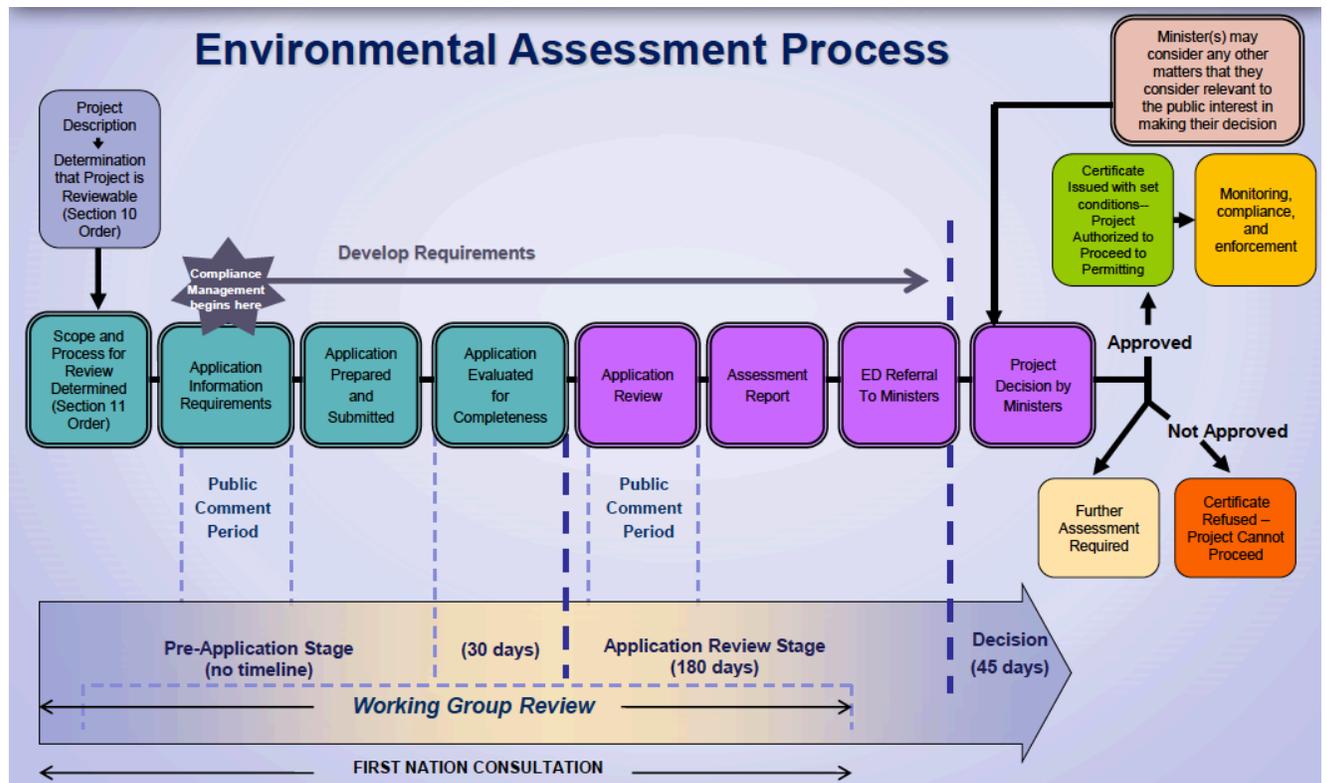


Figure 1: Summary of the BC Environmental Assessment Process⁹⁹

This system as it stands, often fails to fully consider the social determinants of health or long-term health impacts of EI developments in surrounding communities. This is true across several national jurisdictions including the US.^{100,101} Rarely are health impacts beyond immediate exposure to environmental toxins considered during EI project planning, permitting, and approval.¹⁰² Inclusion of health determinants is limited to brief description in baseline studies and impact predictions, with follow-up health monitoring not treated with the same rigour as the monitoring of environmental impacts.¹⁰³ In fact, there is no agreed upon methodology across Canadian jurisdictions by which health is considered in environmental assessments.¹⁰⁴ Canadian Provinces and territories generally

include health as a required consideration in EA, but each have their own standards for doing so. At the federal level, methodological guidance is narrow as the only processes that have been adopted into practice concern human health risk assessments for contaminated sites.¹⁰⁴ A number of authors have criticized the lack of consistent integration of health in practice across the EA process. The work of Bronson and Noble (2006) surveyed government and EA health authorities, consultants, Aboriginal organizations, and proponents to determine perceptions of the extent to which health determinants are considered in northern EAs in Canada.^{105,106} Results indicated that while community health is somewhat addressed in the majority of EAs, the focus is limited to the pre-decision stages and not addressed in post-decision monitoring and follow-up. Noble (2011) refers to follow-up monitoring that does occur is referred to as “comfort monitoring”, as it successfully improves community-industry relations and enhances corporate image but in practice involves little implementation of mitigation.¹⁰⁷ A key finding of this research is that there is clear and statistically significant disconnect between Aboriginal people, EA practitioners, and health practitioners on the extent to which health impacts are incorporated into EA and the performance of EAs in considering impacts to health determinants. This finding is well aligned with those described below in the Canadian gray literature – that the current processes for assessing EI projects contain critical gaps in systematically and consistently considering social determinants of health.

As early as the mid-90s, Aboriginal and rural women in Canada have expressed their concerns about the impacts of EI development on their health and safety through involvement in the Canadian federal and provincial EA processes. As in the case with the international literature on this topic, alcohol and drug use and family and community violence were consistently identified as impacts. In 1995, the Status of Women Council of the North West Territories (NWT) reviewed the Environmental Impact Statement (EIS) for the proposed BHP/Diamet mine at the request of women in surrounding Aboriginal communities of Wha Ti, Lutsel K’e, Coppermine, Rae and Rae Lakes. The study, involving interviews and discussion groups, focused on socioeconomic impacts to women living in remote communities, who felt that the EI study did not adequately

capture their experiences as rural and largely Aboriginal women.¹⁰⁸ Qualitative research revealed that women were deeply concerned about the impacts of increased drug and alcohol abuse on family violence and child abuse that they perceived would be exacerbated by increased access to alcohol and drugs. Further, women asserted that this issue limits the potential for positive impacts of the project to be realized from the EI project, as it affects the capacity of people to acquire and retain employment and manage their finances.¹⁰⁸ As resource extraction continued to expand in NWT, the council conducted a similar review of the EI study for the Diavik mine in 1998, yielding similar sentiments from female community members in Yellowknife. Social impacts identified by women in this case included increased substance abuse and gambling, increased strains on families and marriages, increased family violence, increased incidence of STIs.¹⁰⁹ In addition, they pointed to a desperate need to expand social support and counseling services on-site and in communities to help mitigate these issues. Similarly in 1999, the federal institution Status of Women Canada examined socio-economic components of EIS for the Voisey's Bay Nickel Project in Labrador.¹¹⁰ The EIS for this project looked at existing – and rather dismal – community-based studies that revealed extremely high levels of violence against women, violent crime, child abuse, poor health status, and substandard housing in a number of surrounding Inuit communities. These studies were then used to support the idea that the project would remediate some of these conditions. In fact, women from these communities anticipated that the project would exacerbate violence against women through increasing family stress from shift work and alcohol consumption, and lead to further violence in the home. Consistent in all of these reports is dissatisfaction from women with the way their concerns are represented in the EA process and the way this process captures issues of alcohol and drug abuse and violence. In addition, it links closely with the notion that while EI projects and natural resource “booms” provide opportunities for development, they may come with acute hazards for communities and women residing in them. It is essential that practitioners develop standardized methods of examining these impacts to ensure high-quality, health informed EAs for such projects; EAs that put community health at the centre of the assessment.

The movement for addressing women's concerns on community health and safety in relation to EI projects gained further momentum in the early 2000s as NGOs began partnering with local women to explore the impacts that women felt while living in communities near operating EI projects. In 2000, the Yukon Conservation Society and Yukon Women's Council released the report of a workshop identifying impacts to rural women's health and environments. This report identified family violence, debt, drug and alcohol abuse, and increases in STIs and unwanted pregnancies as key impacts experienced by women in mining communities.¹¹¹ In 2004, Mining Watch Canada partnered with women's advocacy groups to consider mining-related health implications for women living in Labrador West.¹¹² Participants described the overwhelming impact that shift work had on social and family life, saying that shift work was the primary source of family disruption and marital stress. Women perceived that incoming mine contract workers were largely male, and linked this to perception of a "higher than normal" amount of sexual assaults. In addition, they observed increases incidence of addictions and depression. Health professionals observed rises in family violence child abuse since mining operations began at the Iron Ore Company of Canada and Wabush Mine sites, though this was partially attributed to increased health education and awareness activities. While both of these studies were useful in identifying perceived impacts and key areas of concern that need further investigation, they are not generalizable as they did not include baseline assessments of health status and determinants and focused heavily on perceived concerns rather than more objectively measureable parameters.

2.6. Health of rural and Aboriginal women in Canada and British Columbia

On an international scale, Canada performs poorly in terms of health equality between men and women, ranking 100 out of 142 countries in the "health and survival" category of the Global Economic Forum's Global Gender Gap Report in 2014. This ranking is based on the statistical evidence that Canadian women have higher life expectancy and lower disease morbidity than men.¹¹³ However, comparing rural and Aboriginal women to their urban counterparts paints a different picture.

Rural and Aboriginal women in Canada are among the most vulnerable in society, and their health is often under-investigated.¹¹⁴ Rural populations have unique demographic, economic, and social characteristics with respect to health determinants, and are known to have generally poorer health status than Canadians living in urban areas.¹¹⁵ Rural women in particular exhibit higher mortality and fertility rates, lower workforce participation, and a higher risk of mortality and morbidity related to motor vehicle accidents, suicide, poisoning, diabetes, and cancer compared to their urban counterparts.¹¹⁴⁻¹¹⁶ Compounding this, women living in rural and remote communities have less access to health care and social services to address health challenges. In accessing health care, rural women face both physical obstacles related to transportation to health facilities that meet their needs and wait times to see physicians and specialists; as well as social obstacles, related to accessing care and providers that are respectful to their gender, culture, experiences, and perspectives.¹¹⁴

Violence against women, mental health issues, and substance abuse among rural women are critical health challenges in rural communities. Rural women are more likely than their urban counterparts to experience domestic and community violence, and have fewer resources to help them escape violent situations.¹¹⁴ According to the most recent Statistics Canada data, Police-reported violent crime against women living in rural areas is higher than in urban areas and for each male victim of violent crime in rural areas, there are 1.15 female victims.¹¹⁷ Women in both urban and rural areas are also unlikely to report being victims of violent crime to police: among female self-reported victims of violent crime in 2009, only one third of women reported the incident to police.¹¹⁸ At the national level, Statistics Canada data indicates that rates of intimate partner violence and non-intimate partner violence against women are higher in non-census metropolitan areas (including small cities, towns, and rural areas) than in census metropolitan areas.¹¹⁹ Women in rural communities are also more likely report addiction and substance abuse issues, low self-esteem, and being involved in dysfunctional or abusive relationships.¹²⁰ Some research has pointed to hyper-masculine rural culture¹²¹ and negative attitudes

towards women's roles¹²² as sociocultural conditions that contribute to rural women's poverty, exposure to violence, and high prevalence of mental health issues

Aboriginal women in BC face unique vulnerabilities and challenges with respect to health, as their health status is poor compared to non-Aboriginal women. Poverty rates for Aboriginal women are twice that of non-Aboriginal women and they are five times more likely to be single parents.¹²³ Aboriginal women also give birth at younger ages than non-Aboriginal women in BC: in 2007, the rate of pregnancy among women under 20 years old was nearly four times higher for First Nations women than for other BC women.¹²⁴ In terms of sexual health, Aboriginal women are three times more likely to contract HIV/AIDS than non-Aboriginal women. Recent research attributes this to largely to trauma from poverty, experiences with the residential school system, and exposure to violence. This is especially concerning as Aboriginal women are greatly impacted by violence and abuse, having a higher likelihood of being victimized than the rest of the female population.⁶⁶ Aboriginal women in BC are three and a half times more likely to experience domestic or community violence than non-Aboriginal women.¹²³ In 2008, the BC Provincial Medical Officer reported that Aboriginal women were among the most vulnerable to sexual assaults and had a reported rate of spousal violence that was three times higher than the rate for non-Aboriginal women.¹²⁵ Factors that increase the risk of violence for Aboriginal women include exposure to systematic social and economic consequences of colonization and the residential school system¹²⁴ geographic isolation, lack of access to services, lack of transportation, and poverty¹²⁶ – conditions common to rural areas of BC where EI projects operate.

The clear and shocking health inequalities faced by rural and Aboriginal women make them especially vulnerable to the potential impacts posed by EI projects. Considering that the literature reveals that health existing community health issues are perceived to be exacerbated by EI development in both international and Canadian contexts, it is essential that the project permitting and approval processes consider community health and safety implications for women.

2.7. Conclusions

The review of the current literature identifies a number of health outcomes that are experienced by women living in resource-based communities. Extractive industries are associated with:

- Increasing economic dependence on male partners
- Loss of land and resources
- Increased drug and alcohol abuse
- Increased incidence of STIs
- Elevated levels of prostitution
- Poor mental health compared to other rural communities
- Elevated levels of male-on-male violence and assault
- Increased incidence of domestic violence and intimate partner abuse
- Increased stress on family relationships and well-being due to shift work

These impacts are representative of an important notion that proponents, communities, and EA practitioners should consider: that there are both benefits and risks associated with natural resource booms, and that they are being largely excluded from consideration during the EA process. Violence against women fuelled by increased use of drugs and alcohol and a perceived lack of safety for women in EI communities are key findings throughout the literature, particularly the gray literature that relies heavily on observations of women living in EI communities. Given the rural and Aboriginal women are experience elevated levels of violence and have less access to health and social services, they are especially vulnerable to these impacts as they relate to existing and proposed EI projects. The current EA process does not adequately address these issues in pre-application or monitoring and follow-up stages. Without considering issues of concern to communities, we risk further marginalization of the people most vulnerable to impacts. This in turn, erodes the long-term sustainability of both extractive projects and the communities they operate in.

While the potential negative impacts as outlined by the literature are clear, the counterintuitive notion is that EI developments that are meant to produce positive local social, economic, and cultural outcomes may produce negative outcomes in the context of rural and Aboriginal communities. This review has shown also that the EA process, does not, as currently constituted, measure the potential impacts of EI on women's health and safety. Nor does it have a standardized methodology for the incorporation of health and vulnerability in identifying and assessing impacts. This shortcoming persists despite the fact that, as shown by the literature and the studies conducted for the *Ten Steps Ahead* project, women from these communities continuously attempt to draw policy makers' attention to this issue.

One way forward to improve the EA process concerning these issues is to develop a method to more adequately assess the vulnerability of various regions facing EI development. The following chapters of this study will focus on developing a quantitative indicator of regional vulnerability to increased violence in association with EI projects. While the proposed tool does not address methodological difficulties of estimating specific impacts of EI at the geographic level of individual communities, it does at least provides estimates of regional vulnerability that may eventually be adapted to finer geographic units. It proposes a methodology and set of indicators that can potentially be reproduced at the community level and within other jurisdictions.

3. DEFINING AND MEASURING VULNERABILITY

3.1. What is vulnerability?

Vulnerability can be defined as the state of an individual or population being at risk of a certain disease or event, with the factors determining risk related to environmental, psychosocial, psychological, or physiological conditions. While everyone is vulnerable at some point in their lives, some individuals or groups are more vulnerable to developing health problems than others.¹²⁷ In the context of this study, vulnerability is considered to mean the vulnerability of populations, rather than individuals, within a specific geographical region to experiencing violence-related adverse impacts of an EI project. One particularly relevant perspective on vulnerable populations comes from Brownridge in his book on violence against women in Canada.¹²⁸ Brownridge describes vulnerable populations as “groups of individuals who share some common characteristics not held by the rest of the population, who are uniquely vulnerable with respect to risk and/or experiences surrounding violence”.

Vulnerability of populations is a key concept in understanding the existence of differentiated impacts of phenomena on various groups in a society.¹²⁹ It takes into account people and the differences among them in order to analyze social situations and predict how people’s circumstances change or can be changed by an event,¹²⁹ and how different factors affect overall risk.¹³⁰ Vulnerability is often described in negative terms, as the susceptibility to be harmed by an event or phenomenon.¹³¹ It focuses on limitations or lack of access to resources that would or could help people recover from an environmental change. Such resources, including economic, infrastructural, social, political, and ecological, are not equally distributed in societies. Therefore in a given event or situation, people in different social groups are affected in different ways.¹³²

While the greater concept of vulnerability is relatively uniform across disciplines, the way it is described naturally varies between fields of study and practice. In the health field, vulnerability is understood to be effected by both personal factors – genetics,

lifestyle, socio-economic status, gender, race, age, ethnicity – and environmental factors – family, community, society, pollution, hazards.¹²⁷ The state or experience of vulnerability in turn affects psychological, physiological, and social functioning and can lead to certain groups being more likely to experience a negative health outcome. In the environmental field, the concept of social vulnerability is often utilized in assessing an area or system's sensitivity and ability to adapt to environmental shocks such as natural disasters.¹³¹ Social vulnerability refers to the resilience of individuals or communities when confronted by external stresses on human health, such as natural or human-caused disasters, or disease outbreaks.¹³³ This concept is also applied to long-term, “slow acting” phenomena such as climate change.

3.2. Measuring vulnerability

Vulnerability of populations, as opposed to individuals, is often studied using social indicators. Since the 1960s, social indicators have been employed in social science, health, and environmental research.¹³⁴ Common social indicators associated with vulnerability (to various phenomena, including adverse health outcomes) are gender, age, ethnicity, income, and education.¹³⁵ However, there is no definitive set of indicators that measures health or social vulnerability across disciplines and each study must choose and justify its own indicators based on study goals.^{133,136}

Assessing vulnerability can be done in a number of ways. A method often employed in international development and disaster and emergency management is the use of composite indices to estimate the vulnerability of populations living in certain geographical areas. When assessing a population's vulnerability to natural hazards and disasters, physical factors – such as elevation, soil composition, and average precipitation - of the geographic area in which a population resides are also considered. A composite index is a measure used to quantify concepts that are not easily captured by any single indicator.¹³⁷ Many indices of vulnerability aggregate a number of different indicators to create one end value that can be used to compare the vulnerability of populations across regions.^{133,138–141} National indices of social well-being, or lack thereof, have long been

employed on a global scale. As early as the 1970s, the United Nations Research Institute for Development began measuring poverty using a composite economic indicator that included variables such as employment, education, access and consumption of energy and telecommunications, and multi-sector production to create the first general index of socioeconomic vulnerability in a study entitled *Contents and Measurement of Socioeconomic Development*. In the 90s, the discourse and measurement of development shifted yet again from socioeconomic development to the more holistic concept of human development. A well-known example of this is the United Nations Development Programme (UNDP) Human Development Index (HDI), which measures human well-being across countries by aggregating measures of life expectancy, income, and education in effort to measure human well-being without relying solely upon poverty.¹⁴¹ Similarly, the UNDP Gender Development Index measures gender inequality between countries by creating statistical penalties for gender gaps in any of the categories on the HDI. Since the creation of the HDI in 1990, index methodology continues to primarily adopt this multidimensional approach and is becoming more and more utilized at national, regional, and community levels.¹⁴² At the national level, governments create their own regional socioeconomic and health indices. Some examples are the Child and Youth Well-being Index that measures well-being trends among children and youth from the United States (US);¹⁴³ and the Social Vulnerability Index developed by the US Agency for Toxic Substances and Disease Registry that uses US Census data to rank each census tract on 14 social factors to help identify communities that need support in preparing for and recovering from natural hazards and disasters.¹⁴⁴ These types of tools are utilized in the policy, planning, and public health fields as they provide a simple way to quantify and compare complex, multi-dimensional constructs over time and space.¹⁴⁰

In BC, socioeconomic indices were created by the provincial government in 2012 to summarize regional social and economic conditions into a single composite indicator within the province. These indices, which include overall socioeconomic, crime severity, health problems, education concerns, and human economic hardship, are intended to identify regions that may be experiencing high levels of socioeconomic stress.¹⁴⁵ To date however, there is no socioeconomic or well-being index that describes the vulnerability

of women to violence or to any other socioeconomic, health, or environmental stressors. A major contribution of this study working towards refining a composite indicator to assess the vulnerability of women to violence and the existence of health and substance abuse stressors for 26 Regional Districts and 86 Local Health Areas (LHAs) in BC. Unlike Regional Districts, LHAs can be easily combined into their parent Health Service Delivery Areas (HSDAs) and additional data on these larger areas can be accessed for further analysis.

