The FAIR MINING CALCULATOR GUIDE

&

Impact Area Value Calculations

for

Gibraltar Mine

and

Mount Polley Mine

FAIR MINING COLLABORATIVE

2022

www.fairminingcalculator.ca

Author: Glenn M. Grande

Mathematical Design: Dr. Alan Mehlenbacher

Editor: Stan Tomandl

Fair Mining Calculator Software Build: Radar Hill, Victoria B.C.

Additonal Software Design: Rogan McNeill

Map Technician: Daniel Brendle-Moczuk

Indigenous Advisor: Elder Fred John (1935 - 2021)

The Real Estate Foundation of British Columbia

The Western Organization of Research Councils

The Indigenous Environmental Network

Library and Archives Canada Cataloguing in Publication
Grande, Glenn M. 1963 -
The fair mining calculator guide / Glenn M. Grande
ISBN 978-0-9921509-3-8.
1. Mines and mineral resources. 2. Mine monitoring. 3. Mining impacts.
4. Environmental impacts.

DISCLAIMER

This publication, in all its parts, is presented with the understanding by all parties, publishers, readers, and users, that it does not constitute advice or the last words of knowledge, skill, or expertise, in mining, mining law, or mining economics. Any negligent misuse of the information herein, or users' misrepresentation of information, or misinterpretation of the law, or economic data is not the responsibility of the Fair Mining Collaborative ("FMC"), the publisher, FMC's funder(s), and all others associated with the creation of this document. FMC offers no opinion as to the accuracy of the information. The information represented here is current only at time of writing. Readers and users must confirm the currency and accuracy of the sources and should seek certified, professional advice before acting on or relying on the contents of this publication.

Although this report calculates the impact area values for gibrlatar mine and mount polley mine relative to the traditional territory of the Northern Secwēpemc te Qelmūcw, as administered by the northern shuswap tribal council, neither the northern shuswap tribal council, nor any of its members are affiliated in any way with the creation or dissemination of this report. data for gibraltar mine and mount polley mine were obtained using publicly available data. no member of taseko mines limited, gibraltar mine limited, imperial metals corporation, nor mount polley mine corporation, past or present, including ownership, management, employees, sub-contractors, shareholders, nor any and all other affiliates not mentioned here, were involved in the creation of this report.

COVER PHOTO
The Mount Polley breach, Likely, British Columbia, Canada - 4 August 2014. Photo: Still from video of the Mount Polley mine breach at #1 corner. Mount Polley Independent Expert Investigation and Review Panel.

CONTENTS

CONTENTS

Queue at the customs house for mining permits for the Klondike gold rush
on Wharf Street, Victoria B.C. 1897. Photo: Jones & Co.
Image courtesy Royal Museum of B.C. archives.

Introduction

Contrary to the age-old colonial narrative, and the myth of "externalized costs", mining is a net-loss enterprise when the lands and waters sacrificed to the endeavour are given full account; especially lands and waters already under high stress. The legacy of thousands of toxic sites, and decades of catastrophic tailings dam failures, domestically and globally, tell us something is seriously wrong with the mining picture, and has been for a very long time.

The legal boundary of a mine does not make it independent of its surroundings, nor insulate the broader world from its damaging effects. Rights of miners notwithstanding, mines affect the world beyond their boundaries, just as we affect one another, and the earth as a whole. Whether it is a dam failure in Brazil that kills hundreds of people and sends shockwaves around the business world; or seepage from a tailings pond in B.C. entering the food chain a thousand kilometres away, it is clear by now that there is no "elsewhere". We are all connected.

The Fair Mining Calculator is an instrument for understanding and appreciating the impact of a mine on its surroundings so we can mitigate potential damage, think twice before building in over-developed areas, compel industry to use the best available technology and practices, and effectively plan a clear and sober path forward, especially in light of the push for metals to fuel the imminent 'green economy'.

The Calculator is available online at www.fairminingcalculator.ca in a clear and easy-to-use format. Input fields that require one have a glossary link. A copy of the glossary is found on pages 6-8 of this report. One of the main new features of the Fair Mining Calculator is the option to factor for Previously Impacted Areas in order to calculate a mine's impact on the carrying capacity of a given region, such as a watershed, or the traditional territory of an Indigenous nation. The two example mines in this report - Gibraltar and Mount Polley (British Columbia, Canada) - sit forty-kilometres apart on the traditional territory of the Northern Secwēpemc te Qelmūcw (NStQ) - an area already one-third lost to some form of development - a fact which multilplies the impact of those two mines on the remaining territory. The calculations that mutlply the IAVs of Gibrlatar and Mount Polley from the Previously Imapcted Area of the NStQ are contained in this report.

Once the required input fields are filled with the best available data, the Calculator will produce a negative currency value - the Impact Area Value (IAV) - an expression of the externalized costs. But the best feature of the Calculator is not being a blunt instrument. Were any mine to improve its practices and technologies, its IAV would decrease. Whereas, a mine that cuts corners, and relies on shoddy practices, would see its IAV increase.

The Fair Mining Calculator uses a formula we call the Impact Area Value formula. Designed by FMC with Dr. Alan Mehlenbacher, the Impact Area Value formula (aka 'Fair Mining formula') is expressed:

$$NAV * (PF + R_f (PIF + WB))$$

The (per-hectare) Natural Area Value,
(multiplied by) the sum of:
the Project Footprint (plus) Risk factor
(multiplied by) the total Project Impact Footprint
(plus) the surface area of affected Water Bodies

NAV (Natural Area Value)

The Natural Area Value (NAV) is obtained by calculating the per-hectare average price of land in your jurisdiction. Our estimate for the NAV for BC is obtained by calculating the per-hectare average price paid since 2009 by B.C. Parks, the Greater Vancouver Regional District, and the complete record of purchases by the Capital Regional District, to convert private land into parks and green spaces. (See: "Other Metrics" p. 19).

Table 1

Natural Area Value (NAV) - Government Land Acquisitions - B.C.				
#	Agency	Location	Total	Area (Ha)
1	BCParks	Skagit Valley	$320,000	15
2	BCParks	Skaha Bluffs	$5,250,000	304
3	BCParks	Quadra Island	$5,850,000	395
4	BCParks	Galiano Island	$475,000	109
5	CRD	Complete Record of Acquisitions	$48,018,264	4,485
6	CRD	Mount Work Addition (2018)	$1,050,000	28
7	GVRD	Branston Island Regional Park	$585,000	0.785
8	GVRD	Barnston Island Regional Park	$1,075,000	6.79
9	GVRD	Campbell Valley Regional Park	$1,200,000	2.02
10	GVRD	Kanaka Creek Regional Par	$995,000	4.68
11	GVRD	Kanaka Creek Regional Park	$660,000	2.02
12	GVRD	Kanaka Creek Regional Park	$755,000	13.5
13	GVRD	Kanaka Creek Regional Park	$655,000	0.69
14	GVRD	Kanaka Creek Regional Park	$1,120,000	4.5
15	GVRD	Kanaka Creek Regional Park	$685,000	1.09
16	GVRD	Kanaka Creek Regional Park	$785,000	0.946
17	GVRD	Pitt River Greenway	$166,000	1.09
18	GVRD	Pitt River Greenway	$266,000	2.08
19	GVRD	Pitt River Greenway	$986,900	1.68
20	GVRD	Pitt River Greenway	$118,000	1.19
21	GVRD	Pitt River Greenway	$368,700	6.68
22	GVRD	Sumas Mountain Regional Park	$385,830	1.9
23	GVRD	Sumas Mountain Regional Park	$1,932,085	31.9
24	GVRD	Sumas Mountain Regional Park	$1,932,085	32.4
25	GVRD	Tynehead Regional Park	$450,000	0.25
26	GVRD	Tynehead Regional Park	$597,500	0.307
27	GVRD	Widgeon Marsh Regional Park Reserve	$467,500	11.85
28	GVRD	Widgeon Marsh Regional Park Reserve	$2,525,000	7.97
29	GVRD	Widgeon Marsh Regional Park Reserve	$291,319	0.9
		Totals	$79,965,183	5,473
		Average per hectare	$14,610	

PF (Project Footprint)

The Project Footprint (PF) is mainly the legal boundary of the mine; readily visible in open pit mines, less so in underground mines. The PIF includes all stockpiles, pits and impoundments, infrastructure, roads and rights of way. It may also include any critical, immediate, peripheral disturbances outside the property boundary that would not exist but for the mine.

