

Voices of Impact: Assessing Felt Impacts of Open-Pit Gold and Copper Mining in British Columbia

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A thesis

submitted in partial fulfillment of the
requirements for the degree of

Master of Landscape Architecture

University of Washington

2020

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Program Authorized to Offer Degree:

Landscape Architecture

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Abstract

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Salmon bearing river systems connect communities of Southeast Alaska and Northern British Columbia supporting rich ecological diversity throughout the region. The fishing economies, cultural traditions, and identities of coastal and river communities in this region survive by the health of these rivers. The watersheds support subsistence lifestyles that First Nations have relied on for over 10,000 years. An increase in mineral demand worldwide has led to a rapid growth of open-pit gold and copper mining in Northern BC, which has become known for its lenient policies and regulations toward resource extraction. Contemporary mining practices, inadequate public consultation and insufficient regulation around such large-scale projects leads to polluted waterways and degraded ecosystems, impacting communities who rely on these landscapes.

This research utilizes story mapping as a tool to analyze the environmental and social impacts experienced by residents in the watershed and highlight the need for incorporating more human experience and qualitative data into Environmental Impact Assessments (EIA). I used video interviews from community stakeholders throughout the region that share their experience and concerns around open-pit mining, which I analyzed and mapped to generate a more comprehensive understanding of the felt impacts of mining and determine the spatial boundaries of impact.

The findings from this research demonstrate the importance of incorporating qualitative data and local knowledge of the environment, including indigenous knowledge in the EIA process to adequately mitigate impacts. It suggests that story mapping could act as a platform to create a resilient community network and could provide a research tool to fill in gaps created by an inadequate review process of public engagement in the EIA.



VOICES OF IMPACT

Assessing felt impacts of open-pit
gold mining in British Columbia

Ilsa Barrett

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Acronym	Definition
AMD	Acid Mine Drainage
BC..	British Columbia
CAC	Community Advisory Council
CEAA	Canadian Environmental Assessment Act
EAO	Environmental Assessment Office
EIA	Environmental Impact Assessment
IK	Indigenous Knowledge
TAC	Technical Advisory Council
TCC	Tahltan Central Council
TSF	Tailings Storage Facility
VC	Valued Component

VOICES OF IMPACT

Assessing felt impacts of open-pit gold and copper mining in British Columbia

Salmon bearing river systems connect communities of Southeast Alaska and Northern British Columbia supporting rich ecological diversity throughout the region. The fishing economies, cultural traditions, and identities of coastal and river communities in this region survive by the health of these rivers. The watersheds support subsistence lifestyles that First Nations have relied on for over 10,000 years. An increase in mineral demand worldwide has led to a rapid growth of open-pit gold and copper mining in Northern BC, which has become known for its lenient policies and regulations toward resource extraction. Contemporary mining practices, inadequate public consultation and insufficient regulation around such large-scale projects leads to polluted waterways and degraded ecosystems, impacting communities who rely on these landscapes.

This research utilizes story mapping as a tool to analyze the environmental and social impacts experienced by residents in the watershed and highlight the need for incorporating more human experience and qualitative data into Environmental Impact Assessments (EIA). (The EIA is an evidence-based procedure intended to assess the economic, social, and environmental effects of projects, such as mining, to adequately mitigate impacts and ensure no significant damage is done). I used video interviews from community stakeholders throughout the region that share their experience and concerns around open-pit mining, which I analyzed and mapped to generate a more comprehensive understanding of the felt impacts of mining and determine the spatial boundaries of impact.

The findings from this research demonstrate the importance of incorporating qualitative data and local knowledge of the environment, including indigenous knowledge in the EIA process to adequately mitigate impacts. It suggests that story mapping could act as a platform to create a resilient community network and could provide a research tool to fill in gaps created by an inadequate review process of public engagement in the EIA.

APPROACH

I believe that collaborative, multi-disciplinary methods, grounded in the principles of co-production, is a more effective approach to adequately assess and mitigate impacts of mining in trans-boundary waterways of British Columbia (BC) than the methods currently used. Assessment methods must include qualitative and quantitative data, different knowledge types including local and Indigenous Knowledge (IK), more resources, opinions, and concerns in the process.

Co-production is an iterative and collaborative process that has begun to be used in sustainability research. It is based on the belief that one group should not be responsible for defining issues, researching the problem, delivering the knowledge to society, and developing solutions (Norström et al. 2020). In the case of open-pit mining, the company developing the mine should not be solely responsible for determining the scopes of impact, valued components, thresholds for impact and effective mitigation measures. I argue that stakeholders should be given more responsibility and resources to provide input and expertise into this process.

The goal of co-production is to develop comprehensive pathways towards sustainable solutions by collaborating with a wide range of actors and a diversity of knowledge types. Goals of co-production are more than collecting knowledge and ideas through collaboration; it is to develop capacity, build networks, foster social capital, and implement actions that contribute to sustainability. 'The act of engagement across domains and disciplines can be as important for the pursuit of sustainability as the production of knowledge' (Sundin, Andersson, and Watt 2018).

Co-production principles are context-based, pluralistic, goal-oriented, and interactive. Context-based means that there is a clearly stated challenge at hand as well as a defined region of impact. The pluralistic principle of co-production entails that a diverse set of knowledge and ways of doing are equally recognized and valued. The goals of the challenge at hand must be clearly defined to avoid expanding into a realm that is too large and avoid the trap of focusing only on what is measurable. Co-production also requires high levels of participant interaction for the stakeholders or participants to build trust and ensure that knowledge is being translated in a way that everyone understands and considers to be credible (Sundin, Andersson, and Watt 2018).

I propose using story mapping as a tool to facilitate a co-production process to better understand risks of mining in the trans-boundary region and promote responsible mining practices. This platform would be a means of collaborating and creating social networks for knowledge sharing in large, rural regions, like the trans-boundary region, where conventional methods of community engagement have varied success rates (Booth and Halseth 2011). Sharing stories and insights would promote a better understanding of place identity and place attachment in the region to better evaluate the risks of mining. As demonstrated in this project, story mapping could be a platform for collecting, synthesizing, analyzing, and representing experiential data, multidisciplinary insights, spatial information, ideas, concerns, local and indigenous knowledge. This platform seeks to connect communities, organizations, and individuals with similar goals and concerns to work towards potential solutions. In the EIA this method could act as a tool in for public engagement, and a means of providing the public with accessible information about the project.

STORY MAPPING AS A RESEARCH TOOL

Geo-visual narratives, or story mapping, is an effective research tool that can be used to synthesize, analyze, and represent spatial, visual, and textual information as a collective narrative. It enables meaningful participation while generating a compelling product that can be expanded upon. The process and methods used to create a story map can function as its own mode of research that is equally as useful as the final product.

If systematically collected and mapped, human narratives can highlight individual and community concerns, potential effects, and impacts, and help generate a timeline and physical range of impacts. It can support a co-production process by creating a network of different resources, specialists, and knowledge types. It could also provide a platform for increased transparency and accountability in the currently opaque EIA process. *'Integrating (storytelling) into systematic reviews and systematic maps in environmental management and conservation to communicate evidence to stakeholders and other target audiences is yet to be explored and used to its full potential'* (Sundin, Anderson, and Watt 2018).

Collecting narratives of experiences, local knowledge, concerns, or ideas is one step that could be taken to incorporate qualitative data and indigenous and local knowledge into the EIA. Human narratives can help generate a better understanding of what is at risk, and how the direct effects on the environment from mining might translate to social, cultural, and economic impacts

Stories are a more inclusive form of sharing knowledge because they are easily accessible to anyone, no matter the background or context. Storytelling as a tool to explain complex research has, in the past, not been taken seriously as a method of communicating science. However, studies are showing that narratives can increase knowledge retention, the willingness for people to take action and develop trust (Sundin, Andersson, and Watt 2018).

Storytelling is a well-known method for communicating messages and engaging audiences. It is a form of sharing knowledge that is older than any other method and is how indigenous knowledge has been collected and shared for thousands of years. Stories can combine information with emotion which helps create a connection between our *logos* and *pathos* in the brain - meaning that when there is an emotional response connected to facts, it increases the chances that people will absorb, remember, or act on the information (Sundin, Anderson, and Watt 2018).

Maps have long been used as a means of geo-locating stories or as a method of unfolding a narrative. According to Caquard and Cartwright (2014, p. 101) *'The potential of maps to both decipher and tell stories is virtually unlimited'*. Maps can do more than depict geographic space as a cartographic expression, they also have potential to depict a sense of place. In a world that is perceived in different ways based on contrasting realities, embedding narratives into a map can provide insight into what someone's world is like, their limitations and perceived boundaries, their perception of beauty and value.

Today, online maps are used by individuals and communities to trace their own stories in space, these personal annotations give a map greater depth by turning into a device for holding memories, describing experiences, and sharing knowledge (Caquard and Cartwright 2014).

Indigenous communities have been mapping IK as a means of defining their territories and reclaiming dignity over their lands. Although indigenous mapping is often intended to reverse the colonial power of mapping and the associated geographical outcomes, it has also been criticized as to how it forces indigenous spatial perspectives to be put through western lenses and approaches. There are, however, examples in which traditional spatial expressions have been hybridized with western cartographic practices in a successful, respectful way (Caquard and Cartwright 2014).

Emotional mapping is a very powerful geo-participation tool that connects emotions to a place. Maps that connect a person's emotion with a certain space have been shown to be a useful tool in city strategic planning or in the development of public facilities. Strategies to map emotions include crowd sourced information, such as geo-locating places associated with an emotion. This data can be used to find hot spots in a city that are associated with feelings such as fear or happiness to be used to influence city plans or design strategies (Nold 2009). Other artists such as Les Roberts have developed compelling mapping strategies that use the power of video to represent the relationships between places and emotions.

Olivia Molden demonstrates how ESRI's online story mapping application can be used as a research technique to build narratives about individual and collective experiences in her research on the diversity and dynamism of household water experiences in Kathmandu, Nepal.

The goals of story mapping according to Molden (2020, p. 1) include *'to iteratively synthesize the collection, analysis and representation of spatial, visual and textual information as a narrative; to enable meaningful participation of research participants; and generate a visual compelling product that facilitates dissemination.'* She explains that the use of story maps for research is generally focused on outreach, that the process of creating story maps can also function as a mode of research that is as important as the way that the map tells and supports the narratives (Caquard and Cartwright 2014).

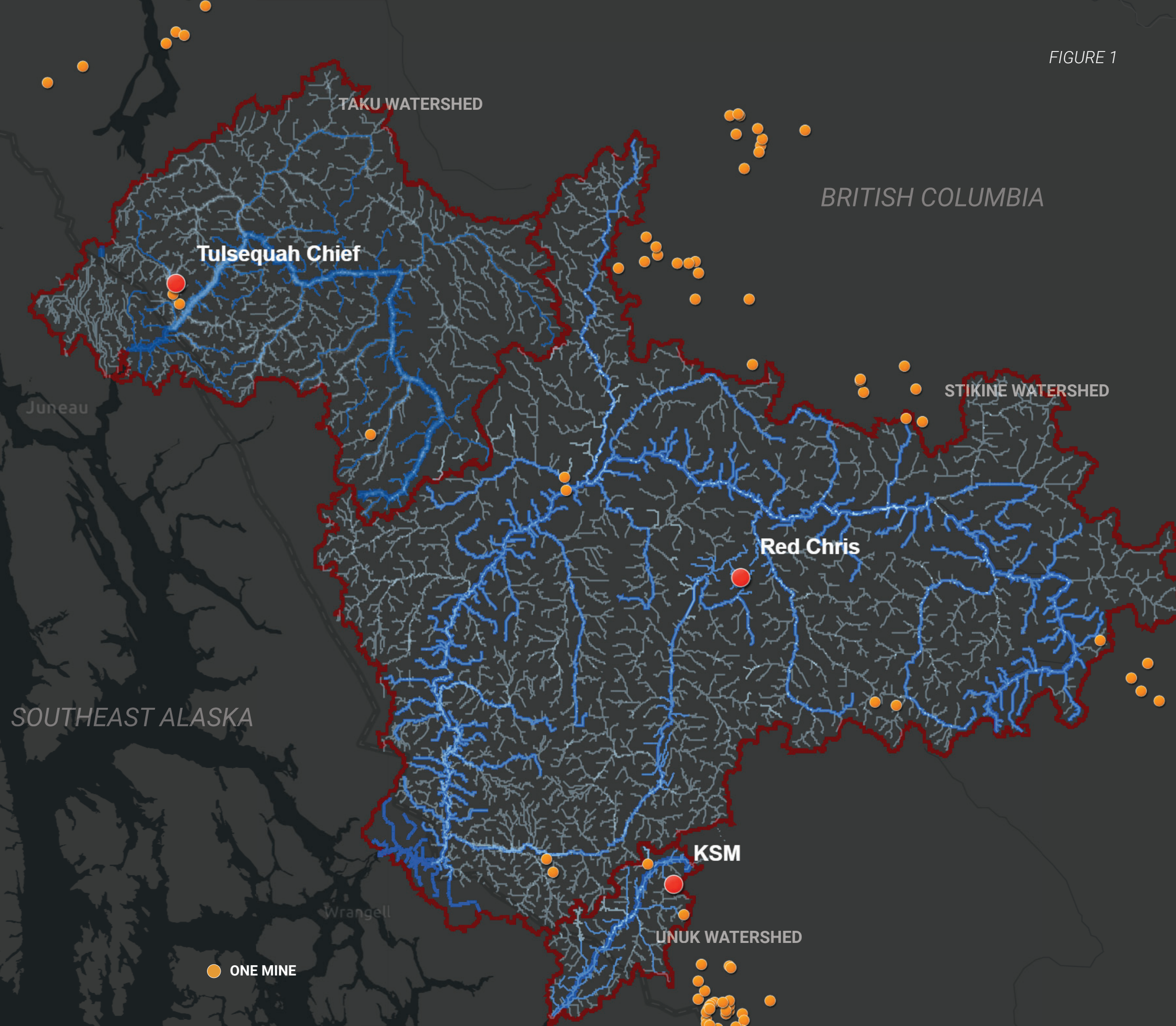
In my research I used ESRI story mapping as a tool to better understand the felt impacts of open-pit mining in the trans-boundary region of Northern BC and SE Alaska and highlight shortcomings in the EIA process. Video interviews from stakeholders and specialists, geographical information, graphic representations of qualitative and quantitative data, and textual information from four case study mines were all incorporated into the narrative. Methods used to analyze the stories and information gathered included, generating graphics to visually represent information about mining practices and impacts, creating maps to represent spatial boundaries and relationships, and making timelines to examine past events. I aggregated common themes of felt impacts and drew pathways back to associated causes. I used all my findings to highlight where and how the current EIA process is lacking and suggest improvements (Link: <https://www.arcgis.com/apps/MapSeries/index>)

BACKGROUND ON TRANS-BOUNDARY MINING

The Golden Triangle, an area in Northern British Columbia (BC) east of Alaska's panhandle, is becoming one of the largest gold and copper mining regions in the world. Due to the rich geology in the region, mineral exploration and mining has been a common occurrence for over one hundred years. Three gold rushes have extracted 130 million ounces of gold, 800 million ounces of silver and 40 billion pounds of copper. After a brief period of relative dormancy, the discovery of new deposits accompanied with higher gold prices, newly developed infrastructure, and a declining snow cover lead to a 66% increase in exploration in the last three years alone (Mills 2018).

Today, at least twelve large-scale open-pit mines in various stages of development sit upstream from some of the last viable salmon rivers on the North American side of the Pacific (Figure 1). Red Chris is a large-scale active gold and copper mine owned by Imperial Metals, located on the Stikine River watershed in Tahltan First Nation territory, upriver from the coastal fishing community of Wrangell, Alaska. Not far up the Taku river from Juneau, AK is the Tulsequah Chief mine, an example of one of the many formerly active mines in the area. It was abandoned in 1957 after a seven year lifespan of mining for gold, copper, silver, zinc and lead, and has been leaching acid mine drainage into the Taku River for the last 63 years, violating the Canadian Fisheries Act, BC mine permits, and water quality standards (Hitselberger 2012). On the Unuk river, inland from Misty Fjords National Monument and Ketchikan Alaska, is the recently opened Bruce Jack gold mine, and the future location of Seabridge Gold's KSM mine, which when built is set to be the largest gold and copper mine in North America, fifth in the world (Mills 2018).

FIGURE 1



Imperial Metals' Mount Polley Mine is located south of the trans-boundary region, in the Secwepemc territory of central BC. A catastrophic disaster occurred in 2014 when the tailings dam failed, releasing 26 billion liters of toxic waste into Quesnel Lake, a once pristine body of water and crucial salmon spawning ground that connects to the Fraser River (Mack 2017). Irreversible damage was inflicted on the landscape, and a legacy of First Nation's subsistence older than ten thousand years was destroyed. For communities in the trans-boundary waterways, Mount Polley mine serves as an example of the level of destruction that contemporary mining practices can inflict on environments and communities. The lack of accountability on the part of Imperial Metals for clean-up or community compensation after the disaster has engendered community distrust of mining companies and their practices.

Even without a disaster, open-pit mines have long-term negative ecological impacts that are experienced by neighboring and downriver communities, with First Nations communities experiencing a disproportionate amount of impact (Baker and McLelland 2002). Despite protests against Canadian mining companies, large scale open-pit mines continue to be licensed with lenient requirements for the mitigation and monitoring of environmental and social impacts, no or minimal requirements for post-closure restoration, and insufficient community compensation and protection.

The EIA is an evidence-based procedure intended to assess the economic, social, and environmental effects of projects, such as mining, to adequately mitigate impacts and ensure no significant damage is done. Currently, EIAs in Canada are limited in scope, not comprehensive or stringent enough to fully identify, assess, and alleviate environmental and social impacts (Mehdic 2014).

Reasons for this include the lack of adequate public consultation and an insufficient incorporation of different knowledge types, especially indigenous knowledge (Stevenson 1996). However, several factors have limited the contributions of traditional knowledge to EIAs. Thresholds to determine the significance of impacts are arguably insufficient and don't incorporate qualitative impacts such as those to individual and community health, culture traditions and heritage sites, or economies and lifestyles that rely on healthy landscapes (Murray et al. 2018).

Follow-up programs, or actions taken after the mine is constructed, to monitor, evaluate, manage, and communicate environmental and social outcomes are in-comprehensive, not well enforced, and do not require incorporating stakeholders in the process (Macharia 2005). As a result, large scale mining is frequently permitted in culturally and ecologically important landscapes with insufficient impact mitigation measures in place.

This research focuses particularly on open-pit gold and copper mining in the trans-boundary watersheds of the Taku, Unuk, and Stikine Rivers that flow from Northern BC through Southeast Alaska, as well as the Mount Polley Mine on the Fraser River. The project evaluates how the risks of mining are currently being measured in the permitting process, examines impacts that are not being sufficiently addressed because they are more difficult to quantify, and conducts an analysis of the gaps in knowledge and information missing from impact assessment procedures. This work clarifies how risks and impacts can be more effectively expressed and visualized, and how structural alterations of impact assessments may benefit communities most affected by mining projects. The project uses story mapping as a research and dissemination method, and suggests that this method could be used as a tool to fill the gap of community engagement, aiding in the analysis of potential risks in future mining impact assessments.

