

HEALTH IMPACTS OF RESOURCE EXTRACTION AND DEVELOPMENT

Towards a better
understanding of
health in relation to
mining and oil & gas
extraction: A
scoping review

A report produced as the result of the Health Impacts of Resource Extraction and Development (HIRED)
Project: a research collaboration between
the Northern Health Authority and the University of Northern British Columbia



About this Report:

In June 2010, Northern Health and the University of Northern British Columbia signed a Memorandum of Understanding to enhance research collaboration focused on health priorities in northern BC. To demonstrate Northern Health's commitment to this partnership, Northern Health supported a research collaboration between Dr. Margot Parkes and Dr. Henry Harder at UNBC and Dr. Sandra Allison at Northern Health for a project entitled "Health Impacts of Resource Extraction and Development". This report is one of a series of products, which resulted from this collaborative project.

The overarching aim for the HIRED project is to determine how the public health impacts of resource development are understood and addressed and how these approaches can be applied and adapted to the specific context of northern BC.

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Suggested citation: Reschny J, Brisbois B, Parkes MW, Harder H (Lead Authors) Allison S, Buse C, Daniels T, Dolan S, Fumerton F, Fyfe T, Kutzner D, McLean E, Oke B, Nowak N, Schmeisser A (Contributing Authors). (2017). *Towards a better understanding of health in relation to mining and oil & gas extraction: A scoping review*. Prepared for Northern Health Authority, Prince George, BC.

We acknowledge that the land on which we continue to work is the traditional unceded territory of the Lheidli T'enneh peoples.

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1 Summary

1.1 Background

Health is influenced by resource development through interrelated socioeconomic, ecological, cultural, and political pathways, which demand upstream, intersectoral responses. These relationships are especially important in countries such as Canada, where the economy remains tightly coupled with the development of natural resources and where the rate and scale of social and environmental change occurring in resource-rich regions is fueling debate regarding health impacts, especially for rural, remote and Indigenous communities.

This scoping review was developed within a larger joint initiative between the Northern Health Authority (NHA) and the University of Northern British Columbia (UNBC), known as the Health Impacts of Resource Extraction and Development (HIRED) project. The **overarching aim** for the HIRED project is *to determine how the public health impacts of resource development are understood and addressed and how these approaches can be applied and adapted to the specific context of northern BC*. Phase 1 of the project, described in this report, utilizes a scoping review methodology to address the following **guiding question**: *What is the scope of published literature that addresses the links between resource extraction from the earth's crust (e.g. mining/oil & gas) and health outcomes?*

A scoping review was selected as a means to provide a 'map' of published knowledge, seeking to identify patterns of established interest and existing research strengths, as well as gaps in knowledge. The purpose of the scoping review is to provide an overview of the breadth of knowledge on the topic and a foundation to guide future detailed exploration, but is not intended to provide an assessment of the quality of evidence or in-depth analyses of specific foci within the broader topic of resource extraction, development and health.

1.2 Methods

The review used a six-stage approach adapted from the Scoping review work of Levac et al. (2010), guided by ongoing consultation with a health sciences research librarian. This included first refining the research question, determining what was relevant to our question through the use of inclusion and exclusion criteria, selecting studies, extracting appropriate sources and thematic 'coding'. The coded results were analyzed and are summarized in this report.

1.3 Results

A total of 21,327 sources were identified through an initial scan of five databases completed by a librarian in collaboration with the research team. From this the team used inclusion and exclusion criteria to include only sources addressing the links between resource extraction from the earth's crust (e.g. mining/oil & gas) and health outcomes. Once this process was completed a final sample of titles and abstracts from documents published between 1995 - 2015 (n = 2800) was identified for analysis using a detailed coding guide. The scoping review coded information pertaining to general descriptors and more detailed results. Specific codes were applied for: (1) sector/type of extractive activity (i.e. mining or oil & gas); (2) affected population; (3) objective of the study; (4) type of health impacts; (5) methodological approach used in the study; and (6) the type of impact pathways examined in the study.

The majority of sources were journal articles, with most sources published in 2012 and a smaller number in 2015 reflecting the fact that searches were carried out prior to the end of that year. The most frequent journals used for publication were those related to occupational and industrial medicine and/or

environmental health. Of the total 2800 references, a total of 86.3% dealt with either mining (n=2397) or resource extraction more generally (n=18). The most frequently-cited affected populations were workers (n=1900 references) and communities adjacent to resource development activities (n=624). Sources characterizing distinct health impacts, such as modelling, epidemiological or toxicological studies were the most common focus for the objective of the studies (86.1% of sources). The type of health impacts identified in the studies included all major health impact categories, yet of these the greatest number of sources focused on respiratory-related impacts (n=609) and various types of cancer (n = 494). The majority of studies (80.2%) used a quantitative study design, and the greatest number of sources focused on exposure to toxic agents such as chemicals or radiation (58.4%) as the type of impact pathway examined.

1.4 Knowledge gaps

The scoping review is the first step towards the overall project aim of determining how the public health impacts of resource development are understood and addressed in scholarly literatures, and how such approaches can be applied and adapted to the specific context of northern BC. The literature described in the findings of this scoping review warrants discussion in relation to an emerging body of research and practice seeking to identify community concerns about resource extraction and development in northern BC. Our analysis suggests relatively scarce coverage in the literature on impacts identified as topical issues in northern BC by project partners (cf. FNHA and NH, 2017), such as those related to mental health and well-being; social determinants of health; and culture and community cohesion, including via ecological pathways. Other knowledge gaps include the limited number of studies focused on the impacts of resource development on women (n=99) and children (n=130).

1.5 Next steps

Results of the present scoping review will inform a second phase of knowledge synthesis that seeks to progress further toward the overall HIRED project aim of determining how the public health impacts of resource development are understood and addressed in relation to northern BC. Our findings suggest two complementary approaches for Phase 2:

1. First, given the apparent lack of correspondence between concerns raised in the Northern BC context (FNHA and NH, 2017) and those covered in literature on resource extraction and health, an appropriate next step would be to focus on epistemological and political influences on research priorities using a meta-narrative synthesis (Greenhalgh et al., 2005). A key priority area for this meta-narrative synthesis will be a focus on Canadian patterns of research in scholarship on resource extraction and health. Within this meta-narrative synthesis, areas of interest may include:
 - *Pathways of impact*: Including patterns of influence between industry and determinants of health spanning social, economic, ecological, cultural pathways;
 - *Impacted Populations*: Including patterns of emphasis, and types of impact /illness;
 - *Response options*: Intersectoral policy and practice implications.
2. Second, the scoping review has provided a sense of strengths and deficits in existing published studies, providing a foundation to identify a series of **targeted systematic reviews** to address knowledge gaps identified in Phase 1. Recommended priorities for targeted systematic reviews include the impact of resource extraction and development on:

- a) *Mental Health and Well-being* - including substance use and other behavioural risk factors;
- b) *Indigenous populations* –recognizing differences across different colonial contexts in Canada and internationally;
- c) *Women and Children* – including direct effects, and indirect impacts within families;
- d) *Worker populations* - including gender and age dynamics;
- e) *Affected communities* - including socio-economic determinants of health (cost of housing, education, public safety etc.).

Additional themes for systematic reviews using the library of 2800 sources may be identified as the HIRED project develops. Future phases of work will also be informed by related projects that are underway, seeking to gain understanding about interrelated health, environment and community concerns associated with resource development in northern BC.

2 Scoping review background

The Health Impacts of Resource Extraction and Development (HIRED) project was developed as a joint initiative between the Northern Health Authority (NHA) and the University of Northern British Columbia (UNBC). The **overarching aim** of this project is determine *how are the public health impacts of resource development understood and addressed, and how these approaches can be applied and adapted to the specific context of northern BC?*

The HIRED project is divided into three phases. Phase 1, described in this report, consisted of a scoping review of existing knowledge on resource extraction and health. Phase 2 will include further knowledge synthesis informed by the findings generated in Phase 1. Phase 3 will involve knowledge translation and exchange through a variety of approaches, including, for example, presentations, publications and reports. This report focuses on the process and findings of Phase 1, which involved a scoping review guided by the **research question:** *What is the scope of published literature that addresses the links between resource extraction from the earth's crust (e.g. mining/oil & gas) and health outcomes?*

3 Rationale

The impact of resource development on human, ecosystem and wildlife health is driven by economic, socio-cultural, political and biophysical interrelationships. These relationships are especially important in regions where the economy is tightly coupled with resource development involving mining, oil and gas, forestry, fisheries, agriculture, aquaculture and hydroelectric activities. Within the context of economic globalization, the rate and scale of socioeconomic and environmental change in resource-rich regions is fueling debate regarding the benefit and risk trade-offs of resource development over time, and raising questions about health impacts, especially in rural, remote and Indigenous¹ communities (Goldenberg, Shoveller, Koehoorn, & Ostry, 2010; Parkins & Angell, 2011).

These debates are reflected in cross-jurisdictional demand for improved tools and processes to detect, analyze and respond to the health impacts of resource development, internationally, and also in Canada (Parkes 2016; Kinnear, Kabir, Mann, & Bricknell, 2013; Office of the Chief Medical Officer of Health [OCMOH] 2012). Further there is a particular need to understand and respond to the cumulative impacts

¹ We use the term *Indigenous* to refer to Indigenous peoples in Canada and also in other parts of the world, consistent with the United Nations Declaration of Indigenous Peoples (United Nations, 2008). Depending on the context, the term *Aboriginal* is used specifically in the Canadian context to refer inclusively to First Nations, Métis, and Inuit peoples of Canada, and the term *First Nation(s)* to denote specific First Nations within Canada and in particular British Columbia.

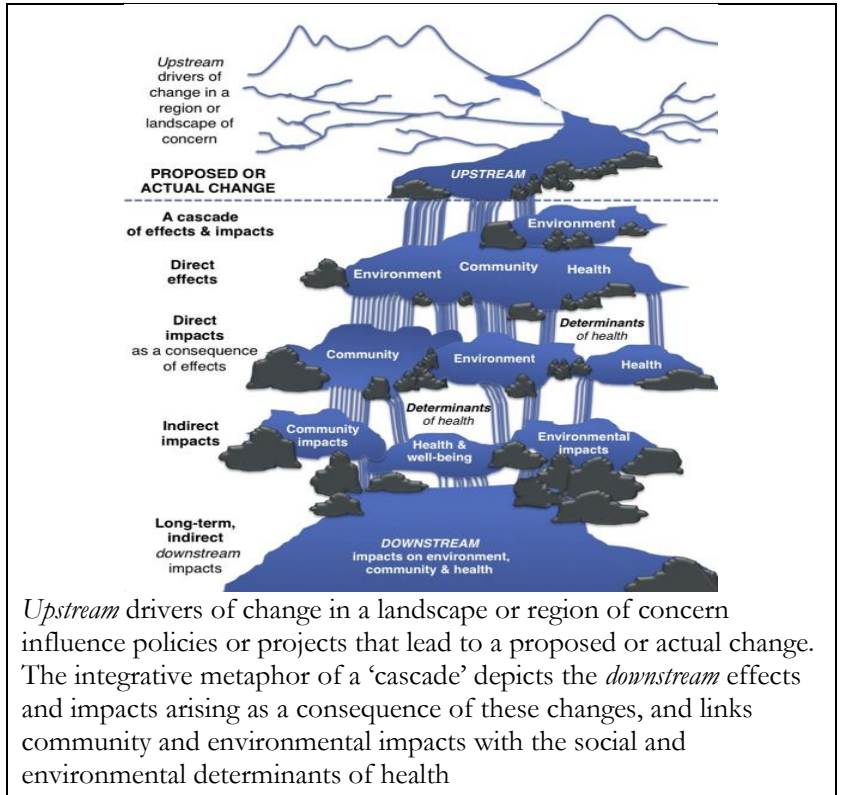
of resource development in ways that recognize combined environmental, community and health impacts resulting from past, present and future resource development across time and space. Cumulative impacts occur when new development happens on land with preexisting effects and impacts resulting from historical decisions and multiple land uses (CIRC, 2015; Gillingham, Halseth, Johnson, & Parkes, 2016). We live and experience cumulative impacts on a daily basis, and they have lasting consequences for people, communities and the ecosystems we depend upon. Cumulative impacts have far-reaching implications for protecting and promoting health, necessitating an intersectoral, upstream, and eco-social perspective. Such a perspective would recognize and respond to socioeconomic factors, such as inequities in health outcomes for communities experiencing the boom and bust cycles of resource development, as well as ecological determinants of health, *i.e.* physical, cultural, and mental health implications of the degradation of land and water resources. In addition, cumulative thinking about resource development and health offers an entry point toward holistic and integrated approaches in relationship to the communities and ecosystems that support us – perspectives that have long been advanced by Indigenous peoples (Greenwood, de Leeuw, Lindsay, & Reading, 2015; Parkes, 2011). The recognition that human health needs to be considered in relation to social and ecological factors (including health of other species) is also consistent with a converging array of international efforts including:

- the Lancet Commission on Planetary Health (Whitmee et al., 2015);
- the 2015 state of knowledge on biodiversity and health co-produced by WHO (Romanelli et al., 2015);
- international attention to One Health (Zinsstag, Schelling, Waltner-Toews, & Tanner, 2011); Wetlands and Health (Horwitz & Finlayson, 2011);
- international initiatives focused on Parks and Health (Kuo, 2010; Maller, Henderson-Wilson, & Townsend, 2009);
- and ongoing attention to ecohealth (ecosystems approaches to health, or systems approaches to promote the health of people, animals, and ecosystems in the context of social and ecological interactions) (Charron, 2012a, 2012b; Parkes & Horwitz, 2016; Stephen, Burns, & Riviere-Cinnamond, 2016; Webb et al., 2010; Wilcox, 2004).

A cumulative perspective on the health impacts of resource development recognizes not only that the environment is a source of hazardous exposures, but also that ecosystems and biodiversity contribute to social determinants of health relating to livelihoods, lifestyles, culture and identity (Horwitz & Finlayson, 2011; Horwitz & Kretsch, 2015; Parkes & Horwitz, 2016). A combined view of the social, cultural and ecological determinants of health (Hancock, Spady, & Soskolne, 2015) draws attention to health inequities, which may be unnoticed in the ‘cascade’ of interrelated environment, community and health concerns arising downstream of resource development in the short, medium and long-term.

Figure 1. Resource development and the cascade of effects and impacts (from Parkes 2016)

The cascade of effects and impacts from resource development underscores the need to consider how *upstream* drivers of change in a region of concern influence policies or projects that lead to proposed or actual changes in the landscape. The integrative metaphor of a ‘cascade’ also highlights the *downstream* effects and impacts arising as a consequence of these changes, and links community and environmental impacts with the social and environmental determinants of health (Parkes, 2016). A notable example of these upstream/downstream dynamics is, “the fact that most assessment processes are initiated long after some of the most critical decisions have been made. These decisions, such as the allocation of mineral rights or land leases, set in motion a series of pre-determined activities that lead towards a particular type of development debate and trajectory” (Halseth, Gillingham, Johnson, & Parkes, 2016, p. 5).