Table 2

Project Footprint (PF)	
Gibraltar	3,643 ha
Mount Polley	2,200 ha

R_f (Risk Factor)

(Probability of Mining Harms)

The R_f is the risk factor that all mining projects carry - either major, medium, or minor failures and seepages. These risk factors, or probabilities[1] (Table 3), are informed by the "Report on Mount Polley Tailing Storage Facility Breach",[2] the Ministry of Forests, Lands and Natural Resource Operations' "Crown Contaminated Sites Program: Biennial Report 2016"[3]; and Office of the Auditor General of British Columbia report "An Audit of Compliance and Enforcement of the Mining Sector."[4] Together, these reports indicate that in B.C. there is a 2.7% chance that a mine will incur a major failure (TSF failure); a 3.3% chance it will incur a medium failure or severe seepage; and a 4.8% chance of minor seepage, making the total weighted probability of all harms 10.8%.

Table 3

Probability of Mining Harms - B.C.			
Harm	Probability Factor	Harm (0-1)	Probability weighted by Harm
Major Catastrophic Failure (TSF failure)	0.027	1	0.027 (2.7%)
Medium Failure (serious seepage)	0.131	0.25	0.033 (3.3%)
Minor Failure (minor seepage)	0.481	0.1	0.048 (4.8%)
Total Weighted Probability			0.108 (10.8%)

1 The risk factors, calculated from provincial figures given in the 3 publications read: 7 'major' TSF failures, 34 'medium' failures, and 125 'minor' failures. Weighted by harm: Major: 1; Medium: 0.25; and Minor: 0.1; Risk Factor by Harm: Major: 0.027; Medium: 0.033; and Minor: 0.048.

2 Independent Expert Engineering Investigation and Review Panel, "Report on Mount Polley Tailing Storage Facility Breach" (Victoria: Government of British Columbia, Queen's Printer, 30 January, 2015).

3 Ministry of Forests, Lands and Natural Resource Operations, Crown Contaminated Sites Program, LNG, Crown Land Opportunities and Restoration Branch, "Crown Contaminated Sites Program: Biennial Report" (Victoria: Queen's Printer, 2016).

4 Office of the Auditor General, Ministry of Finance, British Columbia, "An Audit of Compliance and Enforcement of the Mining Sector" (Victoria: Queen's Printer, 2016). Online: <www.bcauditor.com>

PIF (Project Impact Footprint)

Mines affect the land and water beyond their permitted boundaries. To account for this larger Project Impact Footprint (PIF) we chose an area four-times (4x) greater than the mine's property or Project Footprint (PF). These areas may not feel the direct impact, but are still affected by seepage, dust, noise and other disturbances that would not exist but for the presence of the mine. This will include the water body surface areas which fall within the PIF. The online Calculator default is 4x the PF, but can be manually overridden.

Table 4

Project Impact Footprint (PIF)	
Gibraltar	14,572 ha
Mount Polley	8,800 ha

WB (Water Bodies)

Water bodies (WB) pertains to the surface area of all water bodies outside the PIF under any form of duress from the mine. Water bodies are critical pathways where mining contaminants more easily enter the food chain and the hydrological cycle.

Table 5

Water Bodies (WB)	
Gibraltar	3,831 ha
Mount Polley	4,562 ha

The major WB for Gibraltar and Mount Polley are listed below. Since those WB within the PIF are already counted in the PIF total, only those outside the PIF are calculated for the WB input.

GIBRALTAR (WB)

Fraser River (south of Marguerite to the delta), Cariboo Lake, Cuisson Lake, Souran Lake, Valerie Lake, Rimrock Lake, (fifty small, nameless lakes)

MOUNT POLLEY (WB)

Rainbow Creek, Quesnel Lake, Quesnel River, Caribou River, Horsefly Lake, Quesnel Forks, Spanish Lake, Polley Lake, Bootjack Lake, Morehead Lake,Trio Lake, Frypan Lake, Jacobie Lake, Gavin Lake, Slum Lake, Cariboo Lake.

Risk Factors and Calculator Input Options

The base risk of damage as per Table 3 (0.108), is heightened by other risk factors. Six are common to all mines: *company profile, seismic zone, precipitation zone* - and *comminution, sizing*, and *concentration* of ore in the production chain. Two factors, *dry-stack methods* and *dry-stack liner types* are absent in B.C. Six factors deal with wet tailings storage and management: *pipes, pumps, dam design, embankment slope factors of safety* (FoS), *TSF liner type*, and *solids-by-weight* of the tailings. The Calculator allows for up to 2 TSFs and up to 5 embankments per TSF.

Table 6

Risk Factors and Calculator Input Options					
Risk Factors	Calculator Input Options				
COMMON	1	2	3	4	5
Company Profile	High	Average	Low	Poor	
Seismic Zone	Low	Low/Med	Med	Med/High	High
Precipitation Zone	Low	Low/Med	Med	Med/High	High
Comminution	HPGR	SAB (AG and/or SAG)	3-4 stages downstream		
Sizing	Image Analysis	Automated/ Passive	All Passive		
Concentration	Automated	Auto-Manual Combination	All Manual		
DRY-STACK					
Dry-Stack Methods	3 or more	2	1		
Liner Type	Engineered	Partial	None		
TAILINGS POND (per)					
Piping	Coated Steel	Steel			
Pumps	Positive Displacement	Centrifugal			
Dam Design	Thickened	Downstream	Centreline	Upstream	
Liner Type	Engineered	Partial	None		
Embankment Slopes (FoS)	>1.5	1.5	1.3 - <1.5	<1.3	
Tailings Solids By Weight	56% -78%	30% - 55%			

Glossary of Calculator Terms
(In Order of Appearance)

COMPANY NAME
Parent company or subsidiary; i.e. Imperial Metals, or Mount Polley Mining Corporation.

COMPANY PROFILE
An analysis based on the history of maintenance issues/inspection orders; history, nature, and gravity of regulatory violations; and levels of Indigenous engagement and community relations. There should be enough documentary evidence to support a balanced and objective input based on the company's record. Enter 1 (high); 2 (average); 3 (low); or 4 (poor).

PROJECT NAME
Name of the mine/mining project.

LOCATION
Closest municipal or regional area, jurisdiction, or traditional Indigenous territory - i.e. Williams Lake B.C.; or Cariboo, B.C.; or NStQ Territory.

PROJECT FOOTPRINT
The Project Footprint (PF) is mainly the legal boundary of the mine including all stockpiles, pits and impoundments, infrastructure, roads and rights of way. It may also include any critical, immediate, peripheral disturbances outside the property boundary that would not exist but for the mine.