Case Study Mines

TULSEQUAH CHIEF - ABANDONED

RED CHRIS - ACTIVE

KSM - PERMITTED

MOUNT POLLEY - POST DISASTER

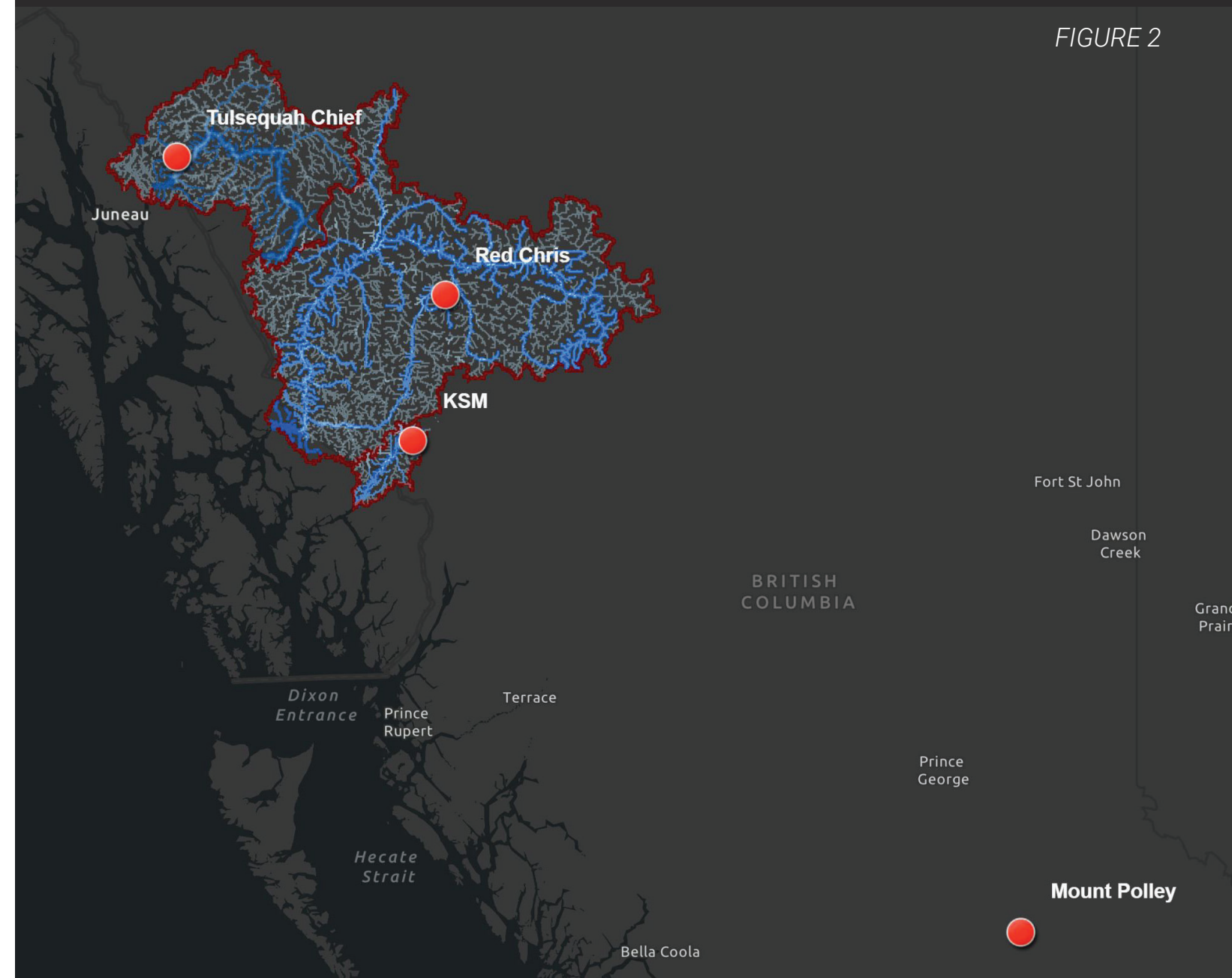


FIGURE 2

MINING FOR PRECIOUS MINERALS

Although large scale open-pit mining can damage the environment and impact certain communities if impacts are not adequately understood and effectively mitigated, mining for minerals exists because humans rely heavily on mined resources as they are an essential part of modern living. Additionally, mining can play a crucial role in a country's economy while providing employment to locals in resource-rich regions.

Iron, zinc, molybdenum, lead copper, gold are the most commonly mined minerals in BC ("Mining in BC | TRCR"). Iron ore is used to manufacture steel, magnets and various auto parts while zinc has many uses including as a protective coating on steel, to alloy a metal with copper to make brass and for chemical compounds in rubber and paint. Molybdenum is used in stainless steels, tool steels, cast irons and chemical lubricants and due to its high melting temperature, it can be found in light bulbs, metalworking dies and furnace parts. Lead is used in batteries, construction, ammunition, nuclear shielding, ceramics, and tubes or containers ("Minerals and Their Uses").

Gold and copper are the minerals most commonly mined in the Golden Triangle in northern BC and the focus of this research (Desjardins 2016). Copper is used in electric cables and wires, switches, plumbing, heating, electrical and roofing materials, transportation, industrial machinery, coins and jewelry ("Minerals and Their Uses"). Although we currently use small amounts of gold in some industrial, electronic, and dental technology, as of 2017 under 18% of the gold supply is used in this manner.

Around 30% is made into bars and coins, much of which is purchased by central banks and stored in vaults underground to be held as official gold reserves. The majority of the gold demand today is for jewelry, which brings into question the necessity of this mineral as a mined resource ("Global Gold Demand by Industry Share 2017").



FIGURE 3 - Bingham Mine. Source: Wikimedia Commons

An increase in demands from countries entering into phases of energy and material intensive development and accelerated consumption rates in wealthier economies has led to a large increase in global metal extraction. In the last thirty years, the rate of extraction has more than doubled ("Trade and Invest BC - Invest in Canada | BC Mining - Gold").

BC is a hot spot for mineral extraction and contains the world's largest concentration of exploration companies and mining professionals. More than 700 mining and mineral firms are based out of Vancouver alone ("Trade and Invest BC - Invest in Canada | BC Mining - Gold"). Along with global increase in demands and higher gold prices, new infrastructure allowing access to remote places and new discoveries of gold deposits such as KSM have led to an increase in mineral exploration and extraction in the Golden Triangle (Desjardins, 2016). In 2017 alone, \$8.8 billion USD worth of mine products were produced from this region ("Trade and Invest BC - Invest in Canada | BC Mining - Gold").

So how is gold and copper extracted from the earth in Northern BC? There are four major forms of mining: placer, in-situ, underground, and, surface. Placer mining is used to sift out valuable metals from sediments, often in river channels or beach sands. In-situ mining is primarily used in mining uranium and avoids removing rock from the ground by dissolving the mineral resource and processing it in place. Underground mining is used to reach much deeper, high quality deposits making them very expensive to operate. Surface mining, which includes open-pit mining, is typically used for shallower and less valuable deposits ("What Are the Main Methods of Mining?" 2014).

While sometimes used for coal mining, open-pit mining is more commonly used in hard-rock mining for mineral ores, including gold and copper, which is the focus of my research. In open-pit mining, the surface of the ground is excavated, and large quantities of soil, plants and, waste rock, or overburden, are removed to expose the mineral deposit. The main objective is to exploit the mineral deposit at the lowest cost while maximizing profits ("Basics of an Open Pit Mine").

SOCIAL IMPACTS

Environmental impacts from open-pit mining translate to social, economic, and cultural impacts to the communities that live near a mine or subsist off the landscapes or waterways being adversely affected by the mine. Mines not only impact the physical health of neighboring communities who breathe in the heavy metal dust and can hear and feel the explosions, but they can also destroy sites of cultural importance, demolish game trails and habitat, and cause a decline in certain fish populations. These losses translate to diminished wild food sources, pressure on resource-based economies, and impacts to ways of life, cultural traditions, and identities. The methods used to evaluate impacts do not fully consider all these losses or document environmental and social risks.

In BC First Nations people are often adversely affected by the large mining projects (Docherty 2010). Mineral claims in BC are very easy to make and often made on First Nations territories or traditionally important land. According to mining watch Canada the current system does not recognize or consider Aboriginal land claims. The federal free entry laws do not require consultation with, or protection of First Nations, nor does it provide them with a role in land resource decisions. Damage to cultural heritage sights, sacred landscapes, and habitats that support subsistence lifestyles all have adverse impacts on First Nation communities.

Mining corporations often promise job security and economic gains to the First Nations communities they are moving into to gain their support; however, according to interviews Tahltan and Secwepemc community members, most positions are given to people who are brought in from elsewhere. The locals that were hired were given low level jobs with little chance of moving up. Jobs provided by mining companies are only temporary; the average lifespan of a mine is only 10-50 years, leaving an unemployed workforce, and an unhealthy landscape in its wake

This boom-bust cycle of mining can have adverse impacts on the well-being of surrounding communities. The University of BC performed a study in Tumbler Ridge, BC to assess community health during the lifespan of an open-pit mine. During the boom cycle, they found that there was an increase in sexually transmitted infections, more pregnancies, and an increase in injuries in the community due to accidents at the mine. They also found that the bust, or closing of the mine, correlated with increased levels of stress, anxiety, depression, and alcoholism than before the mine existed. Community health issues that correlate with both boom and bust cycles include burdens to health and social services, family stress, violence towards women, and addiction issues (Shandro et al. 2011).

Mines also pose threats to subsistence lifestyles in BC and downstream in SE Alaska, Subsistence lifestyles are defined as *'the local production and distribution of goods and services where the objective is not total self-sufficiency nor capital accumulation, rather a continuous flow of goods and service'* (Natcher 2009, p. 85). As of 1990, over 25000 people benefited from subsistence-based fisheries, primarily salmon, in BC. Over three quarters of the total native population consumes fish. The amount of fish consumed per person partaking in subsistence fisheries in Canada is at 60kg, while in Alaska it is at 140 kg per person (Berkes 1990). The harvesting, processing and distribution of wild food and resources is a central component of Canada's northern social economy. Along with the trading of crucial resources and services, there is an exchange of social norms and cultural values that is arguably just as important (Natcher 2009).



FIGURE 4 - Sockeye strips in a smoke house. (Source: Alaska Region U.S. Fish & Wildlife Flicker)

In Northern BC, mining also has secondary impacts on the communities downstream in SE Alaska. The SE Alaska Salmon fishery is considered one of the most sustainable fisheries in the world, generating jobs for over 8,000 people, employing 15% of local working adults in the region, and pumping \$1 billion into the regional economy annually. Recreational and salmon-based tourism attracts over 6,000 people and adds over \$400 million to local economies ("The Economic Value of Alaska's Seafood Industry" 2017). These Alaskan industries along with the cultures, communities, foods and jobs they provide are put at risk when large scale mines like Red Chris, Tulsequah Chief or KSM mine are permitted upriver. The risks to the salmon fishing industry or any other commercial or subsistence fishing industry on the coast and upriver are not adequately considered in the impact assessment.



FIGURE 5 - Commercial salmon purse seining in SE Alaska (Source: Ilsa Barrett)

ENVIRONMENTAL IMPACTS

Large-scale open-pit mining is an energy intensive process that can have drastic environmental implications when mismanaged. These impacts include habitat loss, noise, air quality (dust and pollutants), vibrations, water discharge and runoff, acid mine drainage, subsidence, and material byproducts. Baseline mitigation of impacts typically involves water treatment measures to meet discharge standards, erosion and sediment control, solid waste disposal and control of fugitive dust. Reclamation plans that include top soil remediation, continuous treatment of water and habitat restoration, must be submitted and approved before the mine is permitted ("Basics of an Open Pit Mine" 2010).

Open-pit mines can be immense as can be seen in Figure 6. Due to a decline in the ore grade (percent of ore that contains minerals) of deposits worldwide, more ore has to be extracted from the earth to obtain a quantity of gold or copper mineral that is profitable (Calvo et al. 2016). Improvements in mining technology have made it possible to mine lower quality deposits in a cost-effective way, the result being the development of much larger open-pit mines. An example of how large open-pit mines can get is the Bingham Canyon mine (Figure 3), a copper mine located south-west of Salt Lake City, Utah, US. It is more than 1.2km deep, approximately 4.5 kilometers wide and exports 450,000 tons of mineral ore out of the mine daily (Bland 2014).

HOW BIG IS A MINE?

A comparison to the footprint of seattle

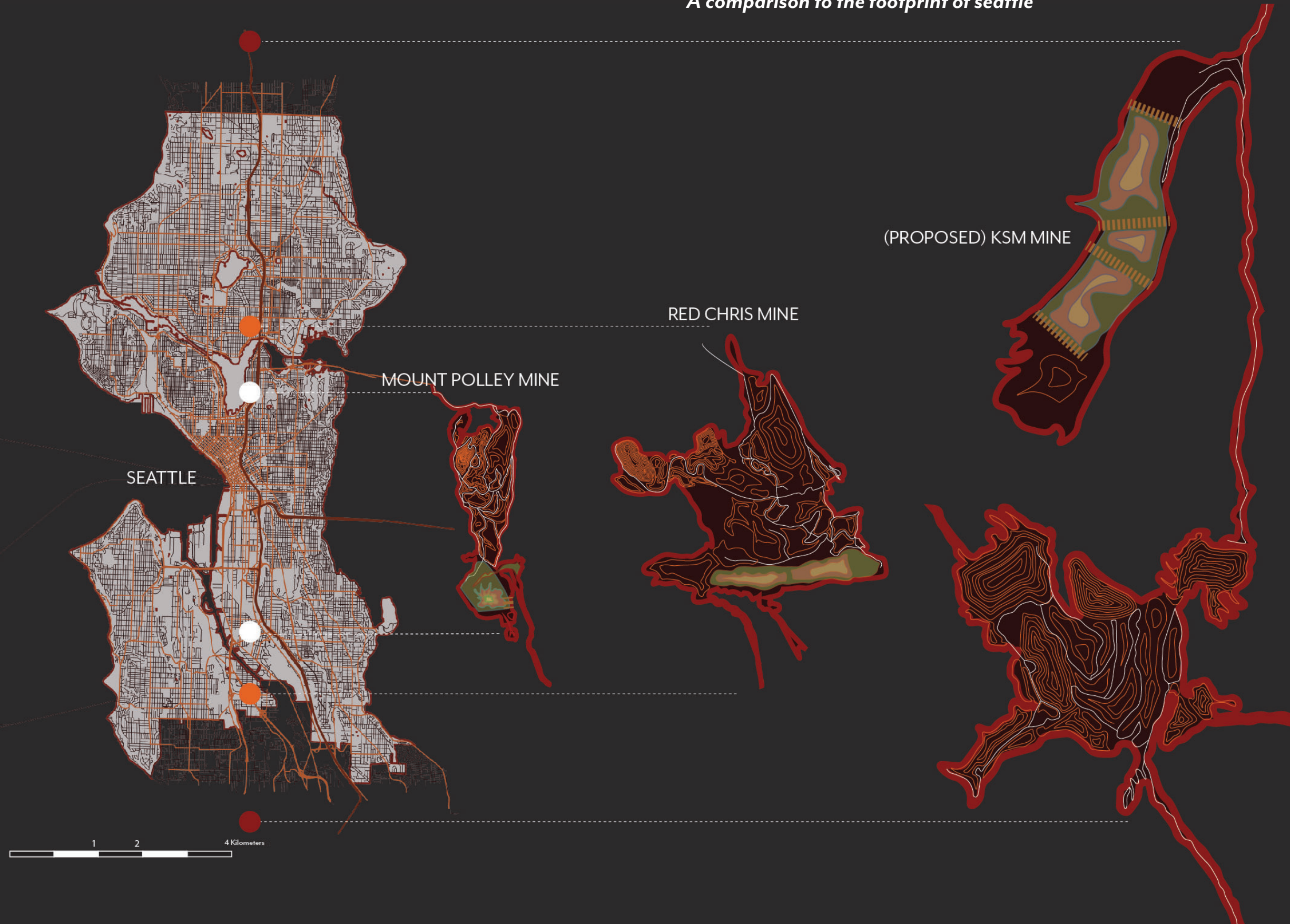


FIGURE 5

DIAGRAM OF A MINE

How acid mine drainage leaches into a water table

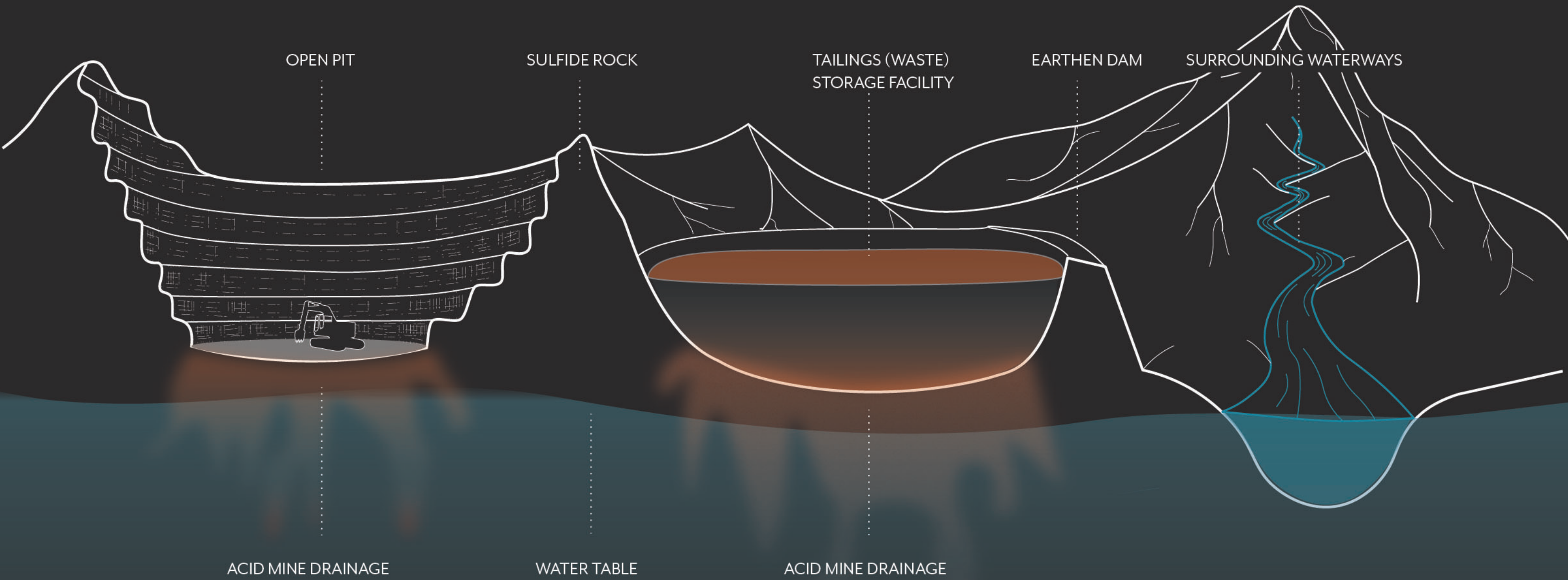


FIGURE 6

Beyond their extraction purposes, large-scale open-pit mining requires systems be developed to manage the “waste” material generated to obtain small amounts of minerals. In order to extract enough copper to make the average gold ring up to 20 tons of toxic waste is produced, while to obtain enough copper for a single wind turbine, 1,667 tons of waste is generated (Bland 2014).

Hardrock mining, such as gold and copper uncovers rock that has been unexposed for geological eras. When crushed, the rock exposes radioactive elements, asbestos like minerals, and metallic dust. Oftentimes, the bedrock contains sulfide, and when exposed to oxygen and water, produces acid drainage, which can leach into the waterways. The large water demands of an open-pit mine depletes freshwater supplies in the region, while wastewater from these processes can heavily pollute nearby water sources. According to the EPA, 40% of the watershed headwaters in the Western United States have been contaminated by mining operations (Bland 2014.)

The desired product is extracted from the ore using mechanical and chemical processes, and the waste produced is known as tailings. Tailings are discharged, normally as a slurry, to a final storage area known as a Tailings Storage Facility (TSF). TSFs are generally above ground although backfilling pits and tunnels is another less commonly used method for dealing with waste. The tailings stored on the surface are deposited behind unreinforced earthen dams, and generally referred to as tailings ponds (Figure 8 and 9). In some cases, liquid is removed from the tailings and it is dry stacked or stored as a paste behind the embankment, which holds back the runoff and bleed water. The more conventional method is to store a slurry of wet tailings, which requires a larger storage facility and taller embankment to hold back the mixture of tailings and water (Lyu et al. 2019).