3.3. Vulnerability indices, GIS, and impact assessment

3.3.1. Using vulnerability indices in GIS applications

Geographic Information Systems (GIS) can be a useful tool for identifying vulnerability with spatial associations in a number of disciplines. In disaster and emergency management, vulnerability assessments involving indexes are often mapped as a way to visually represent the resulting data.^{133,136,138,146–148} In these studies, the index calculations are completed, grouped into classifications, and then mapped, generally using GIS software. The most well-known example of this is the Social Vulnerability Index model developed by Cutter et al in 2003. This model, based on a hazard-of-place framework, was developed using data from the US census to quantify a county's social vulnerability to environmental hazards (such as floods, earthquakes, or hurricanes). Indicators from the census are summed into a composite indicator, mapped, and classified using standard deviation from the mean.¹³³ The resulting map identifies “hotspot” counties where people lack social, economic, and political resources that would help them recover from a natural disaster.

In public health, vulnerability indices mapped using GIS can help identify risk and protective factors within a population or individual's environment. Subsequently, targeted interventions to both address risk factors and allocate resources to areas with the greatest risk and can be carried out. This concept is has been utilized in the fields of

addictions and substance use research,^{149,150} the transmission and prevention of vector-borne disease such as dengue fever,¹⁵¹ and exposure to environmental toxins.¹⁵²

Of particular relevance to this research are vulnerability assessment initiatives that seek to assess the vulnerability of geographic areas to socioeconomic phenomena rather than physiological exposure to a toxin or hazard. Such initiatives attempt to predict vulnerability to negative health outcomes resulting from an event, policy, or phenomenon that is complex, ongoing, and somewhat intangible. For example, researchers at the Kansas Health Institute developed a vulnerability index to predict which counties would be most vulnerable if medical marijuana dispensaries became legal, as part of a larger Health Impact Assessment (HIA) on medical marijuana use conducted by the state. This study identified 13 vulnerable counties based on indicators such as existing drug use among youth, crime, and socioeconomic status. Such an assessment offers policy makers the opportunity to predict where people are most at risk to the negative outcomes associated with the legalization of medical marijuana.¹⁵⁰

Some researchers have also created mapped vulnerability indices relating to violence and conflict. Mossin (2013) assessed regional vulnerability to interethnic conflict in relation to aid allocation in Kyrgyzstan based on three variables: presence of different geographically concentrated ethnic groups; scarce natural resources; and a high percentage of young, unemployed, and unmarried males.¹⁵³ The result was a predictive vulnerability model that identified areas that, while not currently experiencing conflict, may be prone to inter-ethnic violence based on known factors. Similarly, Chainey (2008) developed the Vulnerable Localities Index to identify priority communities in the United Kingdom characterized by disproportionate criminality, victimization, and tension for allocation of policing resources.¹⁵⁴ Other researchers and organizations have sought to use indices and GIS to characterize human insecurity at the country¹⁵⁵ and sub-country¹⁵⁶ level on the basis of measurable factors such as environmental hazard risk, political stability, poverty, communicable and vector-borne disease, and endemic violence.

3.3.2. Limitations

There are a number of critiques aimed at models of social vulnerability to hazards, events, or phenomena. One is that they focus too heavily on the circumstances facing populations rather than their prospects of resisting impacts or recovering from them (i.e., they focus on vulnerability rather than resilience).¹³⁵ Indeed, a persistent issue with composite indices is that it is more difficult to measure an individual or group's ability to use resources than it is to measure their limitations. For instance, while measuring the income of a population is simple, measuring their ability to make good financial decisions is more difficult. However, assessing people's abilities or opportunities to use resources makes it necessary to carry out field work in the local area; and assessors who are meeting their due diligence in capturing baseline conditions in a local area should already be carrying out, commissioning, or consulting such studies if they have not already been undertaken by the community. In addition, some critics argue that using indices derived from the aggregation of many indicators increases the degree of uncertainty.¹⁵⁷ Indeed, the index developer – be it a researcher, government, NGO, or other – must make subjective decisions regarding structure and selection of indicators, transformation and normalization of data, weighting, and rationalizing of the inherent undercounting and overcounting errors that so often plague large datasets such as censuses and national-level surveys.^{157,158} One method of controlling limitations related to aggregation at the outset of the analysis is to set quality dimensions for the variables that make up the composite. The International Monetary Fund, Eurostat, and Organization for Economic Co-operation and Development (OECD) recommend that selection of variables consider six dimensions: relevance, accuracy, accessibility, timeliness, interpretability, and coherence.¹⁴⁰ These are further discussed in section 4.2.

3.3.3. Strengths and opportunities

Despite these limitations, vulnerability indices and mapping have a number of strengths for policy makers and impact assessors. Firstly, vulnerability maps are inexpensive to construct and easy for non-experts to interpret. Policy makers face multiple decisions and

tight timelines, making it challenging to interpret findings of in-depth studies and assessments in a succinct and relevant manner.¹⁵⁹ Vulnerability indices and maps offer end users a visual “hotspot” representation that is easy to understand. Since they often rely on large publicly available datasets, there are few costs associated with obtaining data and virtually no fieldwork expenses. This is an especially valuable trait in the context of the impact assessment processes for major industrial projects, as time and money are a strain on both the proponent and the regulator.

Secondly, vulnerability indices allow for a quantitative estimation of vulnerability at the regional level. Quantitative estimation is often not possible at the community level (e.g. neighbourhood X and neighbourhood Y are considered by residents within and nearby them as a “community”), as the definition of a community is not always aligned with the political boundaries at which data is available. While consideration of a certain group of stakeholders as a community is useful for conceptualizing certain issues and distinguishing between stakeholder groups, these groupings tend to have loosely defined boundaries. In addition, at the level of a community, the data that is available for inclusion in a composite may vary significantly from community to community. The approach used in this study allows for a uniform dataset and the identification of regional vulnerability.

Thirdly, vulnerability indices and mapping allows users to evaluate current conditions (in terms of both individual and composite indices) and monitor these over time.¹⁶⁰ In particular, when the variables used to build these composite indicators are made publicly available, it is possible to evaluate net change and thus visualize and even predict changes.¹⁶⁰ Thirdly, mapping vulnerability indices allows regions to be compared to each other, providing a strong strategic planning tool for the allocation of resources and interventions.^{150,153,154,161} Finally, the use of vulnerability indices and mapping offer an important opportunity to integrate the idea that some populations may experience disproportionate effects of a project into the impact assessment process.¹⁶⁰ Essentially, this could support a more accurate estimation of impacts of a project and how significant they are considering the existence of a vulnerable receptor (i.e.: a vulnerable population).

Traditionally, the concept of vulnerability and vulnerable populations themselves are considered only superficially when evaluating whether or not to permit industrial projects,¹⁶² and some researchers suggest that employing a consistent method for measuring vulnerability with reduce subjectivity and uncertainty in EA methods.¹⁶³ In BC, large datasets that can help characterize vulnerability are easily accessible to impact assessors, proponents, and communities; making it an ideal jurisdiction to integrate vulnerability assessment with the EA process.

4. METHODS

The following chapters focus on the development of a composite index (or indicator) for identifying Health Service Delivery Areas (HSDAs) in BC where violence, poor health, and drug and alcohol issues are endemic and women are vulnerable to violent victimization. The purpose of constructing a vulnerability index in this study is to meet research objectives 2 and 3: to identify indicators of the vulnerability of rural and Aboriginal women to violence and violent victimization; and to use this to develop a GIS tool for assessing and monitoring these indicators in relation EI projects that can enhance the current permitting and development process. A composite indicator focused on the experience of violence among Aboriginal and rural women is key for identifying and understanding regions that are vulnerable to extractives development, as it is clear that EAs in BC fail to adequately capture potential negative outcomes of EI projects for women. The resulting index seeks to visualize the geographic areas with existing high levels of violence, poor health, and drug/alcohol issues, and where women are most vulnerable to being victims of violence.

This study followed a 7 step process based on the OECD *Handbook on Constructing Composite Indicators*¹⁴⁰ and similarly, Cutter's Social Vulnerability Index (2003). These methodologies are well-known and utilized in international development, aid prioritization, public health, and disaster management. The steps are as follows:

1. Develop a theoretical framework
2. Select data and potential indicators
3. Determine index structure and categorization of variables
4. Examine descriptive statistics and correlations between variables
5. Undertake factor analysis on normalized variables to determine which variables can be grouped together to account for the maximum variation in the dataset
6. Normalize and aggregate variables into a single score and a score for each block
7. Visualize data using GIS

4.1. Theoretical framework

4.1.1. Geographic level of analysis

The concept of vulnerability and its measurement is described in detail in sections 3.1 and 3.2. In this study, vulnerability refers to the sensitivity of a BC HSDA and the women residing in it to increased levels of community and domestic violence. HSDAs were chosen as the geographic unit of analysis due to the availability of gender discriminated data for these units in BC.

4.1.2. Defining violence and violent victimization

The scope and definition of violence against women varies widely across disciplines, governments, and even societies. For the purpose of this study, the author frames violence against women using the definition adopted by the United Nations (UN) in the 1993 UN Declaration on the Elimination of Violence against Women. This declaration defined violence against women as: “[...] any act of gender-based violence that results in, or is likely to result in, physical, sexual or psychological harm or suffering to women, including threats of such acts, coercion or arbitrary deprivation of liberty, whether occurring in public or in private life”.¹⁶⁴ This definition is appropriate for this research because it encompasses all forms of violence that women may experience in either private or public realms. This same definition is adopted by Statistics Canada in collecting data and reporting on violence against women, as it makes it possible to “situate women’s experiences of violence in various contexts, and to illustrate how this violence differs in prevalence, severity, and impact from violence perpetrated against men”.⁶⁶

Similar to the method employed by Statistics Canada, this research frames the measurement of violence against the women within the concept of violent victimization. Violent victimization is defined as being a victim of a violence or a violent crime.¹⁶⁵ This includes physical and non-physical violence that occurs within or outside of the home,

perpetrated by either intimate partners or other persons. In Canada, this kind of violence is monitored via both police-reported cases and self-reported cases. Police reported cases are measured by Criminal Code offences recorded in the Uniform Crime Reporting Survey and the Homicide Survey, both of which collect data on the characteristics of victims, accused, and incidents. Self-reported cases are measured in the General Social Survey on Victimization, which includes data on non-physical forms of abuse, consequences of victimization, levels of reporting to police, and social service utilization. Many of the risk factors associated with victimization utilized in this study are based on analysis of the results of these national surveys over several decades.

4.2. Selecting data and potential indicators

The selection of variables for a composite indicator is one of the most important aspects of index building, as the strengths and weaknesses of composite indicators are largely derived from the quality of the variables selected. The choice of indicators is guided by the theoretical framework of the composite indicator, and the availability of data on the topic, and informed decisions made by the researcher.^{134,140} In the case of building vulnerability indices, decisions made by the researcher are significant as there is no definitive set of indicators that measure the complex concept of vulnerability.^{133,166} This is particularly true for the topic of violence and violent victimization of women, as data available on this topic is scarce, and factors that influence vulnerability to violence and violent victimization may vary significantly from person to person. Further research is certainly required to provide a more complete picture of violence against women in Canada.⁶⁶

Variables used in a composite indicator are often a mix of direct and indirect measures.^{135,140} Where possible, it is ideal to select variables that measure a certain element of vulnerability directly. However, a common challenge in index construction is that it is difficult to obtain data on some elements. Bradshaw uses the example of “secondary poverty” that women experience within the home: which reflects the disadvantage that women may face, for example, when a female in a household is not in

the formal workforce and her working partner does not transfer their income to household.¹³⁵ Thus a woman experiences secondary poverty because she does not have access to the household income. This requires the use of proxy indicators in lieu of data that directly measures a woman's secondary poverty. For example, the proportion of two-parent households where a female partner is not in the formal workforce, or the proportion of women who own homes or land title relative to men could be a proxies for secondary poverty.¹³⁵

The criteria for selection of variables was based on six quality dimensions for basic data as defined by OECD, and one geographic dimension defined by the author (section 4.1.1). The criteria are described in detail in the following sections.

4.2.1. Relevance

Relevance describes how the variable contributes value to the overall purpose of the index with respect to incorporation of appropriate topics and coverage of required topics. All indicators are selected based on a comprehensive review of the literature on violence, gender, and extractives development. A full rationale of each variable is described in section 4.2.9. Proxy variables are used only where variables that do not meet the remaining criteria are unavailable.

4.2.2. Accuracy

Accuracy is the degree to which the variable correctly describes or estimates the quantities or characteristics that it is designed to measure. All variables are derived directly from credible provincial or federal institutions that meet appropriate statistical standards. They are commonly utilized in research across education, government, and private institutions.

For this study, datasets were obtained from Statistics Canada, BC Stats, and the Canadian Institutes for Health Research (CIHI). Specific data sources for each variable are outlined in Table 1.

4.2.3. Timeliness

This dimension reflects the length of time between when the data are available and the event or phenomenon they describe. Timeliness must also consider the context of the time period that allows the information to remain valuable and be acted upon. Evaluating timeliness of the selected variables aimed to cover a 4-5 year interval based on the most recently available data across varying data sources. The selection of this time interval greatly affected by the different data collection frequencies of Statistics Canada, BC Stats, CIHI, and the Census of Canada, and time intervals did not always overlap consistently. In general, the author utilized a five-year average from 2009-2012, to best capture overlap with demographic data collected in the census and the various intervals at which existing datasets were available. A five-year average was selected to minimize the influence of year-to-year variation in certain statistics. Where data was only available for specific years or time intervals, the author selected the year or interval that best aligned with the 2009-2012 interval.

4.2.4. Accessibility

This reflects how readily data can be located and accessed from original sources, and the conditions under which users can access statistics. In the case of this study, variables are derived from free, publicly available datasets. Data for each variable was obtained through online download from BC Stats, Statistics Canada, or CIHI. In the case of crime statistics, data were obtained via a custom order from BC Stats in order geographically convert data from police districts to health districts. In addition, data on alcohol consumption and alcohol and drug morbidity were obtained from the Centre for Addictions Research BC, though the original source of these datasets was CIHI. This is especially important due to the proposed use of the resulting GIS tool by and impact assessors, regulators, proponents, and communities – if this tool, or others like it, are to be effectively incorporated into the permitting process for extractive projects in BC, the data required to build and update it must have a minimal financial and technical burden on the user.

4.2.5. Interpretability

This describes the ease with which a user may understand and properly use and analyze the basic data and the resulting index. Selected variables are basic health, crime, and demographic statistics that are directly associated with target populations. To strengthen interpretability, variables were further grouped in to four thematic blocks as described in section 4.3.

4.2.6. Coherence

According to OECD, the coherence of data reflects how they are logically connected and mutually consistent and is considered an aspect of interpretability. Selected variables are based on common health, crime, and demographic concepts that are defined and calculated consistently across jurisdictions and institutions in BC and Canada.

4.2.7. Geography

Variables are available at the HSDA geographic level. This geographical unit was chosen for a number of reasons. Firstly, there were few gender-specific variables available at the level of smaller geographic units such as Local Health Areas (LHAs). Using the HSDA as the geographical unit allowed for access to gender-specific data from nation-wide surveys such as the Canadian Community Health Survey. Secondly, data on crime is particularly difficult to analyze at the LHA level, as these areas do not align well with policing regions. In addition, it is difficult to confirm whether crime victims from a certain LHA actually accessed police services or reported the crime within that LHA. For this study, crime data was important in characterizing existing levels of violence in an area. Thirdly, HSDAs were chosen because datasets at this level were more complete compared with LHAs, where small population sizes lead to missing values for many LHAs.

4.2.8. List of selected variables

Data were downloaded as Comma Separated Values files and viewed using Microsoft Excel software. Table 1 below summarizes the variables selected for this study.

Table 1: List of Variables				
Variables	Code	Year	Unit and Definition	Source
Life expectancy at birth	LIFEEXP	Avg 2009- 2013	Years	BC Stats
Potential years of life-lost (PYLL) from accidents	PYLL_A	Avg 2007- 2011	Five year average of standardized PYLL per 1000 people due to accidents	BC Stats Socioeconomic Indicators of Health Problems
PYLL Suicide/Homicide	PYLL_SH	Avg 2007- 2011	Five year average of standardized PYLL per 1000 people due to suicides or homicides	BC Stats Socioeconomic Indicators of Health Problems
Mental Illness Hospitalizations	MH_HOSP	Avg 2009- 2012	Age-standardized rate of separations from general hospitals through discharge or death following a hospitalization for a selected mental illness ² , per 100,000 population	CIHI
Total Fertility Rate	TFR	Avg 2009- 2012	The average number of births 1,000 women could have if their lifetime fertility was the same as the Age-specific Rate. All figures are calculated using the average of two consecutive July 1st populations and Census Year (July 1 to June 30) period live births of the year stated.	Vital Stats Agency, Ministry of Health and BC Stats
Avoidable Hospitalization Rate (Ambulatory Care Sensitive Conditions)	ACSC_RT	Avg 2009- 2012	Total number of acute care hospitalizations for ambulatory care sensitive conditions in patients younger than age 75 ÷ total mid-year population younger than age 75) × 100,000 (age-adjusted)	CIHI
General/family Physicians rate	DR_RATE	Avg 2011/2 012	Physicians per 100,000 people Physician counts include all active physicians as of December 31 of the reference year. Physicians in clinical and non-clinical practice are included. Residents and unlicensed physicians who have requested that their information not be published are excluded.	CIHI

² The mental illnesses selected for this indicator are substance-related disorders; schizophrenia, delusional and non-organic psychotic disorders; mood/affective disorders; anxiety disorders; and selected disorders of adult personality and behaviour.