PROJECT IMPACT FOOTPRINT
The Calculator default is 4x, but can be manually overridden. The PIF accounts for any areas that may not feel the direct impact, but are still affected by disturbances that would not exist but for the presence of the mine. This number will include water body (WB) areas which fall within the PIF.

WATER BODIES
Water bodies (WB) pertains to the surface area of all water bodies outside the PIF under any form of duress from the mine. Water bodies are critical pathways where mining contaminants more easily enter the food chain and the hydrological cycle.

NATURAL AREA VALUE
The per-hectare value of land in the region/jurisdiction of the mine.

TOTAL REGION AREA
Use if calculating for the Greater Impact Area Value factor. Otherwise enter zero ("0").

PREVIOUSLY IMPACTED AREA
Use if calculating for the Greater Impact Area Value factor. Otherwise enter zero ("0").

SEISMIC ZONE
Natural Resources Canada, at <http://www.seismescanada.rncan.gc.ca/hazard-alea/zoning-zonage/images/BCsimp_NBCC2015.pdf>. Enter 1 through 5 depending on your mine's Seismic Zone. (Canada/B.C. only. Use the equivalent for your area)

PRECIPITATION ZONE

UBC Dept. of Geography Fig.2 - "Continentality Effect: Distance from the Pacific coast" at: <https://ibis.geog.ubc.ca/courses/klink/class04/lskcheng/method.htm>. Enter 1 through 5 depending on your mine's Precipitation Zone. (B.C. only. Use the equivalent for your area).

COMMINUTION

Comminution is the process of crushing and processing ore. The more upstream comminution, the better. However, more stages require more energy, resulting in a higher environmental cost. Where does the bulk of the process occur? Upstream/in-pit, using pre-screening? Or is it spread along a multi-stage process? Enter 1 if the mine uses significant upstream or in-pit High Pressure Grinding Rolls "HPGR"; enter 2 if the mine relies more on "SAG" (Autogenous and/or Semi-Autogenous + Ball Milling); enter 3 if the mine has a 3-4-stage process (Traditional + "Vertimill" or equivalent) with little upstream HPGR and most comminution occurring downstream.

SIZING

Sizing (aka "screening") works in conjunction with Comminution. Technological advances allow for high-speed, electronic scanners to sort ore particles through the production chain. Enter 1 the mine uses a full-automated image analysis process; enter 2 if it uses a combination of automated and passive systems; enter 3 if the mine uses no advanced screening/sorting technology.

CONCENTRATION

Valuable minerals are separated from the ore using various methods of Concentration, alone, or in combination: Gravity – Floatation – Optical – Magnetic – Electrostatic - Programmable Logic Controllers (PLCs) and On-Stream Analyzers (OSAs). Enter 1 if the mine uses less passive gravity separation and more PLC/OSA technology; enter 2 for a combination; enter 3 for a mainly gravity-fed concentration system with little or no PLC/OSA or other automation.

DRY-STACK or TSF? - If **DRY-STACK**, the next two (2) options are:

DRY-STACK METHODS

De-watering of tailings until they achieve the "dryness" required for Dry-Stacking really begins in the production chain. However, if a Dry-Stack is achieved (>84% Solids by Weight), several technologies are available to maintain the Dry-Stack: "Geotubes" – "Zero Water Flux" - "Oxygen Limiters" to manage water balance. Enter 1 if your mine uses 3 or more methods; enter 2 if the mine uses 2 Dry-Stack methods; enter 3 if it relies on a sole method for Dry-Stacking.

LINER TYPE

For all tailings storage types. Whether Dry-Stack or wet storage (TSF pond), storage requires some kind of bottom liner, or layers of filtration to protect groundwater. These are made from different materials, some man-made (underliner), some natural (geoliner). Enter 1 for an engineered liner with 3 (or more) layers (i.e. 2 geoliners, 1 underliner); enter 2 for two layers; enter 3 if the TSF has a single liner.

DRYSTACK or TSF? - If **TSF**, the next six (6) options are:

PIPES

Wet tailings are pumped through steel pipes. Most mines rely on standard duplex steel piping which is more prone to corrosion and incrustation, and requires more maintenance than coated pipes. Enter 1 if the mine uses any type of improved, coated piping such as fused-cast basalt-coated pipes; enter 2 for conventional steel piping.

PUMPS

Two main types of pumps are used to pump wet tailings: Centrifugal (most common, least expensive, highest maintenance) and Positive Displacement pumps which are less common, mainly because of their higher up-front cost. Enter 1 if the mine uses Positive Displacement pumps; enter 2 if the mine uses conventional Centrifugal pumps.

DAM DESIGN

ICMM: https://www.icmm.com/en-gb/environment/tailings

Dam Design refers to the primary TSF or mean-TSF dam design method. Mines will sometimes incorporate one or more of the three main types of dam designs in a single TSF from the original design through subsequent raises. If different methods are used in a single TSF, apply the average. Thickened(1) tailings may still require a small embankment and are not considered pure Dry-Stack. Skip this section if your mine uses Dry-Stack tailings storage, otherwise enter 1 for Thickened, 2 for Downstream, 3 for Centreline, 4 for Upstream - or the average for multiple-TSF designs.

LINER TYPE

Same as "Liner Type" above.

EMBANKMENT SLOPE

Each embankment has its own Static Factor of Safety (FoS)[5] – the ratio of the forces of resistance to the shear forces acting on the dam. See the B.C. Health, Safety and Reclamation Code Guidance Document. The FoS is related to the slope of the embankment (H: horizontal – to V: vertical) and should be publicly available from company literature. Skip this section if your mine uses a Dry-Stack. Otherwise, the scale offers 4 FoS options from best to worst: (>1.5 - enter 1) (1.5 - enter 2) (1.3 - <1.5 - enter 3) and (<1.3 - enter 4).

SOLIDS BY WEIGHT

The percentage of solid matter versus water in the tailings. Enter 1 for tailings in the 56% -84% solids range; enter 2 for tailings in the 30% - 55% solids range.

A placer-mined section of McKee Creek near Atlin B.C. as seen on Google Earth. Mined for over 120 years, McKee Creek was one of 11 named creeks exempt from the discharge provisions in the *Environmental Management Act* by virtue of the *Placer Mining Waste Control Regulation*, 1988, s 3(c), until amended May 2021.

5 Whether the FoS directly correlates to risk is still up for debate. The likelihood of dam failure is subject to other factors. However, the FoS is the only mathmatical expression available that reflects the shear resistance of a slope to the driving force. Any slope below FoS 1.0 is far more likely to fail than a slope with an FoS of 1.5. "With respect to slope stability, FoS is the ratio of shear resistance to driving force along a potential failure plane. A FoS greater than 1.0 implies the available shear strength to resist failure is greater than the driving force to initiate failure. A dam or slope with a lower FoS derived from analyses with a high degree of confidence and reliability may be "safer" or "lower risk" than a dam with a higher FoS derived from less reliable analyses. For this reason, it is necessary to involve experienced dam design professionals in the material characterization, analysis, sensitivity and interpretation of the results." - Klohn Crippen Berger, 2018. Online: <https://www.klohn.com/blog/geotechnical-factor-of-safety-and-risk/>.

Scaling Factor (Sf) and Risk Factor (Rf)

As shown in Table 3, the Base Risk factor is 0.108 (10.8%) for B.C. This is the lowest possible risk based on data from the 3 cited government reports. However, the algorithm also requires a scaling factor to cap the risk at a reasonable *maximum* of less than100%.

A scaling factor of 0.692 caps the maximum risk at 80% (0.108 + 0.692 = 0.8) and is normalized within each input range for each risk factor to evenly spaced values between 0 and 1 as shown in Table 7.