Within the cascade depicted in **Figure 1**, inequities may arise as a consequence of livelihood pursuits, whether among workers, or in families of workers (Kinnear, Kabir, Mann, & Bricknell, 2013; Northern Health, 2012, 2013); lived experiences and local concerns (Lindsay, 2016; Mitchell-Foster & Gislason, 2016; Office of the Chief Medical Officer of Health (OCMOH)); or the grief, loss and mental health and well-being implications arising from changes to local environments and communities (Albrecht, Higginbotham, Cashman, & Flint, 2007; Cunsolo Willox et al., 2011; Harder, 2016; Lindsay, 2016). Furthermore, the impacts of resource development are manifest throughout the life-span and across generations (Northern Health, 2016; Office of the Chief Medical Officer of Health (OCMOH)).

There is growing interest in developing appropriate methods and tools to begin to address the combined social and environmental determinants of health, in order to better understand how resource development influences health and well-being (Parkes 2016). At the same time, due to the complexity of this area, there is also a need to take stock of what knowledge is already available about health impacts associated with resource development, how pathways of impact are understood and who or what is most affected. A starting point is to learn what has been published in the academic literature and in doing so, learn more about what gaps exist in current understanding of health impacts of resource development. The following section introduces the scoping review as means to gain a ‘map’ of published knowledge, seeking to identify patterns of established interest and existing research strengths, as well as gaps in the knowledge that is available in the published literature.

4 Scoping reviews: approach and relevance

The purpose of a scoping review is to “address broader topics” (Arksey & O'Malley, 2005, p. 20) and, “to examine the extent, range, and nature of research activity, determine the value of undertaking a full systematic review, summarize and disseminate research findings, or identify gaps in the existing literature” (Levac, et al., 2010, p. 71). To complete this scoping review we followed a methodology derived from Levac et al. (2010), building on the work of Arksey and O'Malley (2005). A research librarian was consulted throughout our application of Levac et al.'s proposed six-stage process:

Stage 1: clarifying and linking the purpose and research question (*identifying the research question*)

Stage 2: balancing feasibility with breadth and comprehensiveness of the scoping process

Stage 3: using an iterative team approach to selecting studies

Stage 4: extracting data

Stage 5: incorporating a numerical summary and qualitative thematic analysis, reporting results and considering implications of study findings to policy, practice, or research

Stage 6: incorporating consultation with stakeholders as a knowledge translation component of scoping

Following this approach, an important phase of refinement took place during Stage 1 and 2. We began with a very broad scope: seeking an overview of published literature addressing health outcomes from all forms of resource extraction and development, including mining, oil & gas, forestry, fisheries, agriculture, aquaculture and hydroelectric activities. Foundational, clarifying teamwork in Stage 1 determined that such a broad scoping review was not feasible. Instead, a focus on resource extraction from the earth's crust (i.e. mining, oil & gas extraction) provided a more targeted and manageable research question. This focused review prioritized activities of relevance to the resource extraction and development context of northern BC, where both mining and oil and gas are active drivers of change, and a focus of growing community and scholarly concern (CIRC, 2015; Gillingham, et al., 2016). The research team therefore refined of the research question to *What is the scope of published literature that addresses the links between resource extraction from the earth's crust (e.g. mining/ oil & gas) and health outcomes?* This approach focused our attention on what is being published and by whom in a topical and expanding area of resource extraction and development, and also provides guidance for future phases of knowledge synthesis. This initial scoping review provides an important step towards understanding how the public health impacts of resource development are understood and addressed, and how these approaches can be applied and adapted to the specific context of northern BC.

5 Methods

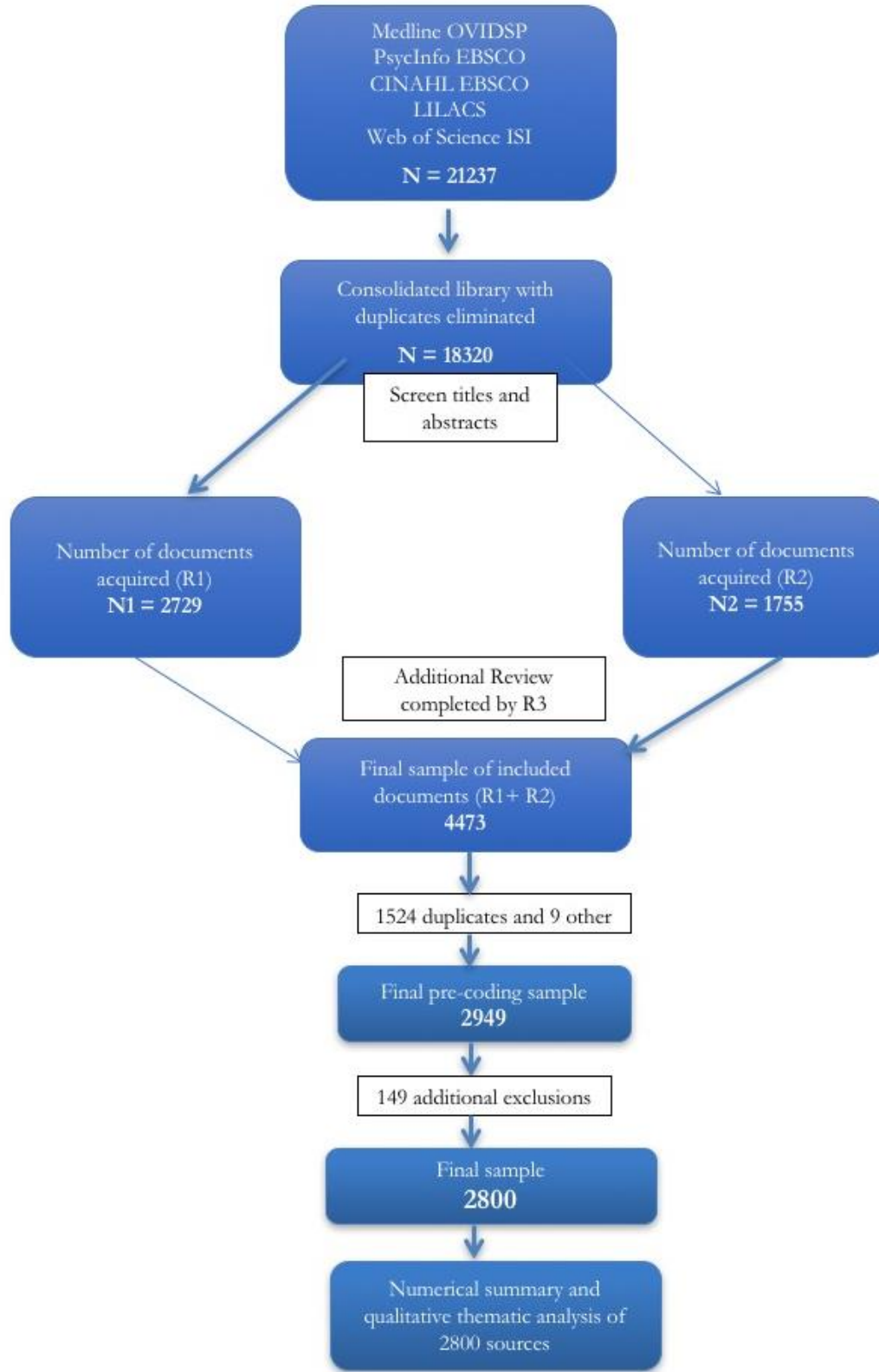
The general search parameters and search terms sought to identify articles related to the extraction of materials from the earth's crust and/or subsequent transport of them, coupled with select health outcomes/impacts. Keyword and subject heading searches were carried out in five databases (Medline OVIDSP, PsycInfo EBSCO, CINAHL EBSCO, LILACS, Web of Science ISI). The research team settled on general search parameters (see Appendix A) for these searches, applying specific date ranges and key terms as described in Table 1 below. These parameters were developed through an iterative process of search design, which included team leads, research staff and the research librarian. An initial set of key 'health outcome' and 'health behaviour' search terms was first drafted by the project lead at Northern Health in order to capture impacts on the Northern BC population. Similarly, an initial set of 'extractive industry' search terms was drafted primarily by the research team at UNBC. During the iterative process additional search terms were suggested and discussed with the librarian, who then conducted a series of test searches. A select number of sources (n=50) from each scan was examined by the research team. The resulting sources were reviewed, and upon review the list of search terms was further refined. Only journal articles, books, and book sections from 1995-2015 were included in the scan.

Table 1. Search terms

Extractive Industries		Health Outcomes/Health Behaviours		
Coal mine	Offshore drilling	Alcohol use	Hepatitis B	Potential Years of Life Lost
Coal mining	Oil and gas (oil & gas)	Alcohol Use Disorder/Alcoholism	Hepatitis C	Premature Mortality rate
Coal-bed methane	Oil and gas drilling	Anxiety	HIV	Public Health
Development of natural gas	Oil and gas extraction industry	Asthma	Hypertension	Respiratory disease
Development of shale gas	Oil and gas industry	Bloodborne Pathogen infections	Inactivity/Sedentary Behaviour	Rubella
Development of unconventional oil and gas	Oil and gas wells	Cardiovascular disease	Infant Mortality Rate	Rural health
Directional drilling	Oil drilling	Chlamydia	Influenza	Sexually Transmitted Infections
Drilling	Oil extraction	Communicable Disease	Injury	Stress
Extraction	Oil industry	COPD – Chronic Obstructive Pulmonary Disease	Ischemic Heart Disease	Stroke
Extraction and processing industry	Oil rig	Crude Mortality Rate	Invasive Meningococcal Disease	Substance Use Disorder
Fracking	Oilfield	Depression	Invasive Pneumococcal Disease	Suicide Rate
Gas drilling	Onshore drilling	Diabetes	Life satisfaction	Syphilis
Gas rig	Opencast mining	Disability Adjusted Life Years	Mastery/Self-esteem/Coherence	Tobacco Use
Hydraulic fracturing	Petroleum industry	Drug use	Measles	Vaccine Preventable Disease
Mining	Pipeline	Dyslipidemia	Mental Health	Well-being
Mining - open pit	Shale	Environmental health	Metabolic Disorders	Workplace injury – Musculoskeletal
Mining - opencast	Shale gas exploitation	Family and Intimate Partner Violence	Mumps	
Mining - closed pit	Shale gas extraction / development	First Nations or Aboriginal or Indigenous Health	Myocardial infarction	
Mining - underground	Slick water stimulation	Gastroenteritis (GI infection)	Norovirus	
Natural gas development	Unconventional gas extraction	Gonorrhea	Other Infectious Diseases of interest	
Natural gas exploration	Unconventional natural gas development	Happiness	Pertussis	
Natural gas extraction		Health Utility Index	Poor diet	

The initial searches with these search criteria yielded a total of 18,320 source once duplicates were removed. An overview of the scoping review project process is provided in **Figure 2** below. This figure depicts the process of moving from 18,320 sources through the process of applying inclusion and exclusion criteria (and removing duplicates) to reach a final pre-coding sample of 2800 sources.

Figure 2. Scoping review process



The research team decided upon and applied ‘inclusion and exclusion’ criteria for the title and abstract review, as seen in **Table 2**. This table was developed by the research staff with input from the research team and librarian. This process included discussion as to the purpose of the scoping review and efforts to ‘balance feasibility with breadth’ as described by Levac et al. (2010) in Stage 2 of the Scoping Review process. Decisions were made in order to narrow the scope while remaining true to the focus of the Phase I guiding question. For example, sources focusing on resource refinement and processing were excluded if the sources did not also include resource extraction and/or transport. The team was also clear that this Phase needed to capture sources that illustrated a health impact in relation to resource extraction.

Table 2. Inclusion and exclusion criteria for title/abstract/article review

Include	Exclude
Journal articles, books, book sections	Conference proceedings
When the title/abstract deals with (extraction OR transport of resources from the earth’s crust) AND (one or more health outcomes OR human exposures to toxic substances).	Papers about refineries, coke plants, mineral processing, petrochemical industry, etc. if they don’t also deal with extraction/transport of resources.
Papers that describe environmental distribution of toxic substances AND actual calculated or measured human exposure and/or health impact.	Papers on environmental distribution of toxic substances without specific human exposure/impact calculation or measurement.
Papers on resource extraction and health services, even if they don’t describe health outcomes (<i>e.g.</i> paramedics on resource extraction worksites)	
	Papers on remediation / characterization methods for contaminated sites UNLESS they also describe calculated / measured human exposures or impacts
Include papers that describe changes in human physiology in relation to resource extraction, even if you don’t recognize those physiological changes as a pathology or health ‘problem’.	
Surveys of occupational health risks at a national, regional / continental or even global level if they specifically mention risks in mining or oil & gas.	Reviews with vague reference to extraction-related health conditions
Descriptions of health interventions to prevent health impacts from resource extraction, even if they do not specify any specific health outcomes.	Papers about development of safer resource extraction technologies if they don’t report measurement of related exposures or impacts in specific people.
Historical accounts of social / legal / political / scientific / health services activity related to health effects of extractive industry (even if they describe events long ago).	
Papers describing mathematical models of resource extraction – health relationships in humans	
	Broad papers about toxic chemicals if they don’t focus substantially on exposures due to resource extraction activities

	Description of educational programs for health professionals on health effects of resource extraction
Articles discussing 'safety' in resource extraction	
Articles on diagnostic tests for health conditions actually or potentially related to resource extraction	

Using this table as a guide, two reviewers assessed the remaining sources and eliminated all exclusions. This step aligns with Stage 3 (*using an iterative team approach to selecting studies*) of the scoping review process as defined by Levac et al. (2010). The first reviewer (R1) was able to eliminate 85% of the sources through this process. The remaining sources included 2729 journal articles, books, and book sections. The second reviewer (R2) completed a similar review in isolation from R1 using the same guide as seen in **Table 2**. R2 identified significantly fewer sources (n=1755), than R1 (n=2729). At this stage sources from both reviewers were combined (n=4484) and duplicates (n=1524) and 11 additional sources (e.g. partial or sections of articles included from an online source called *Figsbare*) were removed, leaving a sample consisting of 2949 sources (see **Figure 2**). As the sources were coded it was determined that there were a number of additional references that would need to be further excluded. These exclusions included sources that did not meet the original criteria for inclusion, but had been missed, as well as those that did not include authors or abstracts. A total of 149 references were further removed, leaving a final total of **2800** (see **Figure 2**).