FIGURE 7- Red Chris Mine tailings storage facility and earthen dam (Source: Juneau.empire)

One of the major concerns regarding the storage of wet tailings is acid mine drainage, which contains heavy metals and radionuclides that can leach into the water table and nearby waterways if not properly isolated (Figure 7). Once radionuclides make their way into an ecosystem, they accumulate in plants, and bioaccumulate up the food chain (“Environmental Risks of Mining”). To mitigate the amount of wastewater leaching into the water table from the TSF, an impervious liner can be placed on the bottom of the pond. This practice is not mandatory in BC and in the case of many mines such as Red Chris Mine, a liner is not used (Lyu et al. 2019).

Another concern of wet tailings storage is the failure of the earthen dam embankment. In this catastrophic scenario, the toxic waste breaches the embankment and floods into the nearest waterway, causing long lasting and potentially irreversible damage. There have been over 200 tailings dam failures worldwide since 1915, including the Mount Polley Mine Disaster in BC (“World Mine Tailings Failures—from 1915 – Supporting Global Research in Tailings Failure Root Cause, Loss Prevention and Trend Analysis”). According to a United Nations Environment Programme (UNEP) report, Canada has the second worst-mining record in the world, second in tailings dam failures to China, with seven in the last decade alone (Narwhal n.d.). The Mount Polley expert panel, created after the 2014 disaster, predicted that an estimated two additional tailings dam failures a decade could occur in BC alone if practices don’t change (Clifton 2016).

Following mine closure, the tailings storage facilities can continue to leach pollutants into nearby waterways for upwards of 5,000 years if not continuously monitored and treated. If intensive remediation does not occur to improve the soil and restore the landscape, the land will sit barren. According to the EPA, there are 500,000 defunct metal mines in 32 western states that the EPA has plans to clean up, and remediation of these sites may cost more than \$35 billion (Bland 2014). In 2006, Canada had over 10,000 abandoned mines, and in BC alone, the predicted cost of cleanup is over \$2.8 billion dollars. If the mining company declares bankruptcy in BC, it is up to the taxpayers to deal with the cost of cleaning the contaminated sites. This policy relieves mining companies of responsibilities to follow through with their clean-up plans (Narwhal 2020).

HOW BIG IS A TAILINGS DAM?

A size comparison

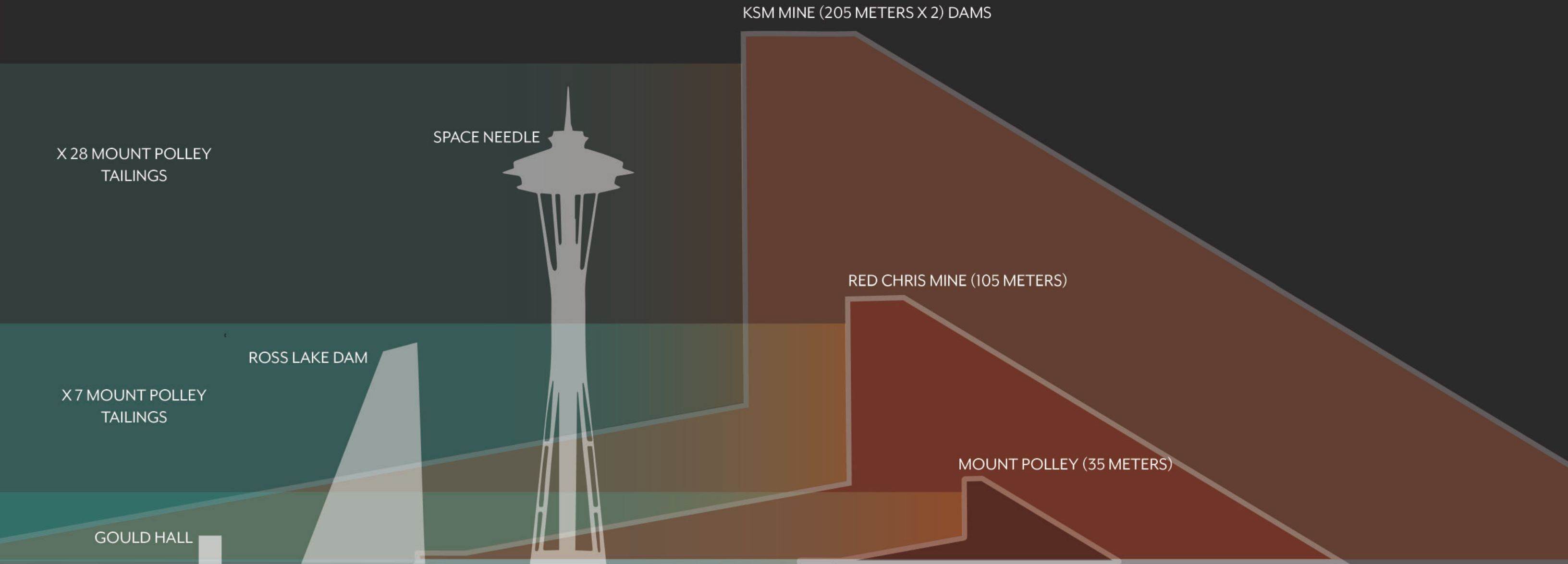


FIGURE 8

ENVIRONMENTAL IMPACT ASSESSMENT BREAKDOWN

How it works, where it falls short

As previously stated, the EIA process is intended to ensure that large-scale industrial projects do not have adverse environmental and social impacts. Before any mining takes place in BC, an evaluation must first be completed to determine whether the project is large enough to require an environmental assessment. A series of public consultations, baseline data collection and identification of valued components in the region is used to scope the potential environmental, social, cultural, and economic impacts associated with a project. The assessment is reviewed by decision-makers who try to make an informed decision on whether the benefits of the project are worth the anticipated impacts, and whether mitigation and compensation measures are necessary. This process is run by the Environmental Assessment Office (the EAO) and is required by the Environmental Assessment Act (Murray et al. 2018).

Figure 9 shows a breakdown of the BC Impact Assessment process as of 2002 and a critique of the failures of the EIA based on the interviews with stakeholders, and stories and timelines of the Tulsequah Chief, Mount Polley, Red Chris and KSM mines.



FIGURE 9

PRE-APPLICATION

A narrow scope of impacts

During the pre-application stage the project is defined, and the potential interests, issues and impacts are laid out (Figure 10). A Technical Advisory Committee (TAC) and a Community Advisory Committee (CAC) are established during this time if deemed necessary, and a Process Order is prepared by the EAO defining the scope of the project and assessment.

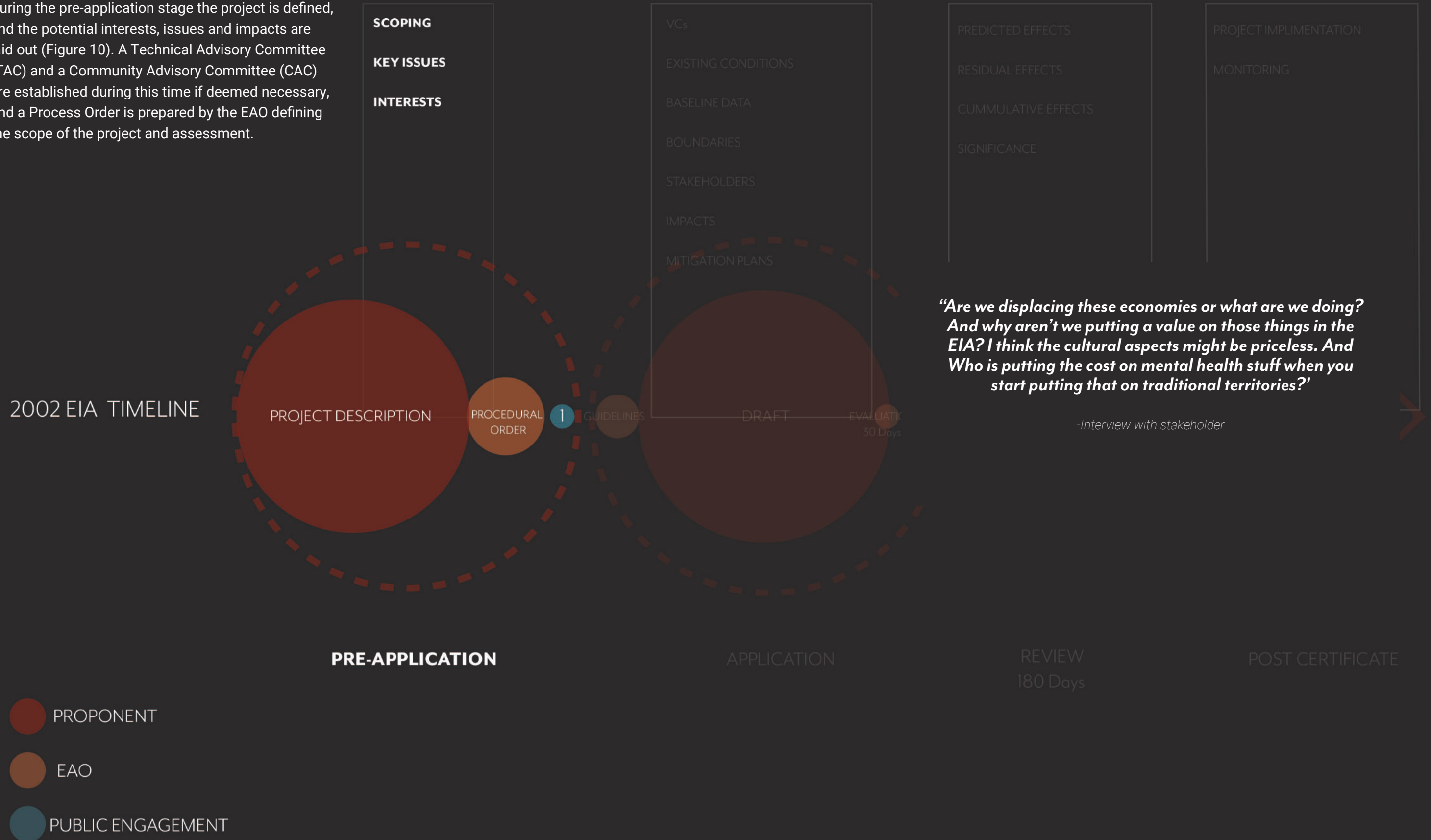
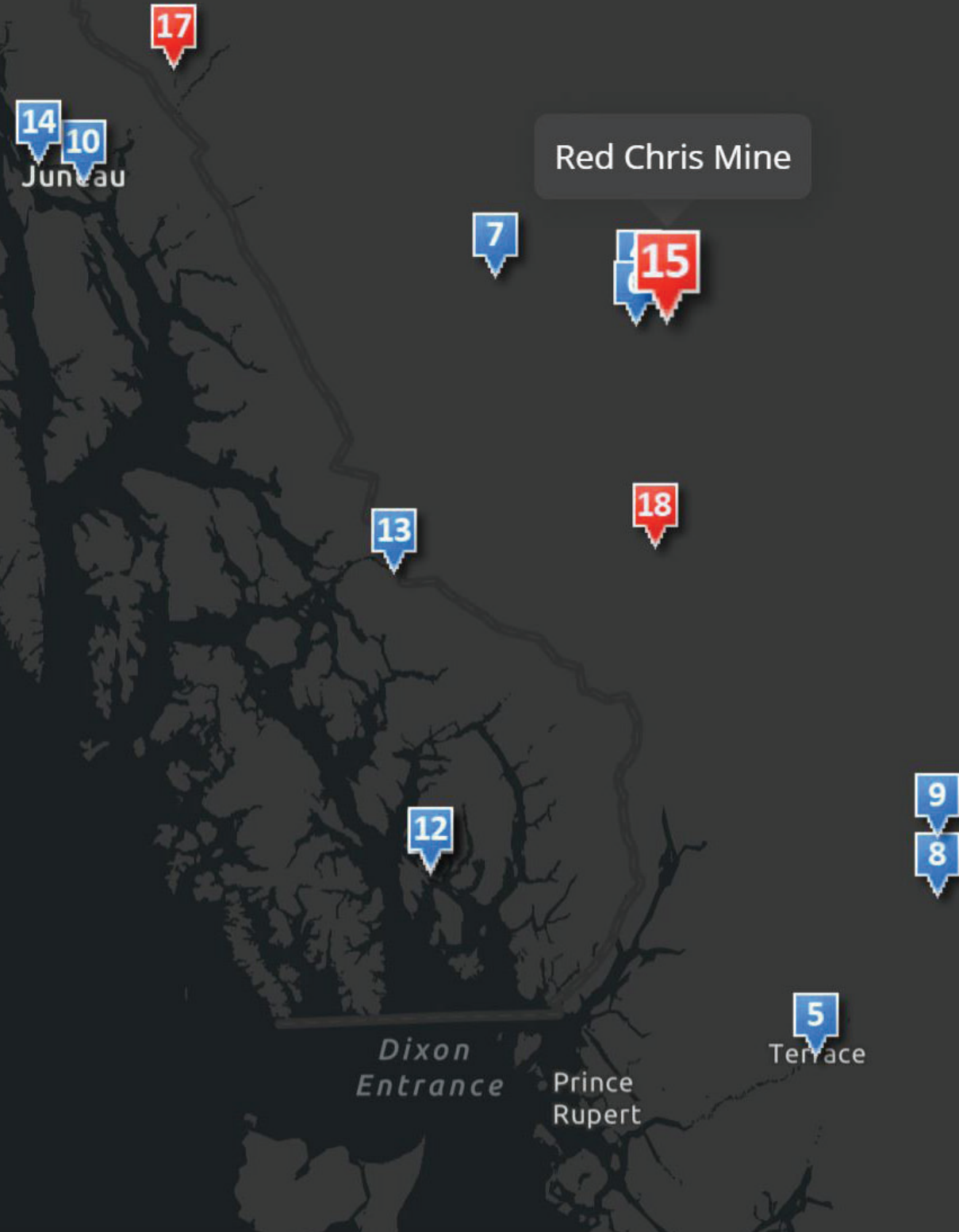


FIGURE 10

The impacts that are scoped at this stage in the process are too narrow- the physical boundary of impact and the types of impacts addressed. Impacts that are difficult to quantify are often not included in the assessment process. As Murray (2018) explains, social and cultural impacts are the most difficult to understand and measure. Due to a lack of research, subsistence harvest impacts are difficult to include in the EIA. Subsistence living is significant in Alaska and Northern BC and its prevalence must be understood before it is possible to quantify the associated risks (Natcher 2009). Community health and well-being, loss of cultural tradition and heritage sites are other impacts that are difficult to measure and therefore, aren't adequately addressed in the assessment.

The area of study to assess impacts in an EIA in BC is small and does not include potential effects on the larger region, such as a watershed. There is currently no independent, comprehensive evaluation of downstream impacts on the trans-boundary waterways of Northern BC and SE Alaska. In the case of Red Chris mine, potential impacts to salmon were not even included in the assessment. The potential impacts to communities, waterways, industries, economies and cultures outside of areas of studies are not addressed.

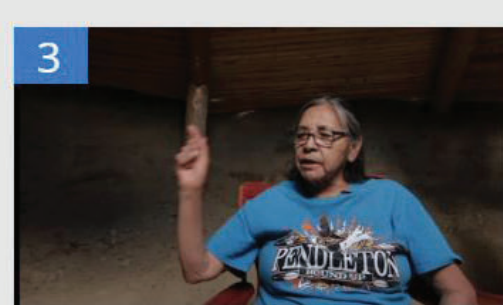
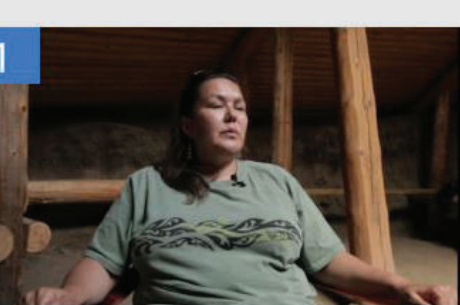


Stakeholders I interviewed in SE Alaska included commercial fishermen, the fleet manager of Trident Seafoods, owner of a business based on outdoor recreation, a member of the SE Alaska conservation council and the coordinator of Salmon Beyond Borders, an organization working to preserve the health of the trans-boundary waterways. Every stakeholder from this region expressed concern that the rivers in SE Alaska could or have already been impacted by upriver mining. As one interviewee explained

“Our economies, ways of life and cultural traditions completely rely on the health of these rivers.”

Alaskans are generally not consulted if a mine is proposed in Northern BC and they currently have no enforceable policies in place to protect them against impacts from mining on the rivers that flow into the state. If there is immense impact, or even disaster, Alaskans have no recourse (Patric et al. 2013).

This story map (Figure 11) locates every stakeholder interviewed on a map (blue) in relation to the Tulsequah Chief, Red Chris and the proposed site for the KSM mine (red). This map demonstrates the boundary of impact that these mines can have and highlights the importance of assessing a larger region of impact in the EIA process that includes the entire watershed. On top of a wider physical region of impacts addressed, the EIA should incorporate more types of impacts. In order to understand the qualitative impacts such as impacts to mental health and loss of cultural tradition, qualitative data needs to be incorporated in the assessment.

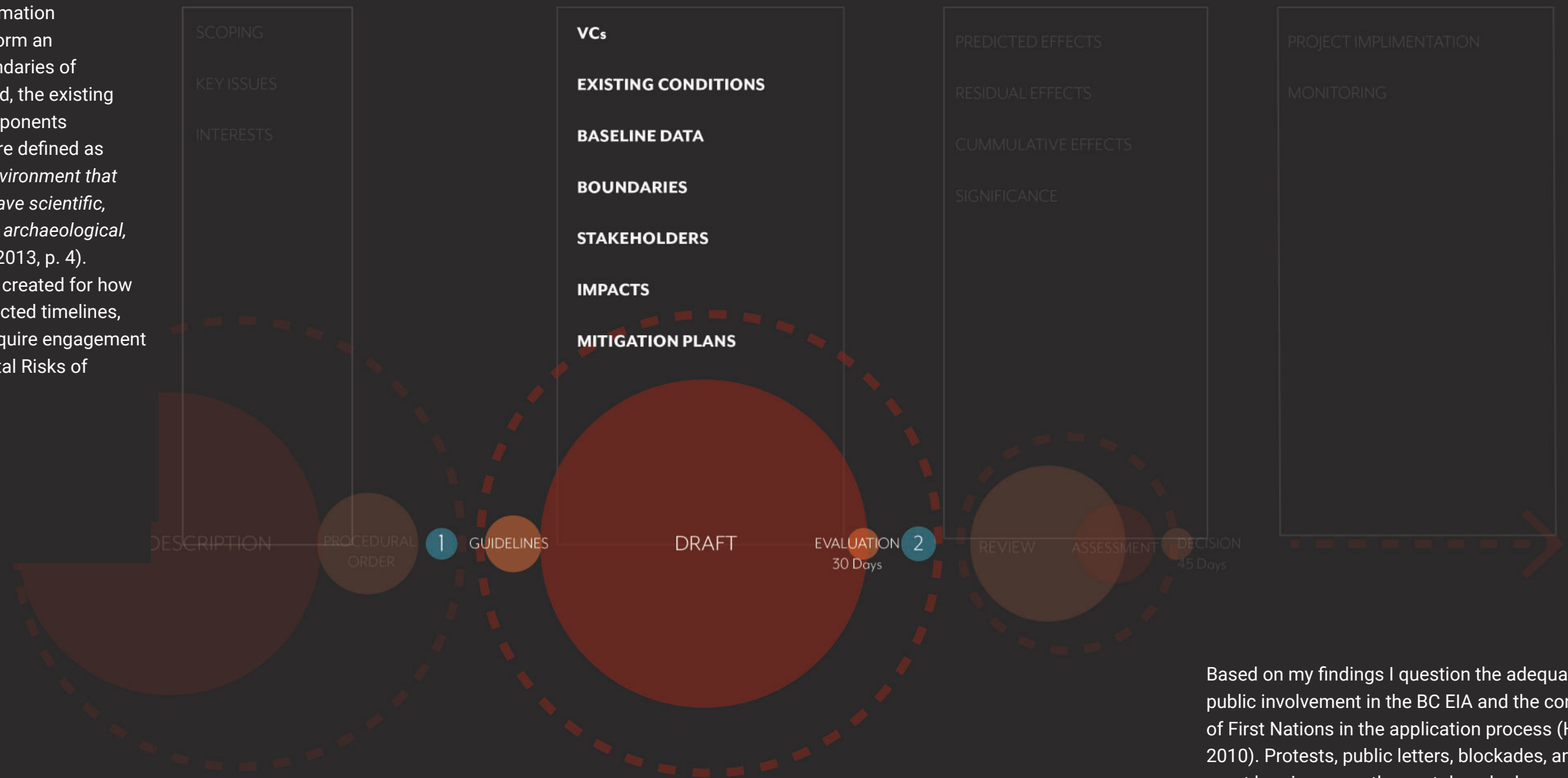


Southwest Alaska is downstream from over twelve

FIGURE 11

Inadequate public engagement

During the application process, information is gathered by the proponent to perform an environmental assessment; the boundaries of impacts and stakeholders are defined, the existing conditions recorded and valued components (VCs) determined (Figure 12). VCs are defined as 'aspects of the natural and human environment that are considered by the proponent to have scientific, ecological, economic, social, cultural, archaeological, historical or other importance' (Caul 2013, p. 4). During this phase, a concrete plan is created for how the assessment will take place, expected timelines, and which chapters in the EIA will require engagement with the TAC and CAC ("Environmental Risks of Mining").