Table 7

Normalizing the Input Ratings Criteria

Risk Factor Criteria Count			
2	3	4	5
2 → 1	3 → 1	4 → 1	5 → 1
1 → 0	2 → 0.5	3 → 0.67	4 → 0.75
	1 → 0	2 → 0.33	3 → 0.5
		1 → 0	2 → 0.25
			1 → 0

For the scaling factor (Sf), the Fair Mining Calculator counts the number of criteria that the user has rated and divides that total by 0.692. This count will vary depending on the number inputs.

For the total Risk Factor (Rf), the Fair Mining Calculator begins with the Base Risk Factor (B.C.) of 0.108, then sums all of the ratings that the user has chosen, and divides it by the Scaling Factor. Table 8 on the following page shows the Base Risk Factor, all input ratings, and Scaling Factor applied to the Gibraltar and Mount Polley mines.

Data for Gibraltar Mine and Mount Polley Mine were obtained from the following sources:

Gibraltar mine:

Weymark, Richard (P. Eng. QP) “Technical Report on the Mineral Reserve Update at the Gibraltar Mine, British Columbia, Canada” (Vancouver: Taseko Mines Ltd., 6 November, 2019).

Klohn-Crippen-Berger, “2014 Annual Dam Safety Inspection Rev. 2., Gibraltar Mines Tailings Storage Facility” (Vancouver: Gibraltar Mines Ltd., November, 2014).

Mount Polley mine:

Baron, Janice, P. Eng.; Brown, Ryan, P. Eng.; Rees, Chris, P. Geo.; Roste, Gary, P. Geo., “Mount Polley Mine 2016 Technical Report” (Vancouver: Imperial Metals Corporation, 20 May, 2016).

Independent Expert Engineering Investigation and Review Panel, “Report on Mount Polley Tailing Storage Facility Breach” (Victoria: Government of British Columbia, Queen’s Printer, 30 January, 2015).

Table 8

Risk Factor Inputs - Gibraltar and Mount Polley					
Risk Factors	Levels	Calculator Input Options			
		Gibraltar		Mount Polley	
COMMON		Rating	Normalized	Rating	Normalized
Company Profile	4	2	0.33	4	1.0
Seismic Zone	5	3	0.5	2	0.25
Precipitation Zone	5	3	0.5	3	0.5
Comminution	3	2	0.5	2	0.5
Sizing	3	2	0.5	3	1.0
Concentration	3	2	0.5	1	0.0
DRY-STACK					
Dry-Stack Methods	3	n/a	n/a	n/a	n/a
Liner Type	3	n/a	n/a	n/a	n/a
TAILINGS POND (per)					
Pipes	2	2	1.0	2(2)	1.0
Pumps	2	2	1.0	2(2)	1.0
Dam Design	4	3[a]	0.67	4(4)	1.0
Liner Type	1	1	0.0	2(3)	0.5
Embankment Slope (FoS)	4	2	0.33	2(4)[b]	0.33
Embankment Slope (FoS)	4	2	0.33	2(4)	0.33
Embankment Slope (FoS)	4	n/a	n/a	2(4)	0.33
Tailings Solids by Weight	2	2	1.0	2(2)	1.0
Criteria Count		13		14	
Scaling Factor (Criteria Count /0.692)		18.7861		20.2312	
Normalized Rating Sum			7.16		8.74
Risk Factor (Norm Sum/Scaling Factor)		(7.16/18.7861) = 0.3678		(8.74/20.2312) = 0.4320	
+Base Risk (B.C.)		+ 0.108 = **0.4891**		+ 0.108 **= 0.5400**	

a. Many mines incorporate different dam designs in one TSF, from the original, through subsequent raises. Gibraltar mine TSF embankments have multiple dam designs, begun as a combination "Modified Upstream" and "Downstream", with subsequent raises using the less-reliable "Upstream" method. We assess their average as "3" or "Centreline" for the overall risk-factor input rating.

b. Mount Polley mine TSF has 3 embankments: South, Main, and Perimeter. Due to the high volume of fluctuations of FoS data as reported in the Investigation Review Panel report, and given the repairs since the Aug. 4 2014 breach, we assigned a value of 2 (FoS 1.5) for each embankment, which is the static FoS in anticipation of closure.

Impact Area Values

Gibraltar and Mount Polley (post-breach)

(Rounded $CAD - 2022)

Applying the data to the IAV formula NAV * (PF + R_f (PIF + WB)) yields the following IAVs for Gibraltar mine and Mount Polley mine:

Table 9

Impact Area Value (IAV)	
Gibraltar	
= $14,610 x (3,643 + 0.4891 (14,572 + 3,831)) =	$185M
NAV x (PF + R_f (PIF + WB)) =	

Table 10

Impact Area Value (IAV)	
Mount Polley (post-breach)	
= $14,610 x (2,200 + 0.5400 (8,800 + 4,562)) =	$138M
NAV x (PF + R_f (PIF + WB)) =	

The $323M combined IAV for Gibraltar and Mount Polley exceeds all taxes and royalties collected by the province of British Columbia from all mining, in all but 5-years since 1986. (See: Table 15, p. 22).

Previously Impacted Area (PIA)

As undeveloped areas become more scarce, their value increases within the diminishing landscape. The greater the amount of natural areas of a region previously impacted by development, the greater the relative impact of any new project. Accounting for a mine's impact relative to the remaining land within a region requires determining the area previously impacted - or Previous Impact Area (PIA) within the given territory.

For the Gibraltar and Mount Polley examples we use the remaining undeveloped territory within the traditional territory of the Northern Secwēpemc te Qelmūcw, the host First Nation to both mines. The PIA is the total area within a region, previously impacted by any development (urban, roads, rights of way), or at any time tenured for resource extraction.

The PIA is obtained by summing the areas in the territory that have been previously impacted by mining tenures (coal, mineral, placer); developed land; roads (including forest tenure roads); rights-of-way (gas, oil, hydro, telecommunications); towns; and harvested forestry areas.

The ratio of the Previously Impacted Area to the total territory area is used to calculate PIA factor = 1/(1-ratio), which increases as the ratio increases, or decreases as land is recovered.

Table 11

Previously Impacted Area - NStQ Traditional Territory			
Map Layer	Units of Measurement		Total kms^2
Total NStQ traditional territory[a]	kms^2		49,882.00
Coal, Mineral, Placer tenures[b]	kms^2		6,559 .00
Roads	Width	Length	
Forest tenure roads[c] (includes culverts/ditches and forest edge clearance)	.075 km	27,168 km	2,037.60
All other roads[d] (aka partially-attributed Roads) 10m widths (0.01km) per lane to account for shoulders, etc.	.01km (1-lane)	6,979 km	69.79
	.02km (2-lane)	48,187 km	963.74
	.03km (3-lane)	72 km	2.16
	.04km (4-lane)	46 km	1.84
	Total Roads		3,075.13
Rights of way[e] (gas/oil, hydro, and telecommunications)			49.00
Towns			180.00
Forestry harvest and logging[f]			7,986.00
	Previously Impacted Area (PIA) (kms^2)		17,849.13
	PIA (ha)		1,784,913
	Total Region Area (ha)		4,988,200
	Ratio		0.357
			1/0.643
PIA factor for remaining territory			**1.56**

a. <https://catalogue.data.gov.bc.ca/dataset/first-nation-statement-of-intent-boundaries-bc>.
b. <https://catalogue.data.gov.bc.ca/dataset/mta-mineral-placer-and-coal-tenure-spatial-view>.
c. <https://catalogue.data.gov.bc.ca/dataset/forest-tenure-road-section-lines>.
d. <https://catalogue.data.gov.bc.ca/dataset/digital-road-atlas-dra-demographic-partially-attributed-roads>.
e. <https://catalogue.data.gov.bc.ca/dataset/tantalis-crown-land-rights-of-way>.
f. <https://catalogue.data.gov.bc.ca/dataset/harvested-areas-of-bc-consolidated-cutblocks->.