Table 3. Type of published literature

Type of Publication/Source	Number
Journal Article	2775
Book	1
Book Section/chapter	24
Total (pre-coding sample)	2800

The next step in this process was analysis of the remaining sources. Aligning with Stage 5 of Levac et al. (2010), we incorporated a numerical summary and qualitative thematic analysis to report results.

5.1 Coding/tagging

Analysis consisted of the application of specific codes/tags represent themes or concepts. Codes/tags were applied to sources that contained a matching theme. The analysis began with the creation of a tagging guide, which included 7 sections further defined in Appendix B (codes and subcodes) and detailed below. This initial guide was drafted by the research team including R1, R2 and R3 and presented to the research leads for discussion. The finalized tagging system is as follows:

1. **Sector/type of extractive industry** was coded as Mining or Oil & Gas
2. **Affected populations** included the following ten subcategories: Males, Females, Children and youth, Seniors, Workers, Surrounding communities, Indigenous groups, Other racial or ethnic group, Migrants, Sex Workers,
3. **Objective of the study** included the subcategories: Characterize health impacts (e.g. modelling, epidemiology, toxicology); Characterize responses (including Occupational health and safety intervention, Health promotion/education, Diagnostic test or screening program, Legal action, Regulation or policy, Social movement (e.g. acts of disobedience/strikes); and Scientific dispute or

advocacy. Only the main objective of each study was coded, meaning analysis included only one code per source.

4. **Type of health impacts** included the list of impacts compiled from provincial, Canadian and WHO categories of types of disease or health outcomes and included the following categories (in alphabetical order): Acute injury (*i.e.* due to accidents); Birth defects and pregnancy issues; Cancer; Chronic disease; Genetic damage; Disability; Death; Infectious disease (STIs); Infectious disease (other); Mental or psychosocial, including trauma and stress; Musculoskeletal; Poisoning, Respiratory; Chronic injury, (*e.g.* back pain, eye strain), Well-being/quality of life; and a General ‘other’ sub-category for undefined impacts. In this category, each source could include more than one code to accommodate the fact that each study may have focused on more than one type of impact.
5. **Methodological approach** of each study, including subcategories: Quantitative, Qualitative, Mixed methods, and Historical
6. **Type of impact pathways** examined by each source, including the following sub-categories: Exposure to toxic substances, Behavioural risk factors, Ecosystem change, Social determinants, Workplace accident or hazardous condition, Occupation name, and Disaster. These sub-sections were developed by the research team in response to the initial review of sources. Additional areas of interest may arise in future analysis of this dataset; however this phase's final coding/tagging guide was developed to provide an overview of the sources related to the guiding question and to identify strengths and gaps in the literature and inform Phase II of this project.
7. **Geographic region** - sources were tagged by geographic region (*e.g.* continent) in which the study took place. Reviewers 4 (R4) and 5 (R5) under the guidance of R3 conducted the initial coding/tagging review for this step.

It is important to note that the majority of sources include multiple tags (*i.e.* type of extractive industry and affected population), sometimes even within the same sub-category. For example, a source might include tags related to ‘affected populations’, such as an ‘Indigenous group’ as well as ‘children’. This was done to capture all themes of a source, while ensuring robust analysis.

6 Results

The results are presented in two sections. First, findings are presented in relation to the general descriptors which provide an overview of the types of publications and their source, including the geographic region(s) on which the study was focused. The next section presents the results of the analysis of the content and orientation of the publications from their title and abstract, in relation to the six thematic categories noted above and detailed in Appendix B.

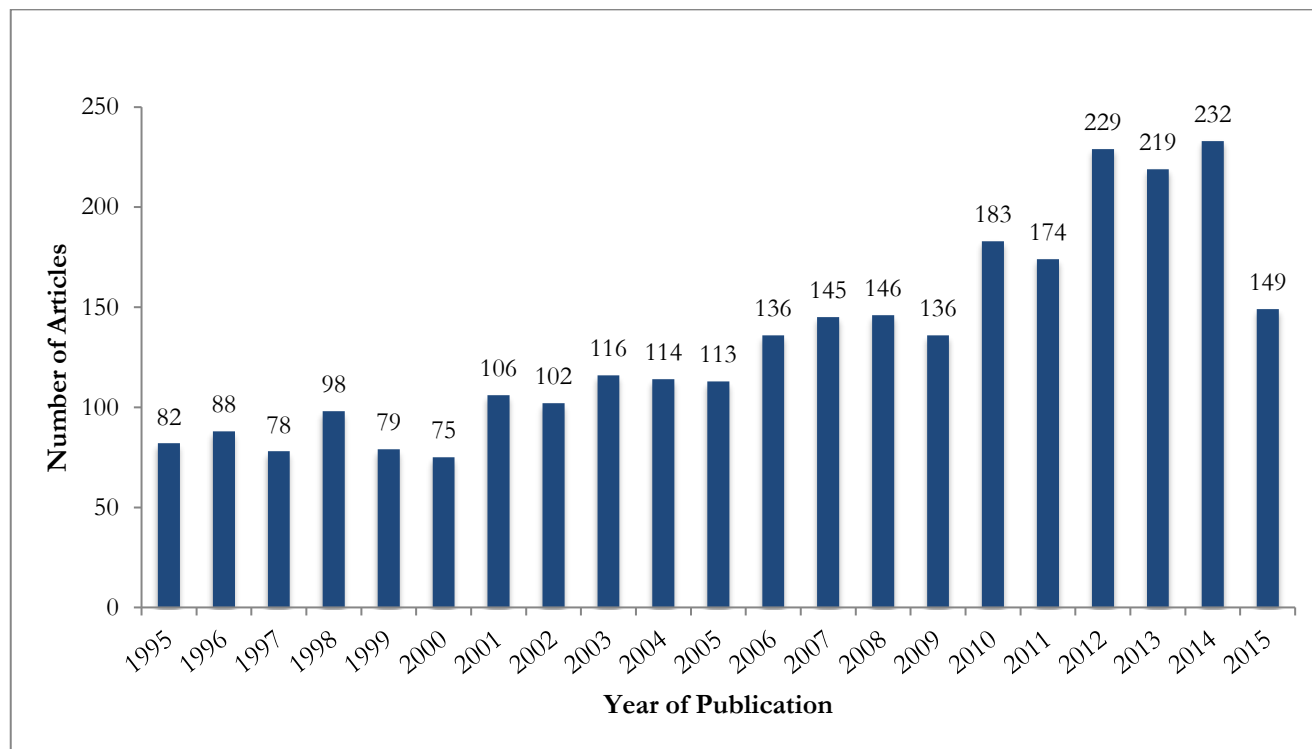
6.1 General descriptors of publications

The review of general descriptors yielded important background information, regarding the distribution of sources by year of publication, journal of publication (for those sources listed as journal articles) and geographic region where the exposures/outcomes took place. These descriptors are further described below.

6.1.1 Year of publication

The total amount of published sources from our review of the scholarly literature that identifies a relationship between mining and oil & gas extraction and human health increased per year, in general, from 1995-2015. The peak year was 2012 with a total of 232 published sources, while the year with the lowest number was 2000 with 75. This distribution is represented in **Figure 3**. All background tables are included in Appendix C.

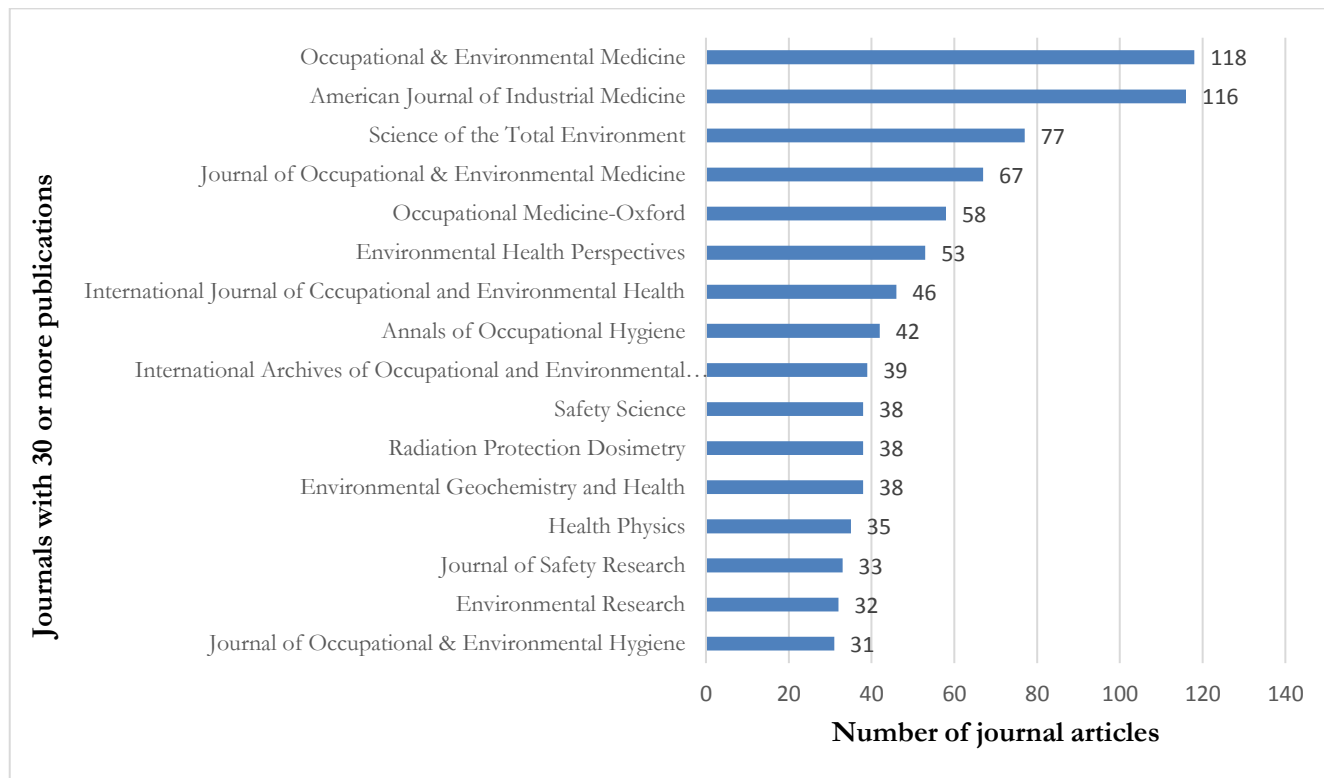
Figure 3. Distribution of published sources per year



6.1.2 Journal article sources per journal

Journal article sources were analyzed for distribution of sources among journals. A table of all journals with 5 or more references included in the scan can be found in Appendix C. By comparison, **Figure 4** below illustrates all journals with 30 or more references. Of these, the 5 journals including the highest number of references included: *Occupational and Environmental Medicine* (118); *American Journal of Industrial Medicine* (116); *Science of the Total Environment* (77); *Occupational Medicine* (58); and, *Environmental Health Perspectives* (53).

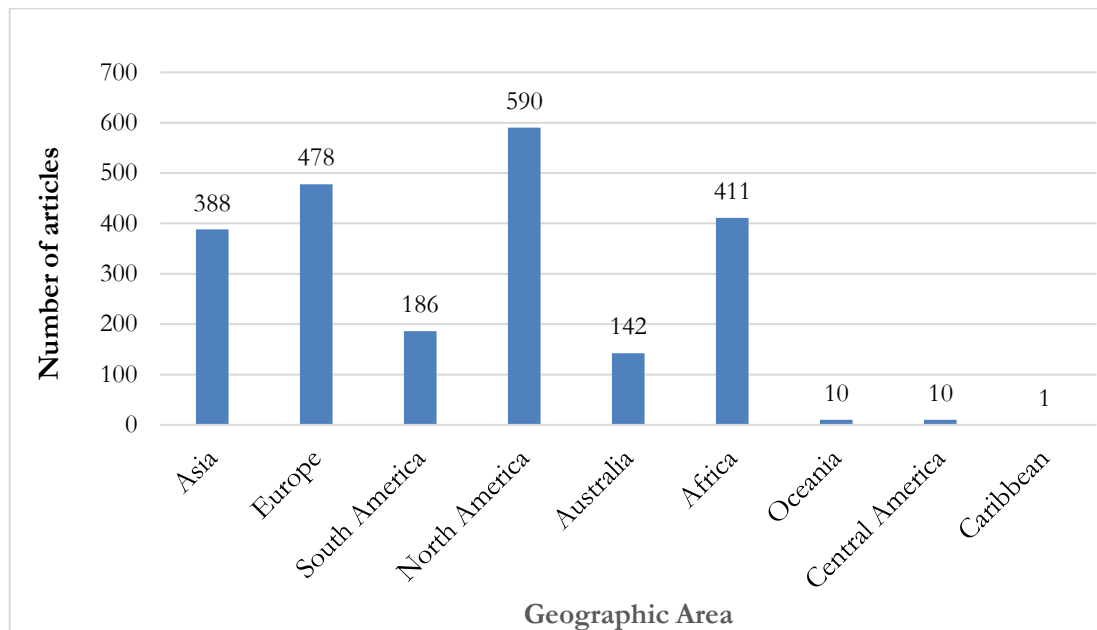
Figure 4. Article distribution of journal of publication (lower threshold: 30 or more)



6.1.3 Geographic area

Analysis of sources referencing specific continents or regions is illustrated in **Figure 5**. Of the continents (excluding Antarctica which was not featured in any sources), numbers of sources ranged from a low of 142 for Australia, to a high of 590 for North America (comprising Canada, the US and Mexico). Small numbers of sources covered regions not easily categorized within continents, including one source in the Caribbean and 10 sources each for Central America and Oceania.