Table 1: List of Variables				
Variables	Code	Year	Unit and Definition	Source
Premature Mortalities	PREMATR_MORT	Avg. 2009-2012	Age-standardized rate of premature deaths per 100,000 population. Premature deaths are those of individuals younger than age 75.	Statistics Canada, Canadian Vital Statistics, Death Database and Demography Division
Serious Violent Crime	SVCRIME	Avg 2009-2011	Offenses per 1000 persons. Includes homicide, attempted murder, sexual and non-sexual assault (level 2 and 3) as well as robbery and abduction.	Uniform Crime Reporting Survey; BC Stats
# Serious Crimes per Police Officer	SCPP	Avg 2009-2011	Count of serious crimes per police officer per year. Serious crimes include: Serious Violent Crime and Serious Property Crime. Serious property crime consists of only breaking and entering.	Uniform Crime Reporting Survey; BC Stats
Sexual Assault Incidents	TSA	Avg 2009-2012	Offenses per 100,000 people. Denominator data is yearly population estimates provided by BC Stats	Uniform Crime Reporting Survey; Canadian Centre for Justice Statistics, BC Stats
Sexual violations against children	TSVC	Avg 2009-2012	Offenses per 100,000 people Denominator data is yearly population estimates provided by BC Stats	Uniform Crime Reporting Survey; Canadian Centre for Justice Statistics, BC Stats
Total assault incidents (non-sexual)	TA	Avg 2009-2012	Offenses per 100,000 people Denominator data is yearly population estimates provided by BC Stats	Uniform Crime Reporting Survey; Canadian Centre for Justice Statistics, BC Stats
Other violent crime incidents (Attempted Murder, Robbery, Abduction, Homicide)	OTHR_CRIME	Avg 2009-2012	Offenses per 100,000 people Denominator data is yearly population estimates provided by BC Stats	Uniform Crime Reporting Survey; Canadian Centre for Justice Statistics, BC Stats
Alcohol Consumption per	ALC_CONS	2009-2012	Per capita litres of absolute alcohol consumption. 1L of Alcohol is	BC Liquor Distribution

Table 1: List of Variables				
Variables	Code	Year	Unit and Definition	Source
capita			equivalent to 58 Std Drinks. This figure includes UBrew and UVin consumption.	Branch and Centre for Addictions Research BC
Non-cannabis drug offenses	NONCAN_DRUG	2009-2011	Offenses per 100,000 people	Canadian Centre for Justice Statistics, BC Stats
Total Drug Offences	TOT_DRUG	Avg. 2009-2012	Total drug-related offences per 100,000 people	Canadian Centre for Justice Statistics, BC Stats
Standardized rate of alcohol hospitalizations	ALC_MRB	Avg 2009-2012	Rate Per 100, 0000 people Age and Sex standardized rate of alcohol related hospitalizations. Includes acute and chronic illnesses.	Centre for Addictions Research BC; BC Vital Statistics and BC Ministry of Health
Standardized rate of drug related hospitalizations	DRUG_MRB	Avg 2009-2012	Rate Per 100,000 people Age and Sex standardized rate of drug related hospitalizations. Includes acute and chronic illnesses.	Centre for Addictions Research BC; BC Vital Statistics and BC Ministry of Health
Population women aged 15-34	F_15TO34	2011	Percentage of women aged 15-34 in the HSDA. HSDA figures were calculated by the mean of LHAs within each HSDA.	Vital Stats Agency, Ministry of Health and BC Stats
Female workforce participation rate	F_WRK_PARTIC	2011	Percent of the female population aged 15 + that is economically active. This is a direct measure from National Household Survey (NHS)	BC Stats Labour Market Statistics; National Household Survey
Population Aboriginal Women	F_POP_AB	2011	Percentage of total population in private households that identifies as Aboriginal women in the NHS.	2011 National Household Survey
Population of single women and women in common law relationships	SINGLE_CMN	2011	Percentage of women in an HSDA that identify as single or being in a common-law relationship on the 2011 Census.	2011 Census
Women who are self-identified heavy drinkers	PERCENT_HEAVYDRINK	Avg 2009-2012	% of women 12 and over who reported having 5 or more drinks on one occasion, at least once a month in the past year.	Canadian Community Health Survey
Women with self-identified poor or fair Health Status	PERCENT_FAIRPOOR	Avg 2009-2012	% of women 12 and over who reported perceiving their own mental health status as being fair or poor.	Canadian Community Health Survey

Table 1: List of Variables

Variables	Code	Year	Unit and Definition	Source
	HEALTH		Perceived mental health refers to the perception of a person's mental health in general. Perceived mental health provides a general indication of the population suffering from some form of mental disorder, mental or emotional problems, or distress, not necessarily reflected in perceived health.	
Women with Activity Limitations	PERCENT_PARTICAL	Avg 2009-2012	Percent of women who reported being limited in selected activities (home, school, work and other activities) because of a physical condition, mental condition or health problem which has lasted or is expected to last 6 months or longer.	Canadian Community Health Survey
Female Mental Health Hospitalization Rate	F_MH_HOSP	2013	Age-standardized rate of separations from general hospitals through discharge or death following a hospitalization for a selected mental illness, per 100,000 population. ³	CIHI
Women living outside of major urban centres	F_SMRURAL_POP		Percent of women living in a small, medium, or rural population centre within an HSDA	Canadian Community Health Survey
Women with less than post-secondary education	NO_POSTSEC	2011	Percent of women who reported secondary school graduation or lower as their highest level of educational achievement	National Household Survey 2011
Median family income	MED_FAM_INC	2010	The median income for a census family in 2010 in Canadian Dollars.	National Household Survey 2011
Percent income assistance	PRCNT_INCOME_A_SST	2011	The percentage of persons in an HSDA who are receiving income support under the BC Employment and Assistance program. This excludes persons with disabilities, children living with relatives, and Aboriginal People living on reserve.	BC Stats; Ministry of Social Development; 2011 Census

³ The mental illnesses included in this indicator are substance-related disorders; schizophrenia, delusional and non-organic psychotic disorders; mood/affective disorders; anxiety disorders; and selected disorders of adult personality and behaviour.

4.2.9. Rationale for inclusion of selected variables

Life Expectancy at Birth and Premature Mortalities

Life expectancy is a general measure of health status in an HSDA. Life expectancy is a measure of overall mortality conditions and therefore is a measure of health conditions.¹⁶⁷ Similarly, premature mortality is a proxy measure for a wide range of health issues that cause premature death.

PYLL Accidents/Suicide/Homicide

Years of life lost from accidents, suicides, and homicides is a measure of general health conditions and longevity and is utilized by BC Stats in the Socioeconomic Indicators of Health Problems index. Accidental PYLL is largely comprised of car accidents, job-related accidents, and other accidental causes of death (ie: poisonings). It allows the concept of longevity to be separated into a specific cause of death, one that is likely more common in regions with a high concentration of primary and manufacturing jobs.¹⁴⁵ Suicide and Homicide PYLL allows the concept of longevity to be separated into causes of death related to mental health differentials between regions.¹⁴⁵

Mental Illness Hospitalizations

Mental illness hospitalizations is an indirect measure of the burden severe mental health issues in a given region. It may reflect differences between jurisdictions, such as the health of the population, differing health service delivery models and variations in the availability and accessibility of specialized, residential and/or ambulatory and community-based services.¹⁶⁸ While it excludes the many individuals who are not hospitalizations, it is a useful proxy measure for severe mental health issues.

Total Fertility Rate

According to some indices (such as the Human Development Index, the Gender Development Index and the Adolescent Girls Vulnerability Index for Uganda) higher fertility rates are an indicator of vulnerability, as women with more children have more household responsibilities and few resources to care for themselves.^{135,142} They are also less likely to leave a violent situation when they have children to care for.¹⁶⁹

Access to primary health care: Avoidable Hospitalization Rate and General Physicians per Capita

Both the avoidable hospitalization rate and general physicians per capita are general measures of access to health care in a region, and therefore, general health conditions. The avoidable hospitalization rate is commonly used as a proxy measure for access to primary care, which is sometimes used as a proxy for rurality.¹⁷⁰ Hospitalizations that could have been avoided with adequate primary care indicate the difficulty people in certain geographical areas have in accessing primary care. Similarly, physicians per capita describes the access to basic physicians' services in a geographical area.

Serious Violent Crime and Serious Crimes per Police Officer

Serious violent crime and serious crimes per police officer are measures of the burden of existing crime issues in an HSDA. Serious crimes per police officer indirectly measures this as it reflects the strength of police resources in relation to crime. Both of these measures are used in the crime severity index by developed BC Stats. This index is used as a proxy measure for personal safety in a given region.¹⁴⁵

Sexual Assault Incidents

Sexual assault incidents is a measure of existing crime issues in an HSDA. As the majority of police reported sexual assault victims are women,¹⁷¹ sexual assault incidents reflect a more gender-specific form of violence. This figure is included in the calculation for Total Serious Violent Crimes in the crime severity index by developed BC Stats.

Total Assault Incidents (non-sexual assaults)

Total assault incidents is a measure of existing crime issues in an HSDA. Total assaults includes domestic and non-domestic assaults. It reflects both intimate partner violence, where women are most likely to be victims, and non-intimate partner violence, where men are more likely to be victims.¹⁶⁵ This figure is included in the calculation for Total Serious Violent Crimes in the crime severity index by developed BC Stats.

Other Violent Crime Incidents

Other violent crime is a measure of existing crime issues in an HSDA. It is comprised of the offences of attempted murder, robbery, abduction, and homicide. These figures are included in the calculation for Total Serious Violent Crimes in the crime severity index by developed BC Stats. Due to low figures of these crimes in most HSDAs, they were combined to represent violent crimes that are not assaults.

Sexual Violations Against Children

Sexual violations against children is not taken into consideration in BC's indicators of crime severity, or any other composite indicator of crime or violence in Canada. While it does not reflect general personal safety in a given region, it provides insight into the pressing issue of child sexual abuse that is prevalent in certain regions of BC, and is a proxy measure for violence within the home.^{1,172}

Alcohol Consumption per Capita

Alcohol consumption per capita is a measure of existing substance abuse issues in an HSDA.

Standardized Rates of Alcohol and Drug Related Hospitalizations

Standardized rates of alcohol and drug related hospitalizations measure the burden of severe alcohol and drug abuse in an HSDA. These figures are proxy measures for harm caused by alcohol or drug abuse.

Non-cannabis Drug Offences and Total Drug Offences

These figures are included as measures of existing substance abuse issues that lead to criminal activity.

Population of Women Aged 15-34

Age is a predictor of both intimate partner and non-intimate partner violence. In general, women between the ages of 15 and 34 are the highest risk group for both police reported and self reported violent victimization.^{66,171} In addition, research suggests that younger

women report elevated rates of physical abuse.¹⁷³ This variable is included to capture the proportion of women in an HSDA within this high-risk age bracket.

Population of Aboriginal Women

According to Statistics Canada and recent research on the health and safety of Aboriginal women in Canada, Aboriginal women are disproportionately at risk for all types of violence.^{66,171,174,175} This variable is included to capture the proportion of Aboriginal women in an HSDA.

Population of Single Women and Women in Common Law Relationships

According to statistics Canada, single women are most at risk of non-intimate partner violence, and women in common-law relationships are most at risk of intimate partner violence.^{66,171} This variable is included to capture the proportion of women in an HSDA who are at increased risk due to being single or in a common-law relationship.

Self-Identified Heavy Drinkers

Women who self-report lower health status also report higher rates of violent victimization (both spousal and non-spousal violence).¹⁷⁴ While it is difficult to determine whether poor health precedes or is a result of violence, some research associates spousal violence with poor eating habits, excessive alcohol consumption, and smoking and notes that many women victims of spousal violence also suffer health problems.¹⁷⁶ Poor health can increase a person's vulnerability as it may be the consequence of a lifestyle or environment that increases the risk of victimization.¹⁷⁷ This variable is included to capture women who are at risk because of their drinking habits.

Self-Identified Fair or Poor Health Status

Similarly to heavy drinking, women who self-report lower health status also report higher rates of violent victimization (both spousal and non-spousal violence).¹⁷⁴ While it is difficult to determine whether poor health precedes or is a result of violence, some research associates spousal violence with poor eating habits, excessive alcohol consumption, and smoking and notes that many women victims of spousal violence also

suffer health problems.¹⁷⁶ Poor health can increase a person's vulnerability as it may be the consequence of a lifestyle or environment that increases the risk of victimization.¹⁷⁷ This variable is included to capture women who are at risk because of their health status.

Self-Reported Activity Limitations

According to Statistics Canada, women with activity limitations are at increased risk of both physical and sexual assault and violent abuse by a spouse or partner. In addition, they are more likely to experience severe forms of spousal violence (such as being choked, hit, or beaten with an object).^{66,178} This variable is included to capture women who are at increased risk of violence due to an activity limitation.

Female Mental Health Hospitalization Rate

The relationship between violence, substance abuse, and mental health problems is complex; with mental health and substance use both resulting from violence and placing women at increased risk.¹⁷⁹ However, there is evidence that mental health issues and substance use can create a vulnerability to violence that is exacerbated by pre-existing issues.¹⁸⁰ This variable captures women who are at increased risk of violence due to mental health issues.

Women Living Outside of Major Urban Centres

Some research suggests that women living outside of major urban centres are more likely to experience both spousal and non-spousal violence. Indeed, according to Statistics Canada, women residing in small cities, towns, and rural areas report higher rates of police-reported intimate partner and non-intimate partner violence.⁶⁶ In addition other research on violence against women suggests that patriarchal attitudes employed by male partners may be stronger and more prevalent in rural areas. This patriarchy in turn, is associated with increased violence against women.¹²⁸ Women living outside of major urban centres was captured in this study as women who reside in small or rural population centres as defined by Statistics Canada in the 2011 census.

Socioeconomic Status: Women With Less Than Post-Secondary Education; Percent of Persons Receiving Income Assistance; and Median Family Income

The relationship between socioeconomic status (including income and level of educational attainment) women's violent victimization is complex. Low socioeconomic status has generally been associated with violence against women.¹⁸¹ While women from all socioeconomic backgrounds experience violence from intimate partners, there is considerable evidence that women from lower socioeconomic groups experience more intimate partner violence.¹⁸²⁻¹⁸⁴ Lower family income is associated with increased violence in many instances,^{182,184,185} and higher levels of women's educational attainment is associated with low levels of violence in a number of studies.¹⁸⁶

4.3. Index structure and categorization of variables

Constructing vulnerability indices, like other composite indices, is a somewhat subjective process. It requires decisions made by the researcher on the structure, normalization, and weighting of the index.¹⁴² An index can have one dimension (i.e.: poverty), or multiple dimensions (i.e. access to safe drinking water, food and nutrition, sanitation, shelter, education). There are two approaches to identifying relevant dimensions: through subjective decisions based on theory and literature; or through a combination of theory and data analysis.^{133,142,187} When the former method is used, the researcher makes decisions about what indicators to include based on other indices and existing literature. When the latter – more quantitative, but not necessarily more rigorous – method is used, a multivariate analysis such as factor analysis can be used to take a large set of indicators and determine which variables form meaningful and independent subsets within the dataset.¹⁴² Essentially, this statistical technique decreases the number of variables used in the analysis by identifying the variables that account for the majority of the data variance.^{133,187}

This study used a combination of both methods, consulting the literature to form the overall structure of the index, as well as performing a factor analysis to determine variables that were meaningful and independent within the dataset. The index consists of

four blocks of related variables that are useful to group together when seeking to gain insight into violence and vulnerability in relation to EI development. These blocks are derived from several themes identified in the literature. First, that population health status varies from region to region in BC, suggesting that there are underlying issues that make certain populations healthier and better able to access services than others, and that some regions need additional resources and preventative care more than others.¹⁸⁸ Second, that some areas have existing issues related to violent crime and substance abuse, and that these issues are perceived to be exacerbated with the development of EI projects. Third, that there are certain populations of women, based on social and demographic characteristics, that are more likely to be victims of violence. The theoretical justification of each block is discussed below.

4.3.1. General health status

Variables in this block are indicators of general health conditions in a region, reflecting both a gap in preventative care and access to services, and the potential public health impacts of violence. When conceptualizing vulnerability within the realm of EI development, people with lower health status are generally less able to cope with environmental and health stressors, including increased exposure to violence. In addition, violence is an issue that has serious public health consequences which impact overall health and well-being in a region.¹⁸⁹ It can have health implications over the lifespan of an individual as well as be a reason why individuals may seek health care or social services. The impact of violence on the health of an individual, in turn, may be influenced by their ability to access health and social services.

4.3.2. Existing violent crime

Variables in this block indicate the level of violence endemic in the region. Due to privacy rights guaranteed by the *Statistics Act*, it is not possible to differentiate between male and female victims of violent crimes at the sub-provincial level. However, existing levels of violent crime provide insight into the prevalence of acts of violence where men, women, and children are victims. In some agencies, such as BC Stats, crime incidence and prevalence are used as a proxy measure to the perception of relative personal safety

between regions.¹⁴⁵ Sexual assaults in particular are disproportionately comprised of female victims as they are more likely to report sexual assaults.¹⁸⁴

4.3.3. Drug and alcohol-related issues

Variables in this block measure the level of drug and alcohol related issues in an HSDA, using both crime and hospitalization data, capturing substance use as both a public safety and a public health issue. Existing drug and alcohol issues are important to consider when examining violent victimization due to the role that they often play as a driver in acts of violence,^{190,191} particularly acts of intimate partner violence perpetrated against women.¹⁹²

4.3.4. Population risk factors

Variables in the fourth block measure the relative population of women in a region who have demographic and socio-economic characteristics that put them at a higher risk of violent victimization. The rationale behind these individual level risk factors is reviewed in section 4.2.9. This final block is meant to directly measure the likelihood that women in a given region are or will be victims of violence.

Table 2 below summarizes the variables that are included in each block.

Table 2: Variables by block	
1. Health Status	
LIFEEXP	Life expectancy
PYLL_A	PYLL Accidents
PYLL_SH	PYLL Suicide/Homicide
MH_HOSP	Mental Illness Hospitalizations
PREMATR_MORT	Premature mortalities
ACSC_RT	Avoidable Hospitalization Rate (Ambulatory Care Sensitive Conditions)
DR_RATE	General/family Physicians rate
2. Endemic Violence	
SVCRIME	Serious Violent Crime
SCPP	# Serious Crime per Police Officer
TSA	Sexual Assault Incidents
TSVC	Sexual violations against children

Table 2: Variables by block	
TA	Total assault incidents (non-sexual)
OTHR_CRIME	Attempted Murder, Robbery, Abduction, Homicide ,
3. Drug and Alcohol Issues	
ALC_CONS	Alcohol Consumption per capita
NONCAN_DRUG	Non-cannabis drug offenses
TOT_DRUG	Total Drug Offenses
ALC_MRB	Standardized rate of alcohol hospitalizations (per 100,000)
DRUG_MRB	Standardized rate of drug related hospitalizations (per 100,000)
4. Individual Risk Factors	
F_15TO34	% Population women aged 15-34
F_WRK_PARTIC	Female workforce participation rate
F_POP_AB	Population Aboriginal Women
SINGLE_CMN	Population single women AND women in common law relationships
F_INSIDEMIZ	Women living inside of Metropolitan Influenced Zones
F_SMRURAL_POP	Women living outside of CMAs
PERCENT_HEAVYDRINK	Self-identified heavy drinkers
PERCENT_FAIRPOOR_MH	Self- identified poor or fair Mental Health Status
PERCENT_PAINAL	Pain Related Activity Limitations
PERCENT_PARTICAL	Participation Related Activity Limitations
PERCENT_MOOD	Self-reported mood disorder
TFR	Fertility Rate
NO_POSTSEC	Women without post-secondary education
F_MH_HOSP	Female Mental Health Hospitalizations
PERCENT_FAIRPOOR_HEALTH	Self-identified poor or fair health status
MED_FAM_INC	Median Family Income
PERCENT_INC_ASST	Percentage of persons on provincial or federal income assistance

4.4. Examine descriptive statistics

Descriptive statistics were computed using *IBM Statistical Package for the Social Sciences (SPSS)* software. The selected indicators were inputted into *SPSS*. Descriptive statistics were computed for the entire dataset to determine mean, median, variance, min-max values, and skewness for each variable. A skewness cutoff between -2 and +2 was

used to determine normal distribution of each variable. After this, Pearson correlations were computed within each block and between blocks using *R Statistical Package* to determine co-correlations.

4.5. Factor analysis

Before a factor analysis can be conducted, variables must be normalized to the same scale so they are comparable. Normalization was completed by centering each variable using the mean, and scaled using z-scores, with a mean of 0 and a standard deviation of 1. Z-scores indicate how many standard deviations a data point is from the mean.

Within each of the four blocks, a factor analysis was performed using a varimax rotation. The purpose of factor analysis is to reduce the number of variables in a dataset by removing duplication from a set of correlated variables. The result is a set of “factors” – essentially new variables made up of a combination of the inputted variables – that are made up of sets of variables from the original dataset that are relatively independent of each other. These factors are interpreted by the researcher to gain insight into categories within the dataset, all the while maximizing the variability across the dataset. A varimax rotation was used because it offers a way to simply identify each variable with a single factor. It does this by rotating the factor axes to maximize the variance of the squared loadings of a factor on all the variables in a factor matrix. The factor analysis was completed using *R Statistical Software*, which uses a Chi Square based goodness-of-fit test to test whether or not the number of factors is statistically significant. *R* completes the analysis when there are sufficient factors based on a p-value of >0.05 .

Factor loadings were then manually examined within each block, using a cutoff of 0.2 as a guide. If a factor loading for any variable was below 0.2, it was automatically removed from the factor. The factor loadings were then subjectively examined and the loadings interpreted. Based on the strength of factor loadings, some variables were removed from the analysis due to low loadings across factors. The factor analysis was performed again on the revised dataset and the loadings subjectively examined to create logical,

interpretable factors within each block. This is one of the most important and controversial elements of factor analysis, as researchers need to make decisions about excluding variables and whether the groupings of original variables make sense in the context of the research.¹⁹³ To limit subjectivity in this study, decisions on inclusion or exclusion of variables and the real-world meaning of identified factors were informed by the current literature on violence and the vulnerability of women in Canada and BC, as described in Section 4.2.