Greater Impact Area Value (GIAV)

The Greater Impact Area Value (GIAV) is not a Calculator input, but will appear as the "Greater Impact Area Value" below the calculated IAV total. When multiplied by the factor of 1.56, the IAV for each mine in our example becomes the Grand Impact Value within the defined NStQ territory, relative to its shrinking, viable land base.

Table 12

Greater Impact Area Value (GIAV)		
Gibraltar		
GIAV = PIA factor x IAV	1.56 x $185M	$289M

Table 13

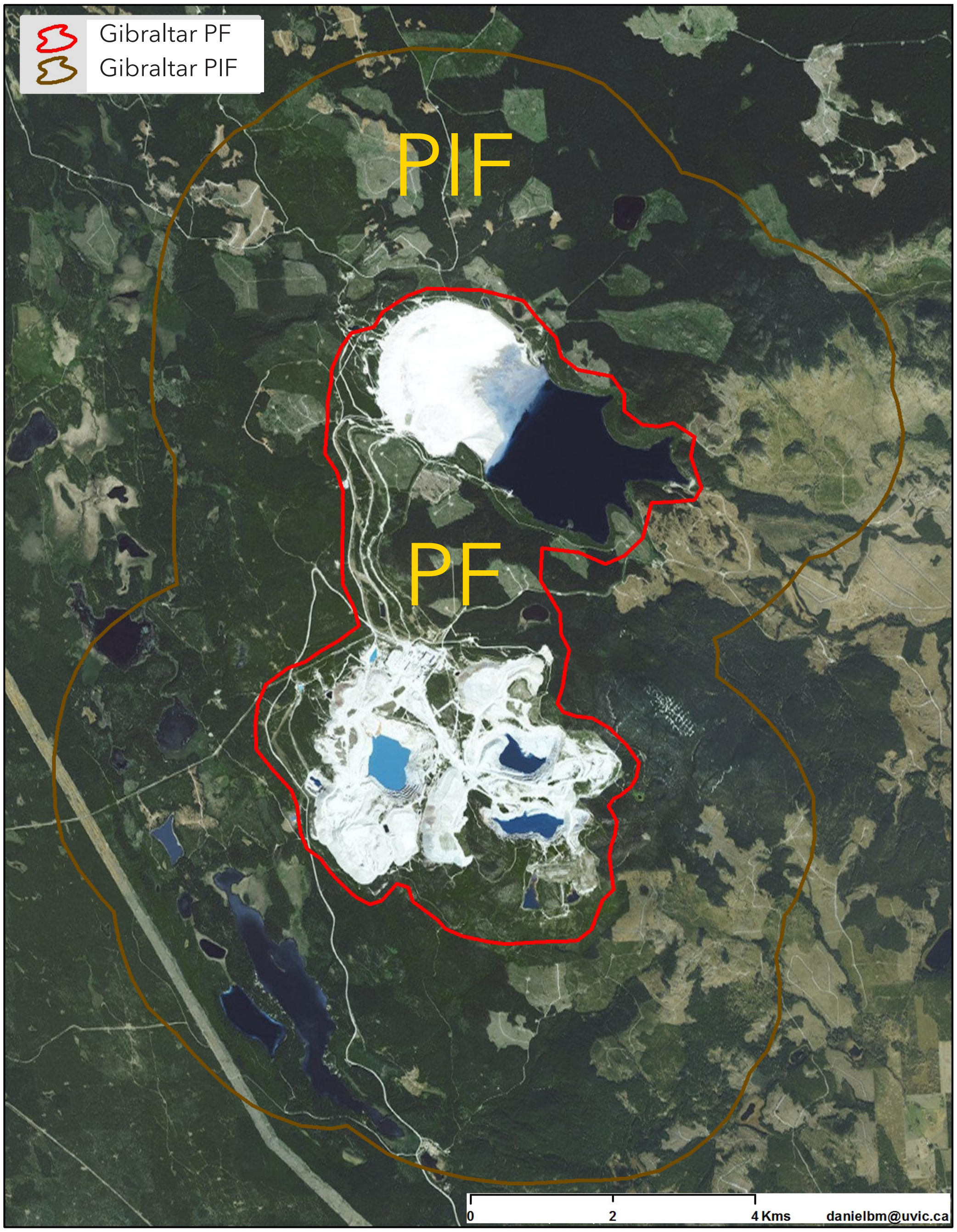
Greater Impact Area Value (GIAV)		
Mount Polley (post-breach)		
GIAV = PIA factor x IAV	1.56 x $138M	$215M

For an idea of the permanent nature of mine damage, the Brenda Mine near Peachland, B.C. is considered a model of reclamation; however, its water treatment plant must remain active for the next 150 to 200 years.*

*Original permit issued Feb. 20, 1969 authorized discharge of treated water into MacDonald Creek which flows into Trepanier Creek and then into Okanagan Lake; amended Jan. 22, 2014. Online: <https://www.glencore.ca/.rest/api/v1/documents/477b9436127765832651e045bae-808da/Brenda_Permit_263_20140122.pdf>.

Map I
Gibraltar Mine:

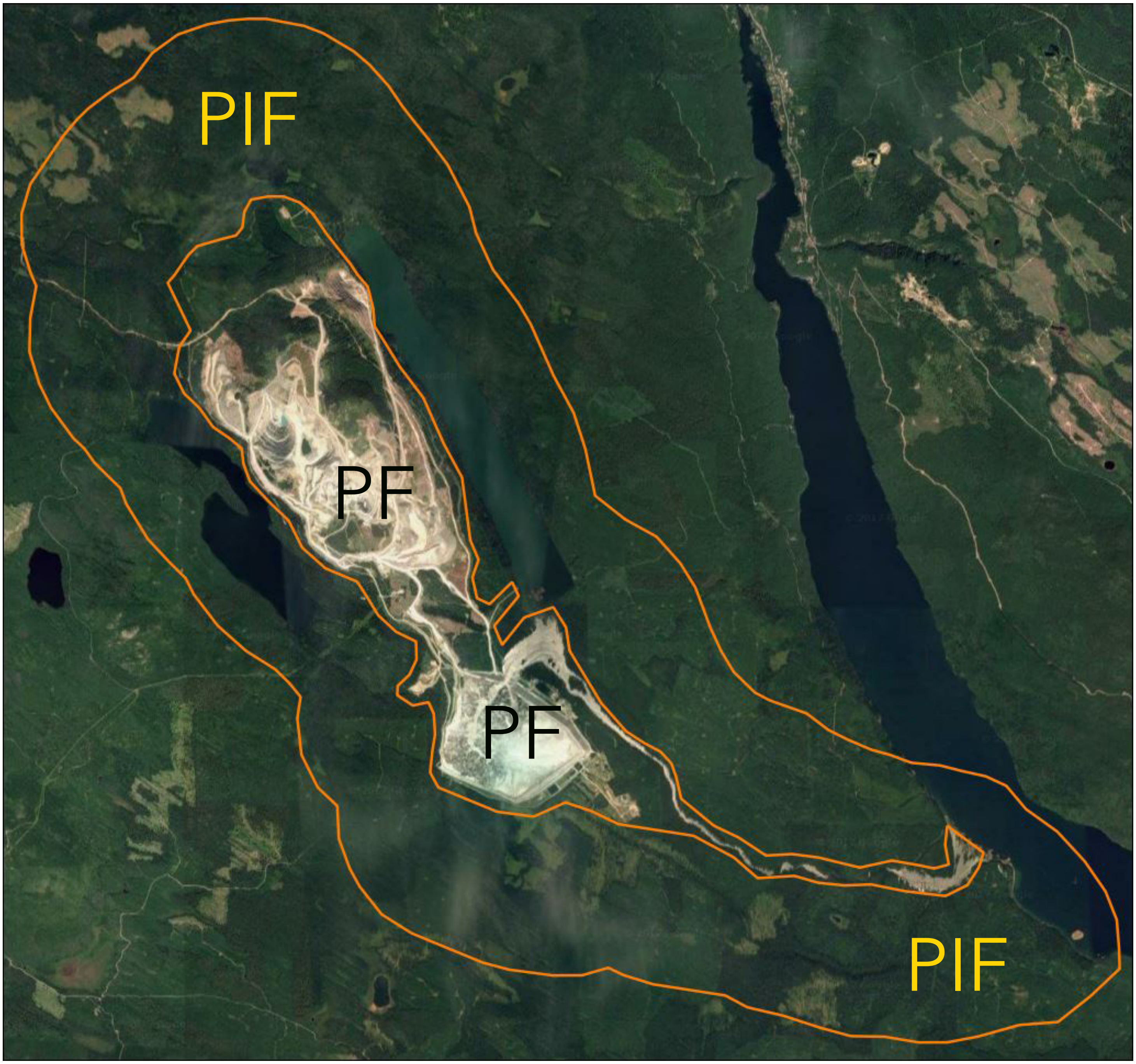
Project Footprint (PF) 3,643ha
and
Project Impact Footprint (PIF) 14,572ha