Figure 5. Distribution of sources by continent or region



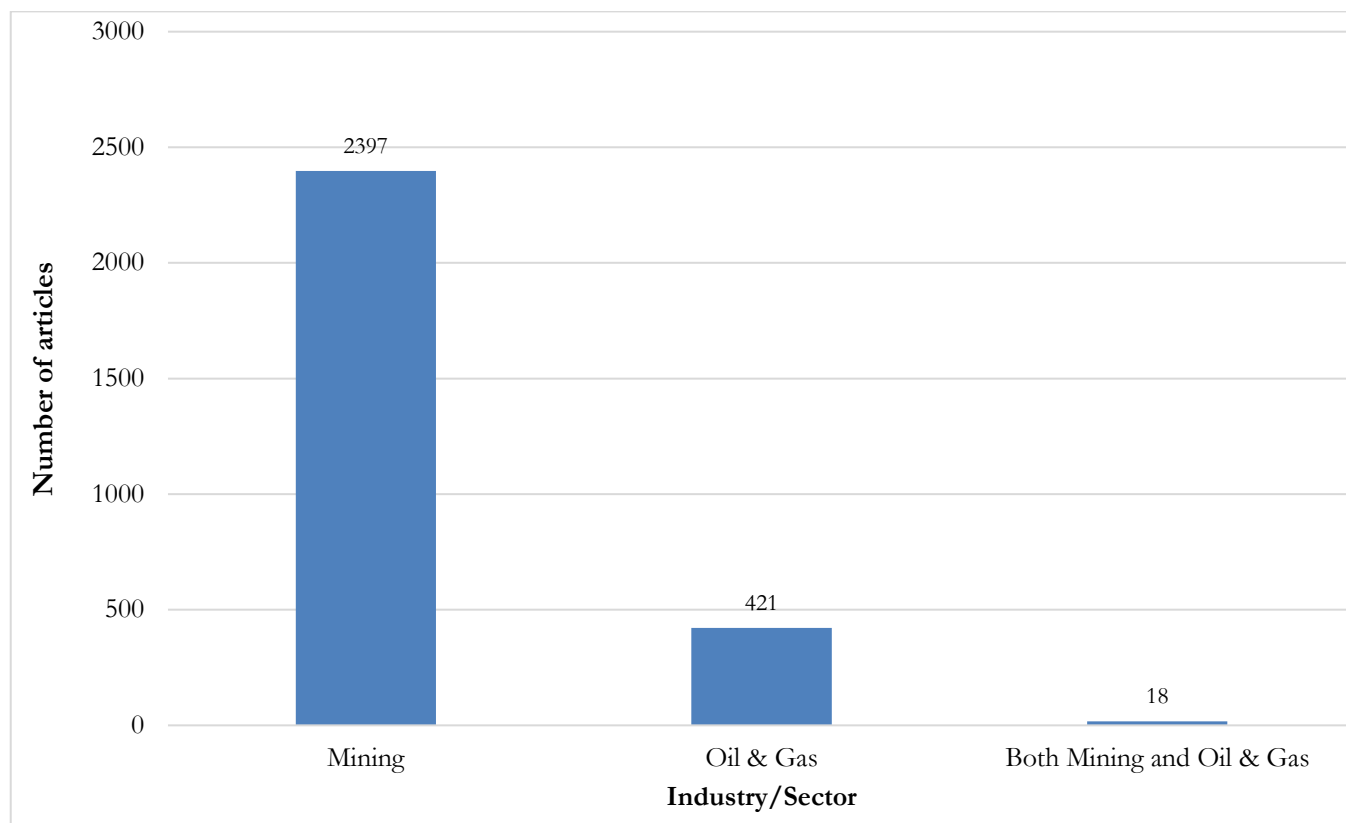
6.2 Content and orientation of publication

Findings regarding the content and orientation of the publications are presented here in relation to the six categories identified above and detailed in Appendix B: (1) sector/type of extractive activity; (2) affected population; (3) objective of the study; (4) type of health impacts; (5) methodological approach used in the study; and (6) the type of impact pathways examined in the study. The combined codes for each section are also located in Appendix D.

6.2.1 Sector/type of extractive industry

In examining type of extractive industry, the overwhelming majority of sources (2415 of 2800, or 86.3%) were coded with 'Mining'. A much smaller number (439, or 15.7%) were coded as 'Oil & Gas'. As mentioned in the above 'Methodology' section coding/tagging involved potential overlap between categories, as sources may have focused on *both* mining and oil and gas industries. As such, the above percentages sum to slightly over 100%, reflecting the fact that a small number of sources (18) discussed both mining and oil & gas, including in the context of resource extraction more generally. The distribution of sources by sector or type of extractive industry is illustrated in **Figure 6**.

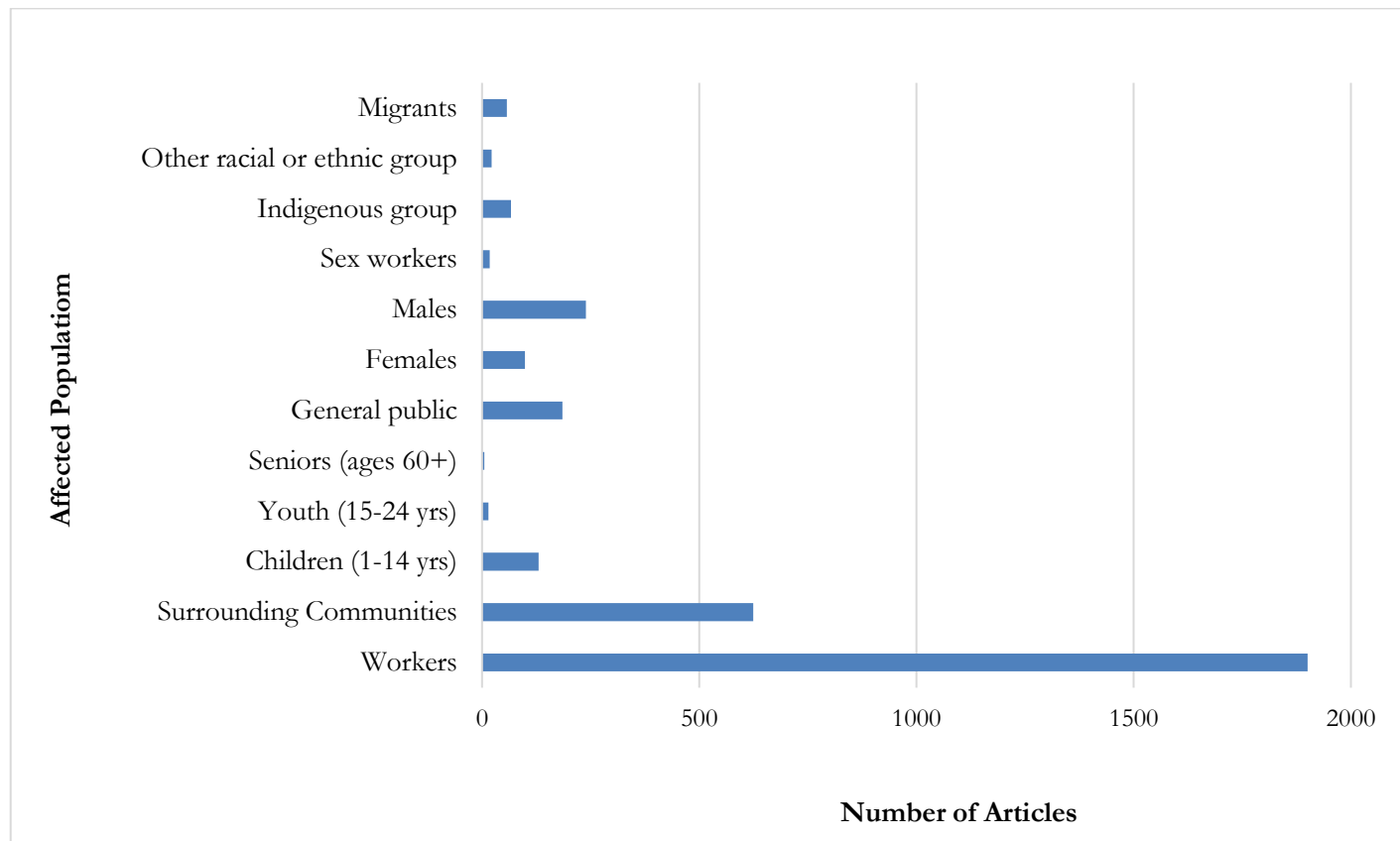
Figure 6. Distribution of sources per industry/sector



6.2.2 Affected population

The research team coded for key affected populations in the scoping review, such as workers and migrants; proximity to extraction/development activities (*e.g.* surrounding communities and indigenous groups); other specific populations, such as sex workers, and the general public; as well as specific age demographics (*i.e.* children, youth and seniors); and gender (*i.e.* male, female). This means that some sources were coded more than once when they identified more than one type of population group. The largest number of sources identified workers ($n=1900$ or 67.9%) and surrounding communities (624, or 22.3%) as affected populations - summarized in **Figure 7**. Another notable affected population was the general public (185, or 6.6%) meaning non-specified population groups. Other affected groups, such as migrants (2.0%), Indigenous groups (2.4%) and sex workers (0.6%) were tagged in fewer sources. For gender specific analysis, a greater number of sources identified males as an affected population (8.5%) than females (3.6%). Finally, in age related analysis a greater number of studies identified children (4.6%) as an affected population than youth (0.5%) or seniors (0.2%).

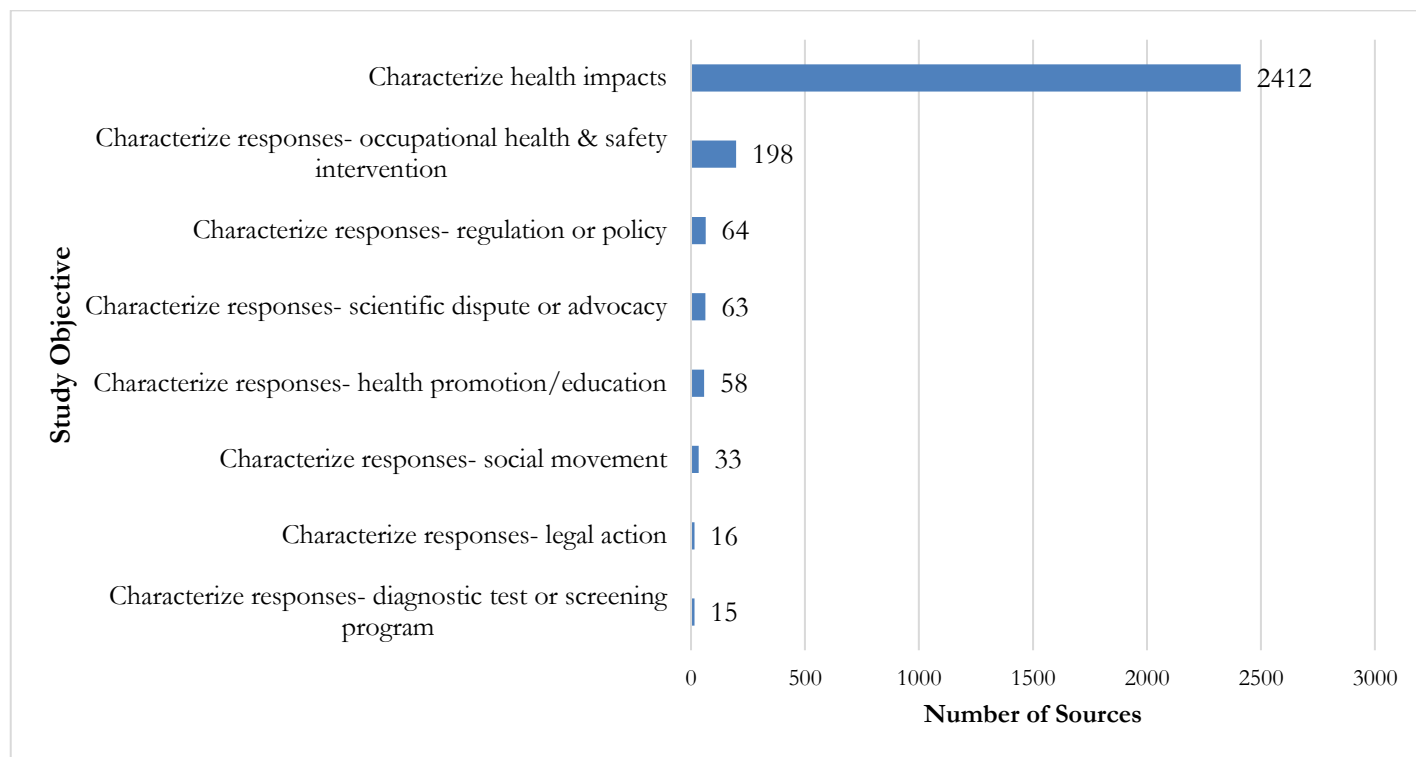
Figure 7. Distribution of sources per affected population focus



6.2.3 Objective of study

Sources were also coded for the main study objective. These were divided into two main categories: (1) studies that characterized health impacts, such as modelling, epidemiological, qualitative or toxicological studies; and (2) studies that characterized specific responses to health impacts. The latter were further divided into sub-categories. For the purpose of this section, **Figure 8** below represents all study objectives, including sub-categories. The majority of studies characterized health impacts, with 2412 sources (86.1% of the total library). Sources that characterized specific responses to health impacts included a combined total of 447 sources (16.0% of the total library). Of these sources dealing with responses, the greatest number were related to occupational health and safety interventions (n=198).

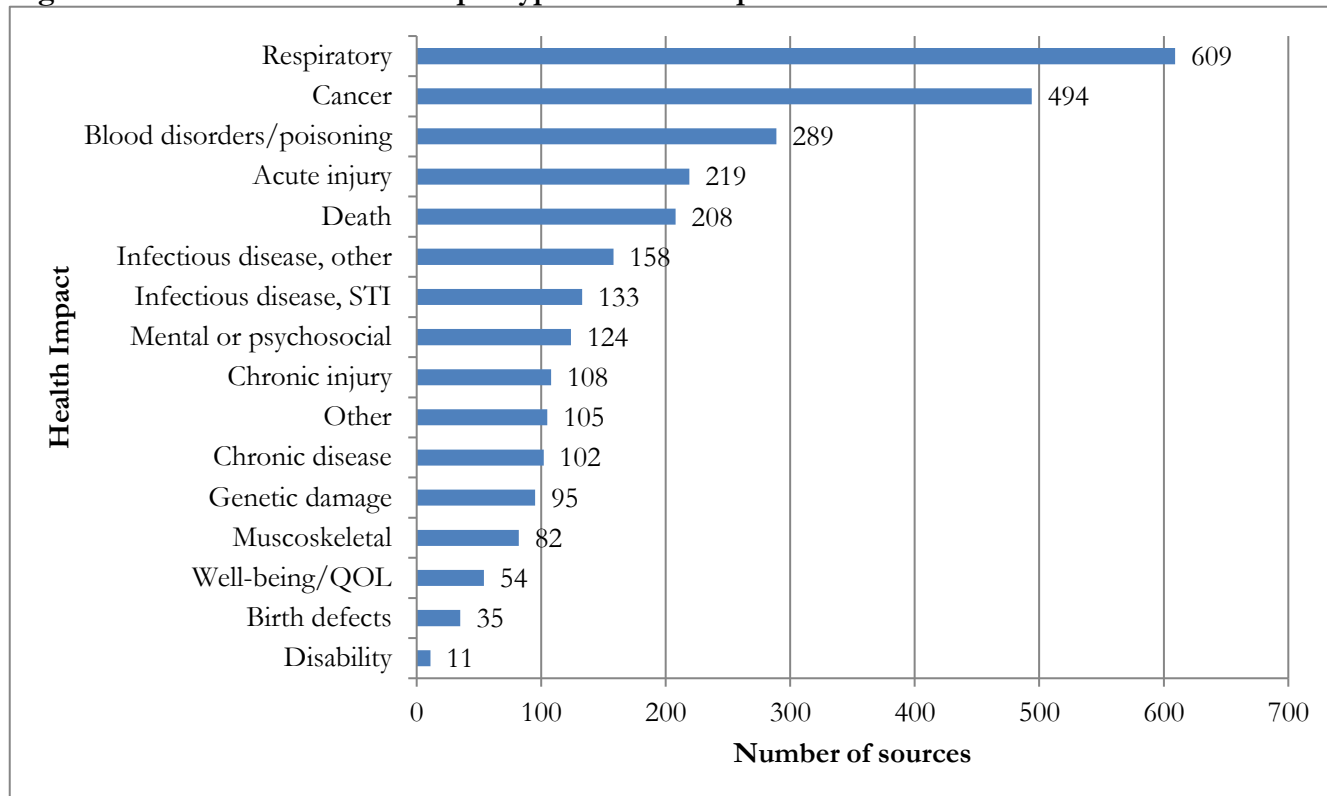
Figure 8. Distribution of sources per varying objectives of studies



6.2.4 Type of health impacts

The type of health impacts in reviewed articles included all major health impact categories, such as those related to mental or psychosocial, respiratory, cancer, musculoskeletal, infectious diseases (*e.g.* STI-related and other), genetic damage, acute injury, chronic injury, chronic disease, birth defects, poisoning, well-being/quality of life, disability and death (**Figure 9**). It is important to point out that sources often were tagged with more than one code, as many studies included more than one impact. The greatest number of sources focused on respiratory-related impacts ($n=609$, or 21.8%) and various types of cancer (17.6%), as seen in Figure 10. These were followed by sources dealing with poisoning and toxicity (10.3%), acute injury (*i.e.* accidents) (7.8%) and death (7.4%). Very few sources focused on topics such as wellbeing/quality of life (1.9%) and disability (0.4%).