- PROPONENT
- EAO
- PUBLIC ENGAGEMENT

Based on my findings I question the adequacy of public involvement in the BC EIA and the consultation of First Nations in the application process (Haddock 2010). Protests, public letters, blockades, and even court hearings over the past decade demonstrate that the EIA process in BC to evaluate open-pit mining is not working for the public (Berman 2014; News 2017).

For many projects, non-government organizations representing river conservation groups, outdoor recreation, fisheries, or salmon enhancement, among others, have raised concerns, but are told by the mining company that they fall outside of the scope of the project being reviewed, or in other words that they are not relevant (Haddock 2010).

In an evaluation of the public participation process in BC, researchers found that the public had low satisfaction rates with the engagement process. Common themes included a lack of trust for the proponent and government, lack of transparency, a feeling that public opinion wasn't valued, and a critique that the public was consulted too late in the process (Booth and Halseth 2011).

Although the impacts on indigenous people are significant, their participation in mine development has historically been minimal. The ability of First Nations to participate can be impacted by a multitude of variables including lack of community resources, language barriers, complex terminology, the time and location of public review periods, and a narrow scoping of impacts (Baker and McLelland 2002).

Insignificant public consultation can be seen throughout the process of the assessment and permitting of Imperial Metal owned Red Chris mine. On April 11th, 2004, the impact assessment process had to be extended by the EAO due to unaddressed concerns from the Tahltan Central Council (TCC). By March 16, 2005, Red Chris filed a report demonstrating how they would address First Nation concerns, however the TCC immediately responded with a letter claiming that their concerns were still not adequately understood or addressed. ("ENVIRONMENTAL ASSESSMENT OFFICE RED CHRIS PORPHYRY COPPER- GOLD PROJECT ASSESSMENT REPORT" 2005)

Tahltan First Nation stakeholders living near Red Chris Mine that were interviewed expressed that in the EIA, the duly elected officials were consulted and no one else, and the officials elected to participate don't necessarily represent the concerns of the entire band. The lack of consent from Tahltan First Nation people who would be most impacted by the implementation of Red Chris Mine, led to protests and a blockade of the road that lasted over a month.

Along with an overall lack of consent, another major limitation in the involvement of indigenous people in mine development is the undervaluing of indigenous knowledge (IK) by the Canadian Environmental Assessment Act (CEAA), which is demonstrated by the impact assessment framework missing the incorporation of IK (Paci, Tobin, and Robb 2002). IK spans thousands of years, and baseline site data and information could be expanded through the incorporation of this knowledge. Information about the ecology and how it has changed over time, indigenous relationships with the landscape, and a deep understanding of systemic interactions in the environment are elements of IK that could be useful in an EIA. Collaboration and knowledge sharing between stakeholders could also be mutually beneficial; if correctly done the recording of indigenous knowledge has the potential to benefit First Nations by providing other means to share knowledge (News 2017).

Other evidence of inadequate public engagement can be seen in the permitting of the KSM mine, which will be located just upriver from Misty Fjords National monument and the fishing town of Ketchikan, AK. The SE Alaska Conservation Council protested plans for the KSM mine by trying to convince Canadian authorities that project owners didn't fully follow guidelines requiring stakeholder engagement and environmental protections. The agency rejected that appeal on the basis that there is no formal requirement for them to engage with Alaska (News 2017).

Out of the fourteen stakeholders that had been interviewed, eleven expressed that there had been a lack of consent or inadequate public engagement in the permitting of mines in their region. This process needs to engage a wider range of stakeholders and incorporate public opinion and ideas from the very beginning. Baseline data and current conditions should incorporate local and indigenous knowledge. Stakeholder groups should be given resources to participate in the process at a higher level.

"You would expect something more from your own government"

-Interview with Likely local referring to the permitting of Mount Polley Mine to discharge directly into the lake without consent from First Nations and other locals

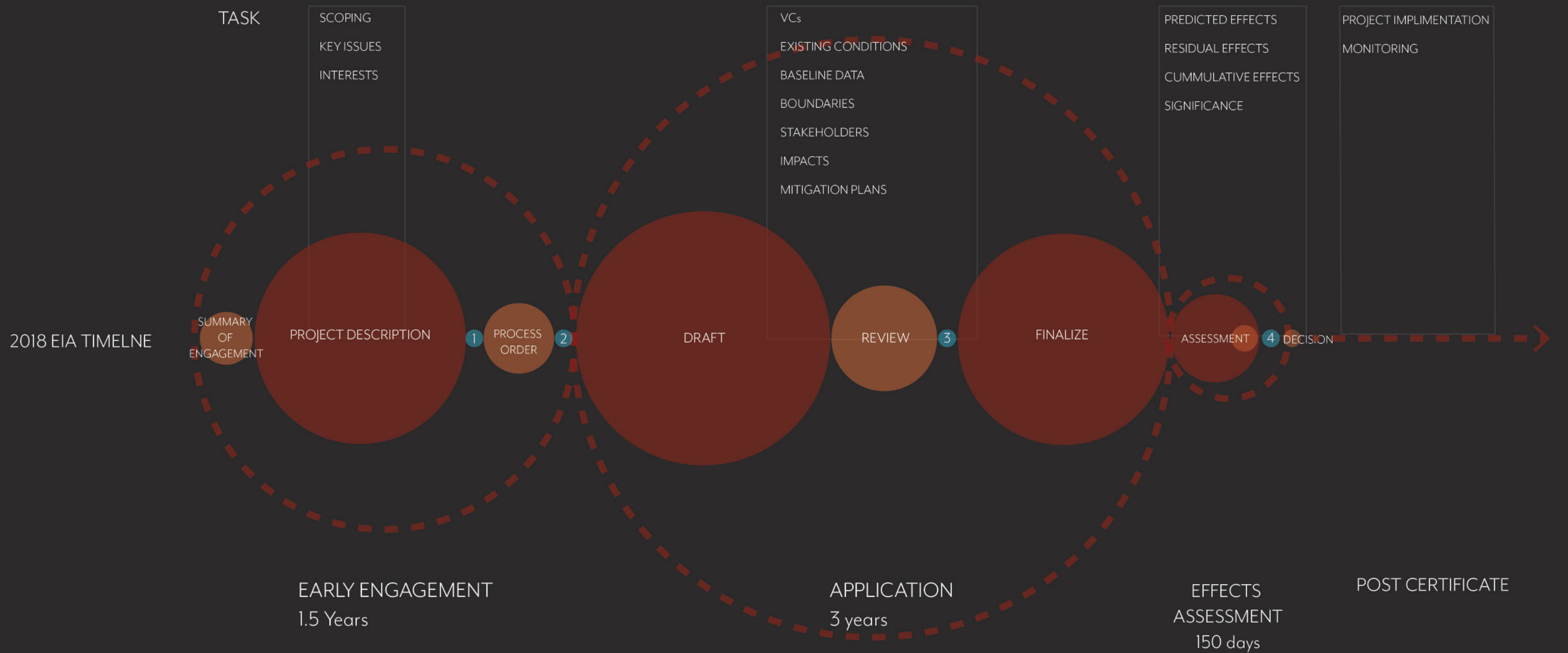
"They signed agreements with duly elected official without consulting us"

-Interview with Tahltan stakeholder discussing Imperial Metals

"Is it adequate consultation, no. And they are certainly not even held accountable or have to listen to anything we say whether or not they are consulting with us."

-Interview with stakeholder in SE Alaska

FIGURE 13



The 2018 EIA Act takes a positive step in addressing the disapprovals of the public consultation process and Indigenous involvement and consent by adding two additional public comment periods and more time allocated to consulting with First Nations (Figure 13). However, it continues to be greatly criticized. The bill requires the EAO to seek 'consensus' with Indigenous nations, however, the First Nations Leadership Council points out that 'the Act does not go far enough in meaningfully implementing the minimum standards affirmed within the UN Declaration, as the Act still allows for projects to proceed if consent is withheld by Indigenous Nations' ("BC's Proposed New Environmental Assessment Act: Some Things Have Really Changed...others, Not so Much" 2018).

THE ASSESSMENT REPORT

Insufficient mitigation measures

After the application is accepted, the assessment report begins (Figure 14). Generally, a VC framework is used in the impact assessment. In this methodology, a VC is selected, boundaries of impact are established, and baseline conditions are described and analyzed. Then, an impact prediction takes place to forecast the likely changes in the environment that will occur because of development. Potential mitigation and enhancement measures are determined in response to the predicted effects. Residual effects, or those that would remain after mitigation measures, and cumulative effects, or the negative impacts that will compound over time, are assessed for significance. The assessment report contains an evaluation of impacts, responses to public concerns, and the development of a follow-up strategy to monitor impacts and the successes or failures of mitigation techniques. It can be concluded that without a comprehensive understanding of the range of impacts, it is not likely that the mitigation measures required by the Environmental Assessment Certificate will adequately address all potential impacts (Environment 2018).

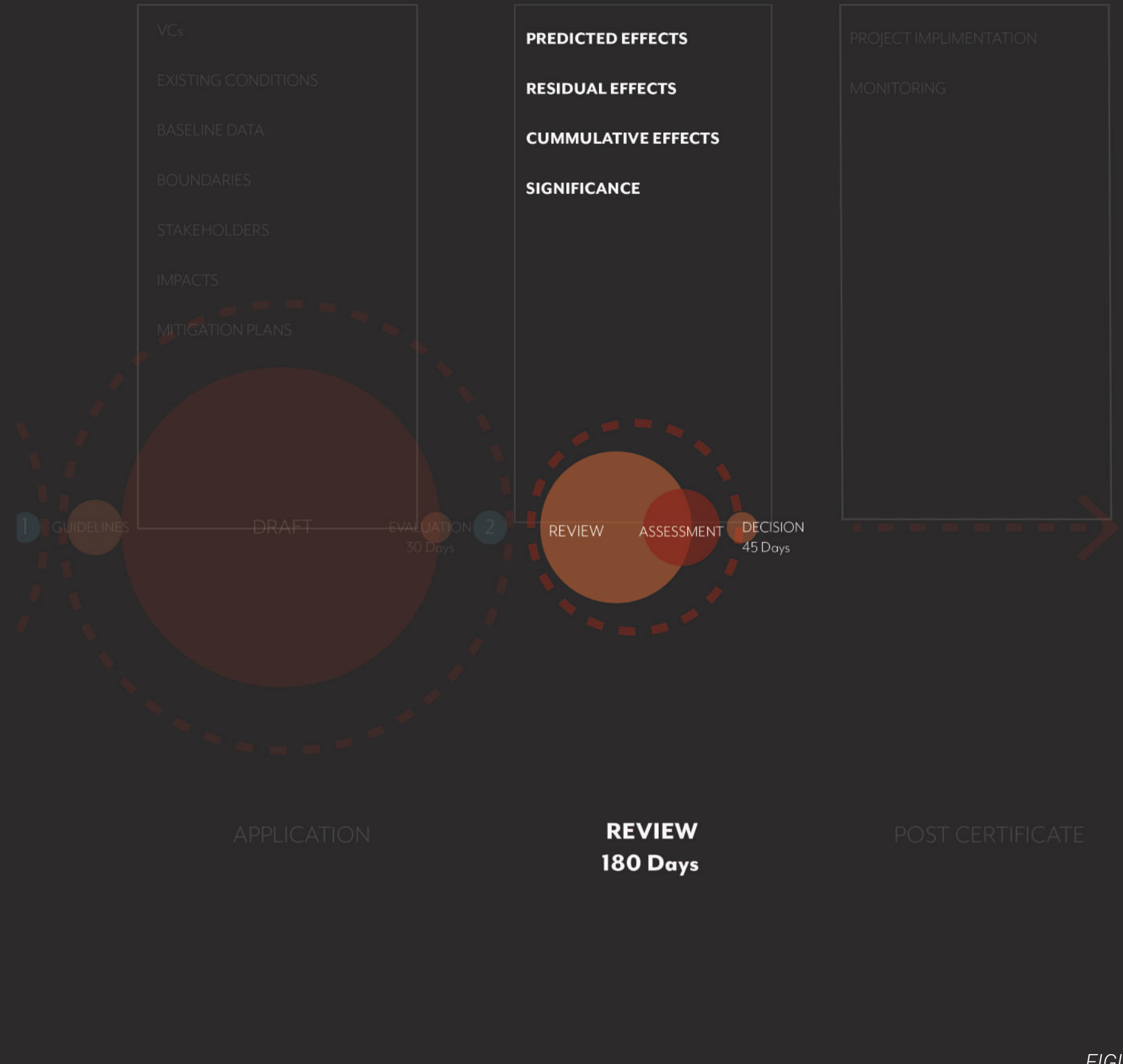


FIGURE 14

This portion of the EIA does not provide a set of actions to adequately mitigate impacts. An open letter was written to Premier Horgan by academics and science professionals highlighting where the BC EIA needed improvement. The letter brought up that there is a lack of scientific, independent, and peer reviewed evidence used to determine impacts in the EIA. In this process, the proponent, who has vested interest in project approval, is responsible for overseeing, collecting, and presenting most of the evidence that is used in the EIA. The fact that most of the evidence is analyzed internally may lead to biased data collection or interpretation and distrust from the public. Evidence for environmental risk is evaluated by a TAC, whose composition would in large part include provincial staff that need not be experts on the proposed work. There are currently no requirements for an independent peer-review of the evidence about environmental risk. Evaluation from experts in relevant fields that are not associated with the government or the proponent is a standard scientific best practice that doesn't exist in the EIA process (Docherty 2010).

One of the most varied and complex aspects of the EIA process in Canada is determining whether impacts are 'significant', in other words, if the impacts will outweigh the benefits of the project (Murray et al. 2018). Thresholds, or the determined level that must be reached for there to be an impact, are inaccurate or not available for every impact considered, especially for social and cultural impacts. Out of all the VCs, generally less than 10% of them are evaluated using thresholds, meaning the process of determining whether a mine will have 'significant' adverse effects is largely subjective (Murray et al. 2018).

Imperial Metal's Red Chris Mine demonstrates that as a result, the mitigation measures and monitoring plans are less than effective. Tahltan Elders interviewed explained that four cultural heritage sites, some of the hunting camps that Tahltan people used for many generations, were destroyed during the building of the mine. The location of the mine is on what once was Tahltan moose hunting territory as well as prime moose calving habitat. A man who lives near Red Chris said that trees in an old growth forest were mapped out during the EIA to be preserved, and then later they were all cut down. Many species of animals were not even considered in the Red Chris assessment report, including impacts to salmon.

Black Lake, a trout habitat traditionally used for fishing by Tahltan First Nations, was made into the tailings storage facility at Red Chris Mine. The tailings pond does not have a liner to mitigate the amount of acid mine drainage, heavy metals and other toxins going into the water table. Within a year, selenium levels had doubled in fish samples taken from nearby Ealue Lake, raising concerns about impacts to aquatic life. Although these levels were said to not be high enough to impact human health, Iskut Band Councilor suggested the locals cease to eat fish from the lake ("Selenium Levels in Fish Raise Concerns about Pollution from Red Chris Mine" 2016).

More advanced techniques and technology for mitigating the impacts of mining does exist. It should be required that mines line the tailings waste facilities, and that dry tailings storage is used rather than wet storage. Many of the stakeholders interviewed expressed that the most important way to mitigate the impacts of mining is to mine in more responsible locations. Fragile ecosystems, culturally significant sights and valuable watersheds should all be made off limits. Stakeholders also made suggestions for how locals should be compensated for impacts including with offering locals higher level jobs. The stakeholders should be included in the process of determining mitigation practices and compensation.

"It doesn't look good to me. I mean when you put a tailings pond in there and don't line it with anything...all of that arsenic.. heavy metals... eventually it goes into the water system, it has to, where is it going to go."

-Interview with stakeholder discussing Red Chris Mine tailings management

"They did what they call a long term management plan, in BC speak that is four years, that's their 'long term' plan of dealing with waste"

-Interview with stakeholder discussing Mount Polley

IMPLEMENTATION

No accountability

During the final stage of the EIA, the EAO and Provincial decision makers provide recommendations, which are incorporated into the project. Finally, ministers from the Provincial government determine whether the proponent receives a certificate to implement the project. The Environmental Assessment Certificate identifies project activities and facilities and dictates how the project must be carried out. It also states how mitigation measures will be implemented to offset a project's impacts (Environment 2018). The project is implemented with the predetermined mitigation and monitoring plans incorporated after the post certification period.

On top of a potentially insufficient mitigation and monitoring plan, research and interviews with stakeholders demonstrates a common theme of public distrust that the mining company will follow-through with all mitigation plans and or be held accountable to clean-up after themselves. As it is now, the mining companies are essentially self-monitored and follow-up programs are inadequate or not implemented at all.

A follow-up is defined as a program for verifying the accuracy of impact predictions and determining the effectiveness of the mitigation measures that were identified in the EIA to manage potentially negative environmental impacts. In BC, follow-up programs are not required and are only implemented when warranted. When a follow-up program is implemented, the lessons learned are often not documented (Macharia 2005).

In addition to inadequate follow-up to monitor mitigation efforts, the system of 'professional reliance,' which was implemented as a regulatory tool in BC in the early 2000's, allows the proponent, or mining company, to enforce their own environmental regulations (Narwhal 2018).

When the system was developed, former premier Gordon Campbell assured the public that shifting to have professionals in the private sector oversee the environmental standards rather than government agencies would not diminish environmental standards. The professional accountability of industries would be maintained through the enforcement of codes of ethics and the disciplinary processes of professional associations, rather than the approval of plans, permits and license by government agencies (Narwhal 2018).

Researcher and writer for the Boundary Environmental Alliance expressed that professional reliance, used to '*off-load Government's oversight of public resources, has resulted in a handover of resources to proponents and those developing or exploiting resources, effectively enabling industry to dictate conditions affecting public resources*' ("Professional-Reliance-and-Environmental-Regulation-in-BC_2"). The privatization of monitoring can translate to a withholding of information and presenting biased information to the public, distrust, and a lack of accountability that the ecosystems will be protected to a high standard.

This lack of accountability that a mining company is held to, thanks to the systems of self-monitoring and insufficient follow-up programs, can be seen through the disaster at the Mount Polley Mine. In 2014 the tailings dam failed, releasing 26 billion liters, the equivalent of 12,000 olympic size swimming pools, worth of toxic slurry containing arsenic, mercury, and copper into Lake Quesnel, previously one of the most pristine deep-water lakes and one of the largest salmon spawning lakes in BC (Byrne et al. 2018). The lake provided drinking water to the town of Likely and was a crucial salmon and trout spawning ground. It feeds into the Fraser River, which flows through Vancouver and hosts all five species of salmon, supporting commercial and traditional subsistence fisheries in Washington, BC, and Alaska.