-$289M
Grand Impact Value of Gibraltar mine - relative to NStQ traditional territory.

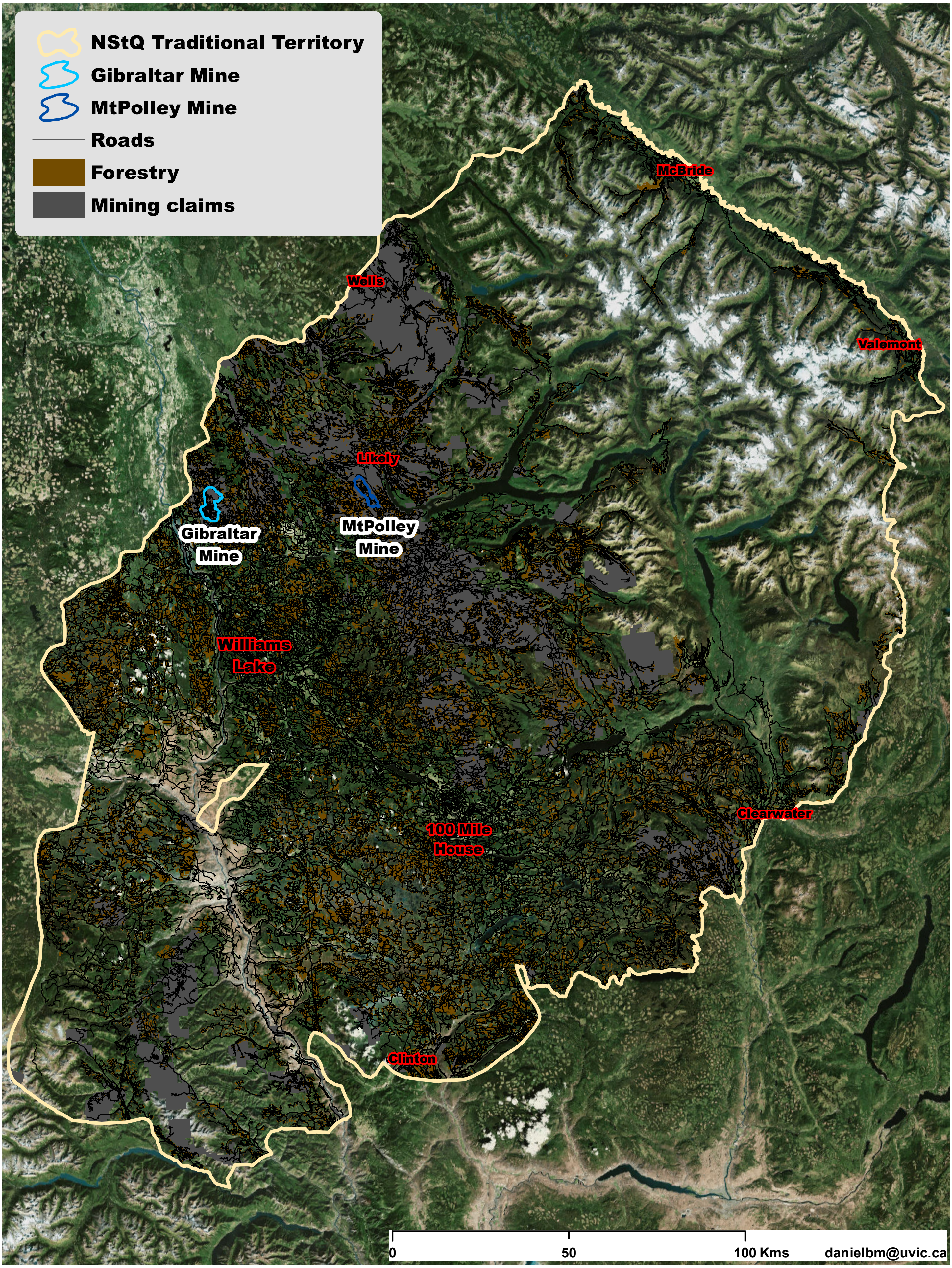
Map II
Mount Polley Mine:

Project Footprint (PF) 2,200ha
and
Project Impact Footprint (PIF) 8,800ha



-$215M
Grand Impact Value of Mount Polley mine (post-breach) - relative to NStQ traditional territory.

Map III


NStQ Traditional Territory
Gibraltar Mine
MtPolley Mine
Roads
Forestry
Mining claims
McBride
Wells
Valemont
Likely
Gibraltar Mine
MtPolley Mine
Williams Lake
Clearwater
100 Mile House
Clinton
0
50
100 Kms
danielbm@uvic.ca

The Legacy Issue

Over one-hundred years of mining elapsed in B.C. with no enforceable reclamation standards, until1969[6] when reclamation requirements for coal and hard rock mineral mines were first introduced, followed by requirements for coal and mineral exploration sites in 1973.[7] Since then, reclamation regimes have only addressed activities within a mine's common law boundaries - the time and materiel needed to fulfil the conditions of the permit.[8] Even then, most fall short. Never in any regime has there existed a law for decommissioning[9] the tailing storage facility, which would drastically reduce the Impact Area Value. Yet, no amount of reclamation, even decommissioning, can completely reverse decades of accumulated impacts. An effective, perpetual water treatment regime may lessen the impact on local water-bodies. A change in ownership may also affect the IAV. However, once a mine is built it will never achieve an IAV of zero ($0) in its operating life, nor in its afterlife, even after reclamation is legally finalized.