Figure 9. Distribution of sources per type of health impact



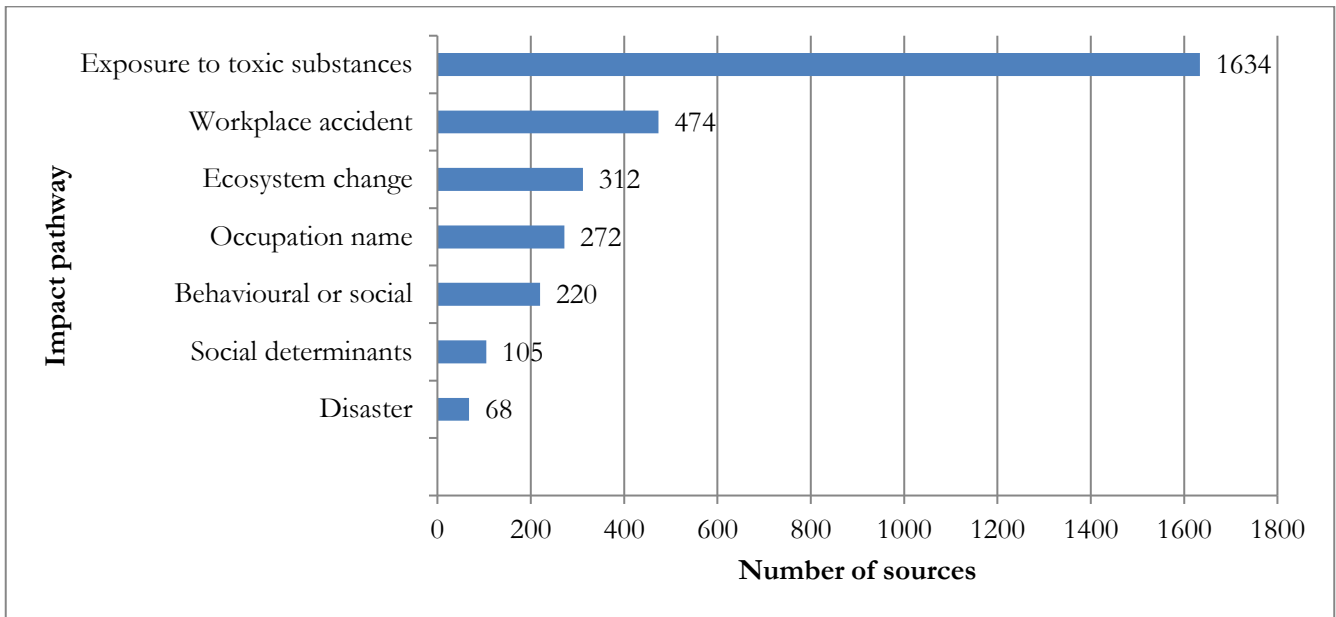
6.2.5 Methodological approach

Articles were coded in relation to three main methodological approaches: quantitative, qualitative, and mixed methods. The majority of sources (80.2%) employed quantitative approaches. By comparison, very few used qualitative approaches (4.4%), mixed methods (2.5%) or historical approaches (2.8%). A total of 306 sources did not include a discernible research methodology and so were not coded at this stage. Consistent with the findings above, many studies without a specific research methodology were associated with sources that characterized specific *responses* to health impacts, as compared to studies that characterized health impacts.

6.2.6 Type of impact pathways examined

A final category coded in the scoping review was the type of impact pathway that each source examined. Seven impact pathways were identified: (1) exposure to toxic substances; (2) behavioural risk factors; (3) ecosystem change; (4) social determinants; (5) workplace accidents or hazardous conditions; (6) occupation-related; and (7) disaster. Again, sources could receive more than one code, as some studies detailed more than one impact pathway. The greatest number of sources focused on exposure to toxic agents ($n=1634$ or 58.4%). This primarily included exposure to chemical or radiological agents. This was followed by workplace accidents or hazardous conditions (16.9%), including, for example, mine explosions, as well as shift-work, exposure to harsh climates, or sleep deprivation. Those related to individual behavioural risk factors (7.9%), social determinants of health (3.8%) and disasters (2.4%) had the fewest number of sources. Of relevance to the ecological dynamics described in the introduction to this report, a total of 312 sources (11.1%) dealt with ecosystem change as an impact pathway. This distribution is highlighted in **Figure 10**.

Figure 10. Distribution of sources per impact pathway examined



7 Synthesis and discussion

The following synthesis and discussion addresses several interrelated themes, including: insights arising from the preliminary ‘map’ of published studies (noting areas of emphasis as well as gaps), limitations, and next steps towards the overall aim of adapting and applying the learning to the northern BC context. This section is followed by a final section, which outlines conclusions for Phase 1 and recommendations for next steps in Phase 2.

The purpose of the scoping review was to determine the scope of published literature that addresses the links between resource extraction from the earth’s crust (e.g. mining/oil & gas) and health outcomes. An overview of the topical areas and focus of the studies, including examples of the most prominent and least prominent foci (i.e. gaps) is found in **Table 4** below.

Table 4. Summary of Findings

Topical Areas	Focus of study – most prominent	Focus of study – least prominent (gaps)
Publication focus	<ul style="list-style-type: none"> • Industrial exposures • Occupational medicine 	<ul style="list-style-type: none"> • Environment • Socioeconomic • Culture • Relationships between these topic areas
Affected populations	<ul style="list-style-type: none"> • Workers • Surrounding Communities • Males • Children 	<ul style="list-style-type: none"> • Indigenous • Migrants • Female • Youth and seniors

Geographical distribution	<ul style="list-style-type: none"> • Continent: North America 	<ul style="list-style-type: none"> • Continent: Australia
Objective of the study	<ul style="list-style-type: none"> • Modelling, epidemiological or toxicological studies 	<ul style="list-style-type: none"> • Occupational health and safety intervention • Health promotion/education • Diagnostic test or screening program • Legal action • Regulation or policy • Social movement • Scientific dispute or advocacy
Types of health impacts	<ul style="list-style-type: none"> • Respiratory • Cancer 	<ul style="list-style-type: none"> • Mental health • Well-being • Chronic injury and disease • Disability
Methodological approach	<ul style="list-style-type: none"> • Quantitative 	<ul style="list-style-type: none"> • Qualitative • Mixed-methods • Historical
Types of impact pathways	<ul style="list-style-type: none"> • Exposure to toxic substances • Workplace accidents or hazardous conditions 	<ul style="list-style-type: none"> • Behavioural and social determinants pathways • Ecosystem change and disasters

In reviewing the summary provided in Table 4, it is important to remember that scoping reviews are intended to provide a broad overview of the published literature, and are not meant to include an assessment of the quality of evidence, or provide a detailed synopsis of singular points of interest (Levac et al., 2010). The patterns of emphasis are findings from general indicators in titles and abstracts of peer reviewed publications and do not reflect information available in reports and grey literature, including, for example, unpublished health impact assessments. With this in mind, the scoping review findings raise questions about how to interpret knowledge gaps. The absence of a topic from the literature does not necessarily mean that the topic is not important but instead could indicate, for example, that: (1) the issue has not been studied or is understudied; (2) studies have been undertaken but the work has not been published; or, (3) papers addressing more ‘integrative’ or complex interactions among issues and pathways may be harder to get published. Without further analysis, it is difficult to unpack trends in the types of research that are funded, conducted, and ultimately published in peer-reviewed sources. Possibly influences include expectations surrounding ‘traditional methods’ of biomedical research, and the challenges of matching research design to the complexity of cumulative determinants of health impacts from resource development (Parkes 2016).

The overview and ‘map’ of published studies provided by this scoping review has also helped to identify key topic areas, patterns of emphasis and gaps, as well as noteworthy geographical patterns in published studies. A notable finding from the scoping review was the number of studies focusing on North America. Also notable are the types of studies included in the scoping review sources. These studies were predominantly quantitative (e.g. modelling, epidemiological or toxicological). This orientation is reflected in the types of journal in which studies were published, such as *Occupational and Environmental Medicine* and the *American Journal of Industrial Medicine* (Figure 4), and consistent with the overall orientation to industrial exposures and occupational health illustrated by the patterns of pathways reflected in Figure 11. The review identified a lack of studies in other areas, such as policy, legal, or educational studies. This may be the result of the broad questions asked in the original scan conducted by the librarian. Another explanation

could be that the true scope of the health impacts of resource development are under-researched, and the patterns of existing publications reflect a response to industry needs, demands, including the health of workers and surrounding communities as they relate to the biological and chemical pathways of toxins that contribute injury and disease (Masuda, Zupancic, Poland, & Cole, 2008).

Our findings provide a portrait of what is available and what is missing in the published literature. The first phase of this project has highlighted gaps in our knowledge of the health impacts of resource extraction and development. This becomes especially evident when the findings from the scoping review are compared with emerging scholarly and community concerns about the health impacts of resource extraction and development in northern BC (Buse, Jackson, Nowak, Fyfe, & Halseth, 2016; Gillingham et al 2016; Northern Health 2012, 2013; Parkes, 2016; Shandro, Veiga, Shoveller, Scoble, & Koehoorn, 2011; Shandro, Jokinen, Kerr, Sam, Scoble & Ostry, 2014). Areas where the published literature has not been found to match concerns in northern BC include, for example, impacts of resource extraction and development on mental health and well-being; impacts mediated through social determinants of health; impacts involving cultural change and community cohesion; and ecological pathways, especially in interaction with social/cultural/community dynamics (see for example FNHA and NH, 2017). Since the scoping review was intended to increase awareness of what has received more and less attention in the published literature, this will help to guide priorities and focus attention for future phases of the HIRED Project and will also be informed by related projects that are underway, such as the ECHO Network (Environment, Community, Health Observatory) seeking to gain understanding about interrelated health, environment and community concerns associated with resource development in northern BC, across Canada and internationally (ECHO, 2017). Phase 2 will begin to address these priority topics for northern BC through a staged approach that is further detailed in the recommendations section.

8 Recommendations for Next Steps

This scoping review was designed to inform a second phase of knowledge synthesis that will progress further toward the overall HIRED project aim of *determining how the public health impacts of resource development are understood and addressed, and how these approaches can be adapted and applied to the northern BC context*. The ‘map’ of published studies has identified both areas of emphasis and gaps. However, a scoping review does not allow a clear understanding of underlying epistemological and political economic influences that could be contributing to gaps in the literature. Recognising the need for future research, the findings in Phase I have led to **two overall recommendations**. First, we have identified the benefit of conducting **meta-narrative analyses** describing and exploring ‘storylines’ and their epistemological/methodological bases; and second, a series of **targeted systematic reviews** informed by the identified priorities.

Meta-narrative synthesis is a ‘theory-based’ approach to knowledge synthesis of diverse bodies of evidence (Greenhalgh et al., 2005). The purpose of a meta-narrative review is to examine a specific question by exploring the variety of ways in which different disciplines or other knowledge traditions have attempted to answer that question (Wong, Greenhalgh, Westhorp, Buckingham, & Pawson, 2013). In order to understand guidance provided by these disparate approaches, “we would have to consciously and reflexively step out of our own world-view, learn some new vocabulary and methods, and try to view the topic through multiple different sets of eyes” (Wong, et al., 2013, p. 2). Such an approach allows for different bodies of knowledge to be brought to bear on complex or ‘wicked’ problems, where the narrow inclusion and exclusion criteria of traditional systematic reviews would eliminate important relevant information. Detailed methods for meta-narrative review have been developed by Greenhalgh et al. (2005) and further refined by Wong et al. (2013). A key priority area for this meta-narrative synthesis will be a focus on **Canadian patterns of research in scholarship on resource extraction and health**. Within this meta-narrative synthesis, areas of interest may include:

- *Pathways of impact:* Including patterns of influence between industry and determinants of health spanning social, economic, ecological, cultural pathways;
- *Impacted Populations:* Including patterns of emphasis, and types of impact /illness;
- *Response options:* Intersectoral policy and practice implications.

Targeted systematic reviews involve reviews of the literature that address clearly formulated questions and use systematic and explicit methods to: identify publications; select publications relevant to the research question; critically appraise the publications; analyze the data reported in relevant publications; and report the combined results from relevant publications (Moher, Liberati, Tetzlaff, & Altman, 2009). A systematic review therefore extends and deepens the approach taken in a scoping review, adding assessment of study quality and potentially mathematically combining results to arrive at pooled effect estimates (e.g. in a meta-analysis).. Recommended priorities for targeted systematic reviews include a focus on key areas that were identified as ‘gaps’ in the scoping review, including the impact of resource extraction and development on:

1. *Mental Health and Well-being* – including substance use and other behavioural risk factors;
2. *Indigenous populations* – globally, recognizing differences across different colonial contexts;
3. *Women and Children* – including direct effects, and indirect impacts within families;
4. *Worker populations* – including gender and age dynamics;
5. *Affected communities* – including socio-economic determinants of health (cost of housing, education, public safety etc.).