The failure occurred due to several large errors The first is an insufficient geo-technical survey that did not detect a large, slippery clay layer under the dam, the second is that the mine administrators allowed the dam to fill with water rather than only tailings, and lastly, the dam was built with a much steeper slope than the 3:1 slope in the original design. The combination of these three large oversights led to the largest environmental disaster in Canadian history whose impacts will be felt for generations (Clifton 2016).

Imperial Metal's response demonstrated a lack of understanding or consideration of the felt impacts of this disaster. Local Secwepemc women explained that after they had expressed their anger and sadness about losing a food source and way of life associated with their subsistence fishing legacy, Imperial Metals sent the community a box of canned salmon as compensation; the equivalent of three 6 oz tins to each person for the entire year. This inadequate form of compensation was interpreted as more than insulting.

Local communities lost a critical drinking water source, a local old growth forest grove, and fly-fishing businesses, and have inherited contaminated resources to pass on to future generations. According to an interview with a local from Likely, BC, the only attempt to compensate for this loss came in the form of plastic water bottles delivered to the community for one month. A local Secwepemc woman expressed that these calloused attempts at compensating for the impact of the disaster highlight not just the lack of accountability the mine is held to, but an absence of understanding or willingness to understand what was really lost (In-person interview, 2017).

“Their callous arrogance and lack of understanding of what that salmon really means to us was really staggering.”

- interview with Secwepemc stakeholder, 2017

Mount Polley Mine was up and running within two years with no fines or consequences and no plans

to clean-up the tailings waste. Two years later, Mount Polley applied for a permit to discharge their wastewater directly into lake Quesnel. This was something that would never have been considered before the disaster, but the decrease in water quality of the lake made that a possibility for the mine. According to interviews with locals from Likely, BC, two hundred letters were written from the local community groups in protest of the further pollution of the lake, however the permit was approved without a hitch and Imperial Metals can now able to pipe the wastewater from Mount Polley directly into the lake, in essence benefiting off of the disaster (In-person interview, 2017).

The Mount Polley expert panel was created by the BC government to investigate the Mount Polley tailings dam failure and offer recommendations for future mines. The panel predicted that if mine waste disposal practices continue as usual; 2 tailings dam catastrophes could occur every decade in BC. A series of recommendations was issued, the most significant one being that policy shift to require dry tailing storage rather than wet tailings storage. Although BC Mines Minister Bill Bennett pledged that he would implement all recommendations, this core recommendation to switch to dry tailings has yet to be implemented into a single mine (Clifton 2016).

Red Chris Mine was officially permitted to begin operation in 2014, shortly after the Mount Polley mine disaster. Despite recommendations from the Tailings Dam Advisory Council, Red Chris proposed the same TSF technology as Mount Polley but at a larger scale. A group of Tahltan elders, known as the Klabona Keepers, blockaded the entrance to the mine, camping out for more than a month and taking over two mining drills in attempts to prevent impacts to their communities, the Sacred Headwaters of the Stikine, Nass and Skeena rivers and their traditional hunting and fishing grounds. The concern being not only that the Red Chris Mine is too similar to its sister mine Mount Polley, but that the disaster at Mount Polley demonstrated a lack of accountability enforced for the mines to clean up after themselves or effectively mitigate their impacts (Writer 2015).

The KSM mine was permitted around the same time with plans to use the same storage facilities that failed at Mount Polley but at a much larger scale. Stakeholders interviewed in Ketchikan, downriver from the proposed mine, expressed a deep concern that if the earthen dam failed, the entire fishing industry would be put in peril.

Another way that mining companies are not adequately held accountable is through the clean-up plans and requirements. Not only are the plans made for clean-up arguably inadequate, in British Columbia it is common for a mine to declare bankruptcy and abandon their operations when they are no longer making a lot of profit. Tulsequah Chief Mine is one of 2,000 abandoned mines in British Columbia. The mine has been leaching acid mine drainage into the Taku River watershed AK, since it was abandoned 63 years ago (Environment 2018).

Interviews with stakeholders from Juneau, Alaska who live not far downriver from the abandoned site demonstrate a concern that there are still no plans for clean-up of the mine, even after decades of protests from locals, fishermen, Indigenous groups and conservation groups. According to an interview with a Juneau local, in 2015 Minister of Energy and Mines in BC, Bill Bennett flew over the abandoned Tulsequah Chief mine site with the Alaska lieutenant governor. In a public hearing in Juneau Bill Bennett admitted that he understood Alaskans distrust of BC mining companies and that he was surprised to realize just how close to Juneau the abandoned mine was and embarrassed at the lack of cleanup and consideration (in-person interview 2017).

All of the stakeholders I interviewed at Red Chris Mine expressed concern that Imperial Metals would not adequately clean-up after the mining operation closed, if at all. At Mount Polley Mine, one interviewee explained how after the disaster, although on one hand many people protested the re-opening of Mount Polley mines, the communities were in a sense held

ransom because they were concerned that Imperial Metals would choose to declare bankruptcy and abandoned the site, rather than cleaning anything up (In-person interview, 2013). Imperial Metals did not use their expertise or equipment to remove tailings from the lake and have no plans to do so.

The entire process, from the beginning of the EIA to the operation of the mine, requires greater government oversight. Strict regulations on the type of waste storage facilities, the location of mines, water quality treatment plans, should be more heavily enforced and not monitored internally. Compensation plans should be fully flushed out with local communities during the application process. Mining companies should be required to incorporate lessons learned from past incidents in the EIA and it should be required that mining companies incorporate recommendations from the Professional Tailings Advisory Council. Bankruptcy should not be an easy answer and the clean-up plans developed by the mining companies should be more extensive and given a longer timeline.

Boundary Environmental Alliance recommends that professional reliance should be eliminated as a regulatory tool and that 'each and every corporation, company, commercial entity, individual, and/ or association that is engaged in the use of or exploitation of public 'resources' (land, water, forests, wildlife, fish, and birds) must be subject to scrutiny and regulatory oversight by an open, accountable, structured, disciplined and supervised Public Service Ministry.' ("Professional-Reliance-and-Environmental-Regulation-in-BC") A mandatory, long lasting follow-up should include baseline data repeatedly collected before and after implementation, the incorporation of local knowledge into evaluations, the continuous monitoring of socio-economic elements, and firmer requirements regarding public involvement.

“Bankruptcy within mining companies is happening all over the place in BC.”

-Interview with stakeholder from SE Alaska

“They’ll just walk away from it, they won’t replant it or re-seed it or bring it back to natural.”

-Interview with stakeholder discussing Red Chris

“They say that it would do more harm to remove them. If that was gold at the bottom of the lake, they would find an environmentally sensitive way to remove every last drop.”

-Interview with Secwepmec stakeholder discussing the clean-up of Mount Polley Mine disaster

ENTIRE PROCESS

Lack of transparency

The lack of accountability that mining companies are held to is reinforced by the lack of transparency that can be seen throughout the entire process. An open letter written to Premier Horgan by over 180 academics and science professionals highlighted several deficiencies of the BC EIA Act including the fact that the BC EIA process does not require that all data generated by the proponent, or the evaluation of evidence by the Advisory Committee, be made available to the public. (Docherty 2010)

In 2008 Mine Watch Canada took Red Chris Mine to court on the basis that the proposed Red Chris mine in northwestern BC was improperly approved. Red Chris mine had done what many large mining companies continue to do, and had subdivided the project into smaller projects. Essentially, the portion of the project undergoing the environmental assessment becomes easier to permit and the other pieces will be implemented later in small portions that don't trigger the need for a review under the CEAA. Although the Supreme Court of Canada ruled the proposed Red Chris mine was in fact abusing the impact assessment process with this method, the victory did not amount to any significant changes. The proposed mine was allowed to go ahead with no further environmental review after the court determined that Red Chris presented a significant threat to the environment. ("Court Ruling on Red Chris Mine Highlights Duplication in Environmental Assessment" 2010)

Many stakeholders in the trans-boundary watershed and near Mount Polley expressed a lack of transparency from the mining companies. A local resident of Likely, a town near the Mount Polley Mine described how Imperial Metals often leaked out small bits of information at a time to avoid presenting the bigger picture.

Interviews with stakeholders living near Red Chris and Mount Polley mines expressed difficulty accessing information around environmental monitoring and results. Community members around Red Chris were not certain what the post closure remediation plans looked like, how heavy metal dust was being dealt with or which animals were being monitored. At Mount Polley mine, stakeholders expressed that they did not know how to find information on where and how water samples were being taken and whether any studies were done on the impacts on the local animals that drink the water and eat the fish out of lake Quesnel (In-person interviews, 2017).

In many cases, this lack of transparency around activities happening at the mine and monitoring results translated to a lack of trust of the mining companies. Several community members expressed not only that they distrusted that the mine was taking enough measures to decrease environmental impact, but that they had no reason to believe that the data they did share was not biased. The previous mining coordinator for SE Alaska stated that he had discovered many instances of mines fudging their data, misrepresenting results, and taking deep-water samples in shallow locations.

The EIA process needs to have absolute transparency from the beginning. This includes making every plan and monitoring result public and sharing information in a way that is accessible and easy to understand. Resources should be provided to stakeholders to develop the best platforms and methods of sharing information and answering questions.

"I don't know who to believe about the monitoring of the level of toxins and metals in the fish. But if it is not good enough for us to eat what is it doing to the animals?"

-Interview with Secwepmec elder discussing Mount Polley

Mine disaster

"They put a gate up, no one goes up there and they do what they please."

-Interview with stakeholder talking about Imperial Metals

"They won't tell you everything at once, they kinda trickle stuff out, and a lot of us it for promotional purposes."

-Interview with stakeholder from Likely, BC

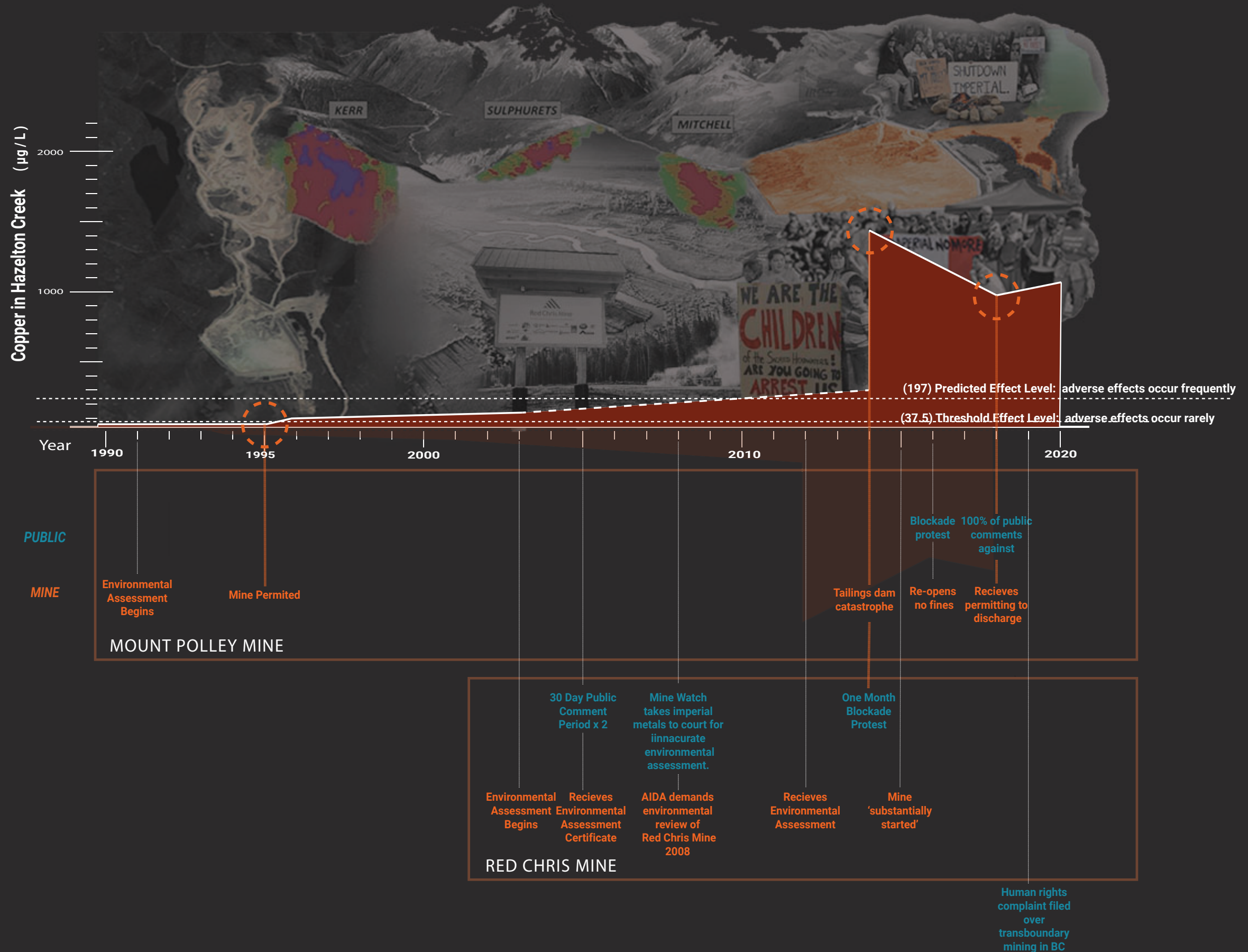
**IMPERIAL METALS TIMELINE:
Public engagement and copper concentration**

FIGURE 15

Hazelton Creek was flooded when the Mount Polley Mine dam breached in 2014. Figure 15 graphs copper concentration in Hazelton Creek based on water quality samples that were taken over time. A steady rise in copper concentration can be seen after the development of the mine, surpassing the predicted effect level in 2010 (the level of copper concentration where it is expected for adverse effects on the environment to occur frequently). The levels of copper in the water spiked after the tailings pond disaster. After Imperial Metals is permitted to discharge water directly into Lake Quesnel, the concentration of copper began to rise again (Byrne et al. 2018).

This timeline also demonstrates when and how the public tried to engage with the mining process and express concerns around these impacts. Due to the inadequacies in the public engagement process, the concerns were not addressed. Imperial Metals was taken to court for mis-representing their project in the EIA. Although they technically lost the hearing, they were able to continue without any changes. After the Mount Polley disaster, Tahltan leaders blockaded the development of Red Chris Mine, which opened with no changes, despite protests. Locals near Mount Polley Mine protested the application for a permit to allow the mine to discharge their waste water directly into Lake Quesnel. The permit was received shortly after.

The inadequacies in the EIA public engagement process, and the inability to incorporate public concerns into the mining process contribute to the inadequacies in mitigating environmental and social impacts.



ASSESSMENT OF FELT IMPACTS

The failures in the EIA in BC can be directly related to the impacts felt by the stakeholders in the region (Figure 16). I used story mapping to aggregate and geographically locate themes of impact that were extracted from the stakeholder interviews. The main themes I found throughout the interviews with stakeholders were an impact to way of life, economic impacts, impacts from inadequate compensation and community health related impacts.