4.6. Aggregation

The variable averages were computed and combined to create an overall score. First, directionality of variables is taken into account by multiplying any variables with opposite directionality to the one prevalent in the dataset by -1. This assured that the direction of association for every variable was low. For example, the directionality of variables measuring crime or alcohol and drug problems is negative, meaning that decreased vulnerability is associated with a low value. In contrast, the direction of association for life expectancy is high, as a higher life expectancy is associated with lower vulnerability. Thus, the life expectancy variable would be multiplied by -1 to assure a consistent direction of association among all variables.

Variable averages were then computed by summing the value of each variable corresponding to an HSDA and then dividing by the number of variables. The variable averages for each variable were then summed to create a single composite score inclusive of all variables for each HSDA. This step was completed in two different ways. First, by performing a Principle Components Analysis (PCA) that assigned a weight to variables based on component loadings. PCA is a factor analysis technique used to produce a set of components (factors) that is an amalgamation of the variables where each variable weighs differently in each component. PCA is used to find optimal ways of combining variables into a small number of components, while factor analysis can be used to identify the structure underlying such variables and to estimate scores to measure latent factors themselves. This technique is commonly used in the building of composite indicators and

indices, especially where multidimensional indicators are utilized and the researcher chooses to assign them weights.¹³³ Second, by a simple average of all of the factors identified in the factor analysis. The reason for this was to compare the results to see if the PCA would produce a different index than the average. Finally, variables were normalized using z-scores again for the PCA weighted results to ensure a mean of 0 and a standard deviation of 1.

4.7. Visualizing data using GIS

The resulting index scores were then spatially visualized using *ArcGIS Desktop 10*. Scores were converted into an ArcGIS compatible table and then a spatial join was carried out. A spatial join is a process whereby an external dataset, spatial or otherwise, is combined with an existing spatial dataset based on common fields. For this study, the resulting index scores were joined to an existing basemap of HSDAs obtained through DataBC. A second spatial join was performed to add the values for each individual variable to the basemap. This created a geodatabase that spatially associates each variable and each index value to a BC HSDA so that geographic areas can be spatially and visually compared to one another based on any single variable, any block score in the index, and any overall index score.

5. ANALYSIS AND RESULTS

5.1. Descriptive statistics

The following table summarizes the preliminary descriptive statistic analysis that was completed for each variable. The primary purpose of this analysis was to examine central tendency and variance, and to determine normal distribution of each variable. When using factor analysis, statistical inference is improved if variables are normally distributed. When variables are not normally distributed, data can be transformed using a variety of statistical methods to make the data better conform to normal distribution. For this study, normal distribution was determined by examining histograms for each variable and using a skewness cut-off of -2 to 2. As demonstrated in **Table 3** below, all variables were determined to be sufficiently normally distributed. In addition, examination of central tendency measures revealed that data did not contain any outliers and thus there were no additional steps necessary to prepare the dataset for factor analysis.

Variable	Min	Max	Mean	Std. Dev	Var.	Skew	Std. Error
ACSC_RT	155.50	521.75	301.84	108.66	11807.11	0.72	0.56
ALC_CONS	4.71	13.27	10.30	2.46	6.05	-0.94	0.56
ALC_MRB	299.49	897.11	538.88	175.00	30626.24	0.17	0.56
DR_RATE	79.00	165.00	122.94	30.17	910.20	-0.10	0.56
DRG_MRB	46.79	138.04	98.60	26.80	718.02	-0.16	0.56
F_15TO34	0.10	0.21	0.14	0.03	7.88	1.11	0.56
F_INSIDE MIZ	0.00	100.00	77.11	28.54	814.65	-1.68	0.56
F_MH_Hosp	351.00	973.33	638.04	169.99	28895.67	0.30	0.56
F_POP_AB	0.01	0.38	0.10	0.09	84.75	2.11	0.56
F_SMRURAL_POP	0.00	100.00	60.83	43.17	1863.93	-0.35	0.56
F_WRK_PARTIC	53.80	68.60	60.17	3.55	12.63	0.47	0.56
LIFEEXP	78.35	85.40	81.55	1.87	3.51	0.28	0.56
MED_FAM_INC	66239.00	91346.00	74990.81	7494.17	56162626.96	0.78	0.56
MH_HOSP	394.00	1145.33	688.08	195.91	38381.96	0.71	0.56
NO_POSTSEC	22.80	47.70	35.50	7.68	59.02	-0.14	0.56

Table 3: Descriptive Statistics							
Variable	Min	Max	Mean	Std. Dev	Var.	Skew	Std. Error
NONCAN_DRUG	89.53	264.40	166.90	46.79	2189.05	0.44	0.56
OTHR_CRIME	19.16	209.70	69.18	52.09	2713.13	1.59	0.56
PERCENT_FAIR POOR_HEALTH	9.05	15.80	12.85	2.15	4.62	-0.50	0.56
PERCENT_ HEAVYDRINK	5.60	17.80	10.63	2.87	8.24	0.64	0.56
PERCENT_PAINAL	12.00	20.85	17.09	2.31	5.36	-0.62	0.56
PERCENT_ PARTICAL	15.60	40.40	31.22	6.48	42.00	-0.96	0.56
PERCENT_ FAIRPOOR_MH	2.40	9.30	6.68	1.81	3.29	-0.78	0.56
PRCNT_INCOME_ ASST	0.60	4.10	1.82	0.85	0.72	1.09	0.56
PREMATR_MORT	148.70	357.80	260.94	57.11	3261.82	-0.13	0.56
PYLL_A	2.40	16.44	10.91	4.30	18.47	-0.48	0.56
PYLL_SH	2.50	13.30	5.24	2.51	6.30	2.29	0.56
SCPP	4.29	8.58	6.77	1.33	1.76	-0.27	0.56
SNGL_CMN	28.47	41.95	32.31	3.84	14.73	1.22	0.56
SVCRIME	1.33	5.35	2.85	1.18	1.38	0.65	0.56
TA	402.55	2548.45	1106.47	595.93	355130.47	1.21	0.56
TFR	1124.08	2049.00	1689.25	276.26	76321.04	-0.61	0.56
TOT_DRUG	373.04	1274.09	794.71	268.28	71973.40	0.10	0.56
TSA	30.09	496.78	144.18	134.02	17961.27	1.69	0.56
TSVC	7.51	55.56	24.84	14.60	213.30	0.77	0.56
Valid N (listwise)	16						

5.2. Variable and block correlations

Prior to performing the factor analysis, Pearson correlations were computed within each block and between blocks. A Pearson correlation analysis produces a correlation coefficient of between -1 and 1. In general, a result of -0.5 to 1 or 0.5 to 1.0 is considered high or strong correlation, -0.3 to -0.5 or 0.3 to 0.5 is considered medium correlation, and

-0.1 to -0.3 or 0.1 to 0.3 is considered low or weak correlation. The purpose of this was twofold. Firstly, to gain preliminary insight into how strongly pairs of variables within and between blocks were related to each other. In particular it was useful to examine correlations between pairs of variables that were measuring similar concepts. Secondly, because moderate or strong correlations between variables in a dataset is one of the assumptions made in utilizing factor analysis. If the variables included in a factor analysis are not correlated or weakly correlated, a factor analysis would be of little value, as only one factor made up of a combination of all the variables would be present in the dataset.

The correlation analysis revealed a medium-highly correlated dataset, with the majority of variable pairs producing a correlation coefficient in the medium to high range. Within blocks 1 and 4, a substantial amount of high and medium correlations were observed. For health status variables, these results were interpreted by the author to be logical and expected, as measures of health status such as premature mortality, potential years of life lost from accidents or suicides/homicides, and mental health hospitalizations would logically correlate with each other. Within population risk factors (block 4), high correlation is also intuitive because many risk factors, such as drinking habits, perceived health status, and mental health morbidity, are linked both logically and by evidence in the literature.^{171,176-178} The variables that displayed mainly weak correlations with other variables in block 4 were females aged 15 to 30 and female workforce participation rate, which were incidentally highly correlated with each other. This too is a logical observation, as age and workforce participation rates are very broad demographic characteristics that may not correlate strongly with more specific characteristics such as mental health morbidity, drinking habits, Aboriginal status, or rurality.

Between blocks, medium to high correlations were also observed. Strong correlations between variables in blocks 1 and 3 and 1 and 4 were interpreted to be logical, as existing drug and alcohol issues would naturally effect health status, as would some of the population level risk factors for women such as perceived health status, percent of women who report activity limitations, mental health hospitalizations, and percent of women who self-identify as heavy drinkers.

5.3. Factor analysis

The purpose of the factor analysis in this study was to reduce variables to a lesser number of underlying factors that are being measured by the variables. In essence, these factors become the building blocks of a composite indicator as they account for the underlying dimensions in a dataset where variables are correlated and may be measuring the same phenomena. In building this composite indicator, a preliminary factor analysis was completed within each block to examine initial factor loadings. A factor loading is a value between -1 and 1 that represents the correlation between the variable and the rotated factor (after the varimax rotation has been applied). Factor loadings give insight into which variables have influence on a factor and allows the researcher eliminate variables that account for very little variation within the dataset. The results of the preliminary factor analysis are represented as a rotated factor matrix below in Table 4.

Table 4: Results of initial factor analysis					
Variable Name	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Block 1					
ACSC_RT	0.908				
DR_RATE	0.136				
LIFEEXP	-0.987				
MH_HOSP	0.833				
PREMATR_MORT	0.996				
PYLL_A	0.762				
PYLL_SH	0.712				
<i>Proportion Var</i>	<i>0.656</i>				
Block 2					
OTHR_CRIME	-0.197	0.917			
SCPP		0.463			
SVCRIME	0.709	0.702			
TA	0.992	-0.103			
TSA	0.614	0.377			

Table 4: Results of initial factor analysis					
Variable Name	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
TSVC	0.807	-0.319			
<i>Proportion Var</i>	<i>0.425</i>	<i>0.3</i>			
<i>Cumulative Var</i>	<i>0.425</i>	<i>0.726</i>			
Block 3					
ALC_CONS	0.674				
ALC_MRB	0.953				
DRG_MRB	0.766				
NONCAN_DRUG					
TOT_DRUG	0.759				
<i>Proportion Var</i>	<i>0.506</i>				
Block 3					
F_15TO34	-0.144	0.915	-0.172	0.123	-0.293
F_INSIDE.MIZ	-0.277	0.283	-0.619	-0.152	
F_MH_HOSP	0.52		0.674	0.336	0.203
F_POP_AB	0.714	0.25	0.507	0.102	0.134
F_SMRURAL_POP	0.738	-0.218	0.26	0.147	0.307
F_WRK_PARTIC	0.11	0.763		0.149	-0.185
NO_POSTSEC	0.941			0.31	
PERCENT_FAIRPOOR_ HEALTH	0.271	0.184	0.272	0.898	
PERCENT_HEAVYDRINK	0.145	0.237	0.841		0.135
PERCENT_PAINAL	0.424	-0.26	0.344	0.42	0.597
PERCENT_PARTICAL	0.36	-0.26	0.202	0.286	0.822
PERCENT_FAIRPOOR_MH	0.168	0.163		0.761	0.197
SNGL_CMN	-0.115	0.871	0.313		0.146
TFR	0.75		0.177	0.112	0.152
<i>Proportion Var</i>	<i>0.238</i>	<i>0.188</i>	<i>0.162</i>	<i>0.14</i>	<i>0.102</i>
<i>Cumulative Var</i>	<i>0.238</i>	<i>0.426</i>	<i>0.588</i>	<i>0.728</i>	<i>0.83</i>

Variables that had low loadings across factors were removed from the analysis. This was a useful step in choosing between variables that were measuring the same concept. For example, both DR_RATE and ACSC_RT are measures of access to primary health care, and there is no feature of either that makes one more appropriate than another in this

analysis. As DR_RATE had very low loadings in Factor 1 in Block 1 compared to ACSC_RT, it had substantially less influence in factor 1 and could be removed without significantly altering the result of the final composite indicator. The same was the case for SVCRIME, PERCENT_PAINAL, PERCENT_FAIRPOOR_MH, NONCAN_DRUG, PYLL_SH. These variables were subsequently removed from the analysis.

The factor analysis was performed again on the revised dataset, yielding 1 to 3 factors per block, a considerable reduction from 1-5 factors per block in the initial factor analysis.

This is demonstrated below in Table 5.

Table 5: Final factor analysis			
Variable Name	Factor 1	Factor 2	Factor 3
Block 1			
ACSC_RT	0.907		
LIFEEXP	-0.986		
MH_HOSP	0.832		
PREMATR_MORT	0.998		
PYLL_A	0.763		
<i>Proportion Var</i>	<i>0.812</i>		
Block 2			
OTHR_CRIME	-0.179	0.981	
SCPP		0.268	
TA	0.991	-0.115	
TSA	0.633	0.46	
TSVC	0.803	-0.321	
<i>Proportion Var</i>	<i>0.412</i>	<i>0.273</i>	
<i>Cumulative Var</i>	<i>0.412</i>	<i>0.684</i>	
Block 3			
ALC_CONS	0.674		
ALC_MRB	0.953		
DRG_MRB	0.766		
TOT_DRUG	0.759		
<i>Proportion Var</i>	<i>0.506</i>		
Block 4			
F_15TO34	-0.2	0.51	0.699

Table 5: Final factor analysis			
Variable Name	Factor 1	Factor 2	Factor 3
F_MH_HOSP	0.797		0.192
F_POP_AB	0.876		0.301
F_SMRURAL_POP	0.822	-0.2	-0.248
F_WRK_PARTIC	0.135	0.845	0.497
MED_FAM_INC	-0.129	0.909	0.126
NO_POSTSEC	0.896		
PERCENT_FAIRPOOR_HEALTH	0.58		0.339
PERCENT_HEAVYDRINK	0.469		0.344
PERCENT_PARTICAL	0.625	-0.355	-0.152
PRCNT_INCOME_ASST	0.734	-0.433	0.293
SNGL_CMN	0.105	0.258	0.838
TFR	0.833	0.211	-0.293
<i>Proportion Var</i>	<i>0.396</i>	<i>0.175</i>	<i>0.16</i>
<i>Cumulative Var</i>	<i>0.396</i>	<i>0.57</i>	<i>0.73</i>

Blocks 1 and 3 contained only 1 factor, meaning that the variables within these blocks were averaged, based on the factor loadings, to create a single factor for each block. Block 2 is made up of 2 factors: variables relating to assault-based crimes (assault, sexual assault, sexual assaults against children), and other serious or violent crimes (other violent crimes, serious crime per police officer). Block 4 contained 3 complex factors that did not have as clear of a narrative as the other blocks. At this stage, the factor loadings within block 4 had to be interpreted subjectively to decipher common themes among variables that loaded heavily on a factor. While the reduction in factors in block 4 after the second factor analysis made this interpretation slightly easier, it was difficult to qualitatively describe these factors in the context of the research. Examining the factor loadings supports this, as across the three factors in block 4, multiple variables have high or medium loadings. Similar to correlation analysis, loadings are considered moderate or strong when they are 0.4 or greater. For example, the first and third factors in block four each contained a number of variables related to social and health characteristics of women that have bearing on their risk of experiencing violence: level of education (NO_POSTSEC), Aboriginal or rural status (F_POP_AB; F_SMRURAL_POP), age

(F_15TO34), marital status (SNGL_CMN), fertility (TFR); and self-reported health status (PERCENT_HEAVYDRINK; PERCENT_PARTICAL; PERCENT_FAIRPOOR_HEALTH). However, as demonstrated below in Table 6, the two factors were not organized in internally consistent ways, with each containing a mix of moderate or strongly loaded variables related to social and health characteristics. In addition, the second factor in block 4 was heavily loaded by income-related variables (MED_FAM_INCOME; PERCNT_INCOME_ASST; F_WRK_PARTIC). In the context of socioeconomic status as it relates to health outcomes, it is difficult to consider financial disadvantage as a standalone factor compared to educational disadvantage, which is encapsulated in the first factor. The reason for this is that the education and income are highly interrelated and are both key in the conceptualization of socioeconomic status.¹⁹⁴ Similarly, it is difficult to consider mental health separately from health status, activity limitations, and alcohol consumption habits, as all of these are closely related to mental health.^{195–197}

Table 6: Preliminary qualitative factor descriptions		
Factor	Variables included	Loading
Factor 1 – Health Status	ACSC_RT	0.907
	LIFEEXP	-0.986
	MH_HOSP	0.832
	PREMATR_MORT	0.998
	PYLL_A	0.763
Factor 2 – Assault-based violent crimes	TA	0.991
	TSA	0.633
	TSVC	0.803
Factor 3 – Other serious and violent crimes	OTHR_CRIME	0.981
	SCPP	0.268
	TA	-0.115
	TSA	0.46
	TSVC	-0.321
Factor 4 – Prevalence of alcohol and drug issues	ALC_CONS	0.674
	ALC_MRB	0.953
	DRG_MRB	0.766

Table 6: Preliminary qualitative factor descriptions		
Factor	Variables included	Loading
	TOT_DRUG	0.759
Factor 5 – Prevalence of women who are at elevated risk of violence due to Aboriginal or rural status, lack of education, and mental health issues	F_MH_HOSP	0.797
	F_POP_AB	0.876
	F_SMRURAL_POP	0.822
	NO_POSTSEC	0.896
	TFR	0.833
Factor 6 – Prevalence of financial disadvantage	MED_FAM_INC	0.909
	PRCNT_INCOME_ASST	-0.433
	F_WRK_PARTIC	0.845
Factor 7 – Prevalence of women who are at elevated risk of violence due to age, marital status, self-reported heavy drinking, poor health and activity limitations	F_15TO34	0.699
	SNGL_CMN	0.838
	PERCENT_FAIRPOOR_HEALTH	0.339
	PERCENT_HEAVYDRINK	0.344
	PERCENT_PARTICAL	-0.152

Given these complexities and the interrelatedness of many of the variables in block 4, three subjective factors were created to better encompass the context of women and their risk of violent victimization in BC: population level social and demographic risk factors, population level health status of women, and womens’ alcohol consumption habits. A complete delineation of the factors and their component variables is below in Table 7.

Table 7: Final qualitative factor descriptions	
Factor Name	Included Variables
Factor 1 – Health Status	ACSC_RT
	LIFEEXP
	MH_HOSP
	PREMATR_MORT
	PYLL_A
Factor 2 – Assault-based violent crimes	TA
	TSA
	TSVC
Factor 3 – Other serious and violent crimes	OTHR_CRIME

Table 7: Final qualitative factor descriptions	
Factor Name	Included Variables
	SCPP
	TA
	TSA
	TSVC
Factor 4 – Prevalence of alcohol and drug issues	ALC_CONS
	ALC_MRB
	DRG_MRB
	TOT_DRUG
Factor 5 – Population level demographic risk factors for women	F_POP_AB
	F_SMRURAL_POP
	NO_POSTSEC
	TFR
	F_15TO34
	SNGL_CMN
	F_WRK_PARTIC
	MED_FAM_INC
PRCNT_INCOME_ASST	
Factor 6 – Population level health status of women	F_MH_HOSP
	PERCENT_FAIRPOOR_HEALTH
	PERCENT_PARTICAL
Factor 7 – Womens’ alcohol consumption habits	PERCENT_HEAVYDRINK

5.4. Composite indices

The normalized variables were summed to create a composite score within each block and for the dataset as a whole. This score, or composite indicator, is an indexed value based on a sum of the component variables.

5.4.1. Block results

The results of the composite score within each block are below in Table 8.