Additional themes for systematic reviews leveraging from the 2800 sources may be identified as the HIRED project and related research initiatives develop. Interest by members of the ECHO (Environment, Community, Health Observatory) Network (www.echonetwork-reseaecho.ca) may also motivate use of this resource to gain further understanding about specific health, environment and community concerns associated with resource development in northern BC, across Canada or internationally (ECHO, 2017). Due to the pan-Canadian and international scope of work ECHO Network, comparison between the studies in different provinces and/or regions/continents could also be relevant.

9 References

- Albrecht, G. A., Higginbotham, N., Cashman, P., & Flint, K. (2007). Solastalgia: the distress caused by environmental change. *Australas Psychiatry*, 15, 95–98.
- Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International journal of social research methodology*, 8(1), 19-32.
- Centre for Addiction and Mental Health. (2009). Overview of methadone maintenance treatment Retrieved March 28, 2014, from http://knowledgex.camh.net/amhspecialists/specialized_treatment/methadone_maintenance/Pages/default.aspx
- Charron, D. F. (2012a). Ecohealth Research in Practice: Innovative Applications of an Ecosystem Approach to Health. In Springer (Ed.). New York, NY: International Development Research Centre.
- Charron, D. F. (2012b). Ecosystem Approaches to Health for a Global Sustainability Agenda. *EcoHealth*, 9(3), 256-266.
- CIRC. (2015). What are Cumulative Impacts? Retrieved September 23, 2016, from <http://www.unbc.ca/cumulative-impacts/about-circ>
- Corno, L., & De Walque, D. (2012). Mines, Migration and HIV/AIDS in Southern Africa. *Journal of African Economies*, 21(3), 465-498.
- Cunsolo Willox, A., Harper, S., Edge, V., Landman, K., Houle, K., & Ford, J. (2011). 'The Land Enriches the Soul': On Environmental Change, Affect, and Emotional Health and Well-Being in Nunatsiavut, Canada. *Emot Space Soc Spec Issue Ecol Emot*
- Department of the Interior. Mining, E., Safety, Administration, & Department of the Interior. Bureau of, M. (2007). Mine Operator Address, Employment, Accident, and Injury Files Mine Operator Address, Employment, Accident, and Injury Files. *U.S. National Archives and Records Administration Dataverse*, 2007-07-31
- ECHO (2017). The ECHO Network (Environment, Community, Health Observatory): Strengthening intersectoral capacity to understand and respond to health impacts of resource development. Online at: www.echonetwork-reseaecho.ca
- FNHA and NH (2017) *Northern First Nations Caucus Overview of Sub-regional Engagement Sessions - Full Report*. Online at: <https://www.northernhealth.ca/YourHealth/PublicHealth/OfficeofHealthandResourceDevelopment.aspx>
- Gillingham, M. P., Halseth, G. R., Johnson, C. J., & Parkes, M. W. (Eds.). (2016). *The Integration Imperative: Cumulative Environmental, Community and Health Impacts of Multiple Natural Resource Developments*. Cham: Springer International Publishing AG.
- Goldenberg, S. M., Shoveller, J. A., Koehoorn, M., & Ostry, A. S. (2010). And they call this progress? Consequences for young people of living and working in resource-extraction communities. *Critical Public Health*, 20(2), 157-168.
- Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., Kyriakidou, O., & Peacock, R. (2005). Storylines of research in diffusion of innovation: a meta-narrative approach to systematic review. *Soc Sci Med*, 61, 417-430.
- Greenwood, M., de Leeuw, S., Lindsay, N., & Reading, C. (Eds.). (2015). *Determinants of Indigenous Peoples' Health in Canada: Beyond the Social*. Canadian Scholars Press.
- Halseth, G. R., Gillingham, M., Johnson, C. J., & Parkes, M. W. (2016). Cumulative Effects and Impacts: The Need for a More Inclusive, Integrative, Regional Approach. In P. M. Gillingham, R. G. Halseth, C. J. Johnson & M. W. Parkes (Eds.), *The Integration Imperative: Cumulative Environmental, Community and Health Impacts of Multiple Natural Resource Developments* (pp. 3–20): Cham: Springer International Publishing.

- Hancock, T., Spady, D., & Soskolne, C. (Eds.). (2015). *Global Change and Public Health: Addressing the Ecological Determinants of Health. The Report in Brief. CPHA Working Group on the Ecological Determinants of Health*. Ottawa, ON: Canadian Public Health Association.
- Harder, H. G. (2016). Mental Health and Well-Being Implications of Resource Development In M. P. Gillingham, G. R. Halseth, C. J. Johnson & Parkes M.W. (Eds.), *The Integration Imperative: Cumulative Environmental, Community and Health Impacts of Multiple Natural Resource Developments* (pp. 139–141). Cham, ZG: Springer International Publishing AG.
- Horwitz, P., & Finlayson, C. M. (2011). Wetlands as Settings for Human Health: Incorporating Ecosystem Services and Health Impact Assessment into Water Resource Management. *Bioscience*, 61(9), 678-688.
- Horwitz, P., & Kretsch, C. (2015). Contribution of biodiversity and green spaces to mental and physical fitness, and cultural dimensions of health. In C. Romanelli, D. Cooper, D. Campbell-Lendrum, M. Maiero, W. Karesh, D. Hunter & C. D. Golden (Eds.), *Connecting Global Priorities: Biodiversity and Human Health, a State of Knowledge Review*. Geneva: World Health Organization (WHO); Convention on Biological Diversity (CBD).
- Kinnear, S., Kabir, Z., Mann, J., & Bricknell, L. (2013). The Need to Measure and Manage the Cumulative Impacts of Resource Development on Public Health: An Australian Perspective. In A. Rodriguez-Morales (Ed.), *Current Topics in Public Health* (pp. 125-144).
- Kuo, F. E. M. (2010). *Parks and Other Green Environments: Essential Components of a Healthy Human Habitat*. Ashburn, VA: Retrieved from http://www.nrpa.org/uploadedFiles/nrpa.org/Publications_and_Research/Research/Papers/MinKuo-Research-Paper.pdf.
- Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: advancing the methodology. *Implement Sci*, 5(1), 1-9.
- Lindsay, N. (2016). Cumulative Environmental, Community and Health Impacts of Multiple Natural Resource Developments in Northern British Columbia: Focus on First Nations. In M. P. Gillingham, G. R. Halseth, C. J. Johnson & Parkes M.W. (Eds.), *The Integration Imperative: Cumulative Environmental, Community and Health Impacts of Multiple Natural Resource Developments* (pp. 170–173). Cham, ZG: Springer International Publishing AG.
- Maller, C. J., Henderson-Wilson, C., & Townsend, M. (2009). Rediscovering Nature in Everyday Settings: Or How to Create Healthy Environments and Healthy People. *Ecobehavior*, 6(4), 553-556.
- Masuda, J. R., Zupancic, T., Poland, B., & Cole, D. (2008). Environmental health and vulnerable populations in Canada: Mapping an integrated equity-focused research agenda. *The Canadian Geographer*, 54(4), 427-450.
- Mitchell-Foster, K., & Gislason, M. K. (2016). Lived Reality and Local Relevance: Complexity and Immediacy of Experienced Cumulative Long-Term Impacts. In M. P. Gillingham, G. R. Halseth, C. J. Johnson & Parkes M.W. (Eds.), *The Integration Imperative: Cumulative Environmental, Community and Health Impacts of Multiple Natural Resource Developments*. (pp. 173–175). Cham, ZG: Springer International Publishing AG.
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *J Clin Epidemiol*, 62(10), 1006-1012.
- Northern Health. (2012). Part 1: Understanding the State of Industrial Camps in Northern BC: A Background Paper. Prince George, BC: Northern Health.
- Northern Health. (2013). Part 2: Understanding Resource and Community Development in Northern British Columbia: A Background Paper. Prince George, BC: Northern Health.
- Northern Health. (2016). Chief Medical Health Officer's Status Report on Child Health. Prince George, BC: Northern Health.
- Office of the Chief Medical Officer of Health (OCMOH). (2012). *Chief Medical Officer of Health's Recommendations Concerning Shale Gas Development in New Brunswick*. St. Johns, NB: Retrieved from

http://www2.gnb.ca/content/dam/gnb/Departments/h-s/pdf/en/HealthyEnvironments/Recommendations_ShaleGasDevelopment.pdf

- Parkes, M. (2011). *Ecohealth and Aboriginal Health: A Review of Common Ground*. Prince George, BC: National Collaborating Centre for Aboriginal Health.
- Parkes, M. W. (2016). Cumulative Determinants of Health Impacts in Rural, Remote, and Resource-Dependent Communities. In P. M. Gillingham, R. G. Halseth, J. C. Johnson & W. M. Parkes (Eds.), *The Integration Imperative: Cumulative Environmental, Community and Health Effects of Multiple Natural Resource Developments* (pp. 117–149): Cham: Springer International Publishing.
- Parkes, M. W., & Horwitz, P. (2016). Ecology and Ecosystems as Foundational for Health. In H. Frumkin (Ed.), *Environmental Health: From Global to Local* (3rd ed.). San Francisco, CA: Jossey-Bass.
- Parkins, J. R., & Angell, A. C. (2011). Linking social structure, fragmentation, and substance abuse in a resource-based community. *Community, Work and Family* 14(1), 39-55.
- Romanelli, C., Cooper, D., Campbell-Lendrum, D., Maiero, M., Karesh, W., Hunter, D., & Golden, C. D. (2015). Connecting Global Priorities: Biodiversity and Human Health, a State of Knowledge Review. In C. o. B. D. World Health Organisation (Ed.). Geneva: World Health Organization (WHO); Convention on Biological Diversity (CBD).
- Stephen, C., Burns, T., & Riviere-Cinnamond, A. (2016). Pragmatism (or Realism) in Research: Is There an Ecohealth Scope of Practice? *EcoHealth*, 1-4.
- The Complete University Guide. (2016). Studying in South Africa Retrieved September 20, 2016, 2016, from <http://www.thecompleteuniversityguide.co.uk/international/africa/south-africa/>
- Webb, J. C., Mergler, D., Parkes, M. W., Saint-Charles, J., Spiegel, J., Waltner-Toews, D., . . . Woollard, R. F. (2010). Tools for thoughtful action: the role of ecosystem approaches to health in enhancing public health. *Can J Public Health*, 101(6), 439-441.
- Whitmee, S., Haines, A., Beyrer, C., Boltz, F., Capon, A. G., Dias, B. F. D. S., . . . Yach, D. (2015). Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation-Lancet Commission on planetary health. *Lancet*, 386(10007), 1973-2028.
- Wilcox, B. A. (2004). Integrating ecohealth in the school of medicine. *Hawaii Med J*, 63(10), 316-317.
- Wong, G., Greenhalgh, T., Westhorp, G., Buckingham, J., & Pawson, R. (2013). RAMESES publication standards: meta-narrative reviews. *BMC Medicine* 11, 20.
- Zinsstag, J., Schelling, E., Waltner-Toews, D., & Tanner, M. (2011). From "one medicine" to "one health" and systemic approaches to health and well-being. *Preventive Veterinary Medicine*, 101(3-4), 148-156.

10 Appendices

Appendix A: HIRED Scoping Review – Search Notes (Trina Fyfe, Health Sciences Librarian)

General Search Parameters

1. Available medical subject headings, keywords, phrases and proximity searching was used to search the following search terms: "extraction industry" OR mining OR drilling OR shale OR fracking OR "hydraulic fracturing" AND population health OR environmental health OR public health OR mental health.
2. A librarian searched the following databases: Medline OVIDSP, CINAHL EBSCO, PsycInfo EBSCO, Web of Science ISI and LILACS.
3. Searches were limited to English language and 1995 to current.

Specific Database Search Strategies

Medline OVIDSP

#	Searches
1	(coal adj3 (mine or mining)).tw.
2	"coal-bed methane".tw.
3	"coalbed methane".tw.
4	"coal bed methane".tw.
5	(drilling adj3 (directional or offshore or onshore)).tw.
6	fracking.tw.
7	"hydraulic fracturing".tw.
8	(mining adj3 ("open pit" or open-pit or opencast or "closed pit" or underground)).tw.
9	("natural gas" adj3 (development or exploration or extraction)).tw.
10	(oil adj3 (drilling or extraction or industry or wells or rig)).tw.
11	(gas adj3 (drilling or extraction or industry or wells or rig)).tw.
12	"petroleum industry".tw.
13	shale.tw.
14	"slick water stimulation".tw.
15	(unconventional adj3 gas).tw.
16	oilfield*.tw.
17	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16
18	exp Respiratory Tract Diseases/
19	exp Metabolic Diseases/
20	Mental Health/
21	exp Mental Disorders/
22	exp Communicable Diseases/
23	exp Sexually Transmitted Diseases/
24	exp Hepatitis B/
25	exp Hepatitis C/
26	exp HIV/
27	exp Blood-Borne Pathogens/
28	Whooping Cough/
29	pertussis.tw.
30	exp Influenza, Human/
31	exp Measles/
32	Mumps/

33	exp Rubella/
34	exp Pneumococcal Infections/
35	exp Meningococcal Infections/
36	exp Gastroenteritis/
37	exp Norovirus/
38	exp "Wounds and Injuries"/
39	Accidents, Occupational/
40	exp domestic violence/ or workplace violence/
41	exp "Tobacco Use"/
42	Sedentary Lifestyle/
43	(poor adj3 diet).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
44	exp Health Behavior/
45	exp Drinking Behavior/
46	Occupational Health/
47	exp Public Health/
48	((indigenous or First Nations or aboriginal) adj3 health).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
49	((rural or remote or northern) adj3 health).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
50	Rural Health/
51	18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50
52	infant mortality/ or mortality, premature/
53	exp Suicide/
54	"cost of illness"/
55	quality-adjusted life years/
56	Stress, Psychological/
57	exp Self Concept/
58	self-esteem.tw.
59	exp Cardiovascular Diseases/
60	exp Stroke/
61	52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60
62	51 or 61
63	"Quality of Life"/
64	well-being.tw.
65	63 or 64
66	62 or 65
67	"extraction and processing industry"/ or exp mining/
68	((oil or gas) adj3 (transport* or train or trains or pipeline* or barrel*)).tw.
69	17 or 67 or 68
70	66 and 69
71	limit 70 to (english language and yr="1995 -Current")
72	exp Environmental Health/
73	66 or 72
74	69 and 73
75	limit 74 to (english language and yr="1995 -Current")