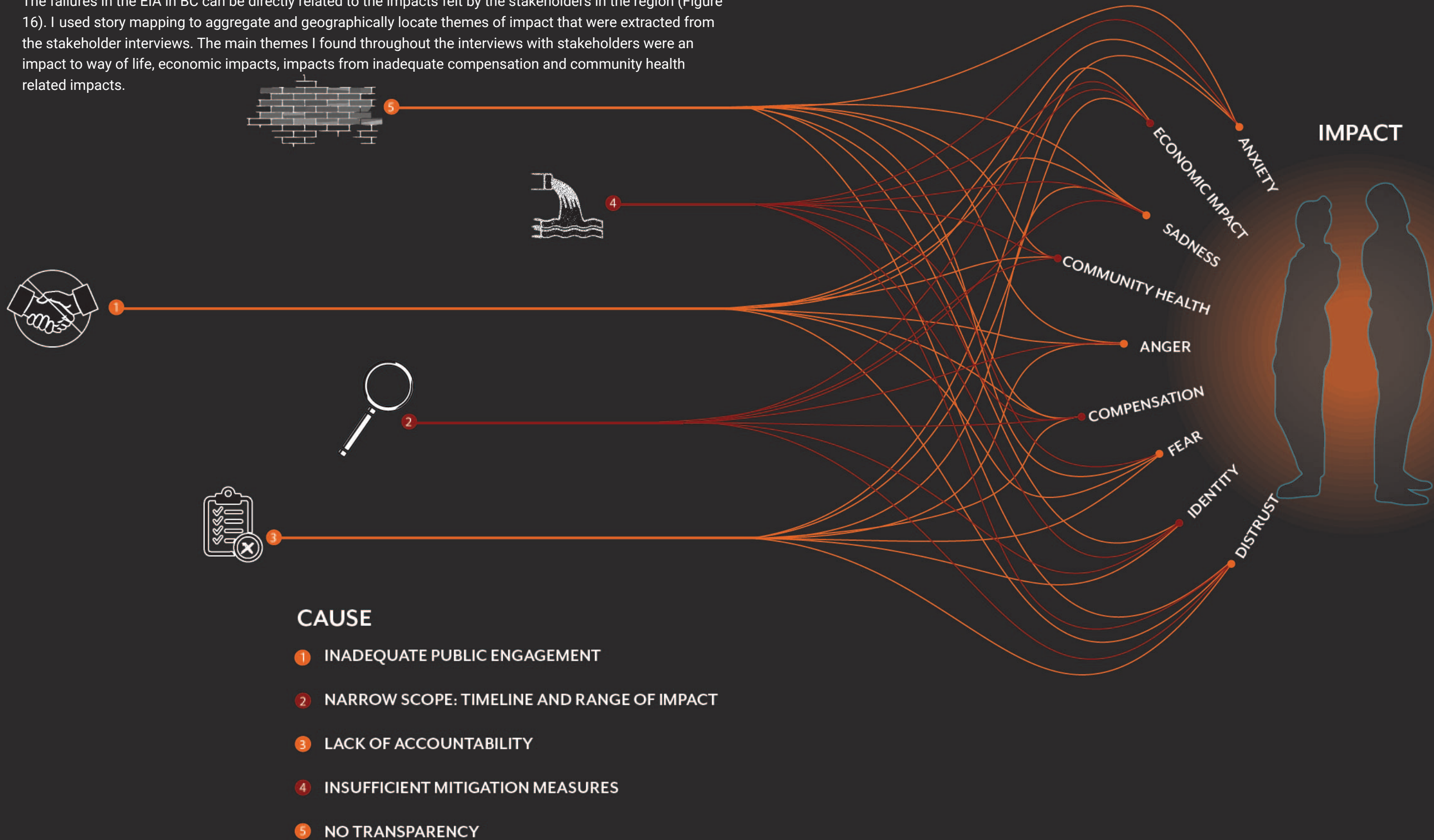
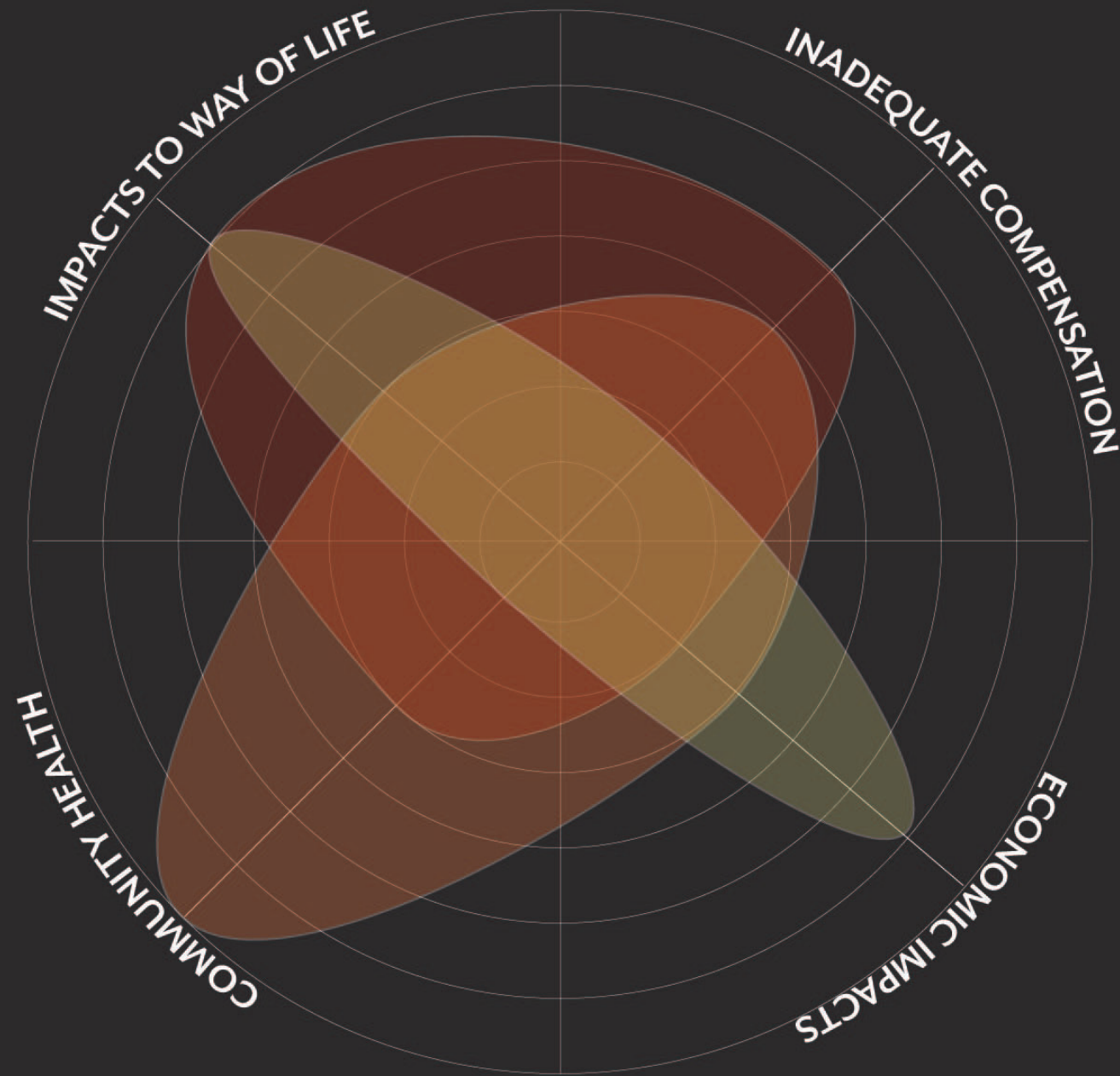
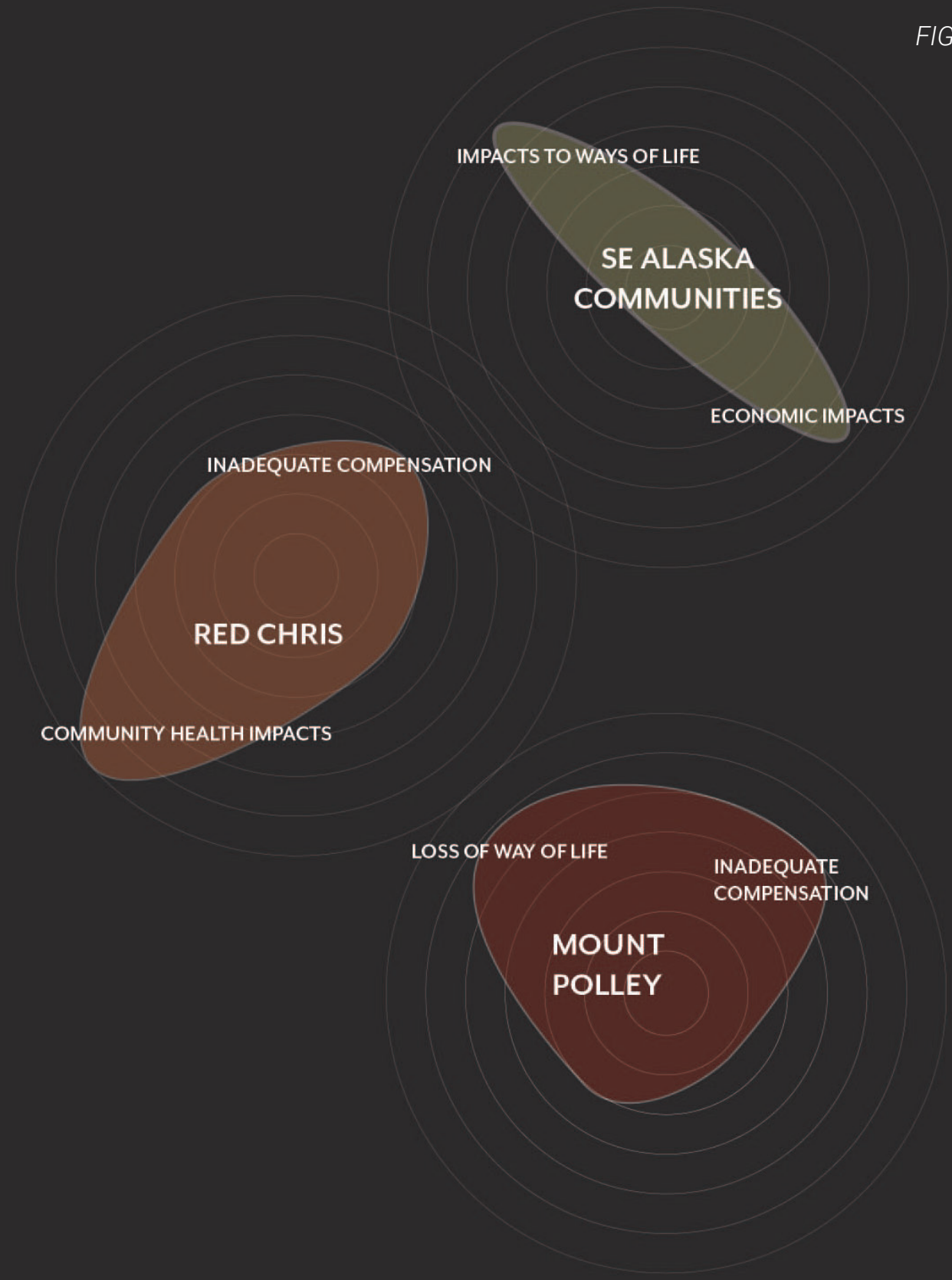


FIGURE 16



PROFILE OF IMPACT

EACH RING = 1 STORY



An impact profile was generated for Red Chris Mine, Mount Polley Mine and the communities in the trans-boundary watersheds downstream from multiple mines (Figure 17). The rings on the circle represent the number of experiences or concerns relating to that theme of impact and the colors indicate whether they corresponded to Red Chris Mine, Mount Polley Mine, or all of the trans-boundary mines. Below are the major

MOUNT POLLEY MINE

A loss of a way of life

Secwepemc First Nations, located along the Fraser River on the periphery of Likely, have a legacy of subsistence salmon fishing on the Fraser River that has been passed down for over 10,000 years. The environmental disaster that occurred at Mount Polley mine when the tailings dam burst led to the destruction of a legacy of subsistence harvest that has been integral in the identities, livelihood and culture of the Secwepemc First Nations for over ten thousand years. It will take many years to fully understand the impacts of the pollutants on the salmon run, but Secwepemc people have already observed a large decrease in return and feel that the salmon is not safe to eat, despite the mine trying to tell them otherwise. If they do not trust the salmon, the food source is as good as lost.

Secwepemc elders explain that subsistence fishing is more than a cultural tradition and a source of nutritious protein, but part of their identity. It is a way to teach methods of fishing and processing fish that are unique to their band, a platform for passing down knowledge of the local ecology and where their languages are revived and taught to the younger generation (In-person interviews, 2017).

Lake Quesnel is a source of pride for locals. Along with subsistence fisheries and a diverse habitat it provided opportunities for outdoor recreation, fly fishing and tourism related business and clean drinking water. Community members from Likely, BC expressed a deep sadness for inheriting a legacy of disaster to pass onto their children.

“I don’t think I’ll touch a salmon from the Fraser, it’s sad, it’s taken away my identity, my connection to this river. It’s been taken from me. My way of life.”

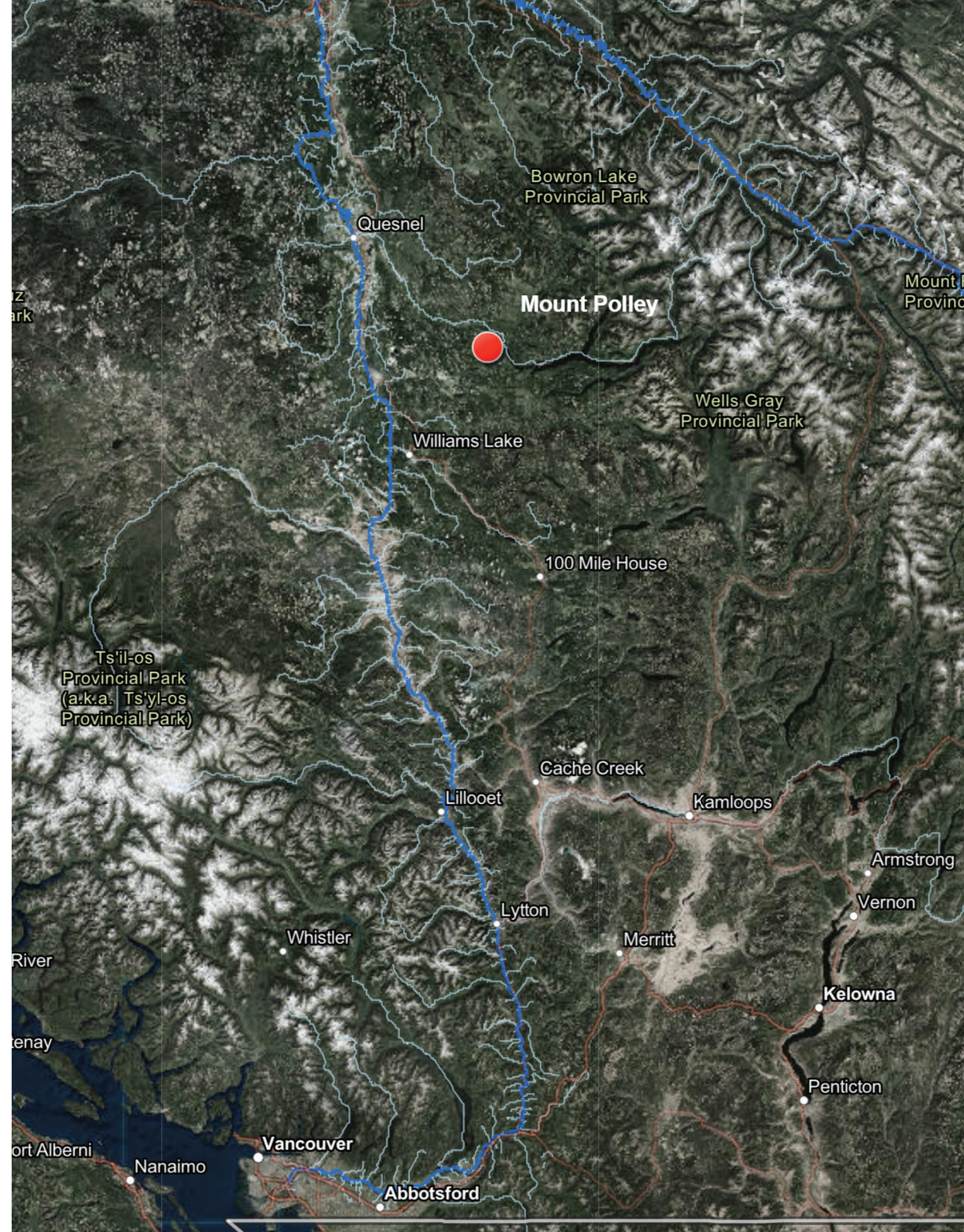
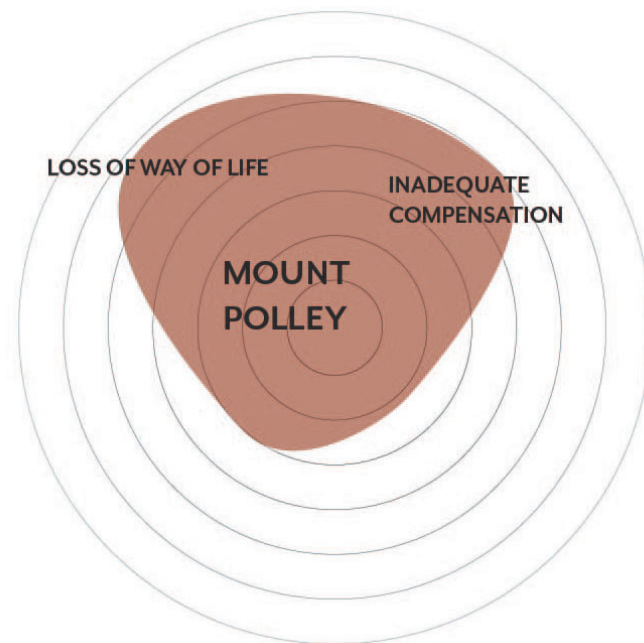
-Interview with Secwepemc elder

Inadequate compensation

In response to the impacts caused by the tailings dam disaster, little to no compensation was provided by Imperial Metals. Households in the town of Likely were given packages of bottled water for several months in light of losing their source of drinking water. First Nations communities were not adequately compensated and according to an interview with Secwepemc elder, they may have not been compensated at all. One stakeholder expressed that on top of monetary compensation, and a promise to clean-up the tailings from the lake, another form of compensation to the bands could be made in the form of employment, particularly in higher level positions that oversee the monitoring and cleanup (In-person interviews, 2017).

“I’m not sure what the compensation level is for the bands, if any.”

-Interview with Secwepemc stakeholder



RED CHRIS MINE

Impacts to a way of life

The pit of Red Chris Mine was once a mountain where the Tahltan people have harvested moose for thousands of years. Black Lake, which is now the tailings pond for the mine, was not only a moose habitat ideal for calving, but also a trout fishing lake for generations of Tahltan. A Tahltan man who works at the mine said that he would rather be able to moose hunt and provide food to his family and community than work at the mine, but if that was taken away from him he might as well get a job out of it, even though he was unhappy. Four heritage sites including ancient hunting and fishing camps were identified in the assessment process and then permitted to be destroyed (In-person interviews, 2017).

“There are old camps right around the lake. A lot of our elders used to go up there.”

-Interview with Tahltan elders

Compensation

Imperial Metals told the Tahltan people that this mine would benefit them through employment and compensation. One Tahltan woman stated that families receive \$130 every three months, which is not enough to help. A Tahltan man working at the mine explained that fewer Tahltan were hired than anticipated and they generally were given entry level jobs with no opportunity to move up. He compared working in the mine to being in jail and said that it was common knowledge that most of the workers were unhappy, but nothing was done to improve their experiences. Higher-up positions are most often given to workers that are flown in from out of the region (In-person interviews, 2017).

“They promise good things are going to happen, but I never seen it happen yet.”

-Interview with Tahltan elders

Community health

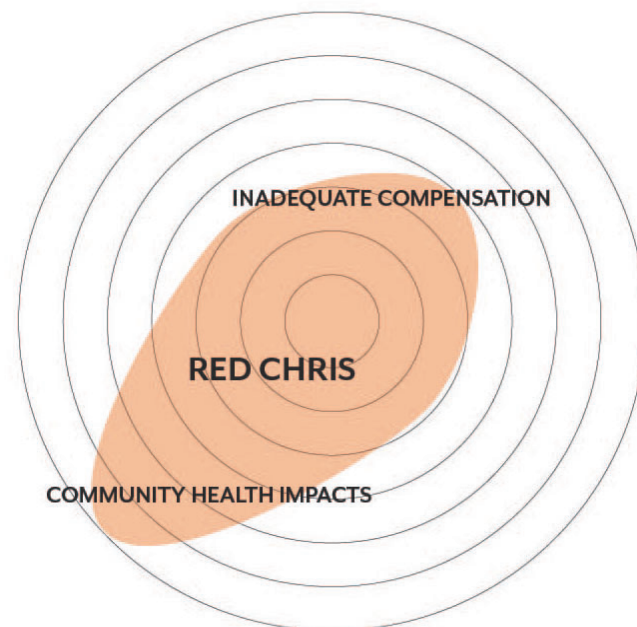
Two Tahltan First Nation elders from Iskut observed an increase in rates of asthma and leukemia since the mine started operation and thought it could be related to the heavy metal dust produced by the mining operations. They expressed distrust for how the mine was monitoring and mitigating the dust and told stories of community members employed at the mine going to bed with dust in their sheets. Other concerns for community health included a correlation with increased drinking and drug use in the community after the mine opened and locals working at the mine expressing that they were unhappy at work (In-person interviews, 2017).

“I thought I’d benefit from it, it doesn’t seem to be working that great for me.... I’m not happy. I’d rather be able to go and get moose and harvest it, honestly.”

-Interview with Tahltan local who works at Red Chris

“Since the past few years too, there’s a lot of people with Leukemia in the community.”

-Interview with Tahltan elders



SE ALASKA COMMUNITIES

Impacts to a way of life

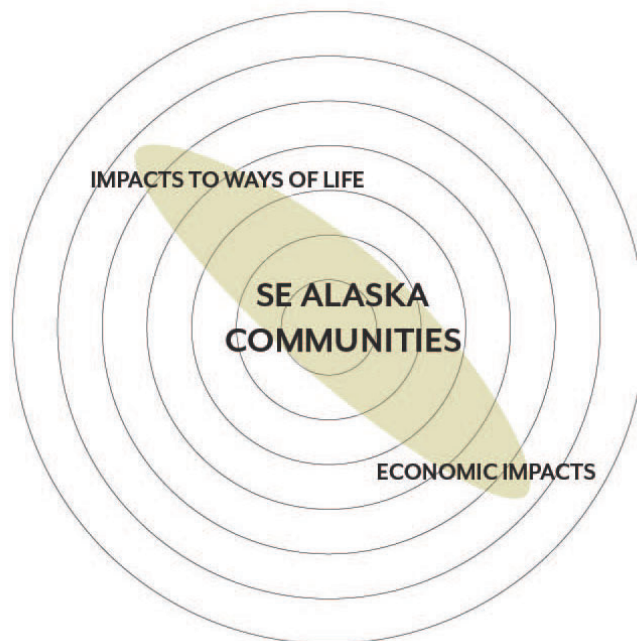
The livelihoods, identities and cultural traditions in SE Alaska are largely dependent on clean water and healthy ecosystems that support healthy fish populations. Fishermen and women articulated a love for their work and expressed that it was as much about supporting their families as it was about the sense of identity, connection with the environment and the strong community that fishing provided them. The potential loss of this way of life brought up feelings of anxiety, fear and deep sadness (In-person interviews, 2017)..

“We know that these tailings dams will fail... and we currently have no mechanism to protect us against that from happening. If and when it happens we have no recourse.”