Table 8: Composite indicator results by block			
Block 1 - General Health Status		Block 2 - Existing Violent Crime	
Richmond	-1.936	South Vancouver Island	-1.142
Vancouver	-0.959	Richmond	-1.082
Fraser North	-0.952	Kootenay Boundary	-1.033
Fraser South	-0.894	East Kootenay	-0.916
North Shore/Coast Garibaldi	-0.880	Okanagan	-0.853
South Vancouver Island	-0.858	Central Vancouver Island	-0.517
North Vancouver Island	0.016	Fraser South	-0.452
Central Vancouver Island	0.080	Fraser North	-0.437
Okanagan	0.085	Thompson Cariboo Shuswap	-0.215
Fraser East	0.428	Fraser East	0.104
East Kootenay	0.482	North Vancouver Island	0.468
Thompson Cariboo Shuswap	0.620	North Shore/Coast Garibaldi	0.647
Kootenay Boundary	0.656	Northeast	0.726
Northern Interior	1.146	Northern Interior	1.088
Northeast	1.200	Vancouver	1.430
Northwest	1.766	Northwest	2.185
Block 3 - Drug and alcohol-related issues		Block 4 - Population-level risk factors	
Richmond	-1.892	Richmond	-1.736
Fraser North	-1.394	Fraser North	-1.202
Fraser South	-1.280	Fraser South	-1.047
Vancouver	-1.196	South Vancouver Island	-0.613
South Vancouver Island	-0.582	North Shore/Coast Garibaldi	-0.605
North Shore/Coast Garibaldi	-0.267	North Vancouver Island	-0.528
Fraser East	0.114	Vancouver	-0.145
Central Vancouver Island	0.167	Central Vancouver Island	-0.083
Okanagan	0.302	Fraser East	0.172
North Vancouver Island	0.515	East Kootenay	0.345
Northern Interior	0.555	Kootenay Boundary	0.399
East Kootenay	0.663	Okanagan	0.490
Northeast	0.748	Northeast	0.507
Thompson Cariboo Shuswap	0.995	Thompson Cariboo Shuswap	0.641
Kootenay Boundary	1.125	Northern Interior	0.871
Northwest	1.428	Northwest	2.535

As evident in Table 8, the results of the composite index Blocks 1, 3, and 4 show some overall consistencies with urban HSDAs in the south of BC such as Richmond, Fraser North and South, Vancouver Island South and North Shore/Coast Garibaldi scoring low in each block as compared rural HSDAs such as Northern Interior, Northeast, Northwest, Thompson Cariboo Shuswap, and East and Boundary Kootenay. This suggests that issues related to health and drug and alcohol abuse are more pronounced in rural, particularly northern HSDAs, and that there is a high prevalence of women who are at heightened risk of violent victimization in these regions. Results for block 2 were an exception. High levels of violent crime is present in both southern, urban HSDAs and northern, rural ones. These results will be interpreted and discussed in detail in section 6.1.

5.4.2. Overall composite index results

In constructing the overall index, the summing of variables was performed in two ways in order to decipher whether or not it was appropriate to treat each block as having equal weight in the overall index. First, a principle component analysis (PCA) was performed in *R* that assigned a weight to variables based on loadings from the first principle component. Second, the final scores were computed using an equally weighted average of the seven factors resulting from the factor analysis. A separate set of composite scores were also calculated to compare the index results based on two different methods of incorporating block 4. This was done to examine how calculating block 4 in different ways influenced the result of the overall index. Similar to the previous step, the score for block 4 was calculated first based on its three subjective component factors as discussed in section 5.3, and then based on an average of all of its component variables. This second method treats all variables in block 4 as if they are a single factor with equal loadings. Similar to the index disaggregated by block, the overall results show consistency across methods, with northern, rural HSDAs scoring the lowest and urban HSDAs in the lower mainland and Vancouver Island scoring the highest. Due to the similarity between the results of the two different methods used to calculate scores for block 4 the author chose to create mapped results only for the first method, using the

subjective component factors to represent block 4. The interpretation of these results are summarized in Table 9 and Table 10 below and further discussed in section 6.1.

Table 9: Overall composite indicator results using factor analysis in block 4			
Equal Weight		PCA Weighted	
HSDA	Composite Score	HSDA	Composite Score
Richmond	-1.925	Richmond	-1.938
Fraser North	-1.155	Fraser North	-1.183
Fraser South	-1.064	Fraser South	-1.085
South Vancouver Island	-0.926	South Vancouver Island	-0.862
North Shore/Coast Garibaldi	-0.320	Vancouver	-0.429
Vancouver	-0.252	North Shore/Coast Garibaldi	-0.423
Central Vancouver Island	-0.102	Central Vancouver Island	-0.052
Okanagan	0.007	North Vancouver Island	0.084
North Vancouver Island	0.137	Okanagan	0.106
East Kootenay	0.166	Fraser East	0.244
Fraser East	0.237	East Kootenay	0.281
Kootenay Boundary	0.332	Kootenay Boundary	0.469
Thompson Cariboo Shuswap	0.591	Thompson Cariboo Shuswap	0.655
Northeast	0.921	Northeast	0.905
Northern Interior	1.060	Northern Interior	1.016
Northwest	2.293	Northwest	2.213

Table 10: Overall composite indicator results without factor analysis in block 4			
Equal Weight		PCA Weighted	
HSDA	Composite Score	HSDA	Composite Score
Richmond	-1.885	Richmond	-1.893
Fraser North	-1.137	Fraser North	-1.165
Fraser South	-1.049	Fraser South	-1.067
South Vancouver Island	-1.002	South Vancouver Island	-0.943
North Shore/Coast Garibaldi	-0.459	North Shore/Coast Garibaldi	-0.579
Vancouver	-0.307	Vancouver	-0.492
Okanagan	-0.058	Okanagan	0.037
Central Vancouver Island	-0.006	Central Vancouver Island	0.055
East Kootenay	0.100	East Kootenay	0.211
Fraser East	0.294	North Vancouver Island	0.274
North Vancouver Island	0.313	Fraser East	0.307
Kootenay Boundary	0.320	Kootenay Boundary	0.458
Thompson Cariboo Shuswap	0.611	Thompson Cariboo Shuswap	0.677
Northeast	0.925	Northeast	0.908

Table 10: Overall composite indicator results without factor analysis in block 4			
Equal Weight		PCA Weighted	
HSDA	Composite Score	HSDA	Composite Score
Northern Interior	1.104	Northern Interior	1.062
Northwest	2.236	Northwest	2.149

5.5. A mapped vulnerability indicator for violent victimization in BC

The results of the index were mapped using *ArcGIS Desktop 10*. Once the data were joined to the basemap, they were visually classified using the map symbology function. This utility allows the researcher to classify numerical fields into graduated symbols that show a quantitative difference between different mapped features by varying the size, frequency, or colours of the symbols. In addition, it classifies the data based on a number of classes (or intervals) that is predefined by the user. For this study, a graduated colour scheme including 7 classes was used. Breaks between classes were identified using Jenks optimization, a method of statistical classification that groups data into classes based on an algorithm that reduces variance within groups and maximizes variance between them. In essence, data are visually classified using 6 natural breaks occurring in the dataset. This means that HSDAs are grouped together ranking and colour based on how close their composite indicator scores are. The author chose to display index results as 7 classes purely to visually capture variability between HSDAs. Given the large size of some of the HSDAs, allowing for more colour variation between areas made it easier to decipher differences between index scores of HSDAs.

The indicator scores were displayed on a basemap of the geographic delineation for HSDAs, which has not changed since the new provincial health regions were introduced in 1997. The index results were then overlain with data points from the BC EAO and the BC Oil and Gas Commission. These points display metal and coal mines that have received EA certificates or are in the amendment stage (“operating”), metal and coal mines that are in the development and pre-application stages (“proposed”), and operating oil and gas facilities. The following pages display the results of the mapped vulnerability indicator for each thematic block as well as for the overall index.

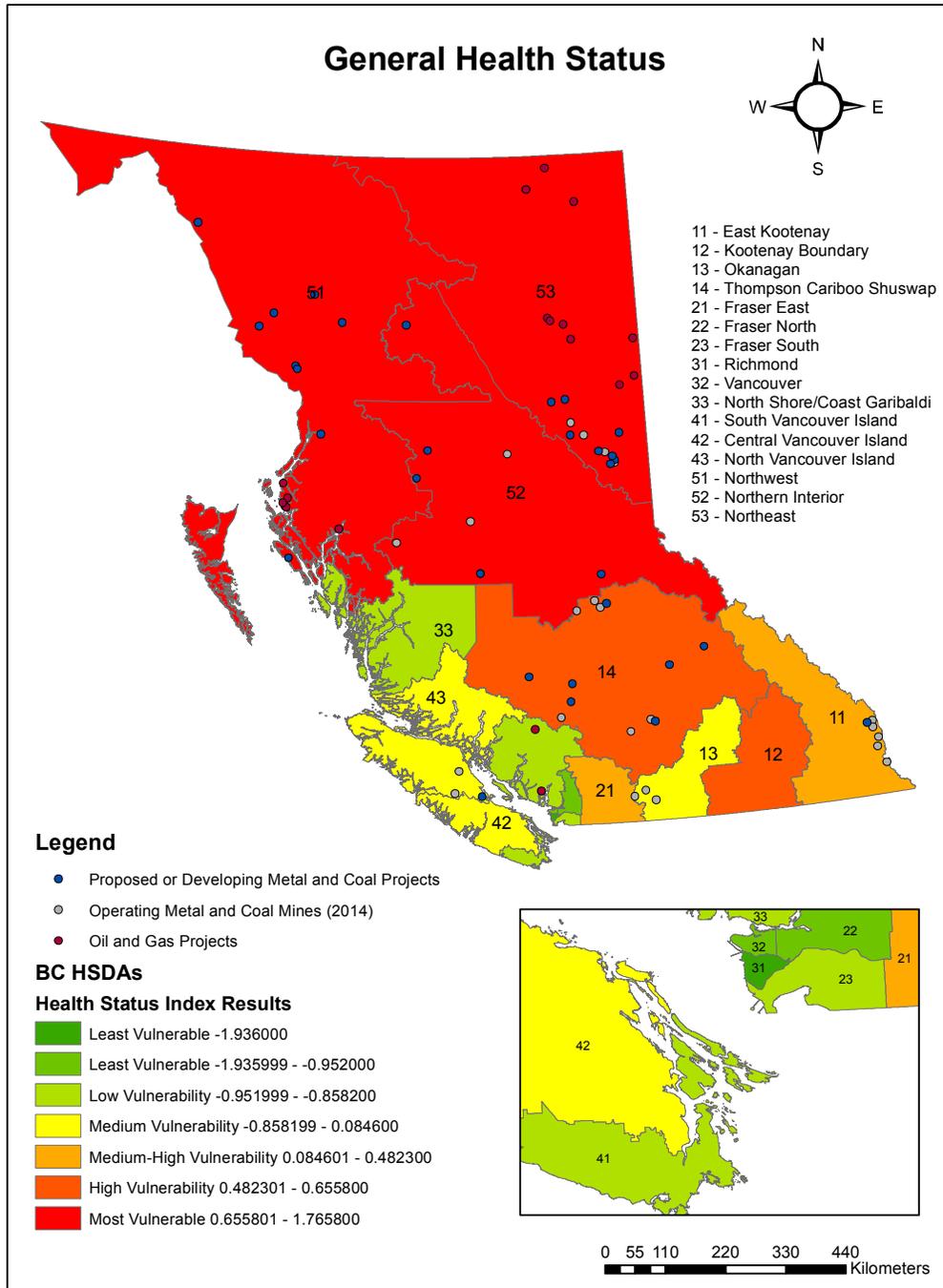


Figure 2: Mapped health status (block 1) composite indicator results

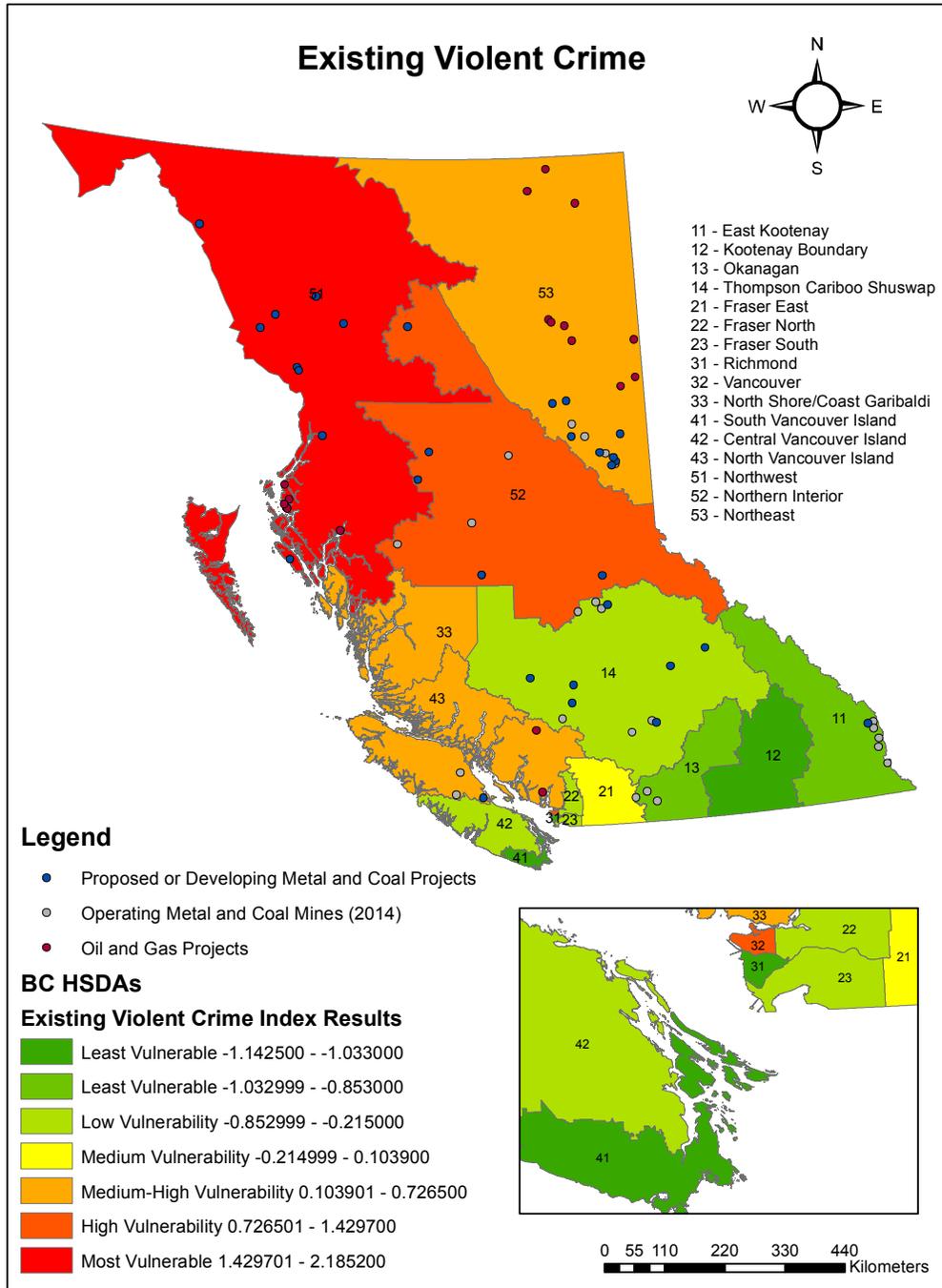


Figure 3: Mapped existing violent crime (block 2) composite indicator results

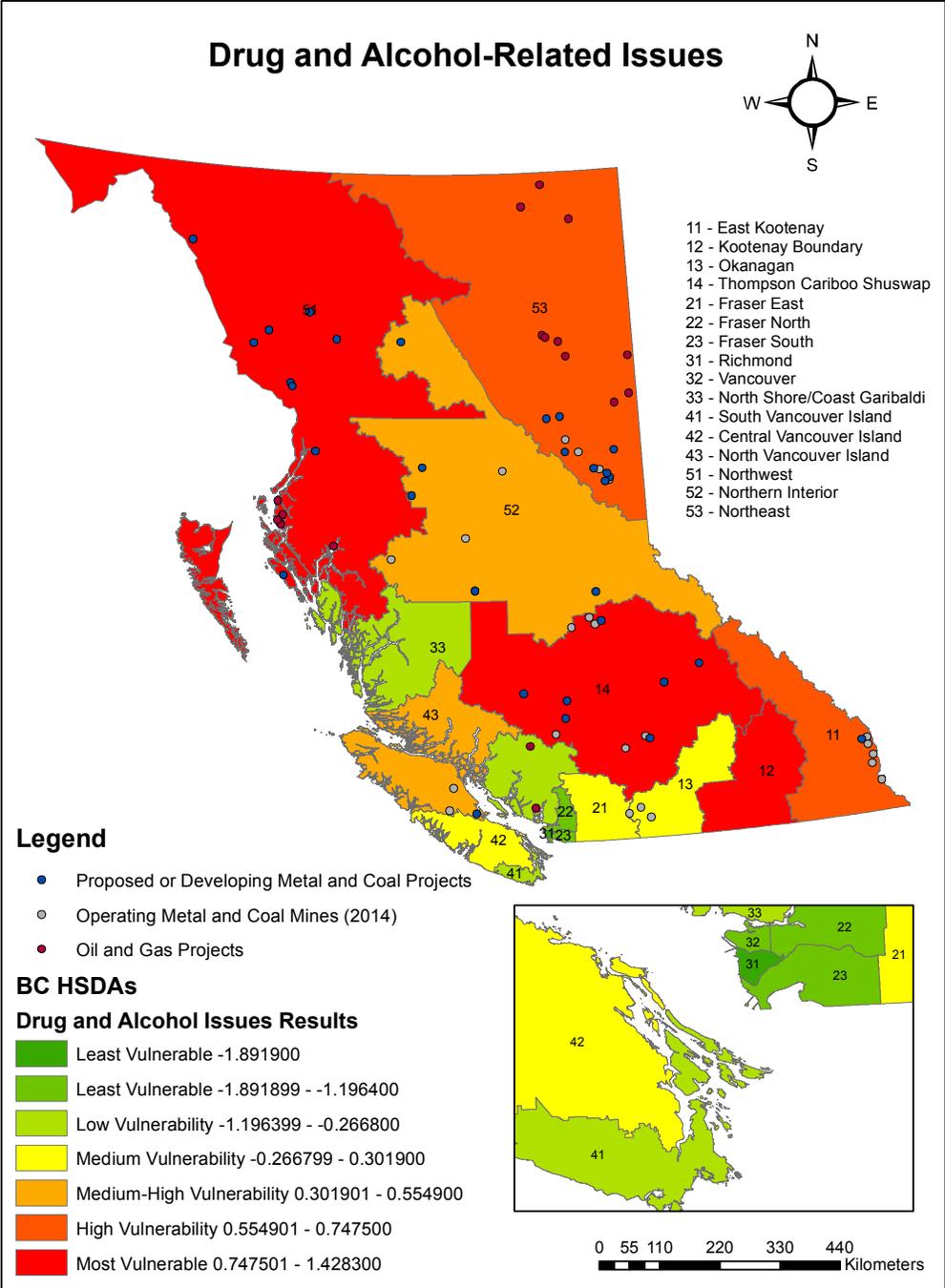


Figure 4: Mapped drug and alcohol related issues (block 3) composite indicator results