LILACS

tw:((tw:("extraction industry" OR mining OR drilling OR shale OR fracking OR "hydraulic fracturing")) AND (tw:(population health OR environmental health OR public health OR mental health))) AND (instance:"regional") AND (la:("en") AND

year_cluster:("2013" OR "2014" OR "2012" OR "2011" OR "2009" OR "2015" OR "2007" OR "2008" OR "2010" OR "2006" OR "2003" OR "2004" OR "2001" OR "2000" OR "1998" OR "2002" OR "1999" OR "2005" OR "1995" OR "1996"))

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[Accessibility Information and Tips](#) Revised Date: 07/2015

Print Search History

#	Query	Limiters/Expanders
S67	S46 AND S64	Limiters - Published Date: 19950101-20151231 Search modes - Boolean/Phrase
S66	S46 AND S64	Limiters - Published Date: 19950101-20151231 Search modes - Boolean/Phrase
S65	S46 AND S64	Search modes - Boolean/Phrase
S64	S47 OR S48 OR S49 OR S50 OR S51 OR S52 OR S53 OR S54 OR S55 OR S56 OR S57 OR S58 OR S59 OR S60 OR S61 OR S62 OR S63	Search modes - Boolean/Phrase
S63	TX (oil OR gas) N3 (transport* OR train OR trains OR pipeline* OR barrel*)	Search modes - Boolean/Phrase
S62	TX oilfield*	Search modes - Boolean/Phrase
S61	TX unconventional N3 gas	Search modes - Boolean/Phrase
S60	TX "slick water"	Search modes - Boolean/Phrase
S59	TX "slick water stimulation"	Search modes - Boolean/Phrase
S58	TX shale	Search modes - Boolean/Phrase
S57	TX "petroleum industry"	Search modes - Boolean/Phrase
S56	TX gas N3 (drilling OR extraction OR industry OR wells OR rig)	Search modes - Boolean/Phrase
S55	TX oil N3 (drilling OR extraction OR industry OR wells OR rig)	Search modes - Boolean/Phrase
S54	TX "natural gas" N3 (development OR exploration OR extraction)	Search modes - Boolean/Phrase
S53	TX mining N3 ("open pit" OR open-pit OR opencast OR "closed pit" OR underground)	Search modes - Boolean/Phrase
S52	TX "hydraulic fracturing"	Search modes - Boolean/Phrase
S51	TX fracking	Search modes - Boolean/Phrase
S50	TX drilling N3 (directional OR offshore OR onshore)	Search modes - Boolean/Phrase
S49	TX "coal-bed methane" OR TX "coalbed methane" OR TX "coal bed methane"	Search modes - Boolean/Phrase
S48	TX coal N3 (mine OR mining)	Search modes - Boolean/Phrase
S47	(MH "Extraction and Processing Industry") OR (MH "Mining")	Search modes - Boolean/Phrase
S46	S43 OR S44 OR S45	Search modes - Boolean/Phrase
S45	(MH "Health and Life Quality (Iowa NOC)+")	Search modes - Boolean/Phrase
S44	(MH "Environmental Health")	Search modes - Boolean/Phrase
S43	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42	Search modes - Boolean/Phrase
S42	(MH "Quality of Life+")	Search modes - Boolean/Phrase
S41	(MH "Stroke+")	Search modes - Boolean/Phrase
S40	(MH "Cardiovascular Diseases+")	Search modes - Boolean/Phrase
S39	TX self-esteem	Search modes - Boolean/Phrase
S38	(MH "Self Concept+")	Search modes - Boolean/Phrase
S37	(MH "Stress, Psychological+")	Search modes - Boolean/Phrase
S36	(MH "Quality-Adjusted Life Years")	Search modes - Boolean/Phrase
S35	(MH "Economic Aspects of Illness")	Search modes - Boolean/Phrase
S34	(MH "Suicide+")	Search modes - Boolean/Phrase
S33	(MH "Infant Mortality")	Search modes - Boolean/Phrase
S32	(MH "Rural Health")	Search modes - Boolean/Phrase
S31	TX (rural or remote or northern) N3 health	Search modes - Boolean/Phrase
S30	TX (indigenous or First Nations or aboriginal) N3 health	Search modes - Boolean/Phrase

S29	(MH "Public Health+")	Search modes - Boolean/Phrase
S28	(MH "Occupational Health+")	Search modes - Boolean/Phrase
S27	(MH "Drinking Behavior+")	Search modes - Boolean/Phrase
S26	(MH "Health Behavior+")	Search modes - Boolean/Phrase
S25	TX poor N3 diet	Search modes - Boolean/Phrase
S24	(MH "Life Style, Sedentary")	Search modes - Boolean/Phrase
S23	(MH "Smoking+")	Search modes - Boolean/Phrase
S22	(MH "Domestic Violence+") OR (MH "Workplace Violence")	Search modes - Boolean/Phrase
S21	(MH "Accidents, Occupational+")	Search modes - Boolean/Phrase
S20	(MH "Wounds and Injuries+")	Search modes - Boolean/Phrase
S19	TX norovirus	Search modes - Boolean/Phrase
S18	(MH "Caliciviridae Infections")	Search modes - Boolean/Phrase
S17	(MH "Gastroenteritis+")	Search modes - Boolean/Phrase
S16	(MH "Meningococcal Infections+")	Search modes - Boolean/Phrase
S15	(MH "Pneumococcal Infections+")	Search modes - Boolean/Phrase
S14	(MH "Rubella+")	Search modes - Boolean/Phrase
S13	(MH "Measles+") OR (MH "Mumps")	Search modes - Boolean/Phrase
S12	(MH "Influenza, Human+")	Search modes - Boolean/Phrase
S11	TX pertussis	Search modes - Boolean/Phrase
S10	(MH "Whooping Cough")	Search modes - Boolean/Phrase
S9	(MH "Bloodborne Pathogens")	Search modes - Boolean/Phrase
S8	(MH "Human Immunodeficiency Virus+")	Search modes - Boolean/Phrase
S7	(MH "Hepatitis B+") OR (MH "Hepatitis C+")	Search modes - Boolean/Phrase
S6	(MH "Sexually Transmitted Diseases+")	Search modes - Boolean/Phrase
S5	(MH "Communicable Diseases")	Search modes - Boolean/Phrase
S4	(MH "Mental Disorders+")	Search modes - Boolean/Phrase
S3	(MH "Mental Health") OR (MH "Psychological Well-Being")	Search modes - Boolean/Phrase
S2	(MH "Metabolic Diseases+")	Search modes - Boolean/Phrase
S1	(MH "Respiratory Tract Diseases+")	Search modes - Boolean/Phrase

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#	Query	Limiters/Expanders
S62	S56 AND S58	Limiters - Publication Year: 1995-2015 Search modes - Boolean/Phrase
S61	S56 AND S58	Limiters - Publication Year: 1987-2015 Search modes - Boolean/Phrase
S60	S56 AND S58	Search modes - Boolean/Phrase
S59	S56 AND S58	Search modes - Boolean/Phrase
S58	S37 OR S57	Search modes - Boolean/Phrase
S57	TX environmental N3 health	Search modes - Boolean/Phrase
S56	S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S51 OR S52 OR S53 OR S54 OR S55	Search modes - Boolean/Phrase
S55	TX extraction N3 industry	Search modes - Boolean/Phrase
S54	TX mines OR mining	Search modes - Boolean/Phrase
S53	TX (oil or gas) N3 (transport* or train or trains or pipeline* or barrel*)	Search modes - Boolean/Phrase
S52	TX oilfield*	Search modes - Boolean/Phrase
S51	TX unconventional N3 gas	Search modes - Boolean/Phrase
S50	TX slick N3 water	Search modes - Boolean/Phrase
S49	TX "slick water"	Search modes - Boolean/Phrase
S48	TX "slick water stimulation"	Search modes - Boolean/Phrase
S47	TX shale	Search modes - Boolean/Phrase
S46	TX "petroleum industry"	Search modes - Boolean/Phrase
S45	TX gas N3 (drilling or extraction or industry or wells or rig)	Search modes - Boolean/Phrase
S44	TX oil N3 (drilling or extraction or industry or wells or rig)	Search modes - Boolean/Phrase
S43	TX "natural gas" N3 (development or exploration or extraction)	Search modes - Boolean/Phrase

S42	TX mining N3 ("open pit" or open-pit or opencast or "closed pit" or underground)	Search modes - Boolean/Phrase
S41	TX "hydraulic fracturing"	Search modes - Boolean/Phrase
S40	TX fracking	Search modes - Boolean/Phrase
S39	TX drilling N3 (directional or offshore or onshore)	Search modes - Boolean/Phrase
S38	TX (coal N3 (mine or mining)) OR TX "coal-bed methane" OR TX "coalbed methane" OR TX "coal bed methane"	Search modes - Boolean/Phrase
S37	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36	Search modes - Boolean/Phrase
S36	DE "Well Being"	Search modes - Boolean/Phrase
S35	DE "Quality of Life" OR DE "Quality of Work Life"	Search modes - Boolean/Phrase
S34	DE "Cerebrovascular Accidents"	Search modes - Boolean/Phrase
S33	DE "Cardiovascular Disorders" OR DE "Aneurysms" OR DE "Arteriosclerosis" OR DE "Blood Pressure Disorders" OR DE "Cerebrovascular Disorders" OR DE "Embolisms" OR DE "Heart Disorders" OR DE "Hemorrhage" OR DE "Hypertension" OR DE "Ischemia" OR DE "Thromboses"	Search modes - Boolean/Phrase
S32	DE "Self Concept" OR DE "Academic Self Concept" OR DE "Self Confidence" OR DE "Self Esteem"	Search modes - Boolean/Phrase
S31	DE "Psychological Stress"	Search modes - Boolean/Phrase
S30	TX quality-adjusted life years	Search modes - Boolean/Phrase
S29	DE "Health Care Costs"	Search modes - Boolean/Phrase
S28	DE "Suicide" OR DE "Assisted Suicide"	Search modes - Boolean/Phrase
S27	TX infant N3 mortality	Search modes - Boolean/Phrase
S26	TX (rural or remote or northern) N3 health	Search modes - Boolean/Phrase
S25	TX indigenous or First Nations or aboriginal) N3 health	Search modes - Boolean/Phrase
S24	DE "Public Health" OR DE "Epidemics"	Search modes - Boolean/Phrase
S23	DE "Occupational Health"	Search modes - Boolean/Phrase
S22	DE "Drinking Behavior" OR DE "Alcohol Drinking Patterns" OR DE "Animal Drinking Behavior" OR DE "Water Intake"	Search modes - Boolean/Phrase
S21	TX poor N3 diet	Search modes - Boolean/Phrase
S20	TX Sedentary N3 Lifestyle	Search modes - Boolean/Phrase
S19	DE "Health Behavior" OR DE "Safe Sex"	Search modes - Boolean/Phrase
S18	DE "Tobacco Smoking" OR DE "Passive Smoking"	Search modes - Boolean/Phrase
S17	DE "Workplace Violence" OR DE "Partner Abuse" OR DE "Intimate Partner Violence" OR DE "Domestic Violence"	Search modes - Boolean/Phrase
S16	TX occupational N3 accident*	Search modes - Boolean/Phrase
S15	DE "Injuries" OR DE "Birth Injuries" OR DE "Burns" OR DE "Electrical Injuries" OR DE "Head Injuries" OR DE "Spinal Cord Injuries" OR DE "Wounds"	Search modes - Boolean/Phrase
S14	TX norovirus	Search modes - Boolean/Phrase
S13	gastroenteritis	Search modes - Boolean/Phrase
S12	TX Meningococcal OR Pneumococcal	Search modes - Boolean/Phrase
S11	TX mumps	Search modes - Boolean/Phrase
S10	DE "Measles" OR DE "Rubella"	Search modes - Boolean/Phrase
S9	DE "Influenza"	Search modes - Boolean/Phrase
S8	TX whooping cough OR pertussis	Search modes - Boolean/Phrase
S7	TX blood-borne pathogens	Search modes - Boolean/Phrase
S6	DE "Hepatitis" OR DE "Toxic Hepatitis"	Search modes - Boolean/Phrase
S5	DE "Infectious Disorders" OR DE "Bacterial Disorders" OR DE "Epstein Barr Viral Disorder" OR DE "Intracranial Abscesses" OR DE "Parasitic Disorders" OR DE "Sexually Transmitted Diseases" OR DE "Viral Disorders"	Search modes - Boolean/Phrase
S4	DE "Mental Disorders" OR DE "Adjustment Disorders" OR DE "Affective Disorders" OR DE "Alexithymia" OR DE "Anxiety Disorders" OR DE "Autism" OR DE "Chronic	Search modes - Boolean/Phrase

	Mental Illness" OR DE "Dementia" OR DE "Dissociative Disorders" OR DE "Eating Disorders" OR DE "Elective Mutism" OR DE "Factitious Disorders" OR DE "Gender Identity Disorder" OR DE "Hysteria" OR DE "Impulse Control Disorders" OR DE "Koro" OR DE "Mental Disorders due to General Medical Conditions" OR DE "Neurosis" OR DE "Paraphilias" OR DE "Personality Disorders" OR DE "Pervasive Developmental Disorders" OR DE "Pseudodementia" OR DE "Psychosis" OR DE "Schizoaffective Disorder"	
S3	DE "Mental Health" OR DE "Community Mental Health"	Search modes - Boolean/Phrase
S2	DE "Metabolism Disorders" OR DE "Cushings Syndrome" OR DE "Cystic Fibrosis" OR DE "Diabetes" OR DE "Hyperglycemia" OR DE "Hypoglycemia" OR DE "Hyponatremia" OR DE "Lipid Metabolism Disorders" OR DE "Phenylketonuria" OR DE "Porphyria"	Search modes - Boolean/Phrase
S1	DE "Respiratory Tract Disorders" OR DE "Apnea" OR DE "Bronchial Disorders" OR DE "Dyspnea" OR DE "Hay Fever" OR DE "Hyperventilation" OR DE "Laryngeal Disorders" OR DE "Lung Disorders" OR DE "Pharyngeal Disorders"	Search modes - Boolean/Phrase