-Interview with SE Alaska stakeholder

“Our economies, our culture, our traditions of this part of the US is completely dependent on clean water”

-Interview with SE Alaska stakeholder

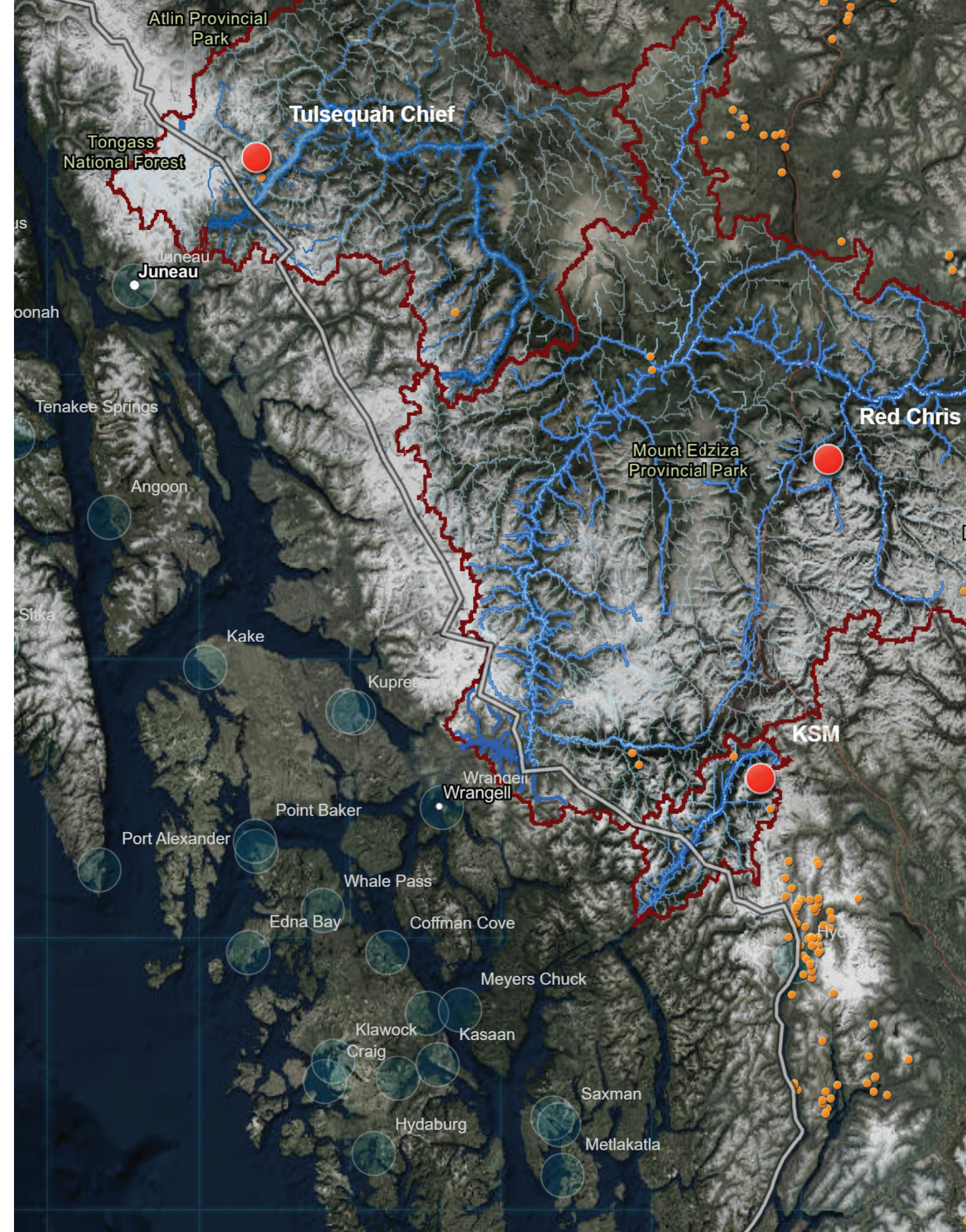


Economic impacts

Community stakeholders explain that the economies in SE Alaska are also largely centered around clean water and healthy fish populations. Annually, thousands of people are employed directly by commercial fishing industries, the main ones being for salmon, halibut, groundfish and shellfish (News, 2017). Seven thousand people are employed directly by the SE Alaska fisheries alone, which put \$1 billion into the regional economy annually.

Seafood processing plants have been employing people for decades according to the Trident Fleet manager. He explained that the cannery in Ketchikan has been running since 1904 and will continue to employ people into the future, unlike mines that often only provide employment for thirty or forty years. Hardware stores, grocery stores, marine supply stores, boatyards, ports, mechanics, restaurants, and bars are a few examples of on-land businesses who would also be heavily impacted in the event of a decline in fisheries.

Stakeholders expressed serious concern around being downstream from a dozen mines, all using wet tailings storage facilities, the same technology that failed Mount Polley. All of the mines in the trans-boundary waterways are acid generating due to the sulfide deposit, meaning acid mine drainage could leach into the waterways. According to the SE Alaska Mining Coordinator, high levels of selenium was already reported at the Mount Polley Mine. Pollution of watersheds could lead to a decline in salmon runs, eulachon runs, impact crab at the mouth of the rivers. Thus impacting the fishing industries and businesses that rely on them and put the way of life of the coastal communities at risk (In-person interviews, 2017).



DISCUSSION & FUTURE APPLICATION FOR STORY MAPPING

The act of generating a story map to analyze the collection of stories emphasized the need for qualitative data to be included in an impact assessment in order to fully understand the effects of mining in this region. Based on the narratives and emotional reactions to mining, it is clear that the EIA process has not been effective in evaluating and mitigating impacts in the region. The EIA process is supposed to help determine if the impacts of the project are too significant for it to continue- where the risk outweighs the benefit. However, no mines in BC have been halted due to an EIA. The four major themes of impact that can be seen through interviews with stakeholders throughout the region demonstrate that there has been significant impact and the current assessment process is less than effective.

Recurring themes in the interviews were extracted to help understand the felt impacts and the corresponding inadequacies in the EIA process for mining in BC. The first theme centers on the gap in the public engagement process and lack of consent for mining to occur in the region. Stakeholders expressed that they felt powerless in the process, that elected officials that were consulted don't reflect the feelings of the community, and that the results of the EIA process were already determined before they started. The large number of protests, letters written and court hearings expressing a lack of consent for mining in this region had no influence.

The inadequate public consultation process goes hand in hand with the concerns around the lack of accountability and transparency. Although certain data and information is required to be publicly accessible, there is an overall lack of transparency when it comes to mining in Northern BC. Not only are the documents including the EIA and the monitoring results nearly impossible to translate and sometimes difficult to find, the mining companies can choose to

leak out small bits of information as they go to avoid presenting the entire picture.

The Mount Polley disaster and the abandoned Tulsequah Chief mine both demonstrate a lack of accountability that the mines are held to. In both cases the mining company was not fined or expected to provide any compensation to communities. In the case of Mount Polley mine, they were able to use the disaster to their advantage by leveraging the lowered water quality of the lake to apply for permitting to discharge directly into the lake, despite protests from the public. There are currently no plans in place to clean up Tulsequah Chief mine which has been discharging acid mine drainage into the Taku for 67 years, or to remove the tailings that Mount Polley spilled into Lake Quesnel and the communities impacted have not been adequately compensated. The lack of accountability and transparency translates to an overall distrust of the mining companies. Stakeholders expressed fear and anxiety knowing that if something goes wrong their communities have no recourse.

The people living in the trans-boundary waterways of BC and SE Alaska maintain a close relationship with the land and rivers. A large portion of SE Alaska's economy is based around commercial, sport and subsistence fishing and these Alaskan industries and the sense of identity, community and tradition that exist with them directly rely on the health of the watershed. Subsistence fishing, hunting and harvesting in SE Alaska and in northern BC is not only a cultural tradition that provides crucial supplies of nutritious food sources, but is seen by many as a legacy and a way to pass down native languages, traditional knowledge and teachings about the local ecology. Irreversible damage to the watershed and landscape due to inadequate mitigation measures, tailings pond disasters and insufficient plans for clean-up has the potential to damage if not completely eliminate the ways of life of the communities whose identities are intertwined with the natural systems. A loss of identity is associated with feelings of anxiety, anger, fear and sadness and can contribute to decrease in overall community health.

SCREENSHOTS OF A STORY MAP Link: <https://arcg.is/099TSH>

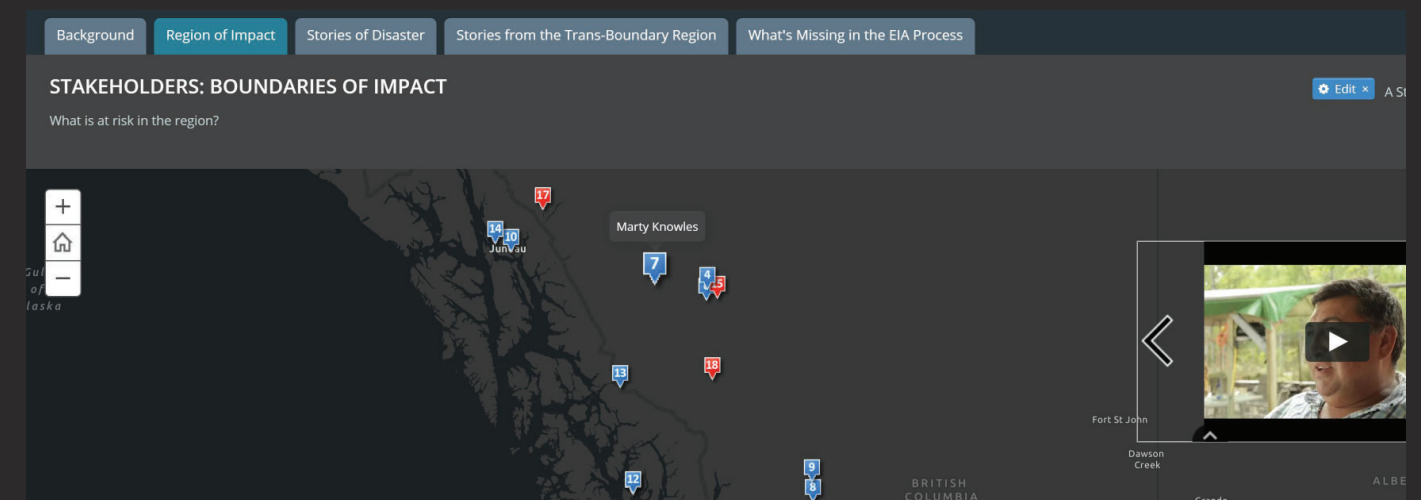
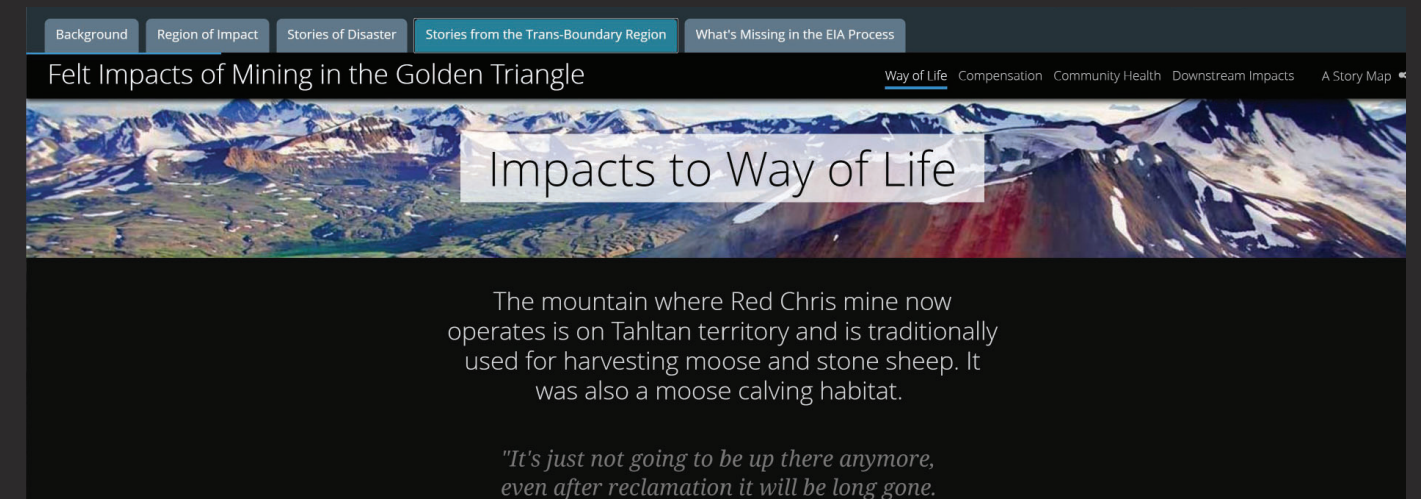
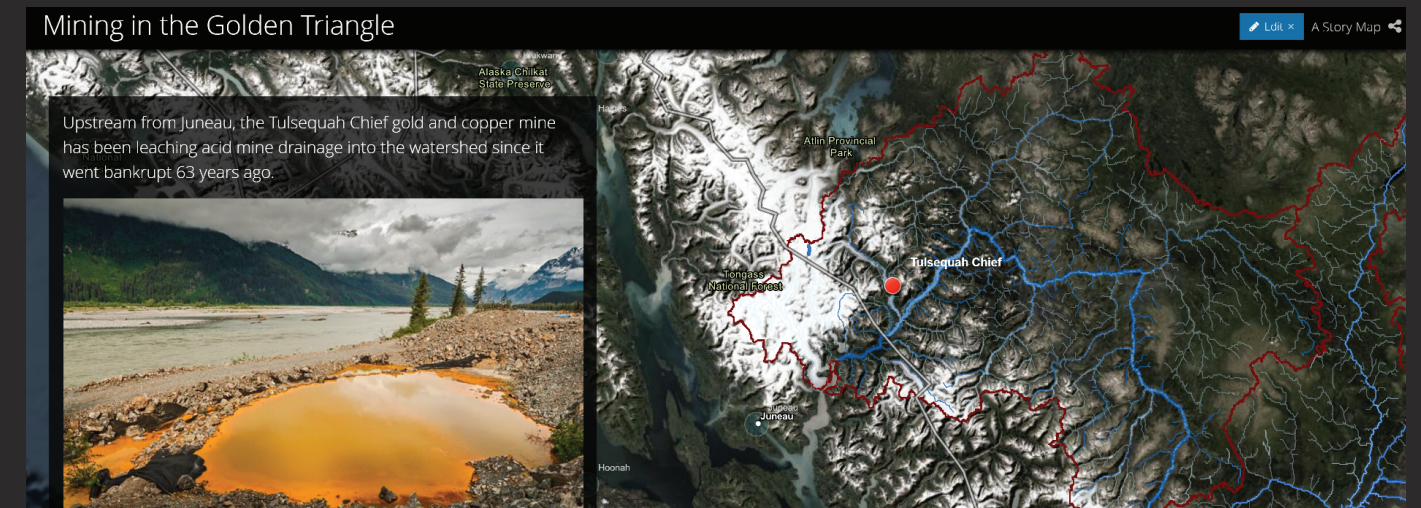
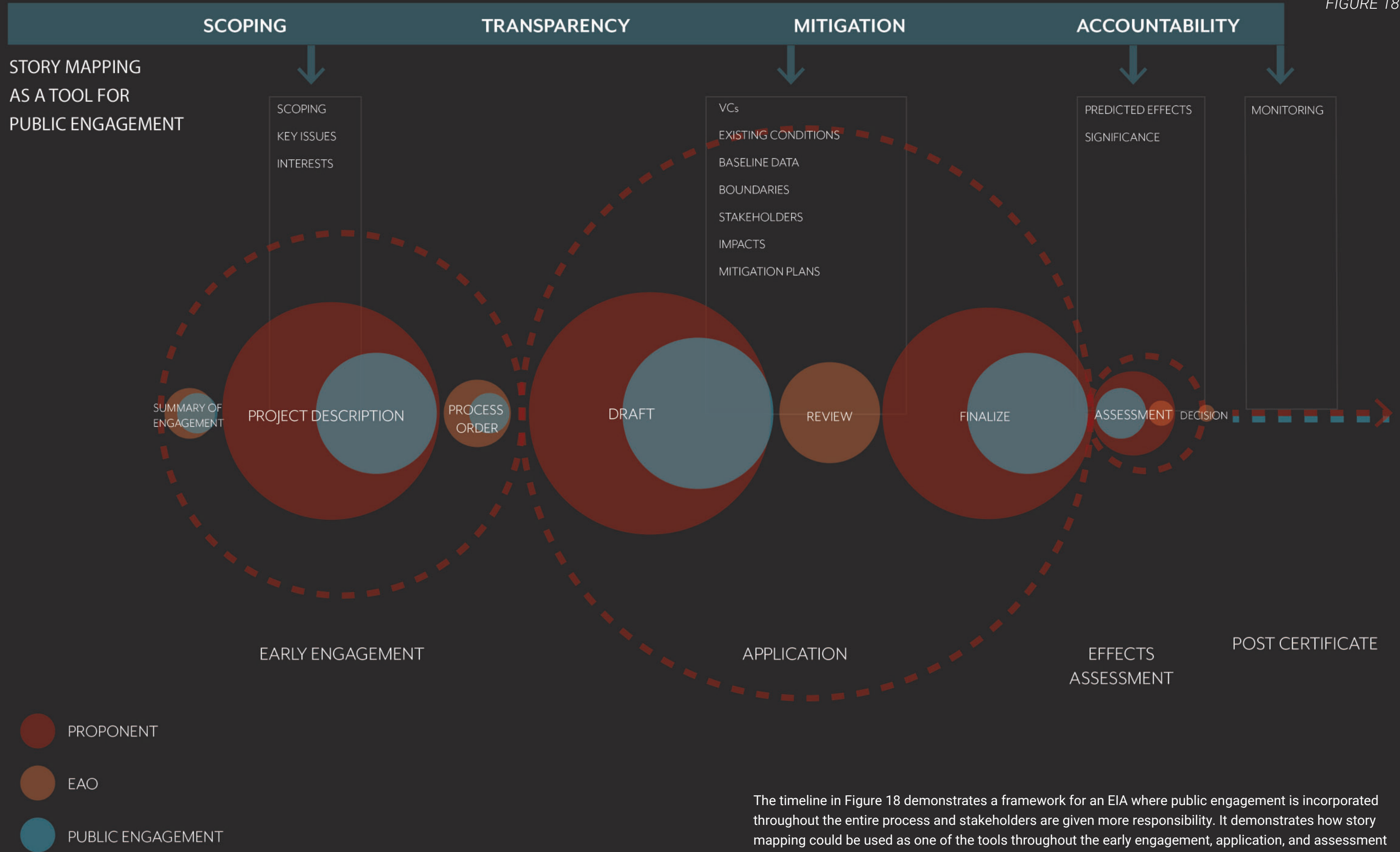


FIGURE 18



The timeline in Figure 18 demonstrates a framework for an EIA where public engagement is incorporated throughout the entire process and stakeholders are given more responsibility. It demonstrates how story mapping could be used as one of the tools throughout the early engagement, application, and assessment process.

SUGGESTIONS BASED ON FINDINGS

Increased scope of assessment

The scope of the EIA could be increased to cover a longer timeline, larger region and wider range of impacts including secondary and qualitative impacts. The exercise of spatially locating the mines within the watershed and the communities and voices of individual stakeholders within that region was used to identify the boundary of impact that a single mining project can have. The scope of the environmental assessment is minuscule compared to the region of impact developed in the story map. For an EIA to be effective, the entire watershed and the communities within it should be assessed.

After assessing interviews with stakeholders in the region, I found that some of the impacts most commonly experienced by people living directly around a mine, or downriver from one, were impacts to a way of life. A loss of a way of life for stakeholders included a loss of cultural tradition, a loss of a food source, a loss of a cultural heritage site, loss of a sense of identity, or impacts to industries and livelihoods. Interviews with several stakeholders demonstrated that impacts to community health, both physical health and mental health, was also common theme. For an EIA to be effective, these types of felt impacts, and the secondary impacts that stem from them, need to be included in the scope. This could be done through developing a framework to assess qualitative impacts, and beginning to quantify some experienced impacts that are more difficult to measure, (an example of this can be seen in figure 16)

Public engagement throughout entire process

The public should be incorporated early on and throughout the entire process to incorporate local environmental knowledge and concerns and ensure accountability. The stakeholders, boundaries

of impact and the VCs should be defined by the proponent and the public together. The proponent should still be responsible for drafting up plans for mitigation, monitoring and reclamation but the public given the power to determine whether the plans are sufficient and suggestions for improvement. Stakeholder groups should have allocated funding to be able to take on increased responsibility in the assessment process and given the option to hire (whether in their own community or from a 3rd party) to assist with the process. Rather than being hired for low-level positions with no room for growth, locals (especially First Nations) should be hired to oversee monitoring and participate in the ongoing restoration and reclamation process after the mine closes.