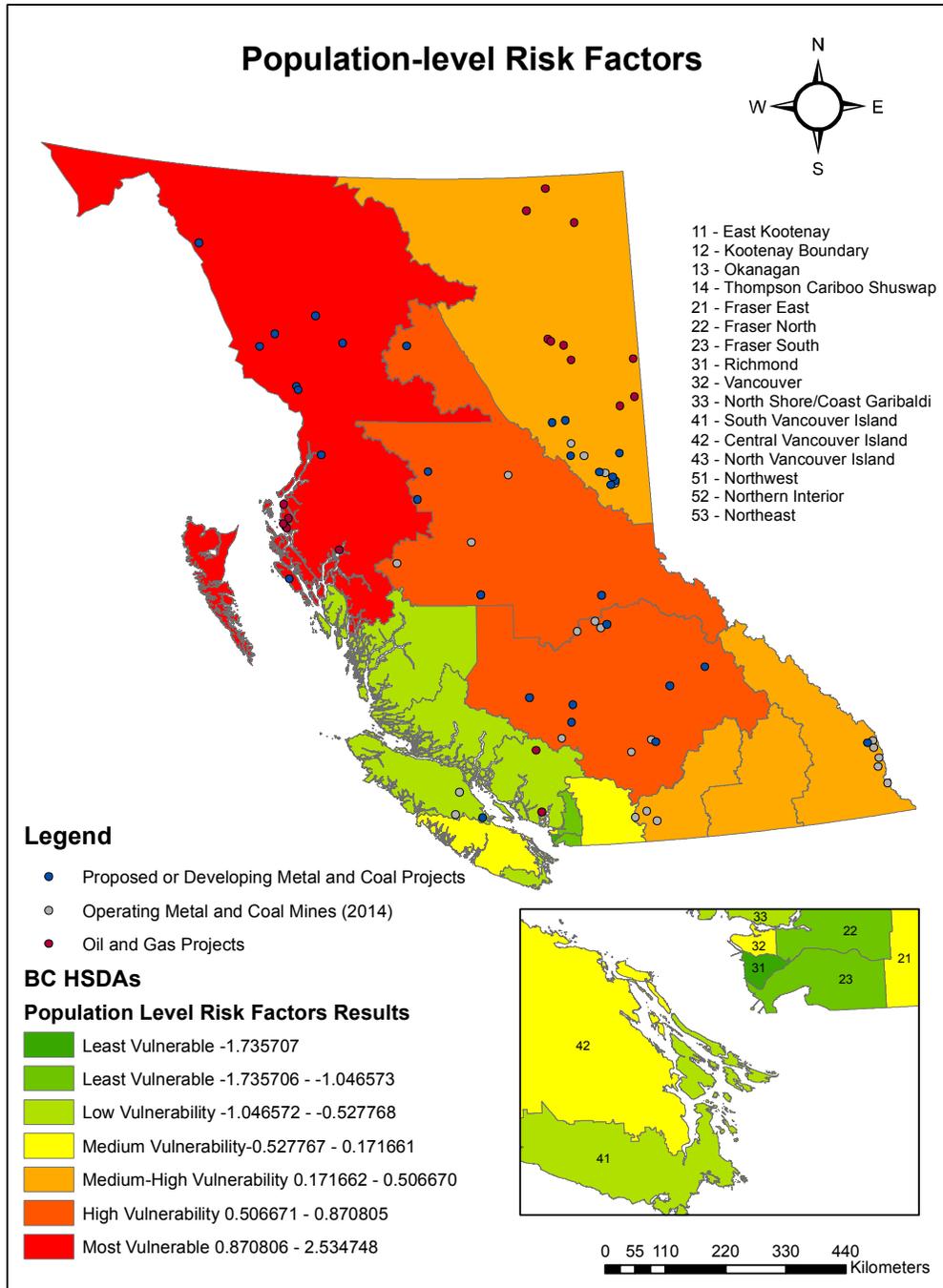


Figure 5: Mapped population-level risk factors (block 4) composite indicator results

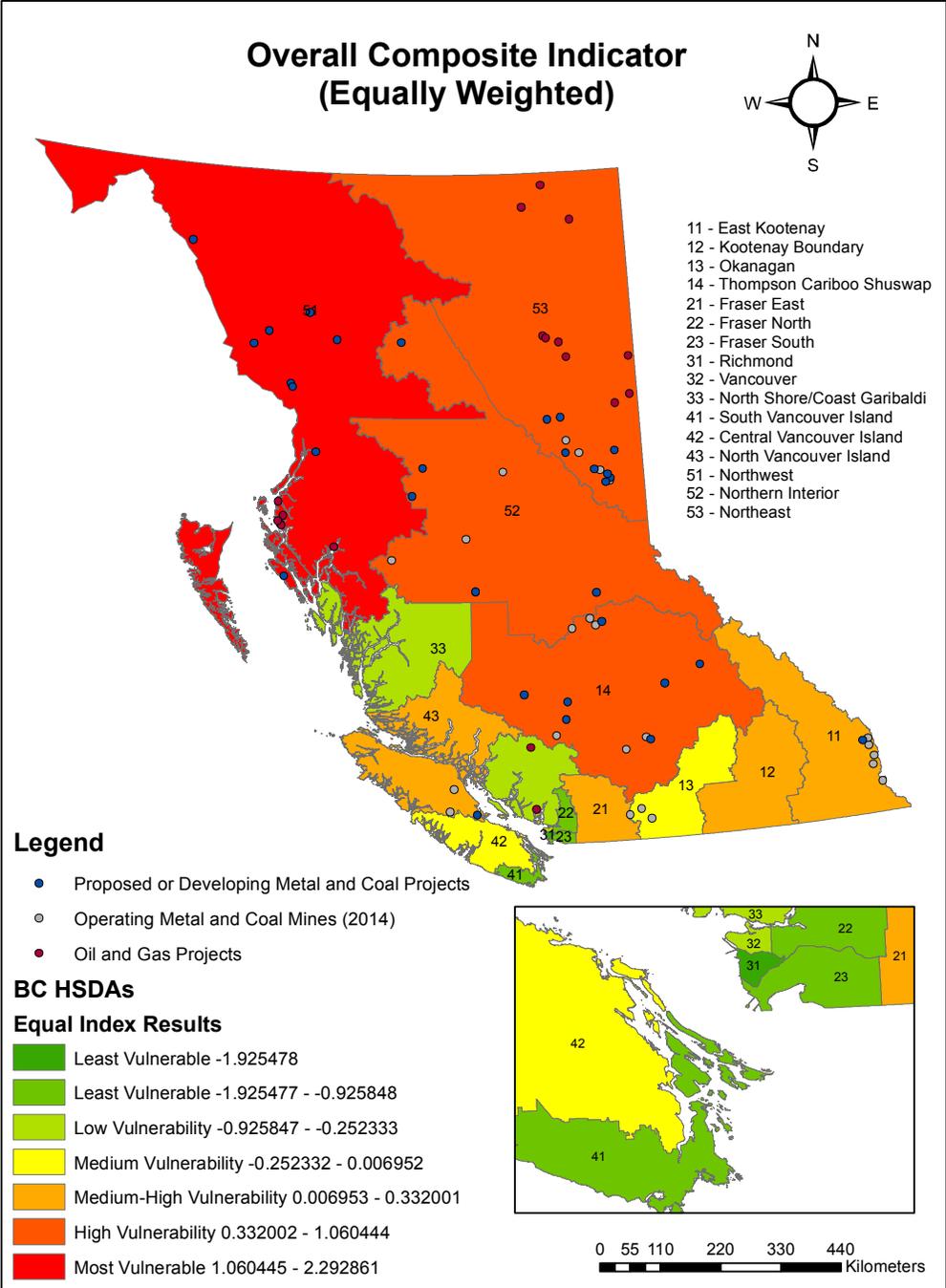


Figure 6: Mapped overall composite indicator results using equal weights

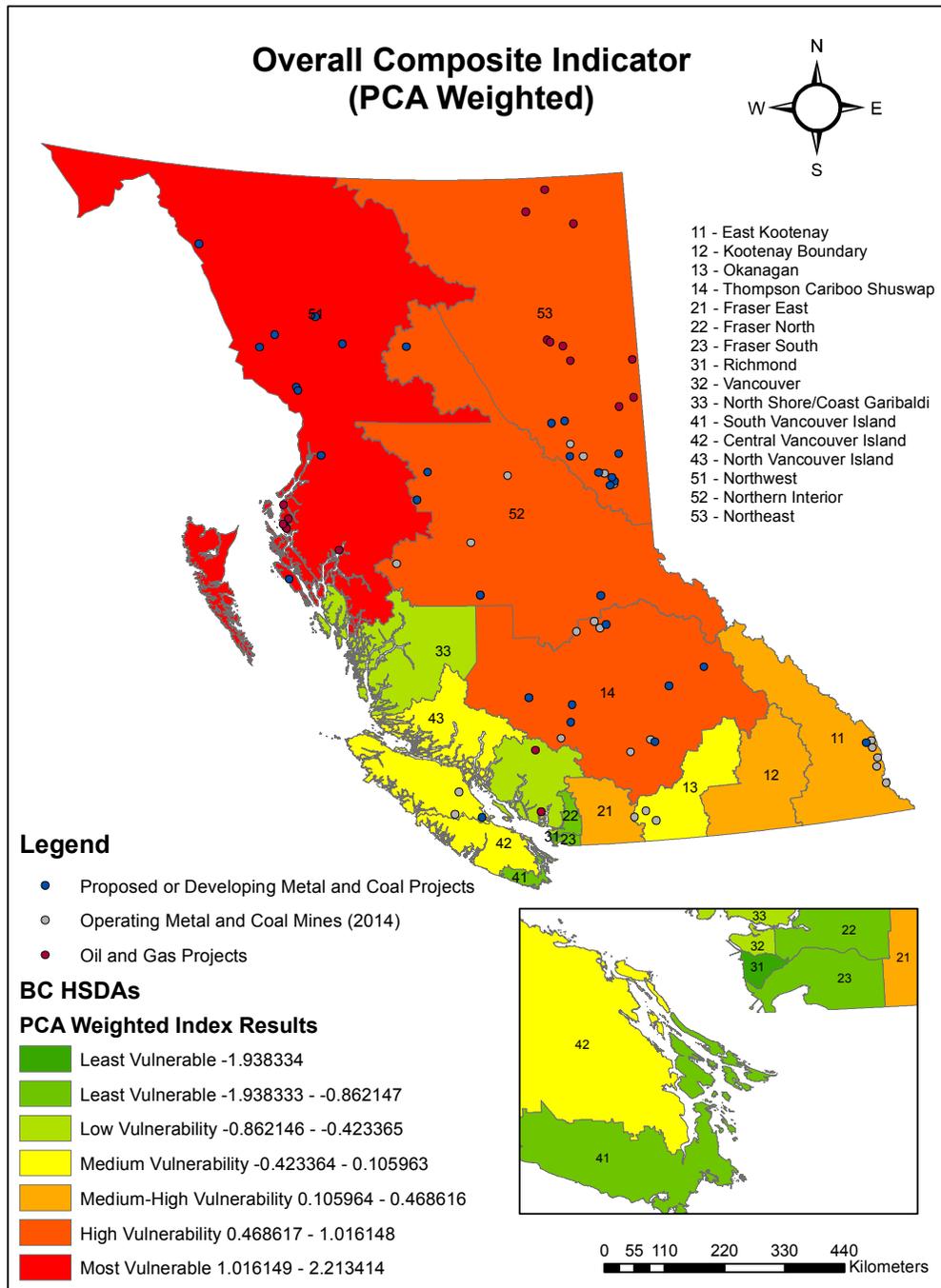


Figure 7: Mapped overall index results using PCA weighting

6. DISCUSSION

6.1. Vulnerable regions, vulnerable people: interpreting the composite indicator

The composite indicator created in this study is one of many methods that regulators, impact assessors, project operators, and communities may use to gain a better understanding of vulnerability to violence in a region. It can be used to gain insight into four critical areas that characterize a population's vulnerability to potential negative impacts that may occur alongside an extractive project: poor health status, endemic violence, drug and alcohol abuse, and the prevalence of women most at risk of being victimized.

Overall, the results indicate a clear north-south divide in terms of vulnerability in BC. This suggests that issues related to poor health, drug and alcohol abuse, and violent crime are more pronounced in BC's northern regions and that their female populations are more at risk of violent victimization than their southern counterparts. In turn, there is overwhelming evidence in the literature that EI projects can impact women's health and safety. According to the design of the proposed indicator, this means that these areas and the populations within them may be more vulnerable to violence-related impacts associated with EI projects. The maps therefore provide an objective image of where, if projects are going to be developed, special initiatives should be undertaken as women in these regions will be at particular risk. Fifty-five out of 72 projects identified on the most current EAO shapefile are located in the four northernmost HSDAs. Namely, these are Northwest, Northern Interior, Northeast, and Thompson Cariboo Shuswap. As these are some of the most remote HSDAs in BC, they face serious challenges in terms of addictions and mental health services shortages,¹⁹⁸ lack of access to health care and emergency services,¹⁹⁹⁻²⁰¹ and lack of accountable and responsive police services.^{202,203} This links back closely to a key finding in the literature: that stressors on communities associated with the EI projects, including substance abuse and violence, can arise very rapidly and compounded with existing strains on health and social services, force already

overextended to catch up with demand. Therefore, the design and implementation of mitigation measures and support services should take place as part of project planning and permitting when regions are identified as vulnerable.

The following sections further discuss findings and interpret the results of the composite indicator for both the indicator as a whole as well as its individual blocks.

6.1.1. Overall results

The results overlain with data from the BC EAO show that the areas where projects are operating or are proposed overlap with areas of high vulnerability. For both the equally weighted and PCA weighted results, the highest scoring HSDA is Northwest, followed by Northern Interior and Northeast, and the lowest scoring HSDAs are Richmond, Fraser North, and Fraser South. However, there are some slight variations between the two sets of results. Table 11 below shows a comparison between the equally weighted and PCA weighted results.

Table 11: Comparison of overall composite indicator results			
Equal Weight		PCA Weighted	
HSDA	Composite Score	HSDA	Composite Score
Richmond	-1.925	Richmond	-1.938
Fraser North	-1.155	Fraser North	-1.183
Fraser South	-1.064	Fraser South	-1.085
South Vancouver Island	-0.926	South Vancouver Island	-0.862
North Shore/Coast Garibaldi	-0.320	Vancouver	-0.429
Vancouver	-0.252	North Shore/Coast Garibaldi	-0.423
Central Vancouver Island	-0.102	Central Vancouver Island	-0.052
Okanagan	0.007	North Vancouver Island	0.084
North Vancouver Island	0.137	Okanagan	0.106
East Kootenay	0.166	Fraser East	0.244
Fraser East	0.237	East Kootenay	0.281
Kootenay Boundary	0.332	Kootenay Boundary	0.469
Thompson Cariboo Shuswap	0.591	Thompson Cariboo Shuswap	0.655
Northeast	0.921	Northeast	0.905
Northern Interior	1.060	Northern Interior	1.016
Northwest	2.293	Northwest	2.213

The equally weighted index treats each block as having equal influence on the overall score, regardless of the number of variables or component factors within it. Thus, the influence of poor health status, drug and alcohol issues, violent crime, and population-level risk factors have equal bearing on the vulnerability score of an HSDA. In essence, these areas are characterized by the poorest health status, highest rates of violent crimes, highest levels of drug and alcohol morbidity, and the highest proportion of women who have high-risk demographic characteristics.

In the PCA-weighted results, more or less the same inferences can be made – the most and least vulnerable HSDAs remain the same. The key differences are in the scores and order of the HSDAs in the mid-range of the index, including: Vancouver, North Shore/Coast Garibaldi, North Vancouver Island, South Vancouver Island, Okanagan, and Fraser East. The scores and overall positions are slightly changed due to the relative weights of the four blocks. The weights of the four blocks were determined by their loadings in the first component when the PCA was completed. These are outlined below in Table 12.

Table 12: PCA weight values	
Block	PCA Weight
General Health Status	0.5529551
Existing Violent Crime	0.3404584
Drug and Alcohol Issues	0.5225144
Population-level Risk Factors	0.5525464

The PCA assigned relatively similar weights to all blocks except for block 3: existing violent crime. Thus, HSDAs that scored higher in block 3 because they have high rates of violent crime but relatively low in all other blocks, received a slightly lower composite score when block 3 is assigned a lower weight. These HSDAs include Vancouver, North Shore/Coast Garibaldi, Fraser East, and North Vancouver Island. Overall, both sets of results are consistent with the finding that the northernmost HSDAs are the most vulnerable in BC.

6.1.2. General health status

The results for this block revealed a clear north-south pattern, where northern, rural HSDAs (Northwest, Northern Interior, and Northeast) ranked the highest on the composite indicator, and the southern, more urbanized HSDAs in the lower mainland and Vancouver Island ranked the lowest. This result is not surprising: it is aligned with current discourse on rural-urban health disparities in BC. Rural British Columbians have lower life expectancy, higher mortality rates, and less access to services than those living close to urban centres.²⁰⁴ In addition, in these areas, those seeking services related to violence – whether to receive treatment for physical injuries or obtain counseling services – may not be able to access them. This in turn, points to the need for health authorities and EI regulators to work together to ensure that resources in these areas can adequately address the risk of increased violence.

6.1.3. Existing violent crime

Existing violent crime was the only block in this analysis that did not display a pronounced north-south pattern of severity. While Northwest HSDA was still the highest scoring area, several southern, rural HSDAs also scored high in levels of existing violent crime. Looking to the data, Northwest HSDA has crime rates that are alarmingly high compared to averages for BC. It has some of the highest sexual assault (391 cases per 10,000, compared the provincial average of 60), sexual violations against children (55 per 10,000 compared to 14), and total assault rates (2584 per 10,000 compared to 808). Vancouver scored the second highest in terms of existing violent crime, and while this is inconsistent with overall findings and those from other blocks, it is not surprising given that it is the most densely populated and metropolitan HSDA in the province. Of all HSDAs, Vancouver has the highest rates of other violent crime (209 cases per 10,000 compared to the provincial average of 112) and sexual assaults (496 per 10,000 compared to 60). Interestingly, the relative positions in the index for this block shifted significantly for East Kootenay, Kootenay Boundary, and Thompson Cariboo Shuswap. These three HSDAs ranked lower in the crime block than in other blocks or the overall results, suggesting that severity of poor health outcomes and substance abuse may not be associated with severe violent crime.

It is important to note that the crime data used in this composite indicator represented reported crimes where charges were laid only. Violent crime that is not reported to police or that otherwise goes undetected by police may vary significantly by region in BC due to quality and quantity of police services and regional perceptions of the criminal justice system. In fact, policing in northern BC has been under scrutiny in recent years for abusive practices, lack of accountability, and inadequate responses to violence against rural and Aboriginal women.^{202,203,205} Given this, it is indeed possible that BC's northern regions may have some of the highest rates of unreported or unrecorded violent crime.

Overall, the northernmost HSDAs in BC, including Northwest, Northern Interior, Northeast, and Thompson Cariboo Shuswap remained 4 out of 5 of the highest scoring HSDAs for existing violent crime. In addition, they have some of the highest rates of sexual assaults in the province, suggesting that women may account for disproportionate victimization.

6.1.4. Drug and alcohol issues

The composite indicator considers drug and alcohol abuse as both a public safety and public health challenge, as substance use can lead to a plethora of health conditions and act as a driver of violent and abusive behaviour. The results of the composite indicator for this block revealed Northwest HSDA as the highest scoring region, followed by Kootenay Boundary and Thompson Cariboo Shuswap. While the results still suggested a north-south pattern, in contrast to the other block results and the overall results, the Northeast and Northern Interior HSDAs ranked slightly lower. This is an interesting finding, especially because Northern Interior HSDA, where the partner communities in the *Ten Steps Ahead* project is located, scored closer to the mid-range of the indicator. As evident in the numerical and mapped index results, Northern Interior ranked lower in terms of the severity of drug and alcohol related issues than surrounding HSDAs. This is consistent with the qualitative findings yielded by other researchers in this project, which characterizes family life in partner communities as containing normalized violence and violence against women. Although alcohol is certainly cited in by community members

as related to violence against women, violence is strongly perceived to be related to intergenerational impacts of residential school abuses.¹ This suggests that any violence mitigation measures employed in highly vulnerable communities may also need to consider that violence can be fuelled by a variety of factors. Among these may be the unique historical context of Northern BC, where many residential school survivors live and work.

Looking back to the original data, the three highest ranking HSDAs have the some of the highest rates of drug and alcohol-related hospitalizations (897, 730, and 650 cases per 10,000 respectively) but not the highest rates of alcohol consumption. The HSDAs with the highest rates of alcohol consumption are North Shore/Coast Garibaldi, East Kootenay, North Vancouver Island, and Central Vancouver Island (13.3, 12.6, 12.0, and 12.1 L of pure alcohol consumption per capita per year, respectively). This suggests that in some areas, alcohol consumption has more severe health consequences on the population than others. This may allude to the presence of a population of people that drink frequently and casually rather than bingeing.