This leaves mining with a legacy issue it can never resolve, because mining is <u>not</u> a temporary land use. Mined land is never returned to its original, natural state because streams cannot be re-made[10], nor can any remediation guarantee the total mitigation of future contamination issues.[11] "Every decision to allow a mine to proceed with a tailings storage facility indelibly transforms rivers and their ecosystems for hundreds to thousands of years".[12] The best reclaimed areas are re-contoured and replanted, often with non-native species, suitable, at best, for agricultural or human uses. The few that undergo ecological succession, returning close to their native state, are to date, negligible.

> Reclamation regimes have only addressed activities within a mine's common law boundaries. Even then, most fall short.

---

6 *An Act to Amend the Mines Regulation Act*, SBC 1969, c 18; Coal Mines Regulation Act, SBC 1969, c 3.

7 *An Act to Amend the Mines Regulation Act,* SBC 1973, c 131; An Act to Amend the Coal Mines Regulation Act, SBC 1973, c 100.

8 Miners submit reclamation estimates to the Ministry which are used in the Ministry's initial calculations. They are reviewed every 5-years. See: Reclamation bond calculator: <https://www2.gov.bc.ca/gov/content/industry/mineral-exploration-mining/permitting/reclamation-closure>.

9 Decommissioning means permanent closure and involves a range of activities: removal of infrastructure; draining and treating the supernatant water from the facility down to the level of the waste rock and/or tailings; capping the TSF with rock, topsoil, or water; and long-term monitoring and maintenance, and "takes into account ... the ongoing quality of the ecosystems surrounding a closed mine site" Lacy, Harley, "Closure and Rehabilitation of Gold Mines with a Focus on Tailings Storage Facilities"; Outback Ecology, Vol 2, No. 44 (31 December, 2016).

10 Palmer, Dr. Margaret A., "Summary: Report on Chuitna Coal Project of PacRim Coal, Chesapeake Biological Laboratory, University of Maryland, August 2009: "A new ditch can be dug where the old stream used to be, and can have the same curves and shape. But it will not have the exchange of surface and groundwater at the stream bed, up-welling areas for fish to lay their eggs in, biodiversity of insects that headwater streams provide as food for fish, the purity of water and nutrients wetlands provided".

11 Several historic B.C. mines (Britannia, Brenda, Giant Nickel) and portions of active mines (Mt. Milligan), have, in one form or another achieved varying degrees of 'successful reclamation' but will require water treatment, monitoring and maintenance in perpetuity.

12 Sergeant, Christopher; Olden, Julian D., "Mine Waste dams threaten the environment, even when they don't fail", The Conversation, 24 February, 2020. Online: <https://theconversation.com/mine-waste-dams-threaten-the-environment-even-when-they-dont-fail-130770>.

Alternative Methods

Following, are brief summaries of other methods that try and capture mining's externalized costs. All but "Social Costs", involve the use of "natural capital"[13], "ecosystem services", or "value components."[14] All of these alternative methods require a significant amount of time and money. For example, the assessment of the Exxon Valdez oil spill using the "Willingness to Pay" methodology, was prepared for the State of Alaska for three-million dollars.[15]

Social Costs

Assessing the social cost of a mine involves the baseline data of a population living in proximity to mining activities, and monitoring and tracking the people impacted by each type of harm over time. Data include fluctuations on, *inter alia*: health care, job/income, property, stressors on social and family life, and crime. A 2016 report examined the effects of Mount Milligan, mine (Nak'azdli Whut'en First Nation territory, near Fort St. James, B.C.) identifying "several local and regional data and social costs, that occur from the start of construction to the end of operations":[16]

1. Loss of land;
2. Increases in industrial traffic;
3. Extent of in-migration of (mainly) transient workers;
4. Loss of access to housing and increased rents;
5. Increased impact on local medical resources;
6. Increased vulnerability for women and youth;
7. Increased crime;
8. Impacts on employment and income for local residents;
9. Availability of education and training for local residents.

Calculating the social, spiritual, and psychological values of natural areas for Indigenous peoples is more than the calculating of things.

Cultural Property

Another method involves "cultural property" - Indigenous cultural values linked to the harvesting and consuming of wild food toward ceremonial use, knowledge transmission, and community cohesion.[17] Cultural property embodies the attachment to a place - the sense of place - and has given rise to the proposition of a cultural indicator for non-market resource valuation in continuous generations lived in one place - a generation being 30-years. However, calculating the social, spiritual, and psychological values of natural areas for Indigenous peoples is more than the tallying of things, but rather appreciating the *loss of identity*, which in turn affects social cohesion and the physical, mental, and spiritual health of community members.

---

13 Trucost PLC for the TEEB for Business Coalition, "Natural Capital At Risk: The Top 100 Externalities of Business", April 2013. Online:<https://www.naturalcapitalcoalition.org/wp-content/uploads/2016/07/Trucost-Nat-Cap-at-Risk-Final-Report-web.pdf> at 3, defines "natural capital" as: The finite stock of natural assets (air, water and land) from which goods and services flow to benefit society and the economy. It is made up of ecosystems (providing renewable resources and services), and non-renewable deposits of fossil fuels and minerals.

14 Forests, rivers, wetlands, yielding a flow of ecological services, including (but not limited to) water filtration, water supply, disturbance regulation, carbon sequestration, wildlife habitat, overall forest cover, and potential economic opportunities such as fisheries, forestry, and mining.

15 Harrison, G. W., & Lesley, J. C. , "Must contingent valuation surveys cost so much?", Journal of Environmental Economics and Management, 1996, 31(1), 79-95.

16 Dr. Janice Shandro, "Ten Steps Ahead-Community Health and Safety in the Nak'al Bun/Stuart Lake Region During the Construction Phase of the Mount Milligan Mine" (Victoria: University of Victoria, Fort St. James District, Nak'azdli Band Council, et al, 2014).

17 Donatuto, J.L., Satterfield, T.A. and Gregory, R. "Poisoning the body to nourish the soul: Prioritising health risks and impacts in a Native American community" (Health, Risk & Society, 13(2), 2012) pp103-127.

Willingness to Pay

Preference and cost-based methods[18] rely on market price data to inform valuations. They involve calculating 'stated preferences', or people's willingness to pay ("WTP") to avoid deleterious environmental effects. Used to assess the Exxon Valdez oil spill, "interviewers were sent to 1,599 doors, in every state, who drastically understated the damage of the oil spill, both to make the study defensible, and because some of the harm was not yet known. Economists minimized the results, making the outcome the absolute least Americans were personally willing pay to prevent another spill - one-fifth of what it might reasonably have been - a price ($2.8B) still so high, it was discarded as incredible and unlikely to succeed in court".[19] This method (in the Exxon Valdez case) also raises questions such as why only U.S. citizens were surveyed when the catastrophe was felt globally; and the fact Exxon executives not only paid nothing in penalties, but continued to receive massive personal benefits.

Shared Decision-Making

The shared decision-making ("SDM") approach has emerged in recent years,[20] involving in-depth dialogue, consultation and incorporating Indigenous elders' knowledge. SDM involves the use of scales to determine the levels and ranges of different impacts. These scales use input data of natural measures (loss of habitat), proxy attributes (diseased trees per-hectare as a measure of forest health), and constructed measures (a scale of 1-10 to measure community support for a forest practice). This meticulous and patient work has proven successful in its application.
I

Other Metrics

Other metrics besides the park acquisition data in Table 1 (p. 2) were considered for assessing Natural Area Value. The Ministry of Energy, Mines and Petroleum Resources values land from a minimum of $1.75/ha to stake (mineral) claims,[21] to a maximum of $40/ha rent in lieu of exploration work.[22] Once ironically called the "waste lands of the Crown",[23] today's mineral tenure is still maintained as the highest priority surface interest in land, with the lowest rent - a colonial common law throwback used to clear the way for easy access to the riches below. The deliberate de-valuation of surface land by the mineral tenure system to allow such cheap and easy access is at the core of mining's environmental problems.