Strict and well enforced mitigation measures

In their interviews, many stakeholders provided insight into how the mining process could be done more responsibly. Highlighting the shortcomings of the EIA and the specific mitigation measures that were lacking based on the stories of the felt impacts was a useful practice in determining potential improvements. The most commonly expressed demand from stakeholders was that mining should only occur in responsible locations where the risk isn't as high. Sacred landscapes with cultural significance, landscapes that support subsistence lifestyles, landscapes that have fragile ecosystems, and landscapes that support sustainable resource based industries, are all examples of landscapes that are considered too valuable to put at risk by a poorly regulated mine.

Planning mines around existing infrastructure or already deforested land along with reducing the footprint of the mine and the amount of waste produced and stored would all help reduce the amount of habitat destruction. Regulations that prevent mining from occurring in critical watersheds or in areas with critical habitats should be strictly enforced.

Other suggestions provided by stakeholders include that mining companies be required to listen to the Tailings Advisory Panel and store waste in dry tailings storage facility, which would nearly illuminate the chance of a tailings disaster. Along with dry tailings storage, a tailings liner should be made mandatory. Water management and restoration plans need to be comprehensive and long term.

There are examples of mining companies around the world that are using advanced techniques and technology to more effectively mitigate impacts. Newmont's former mining site in Minahasa, Indonesian is currently in the process of being transformed into a botanical garden. 1,095 acres of land has been re-vegetated into a forest of mahogany, teak, nyatoah and sengon trees and in 5-7 years the garden will open as a tourist destination that will contribute to regional revenue (Newmont n.d.).

The use of passive treatment technologies for AMD have recently received a lot of interest due to the low cost. Bioreactors and constructed wetlands are the only passive treatment methods that have been used in full-scale at this point but there are other innovations in AMD treatment that are being explored. These include fusing Red mud bauxite which is an alkaline waste product from aluminum refineries to neutralize acidic tailings. Researchers at Pennsylvania State University are using microbial fuel cells to generate electricity while recovering dissolved iron from the AMD. Earth Metallurgy Solutions in South Africa is using filtration and ion exchange to clean the water while recovering resources that can be used for fertilizer and concentrated solar power salts (Martínez et al. 2019).

There are many more steps that the mining companies in BC can take to mitigate the environmental impacts of mining, which translate to social impacts. Responsible land-use planning and more advanced technologies for remediation of soil, water treatment, and restoration, should be enforced.

Transparency

As it is now, an EIA report is very difficult for the average person to interpret. Mitigation and monitoring plans and results are not just difficult to access, they are difficult to understand. It should not only be required that mining companies in BC share every bit of information and every plan that they develop, but there needs to be a change in the way information is shared to make it accessible.

As demonstrated in this research, visual info-graphics and visual narratives are two forms of sharing information in a way that is accessible to a larger audience. Video interviews can be a means of sharing stories about human experience and felt impacts, or a way to share information about mining, or a specific mining project. Interviews that I conducted with the previous mining coordinator for SE Alaska, the director of Salmon Beyond Borders, a marine biologist, a fisheries specialist, and a conservation specialist, all provide specific information about mining and it's impacts in a way that is easy to digest. Visual graphics, and maps are another way to interpret data or textual information in a format that is more accessible.

Accountability

Mining companies should be held accountable for their actions by the government and the public. Increased transparency is one step that can be taken to promote accountability. Another step is to change the policy of self-reliance so that mining companies aren't responsible for monitoring themselves. Local stakeholders should be hired to help oversee the monitoring and restoration efforts to promote accountability and trust. Policies in BC need to change so that it is not so easy for a mining company to declare bankruptcy and walk out without cleaning up their mess.

POTENTIAL USES OF STORY MAPPING

Story Mapping as a tool for community engagement in the EIA

Especially in a rural region where conventional methods of public consultation have proved unsuccessful, I think that story mapping could be one effective tool for community engagement in the EIA. It could serve as a platform to help determine the scope of impacts, the key issues, who and where the stakeholders are. It is a method to gather and analyze qualitative data to be incorporated with the quantitative aspects of the impact assessment process.

Story mapping could be used to help create maps of existing conditions and places of significance and begin to incorporate local and indigenous knowledge. Data extracted from stories and the amount of concern around a potential effect could be used to determine the significance of impacts and identify thresholds. It could also act as a platform for the public to access information about the mining project– to promote transparency and accountability.

Social resilience and networking:

transparency, accountability

Story mapping could act as a platform for community networking and a means of building resilience to resist irresponsible mining. This story mapping case study demonstrates how it might be used in a large region with a dispersed population to crowd-source knowledge, ideas, concerns, occurrences and events and connect communities with resources. Building a network of knowledge and ideas could build community resiliency and provide the much-needed transparency around mining and to enforce accountability.

CONCLUSION

As a global society there is no evidence that there will be a decrease in necessity for copper in construction, marine, technology and medical industries or a cease in demand for gold as a form of currency or jewelry (“Global Gold Demand by Industry Share 2017”). A disconnect exists between the urban areas where the demand is generated and economic benefits are disproportionately received, and the hinterland that bears the weight of resource extraction. If we are to continue demanding mineral resources, we must demand and enforce responsible mining practices (Mack 2017; Sweeting and Clark 2000).

A lack of knowledge and understanding regarding the severity of impacts and associated risks of our demand for minerals is apparent. If we continue to rely on these resources, we must work to bridge the gap in understanding between the urban and rural existences and demand accountable mining practices that don’t extract in areas where the risk is too high. A strengthened understanding and enforcement is essential in maintaining the health of the communities, ecosystems, economies, cultural traditions and identities that feel the pressure of resource extraction. There is a need for a shift in values in our policies and permitting processes to determine whether short term monetary gains are worth the long-term risks.

Storytelling, the oldest form of sharing knowledge can act as a catalyst for generating understanding. Human narratives have the ability to combine knowledge with an emotional connection which is proven to increase the likelihood that the listener will retain the information or be inspired to take action (Sundin, Andersson, and Watt 2018). Stories of felt experiences should be validated as a form of subjective data that can be analyzed and used to develop a more comprehensive understanding of the risks of open-pit mining.

In order to mine responsibly, the impacts need to be fully understood to determine steps that should be taken to mitigate or eliminate potential for impact. Currently, the EIA process in BC isn’t effective in determining or reducing impacts and as a result many communities and ecological regions have suffered irreversible losses (Baker and McClelland 2002). The public engagement process doesn’t fully acknowledge the concerns of the public and has no framework for incorporating the unquantifiable cultural, social, emotional and downstream impacts (Paci, Tobin, and Robb 2002; Toro et al. 2013).

Increasing the amount of community voices in the engagement process is one step, but it isn’t enough. For the EIA process to be effective, a framework should be in place to include qualitative data gathered by the past experiences, current concerns and local and indigenous knowledge of the landscape. The public needs to be engaged throughout the entire process and have a hand in determining and overseeing the mitigation measures, community health, compensation and future plans of the mine. There is a need for public consent, not just consultation.

Story mapping is an effective research tool in collecting and analyzing qualitative data and generating a platform for sharing experiences and knowledge (Molden 2020). This thesis demonstrates how it can be used to better understand the felt impacts of mining in this region and exemplifies how it could be used as a tool for public engagement and understanding the scope of impacts in the environmental assessment process.

Story mapping is not only a powerful tool for the collection, analysis and representation of spatial, visual and textual information as a narrative- it could be used as a platform for community engagement and social resilience. In vast rural areas such as this one, story mapping has the potential to act as a platform to share knowledge and experiences, provide connection to resources to create a unified front to advocate for responsible mining.

BIBLIOGRAPHY

- Aug 16, CBC News · Posted: 2007 8:49 AM CT | Last Updated: August 16, and 2007. 2007. "Environmentalists Pose as Investment Advisers in B.C. Mine Protest | CBC News." CBC. August 16, 2007. <https://www.cbc.ca/news/canada/north/environmentalists-pose-as-investment-advisers-in-b-c-mine-protest-1.662702>.
- Baker, Douglas, and James McLelland. 2002. "Evaluating the Effectiveness of British Columbia's Environmental Assessment Process for First Nations' Participation in Mining Development." *Environmental Impact Assessment Review* 23 (January): 581–603.
- "Basics of an Open Pit Mine." n.d. Accessed May 3, 2020. http://www.mine-engineer.com/mining/open_pit.htm.
- "BC's Proposed New Environmental Assessment Act: Some Things Have Really Changed...others, Not so Much." 2018. *West Coast Environmental Law*. November 2018. <https://www.wcel.org/blog/bcs-proposed-new-environmental-assessment-act-some-things-have-really-changed-others-not-so-much>.
- Berman, Sarah. 2014. "Indigenous Canadians Are Blockading a Mine to Protest Pollution." *Vice* (blog). October 6, 2014. https://www.vice.com/en_us/article/yvqe7w/first-nations-are-blockading-an-imperial-metals-mine-and-the-rcmp-may-intervene-932.
- Berkes, Fikret. 1990. "Native Subsistence Fisheries: A Synthesis of Harvest Studies in Canada." *Arctic* 43 (1): 35–42.
- Bland, Alastair. 2014. "The Environmental Disaster That Is the Gold Industry." *Smithsonian Magazine*. February 14, 2014. <https://www.smithsonianmag.com/science-nature/environmental-disaster-gold-industry-180949762/>.
- Booth, Annie, and Greg Halseth. 2011. "Why the Public Thinks Natural Resources Public Participation Processes Fail: A Case Study of British Columbia Communities." *Land Use Policy* 28 (4): 898–906. <https://doi.org/10.1016/j.landusepol.2011.03.005>.
- Byrne, Patrick, Karen A. Hudson-Edwards, Graham Bird, Mark G. Macklin, Paul A. Brewer, Richard D. Williams, and Heather E. Jamieson. 2018. "Water Quality Impacts and River System Recovery Following the 2014 Mount Polley Mine Tailings Dam Spill, British Columbia, Canada." *Applied Geochemistry* 91 (April): 64–74. <https://doi.org/10.1016/j.apgeochem.2018.01.012>.
- Calvo, Guiomar, Gavin Mudd, Alicia Valero, and Antonio Valero. 2016. "Decreasing Ore Grades in Global Metallic Mining: A Theoretical Issue or a Global Reality?" *Resources* 5 (4): 36. <https://doi.org/10.3390/resources5040036>.
- Caul, Doug. 2013. "GUIDELINE FOR THE SELECTION OF VALUED COMPONENTS AND ASSESSMENT OF POTENTIAL EFFECTS." Environmental Assessment Office, September, 45.
- Caquard, Sébastien, and William Cartwright. 2014. "Narrative Cartography: From Mapping Stories to the Narrative of Maps and Mapping." *The Cartographic Journal* 51 (2): 101–6. <https://doi.org/10.1179/0008704114Z.000000000130>.
- Clifton, Carr. 2016. "Post-Mount Polley Tailings Dam Safety in Transboundary British Columbia," March, 13.
- "Court Ruling on Red Chris Mine Highlights Duplication in Environmental Assessment." n.d. *Vancouver Sun*. Accessed April 1, 2020. <https://vancouver.sun.com/news/staff-blogs/court-ruling-on-red-chris-mine-highlights-duplication-in-environmental-assessment>.
- Desjardins, Jeff. 2016. "The Story of the Golden Triangle in British Columbia." *Visual Capitalist*. July 7, 2016. <https://www.visualcapitalist.com/story-golden-triangle-british-columbia/>.
- Docherty, Bonnie. 2010. "Harvard Law School Responds to AME BC Letter Re. First Nations Report." *The Northern Miner*; Toronto, Ont., November 1, 2010, sec. EDITORIAL.
- Environment, Ministry of. 2018. "Environmental Assessments - Province of British Columbia." Province of British Columbia. May 23, 2018. <https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/environmental-assessments>.
- "ENVIRONMENTAL ASSESSMENT OFFICE RED CHRIS PORPHYRY COPPER- GOLD PROJECT ASSESSMENT REPORT." 2005. Environmental Assessment Office.
- "Environmental Risks of Mining." n.d. Accessed April 14, 2020. <https://web.mit.edu/12.000/www/m2016/finalwebsite/problems/mining.html>.
- "Global Gold Demand by Industry Share 2017." n.d. Statista. Accessed May 3, 2020. <https://www.statista.com/statistics/299609/gold-demand-by-industry-sector-share/>.
- Haddock, Mark. 2010. "Current Issues in Environmental Assessment in British Columbia." *Journal of Environmental Law and Practice*; Toronto 21: 221–45.
- Hitselberger, Joseph P. 2012. "Tulsequah Chief Mine Acid Rock Drainage: Whole Body Metals Concentrations in Dolly Varden Char 11-09," April, 20.
- Lyu, Zongjie, Junrui Chai, Zengguang Xu, Yuan Qin, and Jing Cao. 2019. "A Comprehensive Review on Reasons for Tailings Dam Failures Based on Case History." *Advances in Civil Engineering* 2019 (June): 1–18. <https://doi.org/10.1155/2019/4159306>.
- Macharia, Njoki. 2005. "A Framework for Best Practice Environmental Impact Assessment Follow-up: A Case Study of the Ekati Diamond Mine, Canada." Sarah Njoki Macharia, September.
- Mack, Jacinda. 2017. "3 Years After The Mount Polley Disaster, Our Waters Are Still In Danger | HuffPost Canada." 2017. https://www.huffingtonpost.ca/jacinda-mack/3-years-after-the-mount-polley-disaster-our-waters-are-still-in_a_23049981/.
- "Mapping Emotions." n.d. *Mapping Emotions: Unsafe Places in Olomouc, Czech Republic*. Accessed April 6, 2020. <https://www.arcgis.com/apps/Cascade/index.html?appid=03ce0f0b4cb8414aa02d777f2c60bc8d>.
- Martínez, Natalia Mónica, M. Dolores Basallote, Andreas Meyer, Carlos R. Cánovas, Francisco Macías, and Petra Schneider. 2019. "Life Cycle Assessment of a Passive Remediation System for Acid Mine Drainage: Towards More Sustainable Mining Activity." *Journal of Cleaner Production* 211 (February): 1100–1111. <https://doi.org/10.1016/j.jclepro.2018.11.224>.
- Mehdic, Anur. 2014. "Evaluating the Environmental Assessment Process in Canada and British Columbia: A Case Study of the Prosperity Mine Project." In .
- Mills, Rick. 2018. "Golden Triangle's Red Line." *Mining.Com*, May.
- "Minerals and Their Uses." n.d. Accessed May 11, 2020. <http://scienceviews.com/geology/minerals.html>.
- "Mining in BC | TRCR." n.d. Accessed May 11, 2020. <http://www.trcr.bc.ca/mining-in-bc/>.
- Murray, Cathryn, Janson Wong, Gerald Singh, Megan Mach, Jackie Lerner, Bernard Ranier, St-Laurent Guillaume Peterson, Alice Guimaraes, and Kai Chan. 2018. "The Insignificance of Thresholds in Environmental Impact Assessment: An Illustrative Case Study in Canada." *Environmental Management* 61 (March).
- Narwhal, The. 2017. "Canada Has Second-Worst Mining Record in World: UN." *The Narwhal* (blog). Accessed April 14, 2020. <https://thenarwhal.ca/canada-has-second-worst-mining-record-world-un/>.
- Narwhal, The. 2018. "How B.C. Proposes to Roll Back Industry Self-Regulation." *The Narwhal* (blog). October 23, 2018. <https://thenarwhal.ca/how-b-c-proposes-to-roll-back-industry-self-regulation/>.
- Narwhal, The. 2020. "B.C. Taxpayers on the Hook for \$1.2 Billion in Mine Cleanup Costs: Chief Inspector Report." *The Narwhal* (blog). March 6, 2020. <https://thenarwhal.ca/b-c-taxpayers-on-the-hook-for-1-2-billion-in-mine-cleanup-costs-chief-inspector-report/>.
- Natcher, David. 2009. "Subsistence and the Social Economy of Canada's Aboriginal North." *The Northern Review* 30: 83–98.
- Newmont. (n.d.). Retrieved from <https://lifecycle.newmont.com/post-closure>
- News, Ed Schoenfeld, CoastAlaska. 2017. "Canada Rejects Transboundary Mine Permit Protest." *KTOO*. December 8, 2017. <https://www.ktoo.org/2017/12/07/canada-rejects-transboundary-mine-permit-protest/>.
- Nold, Christian. 2009. *Emotional Cartography: Technologies of the Self*. Place of publication not identified. : publisher not identified.
- Norström, Albert V., Christopher Cvitanovic, Marie F. Löf, Simon West, Carina Wyborn, Patricia Balvanera, Angela T. Bednarek, et al. 2020. "Principles for Knowledge Co-Production in Sustainability Research." *Nature Sustainability* 3 (3): 182–90. <https://doi.org/10.1038/s41893-019-0448-2>.
- Paci, Chris, Ann Tobin, and Peter Robb. 2002. "Reconsidering the Canadian Environmental Impact Assessment Act: A Place for Traditional Environmental Knowledge." *Environmental Impact Assessment Review* 22 (2): 111–27. [https://doi.org/10.1016/S0195-9255\(01\)00095-6](https://doi.org/10.1016/S0195-9255(01)00095-6).
- Patric, Will, Chris Zimmer, Tadzio Richards, and Terry Portillo. 2013. "TRANSBOUNDARY WATERSHED CONSERVATION," 7.
- "Professional-Reliance-and-Environmental-Regulation-in-BC_2015Feb9.Pdf." n.d. Accessed May 12, 2020. http://www.elc.uvic.ca/wordpress/wp-content/uploads/2015/02/Professional-Reliance-and-Environmental-Regulation-in-BC_2015Feb9.pdf.
- "Selenium Levels in Fish Raise Concerns about Pollution from Red Chris Mine." 2016, 2016. <https://www.theglobeandmail.com/news/british-columbia/selenium-levels-in-fish-raise-concerns-about-pollution-from-red-chris-mine/article30410473/>.
- Shandro, Janis A., Marcello M. Veiga, Jean Shoveller, Malcolm Scoble, and Mieke Koehoorn. 2011. "Perspectives on Community Health Issues and the Mining Boom–Bust Cycle." *Resources Policy* 36 (2): 178–86. <https://doi.org/10.1016/j.resourpol.2011.01.004>.
- Stevenson, Marc. 1996. "Indigenous Knowledge in Environmental Assessment." *Arctic* 49 (3).
- Sundin, Anneli, Karolin Andersson, and Robert Watt. 2018. "Rethinking Communication: Integrating Storytelling for Increased Stakeholder Engagement in Environmental Evidence Synthesis." *Environmental Evidence* 7 (1): 6. <https://doi.org/10.1186/s13750-018-0116-4>.
- "The Economic Value of Alaska's Seafood Industry." 2017. McDowell Group.
- "Trade and Invest BC - Invest in Canada | BC Mining - Gold | Trade and Invest BC." n.d. Accessed May 3, 2020. <https://www.britishcolumbia.ca/invest/industry-sectors/mining/>.
- "What Are the Main Methods of Mining?" 2014. American Geosciences Institute. September 14, 2014. <https://www.americangeosciences.org/critical-issues/faq/what-are-main-mining-methods>.
- "World Mine Tailings Failures—from 1915 – Supporting Global Research in Tailings Failure Root Cause, Loss Prevention and Trend Analysis." n.d. Accessed April 14, 2020. <https://worldminetailingsfailures.org/>.
- Writer, Guest. 2015. "Defending the Sacred Headwaters: Klabona Keepers Struggle against Red Chris Mine -." January 4, 2015. <https://basicsnews.org/klabona-keepers-struggle-against-red-chris-mine/>.