6.1.5. Population-level risk factors

The results for this block were consistent with the overall index results and blocks 1 and 3. Northwest, Northern Interior, Thompson Cariboo Shuswap, and Northeast HSDAs scored highest in the composite indicator, followed by Okanagan, Kootenay Boundary, and East Kootenay in the medium-high vulnerability range. In each of these HSDAs, results indicate that there are high proportions of women that possess known demographic, health, and behavioural risk factors for violent victimization. The female population in these HSDAs is more vulnerable due to the characteristics described by each of the factors in block 4. First, they fall into demographic categories that have higher risks of victimization such as Aboriginal status, being under 35, living in a rural area, low educational attainment and income, low workforce participation, high fertility rates, and being single or in a common-law relationship. Second, they have self-reported health issues that put them at higher risk, such as mental health issues, activity

limitations, and perceived poor health. Third, they self-identify as heavy drinkers. It is important to note that the scores for this block are influenced by the fact that drinking habits make up a single factor within block 4. Thus, this variable carries as much influence on its own as the two other factors in block 4, which are comprised of combinations of several other variables. Overall, the results of this block suggest that northern, rural regions such as Northwest, Northern Interior, Thompson Cariboo Shuswap, and Northeast have female populations that are most vulnerable to violent victimization in BC.

6.2. Applications for the BC EA process

It is critical that EA practitioners and regulators comprehensively consider community health, substance abuse issues, violence, and vulnerable populations in the EA process when assessing and permitting EI projects in BC. This means accurately capturing baseline conditions related to these issues, identifying potential impacts to vulnerable populations, assessing significance, and prescribing mitigation measures. The composite indicator proposed in this study is an example of one of many ways that endemic health issues, violence, substance abuse, and violent victimization of women can be better captured at baseline prior to the initiation of an EA process. The summary process outlined by the BC EAO for assessing the impacts of a project based on the VC framework is below in Figure 8. Assessments are required to consider environmental, economic, social, heritage, and health effects of a project – known by impact assessors and regulators in BC as the “five pillars” of EA.

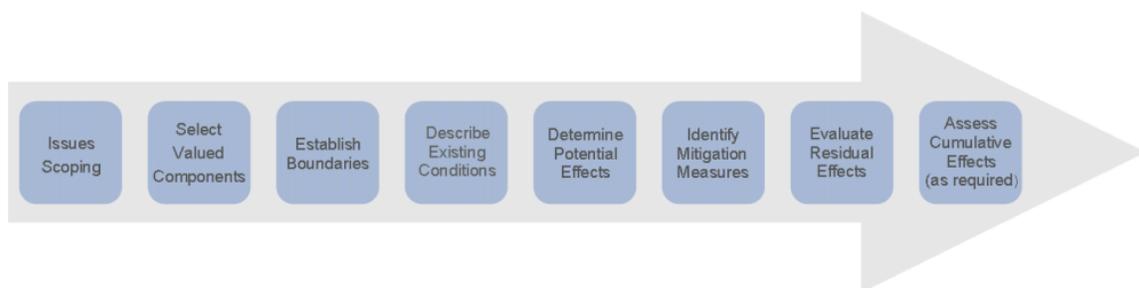


Figure 8: Summary of process for identifying and assessing impacts during a BC EA⁹⁸

There are several steps in this process where a composite indicator such as the one created for this study would enhance the understanding of violence, community health and rural and Aboriginal women in the EA process. The issues scoping phase is a process of compiling and analyzing available information to identify issues (based on the five pillars) that may be related to a project. The issues identified here are used to inform the selection of VCs and should occur before the any documentation is submitted to the EAO.⁹⁸ Utilizing a composite indicator in this stage would inform proponents and impact assessors about existing issues related to health status, drug and alcohol abuse, violent crime, and the presence of women at high risk of violent victimization, thus characterizing the overall project area as potentially vulnerable. In addition, it would tentatively identify community health and safety as a VC and women as a sensitive receptor. When selecting VCs, a composite indicator can also serve as an indicator metric used to measure and report on baseline conditions and trends of a VC. According to the EAO, indicators should comprise an aspect of the VC that is important to its integrity and can be used to understand and evaluate it. This in particular makes the composite indicator a potentially useful tool, as it provides impact assessors with information about the relative vulnerability of an HSDA compared to other regions, and a breakdown of the severity of some key health issues identified by communities affected by EI. When establishing boundaries, the composite indicator can certainly guide the selection of a Regional Study Area, an area based on either natural transition such as a watershed boundary, or a political/economic district. HSDAs could potentially serve as a regional study areas as there is a significant amount of health, economic, and crime data available by this delineation through BC Stats. When describing baseline existing conditions, the composite indicator has obvious applications as it is designed to describe the severity of existing community health issues related to health outcomes, drug and alcohol morbidity, and violent crime. This baseline becomes the benchmark by which VCs are determined to contain sensitive receptors in the determining potential effects stage, and by which the effectiveness of mitigation measures can be measured. In addition, the incorporation of a composite indicator that measures endemic community health and safety issues and the vulnerability of women to violent victimization can help in better designing mitigation measures that address violence. The BC EAO considers mitigation to be “any practical

means or measures taken to avoid, minimize, restore on-site, compensate, or offset the potential adverse effects of a project” and requires all assessments to propose feasible measures to “mitigate to an acceptable level potential adverse effects of the project on selected VCs”.⁹⁸ The composite indicator proposed in this study can certainly inform the design of mitigation measures that target specific elements represented by its four blocks (for example, reducing drug and alcohol consumption and morbidity through workplace programs and increasing addictions services). In addition, it can be used to monitor changes in specific elements over the life of the project. Finally, the composite indicator can be utilized to help characterize residual adverse effects, defined as effects that remain after the implementation of mitigation measures. The composite indicator, especially if computed at a smaller geographic area such as LHAs, can be utilized to describe the sensitivity and resilience of vulnerable women to the changes caused by the project, as well as the magnitude of the residual effect given the proportion of vulnerable women in the project area. Resilience, sensitivity, and magnitude in turn, are several elements that the BC EAO prescribes as criteria for characterizing residual effects.⁹⁸

Overall, an increased understanding of community health issues and the vulnerability of rural and Aboriginal women is important considering the number of EI projects on the horizon in BC. According to the BC Major Projects Inventory, a listing of private and public sector construction projects valued at \$15 million or more, there are 82 EI projects currently proposed falling under the designation of coal or metal ore mining, non-metallic mineral mining, oil and gas extraction, or oil and gas pipeline and related structures construction.²⁰⁶ The majority of projects – excluding some projects too small to qualify under the *Act* – will require EAs. Further, 66 of these projects are located in rural, northern economic development regions, which largely overlap with the most vulnerable HSDAs identified by the composite indicator: Northwest, Northern Interior, Northeast, and Thompson Cariboo Shuswap.

6.2.1. The role of Health Impact Assessment

Health Impact Assessment (HIA) is defined as “a combination of procedures, methods and tools by which a policy, program or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population”.^{207,208} It can provide a means of incorporating human health and the social determinants of human health into the assessment of the potential consequences of projects or public policies using an array of quantitative and qualitative tools.²⁰⁹ In Canada, HIA is largely a stand-alone voluntary process and is not a mandatory requirement of EAs. Assessing impacts on human health often takes the form of a Human Health Risk Assessment (HHRA), defined by the US EPA as systematic process to identify and quantify the nature of adverse effects on human health resulting from exposure to contaminated areas or environments, now or in the future.²¹⁰ HHRA is not well defined in Canada or BC, but generally follows the guidelines set out in Health Canada’s *Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment, Version 2.0* and *Part V: Guidance on Human Health Detailed Qualitative Risk Assessment for Chemicals*.^{211,212} As the titles of these documents imply, the focus of HHRA is on physiological exposure to environmental contaminants and does not consider social, economic, or cultural determinants of health or elements of the project that affect these determinants. The strength of HIA is in its goal to add value to decision making by identifying health impacts that are unexpected, unwanted, and often overlooked in EA and HHRA methodologies, as well as consideration of the influence of health inequities within populations as an inherent part of the process.²¹³ In addition, HIA conceptualizes health holistically, consisting of the overall well-being of an individual or population that is influenced by multiple and interrelated genetic, biological, environmental, social, cultural, and economic factors.

The HIA process, as defined by WHO, consists of five basic steps: screening, scoping, appraisal, reporting, and monitoring. These are described in detail below in Figure 9.

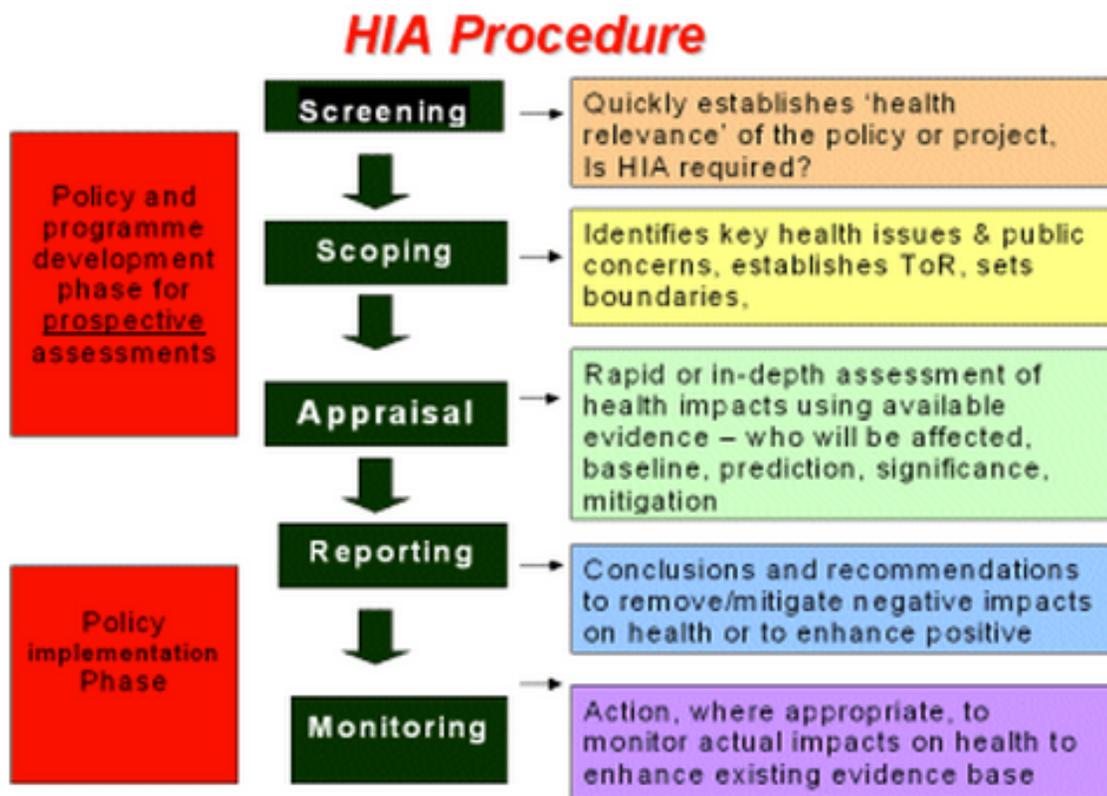


Figure 9: Health Impact Assessment Procedure as identified by the World Health Organization

The HIA model is an ideal platform for incorporating the concept of vulnerable populations and in turn, a composite indicator for measuring vulnerability. The composite indicator developed for this study measures existing issues of poor health, drug and alcohol abuse, violent crime, and the presence of women at high risk of violent victimization. Thus, it can contribute a metric that describes multiple dimensions of community health to an assessment of health impacts. It may be utilized in the screening phase to identify whether the project is located in a high vulnerability area; in the scoping phase to set boundaries, determine what qualitative data should be collected from local stakeholders concerning gender, violence, substance abuse, and health; in the appraisal phase to describe baseline conditions and sensitive receptors; and in the monitoring phase to track changes in the composite score over the medium of long term.

6.3. Potential interventions for extractive industries

Mining, oil, and gas companies have a challenging task when it comes to operating in areas where poor health, violence, and alcohol and drug abuse are common and there are populations that are highly vulnerable to violent victimization. On one hand, companies cannot take responsibility for conditions that existed before they began exploration, construction, or operations. Nor should they compensate for government failures to address pressing issues like violence. On the other hand, existing violence, substance abuse, and vulnerable populations can pose a risk to the project. Social acceptance of an EI project can be affected if communities perceive that the project exacerbates existing issues or creates new ones, and if the company and regulator make little effort to implement activities that reduce impacts or improve a community's resilience to the social, economic, and demographic changes that EI development is associated with. Thus, it is important that proponents have a clear understanding of the context in which they plan to or already operate. This begs the question: how should a company proceed if they - by use of a composite indicator or by any other method – identify that they are working in an area of high vulnerability?

6.3.1. Preventing violence during construction and operations of extractive projects: key lessons from the field

Interventions that address both existing and project-induced community-level violence are not well documented in the extractives sector. In part, this may be due to risk-aversion on the part of operators, as acknowledging that there are issues involving violence in the project area may be perceived as opening the company to public scrutiny and criticism. However, such interventions are not unheard of. This section highlights several examples of measures and programs implemented by mining operators to prevent and mitigate community-level violence and violence against women and girls. These examples are

derived from informal interviews with key personnel involved in three mining projects in Latin America, West Africa, and Southern Africa.⁴

While the cultural and socio-political contexts of these projects were complex and varied, several similarities make them important examples from which key lessons can be drawn. First, all were located in developing countries in areas where domestic violence, sexual assault, and violent behaviour within communities were endemic, common, and arguably, ingrained in the local culture. Second, in each case, the project operator had implemented a community relations or social team, consisting of in-country staff and international experts and consultants to help manage social and health issues during construction and operations phases. Third, in each project, the community relations or social team identified women and/or young girls as a vulnerable group and implemented activities to minimize or prevent their exposure to violence and exploitation.

In Latin America, consultants hired to manage social performance at a large copper mine identified women and single mothers as a priority group for which access to economic opportunities from the mine needed to be improved. Working with the project subcontractors and the mine's social team, the consultants developed training videos and programs to help women develop practical vocational skills to improve their chances of employment. However, detailed research of the local culture and issues scoping activities involving local women revealed that the economic empowerment of women was perceived as a threat to men's traditional role as the sole income earners and providers for families. In turn, this was known to manifest as increased family violence. The company sought offset this while still ensuring that women had access to the project's economic opportunities. As a result, the company provided financial support to develop a satellite office of a well-established national agency devoted to preventing violence against women and providing victims' services in the community. Staff members at this project report that this investment was successful: there were few cases of women accepting jobs and leaving them after a short period, and follow-up monitoring on the program indicated

⁴ Due to confidentiality agreements signed by staff members, the names and exact locations of these projects cannot be disclosed

that the agency's services were being utilized by local women needing to escape violent situations (Personal communication, Project Social Consultant, August 2015). For the company, identifying the issue and providing some support for mitigation increased opportunities for local hiring, decreased turnover from female employees, and contributed to general social acceptance of the project among community members.

In some scenarios, endemic violence in communities surrounding a mining project is more extreme, making company-led violence mitigation even more prudent. At a large metal mine in West Africa, construction and operations were set amid a context of severe community-level violence as the country recovered from a war. In this scenario, sexual assault and gang rape became a national epidemic after years of violent conflict, and traditional beliefs that promoted sexual violence against women and children as a form of social punishment were practiced in some areas. With substantial male-dominated workforce influx expected, the company recognized that increased transmission of STIs and increased incidence of sexual violence were potential adverse effects. The strategy implemented to address this was multifaceted, including: the implementation of safe, consensual sex education campaigns for workers as part of regular Occupational Health and Safety (OHS) operations; the financial support of community-based counseling services for men and women who had been abused or were otherwise affected by sexual violence; and the support of community-level public awareness activities through partnership with a local NGO. The latter two activities were funded as part of the company's overall community development budget, while the former was integrated into regular operating costs (Personal communication, Project Social Consultant, August 2015). Though it is difficult to measure the impact of these initiatives in a region where violence is cultural norm, the company's interventions certainly helped raise awareness of sexual health among workers and supported community-level violence prevention efforts.

A similar strategy was observed in a nickel mine in a remote region of Southern Africa, wherein the operator sought to incorporate anti-violence activities into both regular operations and community development initiatives. In this case, childhood marriage and

statutory rape of young girls were identified as significant and endemic issues. Compounding this, young women and girls in the surrounding area lacked access to economic opportunities, making them vulnerable to exploitation by incoming workers and to entering the sex trade to help support families. Given the project's large migrant workforce, the company's social team recognized this as a potential health and safety risk to young girls, and a reputational risk to the company itself. As part of operations, the company implemented a code of conduct that specifically prohibited employees and subcontractors from having sexual relationships with young girls. This code was promoted through visits to worker accommodations facilities, and subsequently signed by personnel from over 40 of the mine's subcontractors. In addition, the occupational health and safety (OHS) team made awareness of the legal consequences of statutory rape part of the general site induction process that was mandatory for every worker. This included making it clear to workers that if they were violated this policy or witnessed an incident and failed to report it, they were considered implicit, terminated immediately, and would be reported to local police. Subsequently, the company implemented a whistleblower policy to ensure anonymity of workers or community members reporting sexual assaults or statutory rape. To support victims and promote the protection of young women and girls from sexual violence in communities, the company signed a Memorandum of Understanding with UNICEF to implement a number of mitigation measures. This included a contribution of over \$500,000 USD to fund the development of child protection networks at the village level. Over several years, UNICEF undertook educational activities in schools and set up 15 kiosks where youth could access educational materials and collaborate to run their own awareness activities (Personal communication, Project Community Relations Coordinator, August 2015).

Some key lessons can be gleaned from these examples. First, that some companies address issues like sexual assaults and sexual violence through incorporating messages about safe, consensual sex into existing workplace health and safety systems, educating workers on the risks and consequences of their conduct off-site. Second, that these particular companies chose to strategically invest portions of their community relations or corporate social responsibility (CSR) budgets to serve a dual purpose. Their investments

of financial support and staff time show both a public gesture of social responsibility by addressing an issue identified as important by community members, as well as reducing potential reputational risk to the project stemming from this same issue.

6.3.2. Developing interventions on violence prevention and response in the BC extractive sector

The nature and effectiveness of interventions to prevent violence against women is a growing area of research, with many intricacies yet to be understood. In many high-income countries like Canada, programs in the public and private sectors that address violence (such as emergency services or mental health resources for victims) often focus more on interventions that support existing victims than on preventative actions. In a systematic review of violence prevention models focused on multiple forms of violence against women and girls, Ellsberg et al (2014) found that evidence on how to prevent violence against women in developed countries is surprisingly scarce. In countries like Canada, response-based interventions have revealed that victims are increasingly using services and that physical and mental health outcomes are indeed improved when a victim utilizes support services. However, there is little evidence of the effectiveness of programs in preventing initial violence or reducing re-victimization, and less evidence still on the effectiveness of response-based programs for perpetrators.²¹⁴

The economic empowerment of women as a means of violence prevention is a traditional model supported by many development practitioners. However, evidence reviewed by Ellsberg et al and Vyas and Watts (2009) suggests that increased access to credit and assets can either decrease or increase a woman's risk of violence depending on the social and cultural context in which a woman lives.²¹⁵ In North America specifically, some research has explored employment and contribution to household income as a symbolic resource in many heterosexual intimate partnerships – where economic power is a measure of the relative statuses of men and women within a relationship that is structured around expectations of female dependence on a male partner. This model supports the idea that economic empowerment can be both a risk factor and a preventative factor, with the imbalance of economic power (for example, when women are financially dependent on a partner, or when women are the primary income earner and their partner is

unemployed) between males and females in intimate relationships mediating a woman's risk of violent victimization.²¹⁶ This idea brings light to the need for violence prevention measures in high-income countries that go beyond improving women's access to economic opportunities, as a woman's relative poverty does not *always* increase her risk of victimization. While it is obvious that broadening and mainstreaming such interventions requires a commitment from practitioners, policy makers, and civil society, there are certainly micro-level interventions that can be implemented in manageable environments such as the workplace. This presents an opportunity for the BC extractive sector – or any sector for that matter.