Web of Science

#19	#16 AND #4 Refined by: LANGUAGES: (ENGLISH) AND PUBLICATION YEARS: (2013 OR 1996 OR 2014 OR 2012 OR 1995 OR 2011 OR 2010 OR 2009 OR 2015 OR 2008 OR 2007 OR 2006 OR 2005 OR 2004 OR 2003 OR 2001 OR 2002 OR 2000 OR 1997 OR 1999 OR 1998) <i>DocType=All document types; Language=All languages;</i>
#18	#16 AND #4 Refined by: LANGUAGES: (ENGLISH) <i>DocType=All document types; Language=All languages;</i>
#17	#16 AND #4 <i>DocType=All document types; Language=All languages;</i>
#16	#15 OR #14 OR #13 OR #12 OR #11 OR #10 OR #9 OR #8 OR #7 OR #6 OR #5 <i>DocType=All document types; Language=All languages;</i>
#15	TOPIC: (extraction NEAR/3 industry) OR TOPIC: (Department of the Interior. Mining, Safety, Administration, & Department of the Interior. Bureau of) <i>DocType=All document types; Language=All languages;</i>
#14	TOPIC: ((oil OR gas) NEAR/3 (transport* OR train OR trains OR pipeline* OR barrel*)) <i>DocType=All document types; Language=All languages;</i>
#13	TOPIC: ("petroleum industry") OR TOPIC: (shale) OR TOPIC: ("slick water stimulation") OR TOPIC: (unconventional NEAR/3 gas) OR TOPIC: (oilfield*) <i>DocType=All document types; Language=All languages;</i>
#12	TOPIC: (gas NEAR/3 (drilling OR extraction OR industry OR wells OR rig)) <i>DocType=All document types; Language=All languages;</i>
#11	TOPIC: (oil NEAR/3 (drilling OR extraction OR industry OR wells OR rig)) <i>DocType=All document types; Language=All languages;</i>
#10	TOPIC: ("natural gas" NEAR/3 (development OR exploration OR extraction)) <i>DocType=All document types; Language=All languages;</i>
#9	TOPIC: (mining NEAR/3 ("open pit" OR open-pit OR opencast OR "closed pit" OR underground)) <i>DocType=All document types; Language=All languages;</i>
#8	TOPIC: (fracking) OR TOPIC: ("hydraulic fracturing") <i>DocType=All document types; Language=All languages;</i>
#7	TOPIC: (drilling NEAR/3 (directional OR offshore OR onshore)) <i>DocType=All document types; Language=All languages;</i>
#6	TOPIC: ("coal-bed methane") OR TOPIC: ("coalbed methane") OR TOPIC: ("coal bed methane")

	<i>DocType=All document types; Language=All languages;</i>
#5	TOPIC: (coal NEAR/3 (mine or mining)) <i>DocType=All document types; Language=All languages;</i>
#4	#3 OR #2 OR #1 <i>DocType=All document types; Language=All languages;</i>
#3	TOPIC: (environmental NEAR/3 health) <i>DocType=All document types; Language=All languages;</i>
#2	TOPIC: (Meningococcal NEAR infection*) OR TOPIC: ("indigenous health") OR TOPIC: ("aboriginal health") OR TOPIC: ("first nations health") OR TOPIC: ("rural health") OR TOPIC: ("northern health") OR TOPIC: ("remote health") OR TOPIC: (suicide) OR TOPIC: ("cost of illness") OR TOPIC: ("quality-adjusted life years") OR TOPIC: ("psychological stress") OR TOPIC: ("self concept" OR "self-esteem" OR "confidence") OR TOPIC: (well-being OR "well being") OR TOPIC: ("quality of life") OR TOPIC: (cardiovascular disease*) OR TOPIC: (stroke) <i>DocType=All document types; Language=All languages;</i>
#1	TOPIC: (respiratory) OR TOPIC: ("metabolic diseases") OR TOPIC: (Centre for Addiction and Mental Health) OR TOPIC: ("communicable disease") OR TOPIC: (sexually transmitted) OR TOPIC: (hepatitis B OR hepatitis C) OR TOPIC: (HIV OR "human immunodeficiency virus") OR TOPIC: (blood-borne pathogen*) OR TOPIC: ("whooping cough" OR pertussis) OR TOPIC: (influenza) OR TOPIC: (measles OR mumps OR rubella) OR TOPIC: (Pneumococcal NEAR Infections) OR TOPIC: (gastroenteritis OR norovirus) OR TOPIC: (injur* OR wound*) OR TOPIC: (occupational NEAR/3 accident*) OR TOPIC: ("tobacco use" OR smoking) OR TOPIC: (Sedentary Lifestyle) OR TOPIC: (poor NEAR/3 diet) OR TOPIC: ("health behaviour" OR "health behavior") OR TOPIC: ("drinking behaviour" OR "drinking behavior") OR TOPIC: ("occupational health") OR TOPIC: ("public health") OR TOPIC: (infant mortality) <i>DocType=All document types; Language=All languages;</i>

Appendix B. Coding/Tagging Guide

1. Sector / type of extractive activity	
a.	Mining
b.	Oil & gas
2. Affected population	
a.	Workers
b.	Surrounding communities
c.	Indigenous group
d.	Other racial or ethnic group (may further differentiate at later date)
e.	Migrants
f.	Sex workers
g.	Children (ages 1-14) or youth (15-24 years of age) ² *Differentiate if possible
h.	Males
i.	Females
j.	Seniors (those 60+) ³
3. Objective of study	
a.	Characterize health impacts, e.g. 'Modelling', 'Epidemiology', 'Toxicology',
b.	Characterize responses <ul style="list-style-type: none"> i. Occupational health & safety intervention ii. Health promotion/education iii. Diagnostic test or screening program⁴ iv. Legal action v. Regulation or policy vi. Social movement, e.g. acts of disobedience/strikes vii. Scientific dispute or advocacy
4. Type of health impacts	
a.	Mental or psychosocial, including trauma and stress
b.	Respiratory
c.	Cancer
d.	Musculoskeletal
e.	Infectious disease, STI
f.	Infectious disease, other
g.	Genetic damage
h.	Acute injury, e.g. due to accidents
i.	Chronic injury, e.g. back pain, eye strain
j.	Disability
k.	Death
l.	Well-being/quality of life
m.	Birth defects and pregnancy issues
n.	Other
o.	Chronic disease
p.	Poisoning (toxicity)
5. Methodological approach	
a.	Quantitative
b.	Qualitative
c.	Mixed methods
d.	Historical
6. Type of impact pathways examined	
a.	Exposure to toxic substances, e.g. Chemical or radiological

² For the purposes of this project we will use the definition of Youth as defined by the United Nations, see - <http://www.un.org/esa/socdev/documents/youth/fact-sheets/youth-definition.pdf>

³ For the purposes of this project we will use the definition of and older or elderly person as defined by the World Health Organization, see - <http://www.who.int/healthinfo/survey/ageingdefnolder/en/> However Indigenous elders will not be defined by this limit, but based on their individual definitions

⁴ This one should be tagged only if it's a new test or program being developed. If it's using data from an existing initiative, it would be Characterize health impacts'

- b. Behavioural or social, e.g. HIV risk, experience of trauma, etc.
- c. Ecosystem change, e.g. increased malaria risk around gold mines with pooled water
- d. Social determinants, e.g. unstable housing, income, etc.
- e. Workplace accident or hazardous condition, e.g. a mine explosion would count, but so would shift-work, exposure to cold, or sleep deprivation. Would specifically need to exclude exposure to toxic substances, as they're a different tag.
- f. Occupation name, e.g. cancer incidence by occupation, without specifying what factors within the occupation might be responsible
- e. Disaster

7. Geographic area, based on Abstract or Title not Journal title

- a. Asia
- b. Europe
- c. South
- d. America
- e. North America
- f. Australia
- g. Africa
- h. Oceania
- i. Central America
- j. Caribbean

Appendix C. Background Tables

Number of sources by year

Year	Total Number
1995	85
1996	89
1997	84
1998	107
1999	90
2000	78
2001	110
2002	111
2003	121
2004	120
2005	120
2006	143
2007	154
2008	153
2009	149
2010	193
2011	181
2012	240
2013	228
2014	238
2015	154

Numbers of sources by journal

Journal (minimum 5 references)	Total Number
Journal of Occupational and Environmental Medicine	192
American Journal of Industrial Medicine	117
Science of the Total Environment	78
Occupational Medicine	61
Environmental Health Perspectives	57
International Journal of Occupational & Environmental Health	47
Annals of Occupational Hygiene	42
International Archives of Occupational & Environmental Health	39
Safety Science	38
Radiation Protection Dosimetry	38
Environmental Geochemistry & Health	38
Health Physics	36
Journal of Safety Research	33
Environmental Research	32
PloS One (Public Library of Science – Interactive Journal)	26

Journal of Occupational & Environmental Hygiene	25
Industrial Health	25
Work	24
American Journal of Public Health	24
Radiation Research	23
Environmental Monitoring & Assessment	23
Journal of Radiological Protection	22
Scandinavian Journal of Work Environment & Health	21
Radiation & Environmental Biophysics	21
American Journal of Respiratory & Critical Care Medicine	20
MMWR. CDC surveillance summaries: Morbidity and mortality weekly report	19
Journal of Occupational Health	19
Accident Analysis & Prevention	17
International Journal of Tuberculosis & Lung Disease	16
International Journal of Environmental Research & Public Health	15
BMC Public Health	15
Archives of Environmental Health	15
Social Science & Medicine	14
Progress in Safety Science and Technology	14
Journal of the South African Institute of Mining and Metallurgy	14
Journal of Environmental Radioactivity	14
AIDS	14
Regulatory Toxicology & Pharmacology	13
New Solutions: a journal of environmental and occupational health policy	13
Journal of Toxicology & Environmental Health Part A: Current Issues	13
International Journal of Occupational Medicine & Environmental Health	13
South African Medical Journal	12
Risk Analysis	12
Reviews on Environmental Health	12
Journal of Exposure Analysis and Environmental Epidemiology	12
European Respiratory Journal	12
Epidemiology	12
Chemosphere	12
British Journal of Cancer	11
Applied Ergonomics	11
American Journal of Epidemiology	11
Toxicology and Industrial Health	10
International Journal of Industrial Ergonomics	10
International Journal of Hygiene & Environmental Health	10
Human and Ecological Risk Assessment	10
Environmental Science & Technology	10
Environmental Science & Pollution Research	10
Environment International	10
Ecotoxicology Environment & Safety	10
Cancer Causes & Control	10

Bulletin of Environmental Contamination & Toxicology	10
Thorax	9
Resources Policy	9
International Journal of Radiation Biology	9
International Journal of Occupational Safety & Ergonomics	9
International Journal of Environmental Health Research	9
Inhalation Toxicology	9
CHEST	9
Biological Trace Element Research	9
Journal of Loss Prevention in the Process Industries	8
Journal of Hazardous Materials	8
International Maritime Health	8
International Journal of Circumpolar Health	8
International Journal of Health Services	7
International Journal of Cancer	7
Health & Place	7
Ergonomics	7
Environmental Health	7
Central European J Public Health	7
Bulletin of the World Health Organization	7
Archives of Environmental & Occupational Health	7
Toxicology Letters	6
South African Journal of Science	6
Lancet	6
Journal of Environmental Science & Health Part A-Toxic/Hazardous Substances & Environmental Engineering	6
Journal of Environmental Monitoring	6
International Journal of Injury Control and Safety Promotion	6
Indian Journal of Occupational & Environmental Medicine	6
Federal Register	6
Environmental & Molecular Mutagenesis	6
Current Opinion in Pulmonary Medicine	6
Critical Reviews in Toxicology	6
Australian Journal of Rural Health	6
Archives of Environmental Contamination & Toxicology	6
Sexually Transmitted Infections	5
Rural & Remote Health	5
Public Health Reports	5
Mutation Research	5
Minerals	5
Medical Journal of Australia	5
Malaria Journal	5
Journal of Occupational Rehabilitation	5
Journal of Environmental Management	5
Journal of Environmental Health	5

Health and Medicine	5
Cancer Epidemiology Biomarkers & Prevention	5
Applied Occupational & Environmental Hygiene	5
Annals of the New York Academy of Sciences	5
American Journal of Tropical Medicine & Hygiene	5
AIHA Journal: a Journal for the Science of Occupational & Environmental Health & Safety	5
AIDS Care-Psychological and Socio-Medical Aspects of AIDS/HIV	5

Appendix D: Coding/Tagging Combined Results

Code/Tag	Total Articles
1. Sector/type of extractive activity	
a. Mining	2449
b. Oil & Gas	429
2. Affected Population	
a. Workers	1945
b. Surrounding communities	624
c. Indigenous group	68
d. Other racial or ethnic group	24
e. Migrants	53
f. Sex workers	17
gi. Children (ages 1-14)	142
gii. Youth (ages 15-24)	15
h. Males	235
i. Females	98
j. Seniors (ages 60+)	6
k. General public	189
3. Objective of study	
a. Characterize health impacts	2415
b.i. Characterize responses - Occupational health & safety intervention	206
b.ii. Characterize responses - Health promotion/education	54
b.iii. Characterize responses - Diagnostic test or screening program	16
b.iv. Characterize responses - Legal action	19
b.v. Characterize responses - Regulation or policy	89
b.vi. Characterize responses - Social movement	40
b.vii. Characterize responses - Scientific dispute or advocacy	61
4. Type of health impacts	
a. Mental or psychosocial, including trauma and stress	125
b. Respiratory	627
c. Cancer	496
d. Musculoskeletal	83
e. Infectious disease, STI	135
f. Infectious disease, other	156
g. Genetic damage	96
h. Acute injury, e.g. due to accidents	233
i. Chronic injury, e.g. back pain or eye strain	112
j. Disability	11
k. Death	212
l. Well-being/quality of life	57
m. Birth defects and pregnancy issues	34

n. Other	102
o. Chronic disease	106
p. Blood disorders and poisonings	295
5. General methodological approach	
a. Quantitative	2277
b. Qualitative	125
c. Mixed Methods	71
d. Historical	84
6. Type of impact pathways examined	
a. Exposure to toxic substances, e.g. chemical or radiological	1661
b. Behavioral or social, e.g. HIV risk, experience of trauma	224
c. Ecosystem change	315
d. Social determinants	105
e. Workplace accident or hazardous condition	481
f. Occupation name	266
g. Disaster	78
7. Geographic area	
Africa	411
Antarctica	5
Asia	399
Australia	143

Appendix E: Key Messages/Findings

The list below includes the key findings from the scoping review of the published literature regarding Mining, Oil & Gas and related health outcomes. This appendix is intended to be used as a potential policy brief of the results.

- Majority of sources, including journal articles, books, and book chapters, were journal articles
- This Scoping Review, purposely, does not include information available in reports and grey literature (including unpublished health impact assessments).
- Number of articles tripled in 20 years with a peak year of publication in 2012.
- The most frequent journals used for publication were those related to occupational and industrial medicine and/or environmental health.
- Mining was cited in 86.3% of the sources; Oil and Gas in 15.7% of the studies – with some noted overlap between the topic areas.
- Workers (67.9%) and surrounding communities (22.3%) were cited most often in the total number of sources as the ‘affected population’ in a study.
- Of the study objectives cited in the sources, 86.1% focused on distinct health impacts, as described in modeling, epidemiological or toxicological studies
- Most studies (80.2%) used a quantitative methodology in their design
- There is a mismatch between types of studies published and community concerns that were identified as priority topics in northern BC by project partners, including, for example:
 - Impacts on mental health and well-being
 - Impact on determinants of health, via social pathways
 - Impacts to culture, community cohesion, including through ecological pathways