Violence in the workplace, domestic or otherwise, generates significant costs. One of the most comprehensive studies on this was a 2011 cross-sector research project in Vermont that sought to measure impacts of domestic violence on the workplace. Findings indicated that 31% of respondents took paid or unpaid leave related to domestic violence issues, and a total of 44,515 working days were lost due to criminal repercussions of domestic violence. In addition, up to 14% of time taken off was paid for by the employer. When asked about workplace interventions to prevent violence, nearly 44% of respondents perceived that the presence and frequent discussion of a written company policy on domestic violence and the setting of a workplace culture against violence would be effective in reducing impacts.²¹⁷ Across Canada, the cost of domestic violence to Canadian employers was over \$77 million according to a federal government study in 2009.²¹⁸ In BC, an estimated 54% of victims miss three days of work or more per month due to domestic violence, and this does not include the time lost by perpetrators of violence in their own workplaces.²¹⁹

BC employers also have some legal obligations concerning domestic violence. According to section 4.28 of the BC Occupational Health and Safety Regulation, employers must conduct a risk assessment if there are interactions between and employees or other persons that may lead to threats or assaults. In addition employers must establish procedures and policies that address the risk if it is non-imminent (section 4.29), and instruct workers on how to recognize the potential for violence, utilize the procedures and

policies, respond or obtain assistance, and report and document incidents of violence (section 4.30).

In recent years WorkSafe BC has introduced several useful guides for helping employers manage domestic violence in the workplace. For example, employers can follow a simple four-step process for meeting legal obligations concerning domestic violence: assessing risks, eliminate or minimizing risks, instructing workers, and responding appropriately to incidents.²²⁰ Where employers seek to implement more active measures, WorkSafe BC has also established a ten-step process for creating a workplace-specific domestic violence policy.²²¹

Given community concerns about violence associated with EI projects, and the relative vulnerability of many of the regions where EI projects are operating in BC, developing workplace violence-prevention policies in BC's mining, oil and gas operations is a crucial first step. These policies can easily be incorporated into existing workplace OHS systems and employee wellness programs. Outside the fence, it is essential for operators to first understand whether communities they work in have existing violence, substance abuse, and health issues and highly vulnerable populations. In turn, it is prudent for operators to seek out, support, and form partnerships with local agencies or NGOs that are already working to address these issues. Like the cases described in the previous section, utilizing the expertise of organizations already mobilized on the ground is one of the most efficient ways for companies to divert resources towards addressing violence.

6.3.3. Frameworks for improving health, safety, and sustainability performance

In light of the increasing influence and power of host communities, the rise industry accountability to communities conceptualized in terms such as the “Social License to Operate”, and the subsequent increase of the public's scrutiny of the extractive sector, a number of frameworks for improving health, safety, and sustainability performance have emerged. This has occurred in both the Canadian and the global extractive sectors.

In Canada, such frameworks include *Towards Sustainable Mining (TSM)*, developed by the Mining Association of Canada (MAC), and *e3 Plus* developed by the Prospectors and Developers Association of Canada. Focused on the minerals sector, these frameworks aim to provide benchmarks and guidance to improve social, environmental, and health and safety performance for companies who are both in the exploration (*e3 Plus*) and development/operations phases (*TSM*) of mining. *TSM* is particularly relevant to this work, as it applies more to existing and proposed projects that have long-term direct social, economic, and health impacts on surrounding communities and vulnerable populations within them. The *TSM* program includes both conceptual frameworks and specific performance metrics under which performance on Aboriginal and Community Outreach and Safety and Health can be measured and reported using self-assessments.²²⁸ While the performance indicators are certainly progressive, promoting consistent engagement and issues scoping in communities and careful monitoring and reporting of both quantitative and qualitative OHS they lack information on mechanisms for monitoring and mitigating specific health and safety issues in communities. As the findings of the literature review in this work suggest, there is plenty of evidence that issues such as violence, substance abuse, communicable diseases, and traffic accidents are indeed often associated with EI projects.

Internationally, the International Finance Corporation (IFC) implemented the 7 Performance Standards on Environmental and Social Sustainability in 2006.²²⁹ Meeting these standards is mandatory for organizations that have received finance from IFC for industrial projects. The themes of the performance standards are as follows:

1. Assessment and Management of Environmental and Social Risks and Impacts
2. Labour and Working Conditions
3. Resource Efficiency and Pollution Prevention
4. Community Health, Safety, and Security
5. Land Acquisition and Involuntary Resettlement
6. Biodiversity Conservation and Sustainable Management of Living Natural Resources
7. Indigenous Peoples

Of particular importance for this work are performance standards 1 and 4. Performance standard 1 requires the establishment of a formal management system for environmental and social performance throughout the life cycle of the project that includes: policy; identification of risks and impacts; management programs and plans; organizational capacity and competency; emergency preparedness and response; stakeholder engagement; and monitoring and review components.²²⁹ Applying structure to this management system encourages companies to have trained personnel and written management plans and policies for dealing with identified risks and impacts.

Performance standard 4 outlines the company's responsibility to avoid or minimize impacts and risks to community health, safety, and security as a result of project-related activities, with attention to vulnerable groups in the project area.²²⁹ Unlike other frameworks of its kind, performance standard 4 references company responsibilities to specific health and safety issues that are known to be associated with major projects, including community exposure to disease and community interaction with security contractors and personnel. In addition, it takes into account the need for a proponent to identify vulnerable groups and implement mitigation measures that specifically target vulnerable people. While performance standard 4 does not address gender and violence specifically, it does encourage the proponent to "explore opportunities during the project life-cycle to improve environmental conditions that could help minimize their incidence" where certain disease are endemic in communities.²²⁹ As the results of the composite indicator imply, there are many regions in BC where violence could certainly be considered an endemic health issue, if not a disease.

Proponents and regulators in BC have the opportunity to improve environmental, social, and health and safety standards by implementing international best practices such as those outlined in the IFC Performance Standards. Rather than going through a process of proving that risks and impacts associated with a project are or are not significant, the performance standards place social and environmental risks to both host communities and the project front and centre, recognizing that they exist and may be disproportionately experienced by different groups of stakeholders. This in turn places the focus of

environmental, social, and health risk assessment and management on implementing appropriate mitigation measures to avoid or minimize negative impacts. Given how current EAs address issues such as violence at the current time, a paradigm shift such as this is sorely needed in BC.

6.4. Next steps: opportunities for refining the composite indicator

The composite indicator proposed in this study is a successful model for identifying HSDAs in BC where there is poor health status, drug and alcohol abuse issues, existing violent crime, and a high proportion of women at risk of violent victimization. However, the utility, validation, and application of any composite indicator can be improved through revision and experimentation. For this study, access to additional population health and spatial datasets and further research into violence and violence against women in rural BC would provide opportunities to improve this indicator as a tool for impact assessment, community health monitoring, and policy-making. The next phase of work in this project will seek to implement the improvements described in the following sections.

6.4.1. Using LHAs for a finer spatial scale

BC's HSDAs are large areas, sometimes consisting of several small or medium population centres spread across large geographic areas. The utility of the composite indicator could be improved by applying it to 89 smaller LHAs that make up each of BC's 16 HSDAs. Indeed, it is reasonable to expect some variation in health, demographic, and crime statistics across the LHAs that make up each HSDA. Using a smaller geographic area would allow for better estimation and generalization of conditions in each area. In turn, this would improve the indicator's use as a tool for capturing baseline conditions, identifying if a project is in a vulnerable area, assessing the significance of impacts, and monitoring changes over time. However, due to privacy regulations in the *Statistics Act*, obtaining health and crime data for areas with small populations requires considerable processing time, as federal and provincial agencies need to ensure the privacy and safety of individuals. This is especially true regarding

crime data, as it may be possible to identify victims in areas where the population is small.

6.4.2. Accessing additional variables

The validity and utility of the composite indicator could further be improved by incorporating additional variables. Perhaps the most useful of these would derive from data collected in the General Social Survey (GSS) on Victimization, a national survey conducted every 5 years on how Canadians perceive crime and justice and their experiences of victimization. The GSS on Victimization contains some of the most comprehensive data in Canada on violence against women. It collects information on the nature and frequency of violent incidents, detailed characteristics of victims, including their past experiences with violence, and detailed characteristics of the perpetrator. Unfortunately, the data from the GSS cannot be released at the sub-provincial level due to privacy regulations without extended screening and data processing wait times. Incorporating this data into the composite indicator would allow users to know where violence against women is most prevalent and access additional information on the profiles of victims and perpetrators. Research on violence and violent victimization in Canada suggests that women's experience of victimization vary based on characteristics such as ethnic identity (aside from Aboriginal), immigration status, and whether or not they witnessed or experienced violence at a young age.^{128,181} There is also significant variation in characteristics of perpetrators of violence. Knowing more measurable details about victims and perpetrators would allow for a finer analysis of geographical areas in BC where violence is a risk.

Finally, if privacy requirements could be met and time allotted for screening and data processing, several other types of variables could strengthen the composite indicator. These include disaggregating police-reported assault by female victims and by domestic and non-domestic cases. Municipal and federal police forces in BC do categorize domestic or intimate partner violence separately from other incidents of assault, known colloquially as "K-files". However, due to the sensitivity and in some cases, the continued risk to the safety of the victims, this data is difficult to access.

6.4.3. Knowledge translation: making the composite indicator work for communities

Knowledge translation is defined by CIHR as “a dynamic and iterative process that includes synthesis, dissemination, exchange and ethically sound application of knowledge to improve the health of Canadians, provide more effective health services and products and strengthen the health care system”.²³⁰ Relationships between researchers and research stakeholders are complex and involve varying degrees of engagement. However, incorporating KT into research projects is important to ensure that the knowledge created using data from stakeholders, and aimed at strengthening the systems that impact them, is utilized beyond the academic audience for the benefit of the stakeholders themselves. The *Ten Steps Ahead* project employed a bi-directional KT process. The project was initiated with a research advisory board (RAB) – including a variety of community stakeholders health directors and health care providers, community leaders, planners, and community members from the three partner communities – sharing their knowledge and perceptions about mining and community health with the research team. In turn, findings from all research activities were shared first with these same stakeholders, and then with broader stakeholders including: Thompson Creek Metals Company Inc. (Proprietor of the Mt. Milligan Mine); the Northern Health Authority (Aboriginal Health Program), and a broader BC-based audience including the BC Environmental Assessment Office, the BC Ministry of Energy and Mines, and the Mining Association of British Columbia (MABC). The foundation of the work described in this thesis was derived from community health concerns raised by the RAB, and as one of the project’s main KT outputs, the results of this work were presented to the RAB in November 2015.

The composite indicator proposed in this study also has a number of broader applications for community members, local governments, planning committees, and other community based organizations. In its current state, indicator can be utilized by communities to easily examine how their region compares to others in BC in terms of health issues, violent crime severity, drug and alcohol related morbidity, and the prevalence of women

vulnerable to violent victimization. This would be especially useful if the indicator were spatially disaggregated by LHA. Knowing this, communities may be better able to plan and advocate for services that address the issues that are severe in their region. In addition, communities can easily access and reference this information in public comment periods during the EA process, allowing them to further encourage that regulators consider mandating appropriate mitigation measures when making the decision to permit a project. The composite indicator is also well-suited to be incorporated into online, real-time community health monitoring tools such as the BC Community Health Atlas, or act as a standalone, online, open-access tool for users to examine relevant figures and indicators relating to violence and victimization in their communities. Future work in the *Ten Steps Ahead* project will involve refining this indicator and presenting it to a wider audience as part of the project's KT activities.

7. STUDY LIMITATIONS

This section discusses several limitations of the research methodology and findings. These are primarily focused on indicator validation, existing spatial and statistical datasets, and reliance on factor analysis.

One of the key limitations of this project is related to validation of the composite indicator it proposes. Composite indicators can be validated in a number of ways, including assessing the quality and relevance of the component variables,²²² comparing results with other indicators or validating metrics,^{140,222,223} conducting uncertainty and sensitivity analysis,^{157,224} and comparing the indicator's results to known or probabilistic outcomes.²²⁵ According to OECD's *Handbook on Constructing Composite Indicators*, robust validation of a composite indicator should contain a combination of these techniques.¹⁴⁰ That said, many composite indicators focused on development and vulnerability contain the inherent limitation that there is no universal validator against which their results can be compared.²²³ For this study, preliminary validation was undertaken by conducting detailed research in the selection of variables, using proxy variables only where direct indicators were unavailable, and selecting variables based on their concurrent use in research by federal and provincial statistical agencies. Thus, the variables selected both met all the quality criteria outlined by OECD, and are routinely used to measure the same phenomena in contemporary academic and government-led research. As discussed in the previous section, future work will seek to refine and further validate the indicator proposed in this study.

As discussed in the above chapters, this research utilized existing health, demographic, crime, and spatial datasets from a number of federal and provincial sources. Namely, these were Statistics Canada, BC Stats, and CIHR. Specific figures were derived from several different surveying and monitoring tools utilized by these institutions. While the reliability of this data is sound, the author encountered several challenges related to these datasets. First, the data collection tools utilized by the above institutions may have slight

variations in methodology or denominator data when calculating rates. One example of this is the small discrepancy observed between population figures listed in the 2011 Census and the 2011 National Household Survey (NHS). The author addressed this limitation by utilizing denominator data consistent with what was utilized by the particular survey or monitoring instrument from which any figure was derived. For example, the population of Aboriginal women by HSDA was derived from the 2011 NHS, and therefore the percentage of women who identified as Aboriginal within an HSDA was calculated using figures from the NHS. Since this study aggregates these rates and figures into single numerical scores, small variations in denominator data have no bearing on the overall results. Secondly, a few variables utilized in this study were derived from socioeconomic indices by LHA created by BC Stats. These include: PYLL from accidents and serious crimes per police officer. Due to small populations, Snow Country, Central Coast, Stikine and Telegraph Creek LHAs were excluded from these indices. To calculate rates for HSDAs, the mean rates of the included LHAs were used, causing potential limitations in the accuracy of rates for these two variables.

The spatial datasets used in this study had their own unique limitations. First, while the author made effort to utilize data sources that were free and easy to access, this was not possible for all data. Crime rates were not available for free online download by HSDA and required a custom order from BC Stats. Although free of charge for the author, this service would not be free for a user outside of university graduate studies in BC. Second, this study relied on available spatial datasets downloaded from BC Stats, the Ministry of Energy and Mines, and DataBC. Thus, shapefiles that could more accurately depict EI projects in BC, such as a shapefile containing line locations of existing and proposed pipelines or a shapefile that described the various sizes of projects (in terms of investment value, daily production, or workforce) could not be included. These datasets certainly would have added to the utility of a mapped composite indicator. In addition, the EAO shapefile used to display the locations of existing and proposed projects delineates projects only by its phase as defined by the EAO. Thus, any projects that have not yet entered the pre-application stage are not included, and those that have received an EA certificate but are on hold are included. For all future work on this project, a custom

geodatabase that addresses the above issues will be used to depict current status of projects in relation to the composite indicator.

Finally, this study has a number of limitations inherent to using factor analysis. While factor analysis is a data-driven quantitative tool designed to uncover underlying factors in a dataset with many variables, quantitative patterns in data alone do not always produce interpretable results. For this study, the factor analysis did not produce meaningful factors within block 4, so custom factors were created that told a more meaningful story about the data. Although this action adds some subjectivity to the analysis, subjective interpretation in this case is necessary due to the complexity and interrelatedness of the variables included in block 4. In some cases, applying different rotations to the correlated factor matrix can help clarify a factor pattern.²²⁶ While comparing results using different rotation is out of the scope of this study, future research may be able to further explore the effect of different rotation methods on factors in block 4.

8. CONCLUSION AND RECOMMENDATIONS

As part of the *Ten Steps Ahead* project, this study sought to address the research priorities set out by community partners. Namely this was to address the pressing issue of violence against women in BC's resource communities, and contribute to the knowledge base on preventing adverse EI-related impacts that would exacerbate existing issues. In particular, the *Ten Steps Ahead* project seeks to apply findings to the improvement of community health monitoring in BC's resource communities and the process of proposing, permitting, and monitoring the impacts of EI projects. The objectives of this research was to (1) synthesize findings from the academic literature and from grey literature - including reports published by international institutions, government, and community-based research reports - to identify key observed impacts to women's health and safety in relation to EI development; (2) Identify indicators of vulnerability of Aboriginal and rural women to violence and violent victimization in BC; and (3) Develop a composite indicator for identifying HSDAs in BC where violence is endemic and women are vulnerable to victimization that can enhance the current permitting and development process. To meet these objectives the author conducted an in-depth literature review on the topic of women and EI development and utilized the concept of population vulnerability to combine 29 indicator variables into a composite indicator measuring HSDAs with existing poor health status, high rates of violent crime, drug and alcohol abuse issues, and a high proportion of women at risk of violent victimization.

8.1.1. Summary of findings

The key findings of this project are summarized below:

- Women living in resource EI-affected communities around the world experience a number of negative health outcomes, including but not limited to: increased economic dependence on male partners, increased risk of STIs, increased risk of entering the sex trade, poor mental health compared to other rural communities,

- victimization in domestic and intimate partner violence, and increased stress on family relationships and well-being.
- Women in EI communities associate EI developments with a lack of community safety and increased risk of violent victimization fuelled by drug and alcohol abuse.
 - The current EA process in BC often fails to identify community health and safety as a valued component, or women as a vulnerable and sensitive receptor. In addition, data that describes the vulnerable state of Aboriginal and rural women in many of BC's northern, remote communities is under-utilized by proponents or impact assessors.
 - Utilizing a composite indicator to identify areas where women are vulnerable to violent victimization and where health, substance abuse, and violent crime issues are prevalent could help enhance the EA process. This means identifying vulnerable populations and incorporating mitigation measures that minimize impacts on them.
 - Results indicate that the Northwest HSDA is the overall the most vulnerable region in BC to violence-related adverse impacts of EI projects. Northwest scores the highest in each of the individual blocks as well as the overall composite indicator.
 - In general, the four northernmost HSDAs scored highest on the overall indicator as well as in individual blocks. These areas, Northwest, Northern Interior, Northeast, and Thompson Cariboo Shuswap, are the site of a significant number of the proposed and operating mining, oil, and gas projects in BC.
 - A composite indicator can be designed and constructed in multiple different ways. Factor analysis, while it involves some subjectivity, is a useful tool in converting large accessible datasets into more manageable and comparable metrics. The composite indicator proposed in this study is one of many ways in which impact assessors and regulators can better understand the context of vulnerable regions and populations in BC.

8.1.2. Recommendations

The author proposes several recommendations for impact assessors and the BC extractive sector to utilize the proposed indicator, better understand the context of communities in which EI projects operate, and design appropriate mitigation measures for addressing violence.

- Proponents, impact assessors, and regulators should utilize existing health and socioeconomic datasets and composite indicators to better understand existing issues and vulnerable populations in communities.
- EI companies operating or proposing projects in vulnerable regions such as Northwest, Northern Interior, Northeast, and Thompson Cariboo Shuswap HSDAs need to implement mitigation measures geared towards violence prevention. These can take the form of workplace interventions such as a written policy on violence, domestic violence and substance abuse; anti-violence and anti-substance abuse communications and training as part of workplace health and safety; and offering counseling services to employees. Outside of the workplace, operators should consider partnering with local health authorities and organizations to strategize on the best ways to address poor health, endemic violence, and drug and alcohol issues in communities. These initiatives can be supported by community relations, health and safety, or CSR/community investment budgets.
- It is not enough for the above programming to be voluntary. Where existing issues and at-risk populations are identified in communities – via a composite indicator or another method – regulators must mandate that these measures be implemented in the EAO certificate and follow-up to ensure compliance.
- Regulators should utilize data-driven tools such as the one proposed in this study to make decisions about whether the proponent has appropriately captured existing conditions in communities, how significant impacts may be given the population vulnerability of the region, and whether the proposed mitigation measures will sufficiently address the impact.

- Researchers in the field of impact assessment, extractives, and violence as a community health issue must consider including knowledge translation as a key objective of their research. Increasing the knowledge base and public awareness on this topic will help to mainstream the concepts of violence and population vulnerability into EA practice.
- Regulators in BC should consider adapting the requirements of the current environmental assessment process to follow international standards of best practice in environmental and social performance management such as the IFC Performance Standards.
- Community members should make use of existing data and complement it by including their lived experiences during the impact assessment stages.²²⁷

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