---

18 This includes the use of an Environmental Key Performance Indicator model ("EKPI") using Environmentally Extended Inputs and Outputs ("EEIO") and "contingent valuation and lost passive use" damages, which have gained legal standing in some jurisdictions since the assessment of Exxon's liability for damage caused by the 1989 Exxon Valdez oil spill and subsequent civil cases.

19 Wohlforth, Charles, "Costs and values: The legacy of the Exxon Valdez disaster" Scientific American, 30 July, 2010. Online: <https://blogs.scientificamerican.com/guest-blog/costs-and-values-the-legacy-of-the-exxon-valdez-disaster/>.

20 Gregory, Robin, and Trousdale, William, "Compensating aboriginal cultural losses: An alternative approach to assessing environmental damages", (Elsevier: Journal of Environmental Management (2009), 1–11 (2009).

21 BC Reg 529/2004, *Mineral Tenure Act Regulation*, Schedule B, Prescribed Fees.

22 BC Reg 529/2004, *Mineral Tenure Act Regulation*, ss 8(4), 10(5)(6).

23 *Gold Fields Act,* 1859, s V; *Gold Mining Ordinance,* 1867, s 22; and many other statutes, up to and including the *Mineral Act,* RS 1936, c 181, s 14(1): "Every free miner shall, during the continuance of his certificate, but not longer, have the right to enter, locate, prospect, and mine: (a) Upon any waste lands of the Crown ..." the spirit and intent of which still presides over the mineral tenure system today.

Statistics Canada shows the approximate per-hectare value for farm land and buildings in B.C. in 2021[24] at $7,511 per acre ($16,500/ha), while ReMax listings for bare land in the Cariboo Region average is closer to $100,000/ha[25], depending on zoning, and other real estate attributes. Using another jurisdiction's values, or another value regime would yield yet another result, and so on, ad infinitum. Regardless, the issue of monetary value always competes with the certainty of value "that emerges when the soil and the generations who work it, become interchangeable; when the identities of the human beings and the nature of the place are one and the same"[26] - bringing the issue full circle, and back to the question of: "What cultural lens do we use to value land"?

In conclusion, the Fair Mining Calculator captures mining's externalized costs to the lands and waters, and accounts for the cumulative impact new projects have relative to others within a region. Viewing mining projects (and other development) as isolated pockets merely to protect private concerns is no longer viable. The Fair Mining Calculator may be used alone, or in conjunction with the methods outlined above.

The Initiative for Responsible Mining Assurance

The Initiative for Responsible Mining Assurance (IRMA) was founded in 2006 by a coalition of non-governmental organizations (NGOs), downstream businesses, organized labour, affected communities, and mining companies. IRMA represents ethical and environmental mining best practices and standards; including the recognition of the United Nations Declaration on the Rights of Indigenous Peoples, and justice for aggrieved communities. Some of the world's most progressive companies have already undertaken the IRMA certification process, with more in progress. "IRMA envisions a world where the mining industry is respectful of the human rights and aspirations of affected communities; provides safe, healthful and respectful workplaces; avoids or minimizes harm to the environment; and leaves positive legacies."

The Fair Mining Calculator as a regulatory instrument

This report is but one example of two major mines within one First Nation's traditional territory. If we were to calculate this across all First Nations that share the province of British Columbia, it would become clear that contrary to the prevailing message, in reality mining is inherently a net-loss activity when the lands and waters are taken into full account. Figure I on page 25 shows a hypothetical estimate, based on the combined average IAV for Mount Polley and Gibraltar ($323/2 = $161.5M) for the current B.C. major mine inventory (67 mines) at $10.8 billion.

To avoid continuing down this path, the Fair Mining Calculator could be used to set permitting, operating, and area-based cumulative effect thresholds. Perhaps, prior to permitting, a mine would have to demonstrate, and implement measures in its mine plan that would ensure it does not cross a predetermined GIAV threshold of a region, (watershed, traditional territory). Or, if an operating mine's IAV exceeds the mine's contribution to the industry's Value of Shipments, the mine would need to decrease its risk factors, or shut down. The Fair Mining Calculator could compel industry to use best available technologies and practices, and may provide relief to environmental groups and Indigenous nations in the perpetual battle for respectable mining practices.

---

24 Statistics Canada, Table 32-10-0047-01, Per acre value of farm land and buildings, as of July 1, 2021, British Columbia. Online:<https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210004701>.

25 Online: <https://www.remax100.ca/our-listings>.

26 Roberts, Gregory David, "Shantaram" (New York: St. Martin's Griffin, 2004) at 132, describing 2,000 year-old Sunder village in India. Northern Shuswap peoples have lived on their land more than 5,000 years.

The Net-Loss

Impact Area Values
vs.
Value of Shipments, Taxes and Royalties,
and Primary and Secondary Benefits

Value of Shipments
1986 - 2021

The total value of mining in B.C. in Table 14 references data from Natural Resources Canada,[27] (B.C.'s provincial "Annual Production Value" source), and shows British Columbia's annual Value of Shipments,1986 to 2021, as $209B - an average of $5.8B/year.

Table 14

Value of Shipments - B.C. - 1986 - 2021
($000s)

1986	2,511,615	1995	4,501,289	2004	3,739,966	2013	7,111,670
1987	2,896,497	1996	4,339,930	2005	5,384,165	2014	6,815,371
1988	3,325,091	1997	4,681,322	2006	5,990,584	2015	6,185,840
1989	3,343,784	1998	4,466,237	2007	5,611,423	2016	6,703,844
1990	3,954,393	1999	4,535,903	2008	7,402,675	2017	9,177,962
1991	3,839,313	2000	7,901,035	2009	5,622,036	2018	9,783,459
1992	3,500,079	2001	8,623,308	2010	7,165,905	2019	8,869,547
1993	3,538,275	2002	2,863,558	2011	8,981,532	2020	8,118,973
1994	4,066,161	2003	2,887,311	2012	7,826,270	2021	12,899,147
			TOTAL		209,165,470		

Mount Polley - the day after. August 5th, 2014

27 1985-89 *Ibid.* 1990-on: Natural Resources Canada. Online: <https://mmsd.nrcan-rncan.gc.ca/prod-prod/ann-ann-eng.aspx>. Natural Resources Canada suppresses the values of coal production from 2014 on for "confidentiality requirements".

Gross Taxes and Royalties
1986 - 2021

Data in Table15 from the B.C. Ministry of Finance[28] shows the total of all taxes and royalties[29] collected from the coal and metal mining sector by the province of British Columbia from 1986 to 2021at $5.1B - 2.43% of the total Value of Shipments from Table 14, before subsidies - an average of $141.6M per-year.

Table 15

Gross Taxes and Royalties - B.C. - 1986 - 2021 ($000's)							
1986	47,411	1995	52,912	2004	71,558	2013	155,587
1987	48,610	1996	69,820	2005	111,422	2014	111,603
1988	45,428	1997	41,223	2006	231,800	2015	94,678
1989	63,811	1998	45,881	2007	305,925	2016	108,229
1990	62,000	1999	40,919	2008	205,381	2017	263,722
1991	31,654	2000	40,071	2009	327,694	2018	489,392
1992	28,570	2001	52,056	2010	294,793	2019	411,949
1993	29,100	2002	47,324	2011	368,080	2020	257,659
1994	38,891	2003	57,201	2012	362,126	2021	83,309
			TOTAL	5,097,790			

Looking south over the 9 sq. km.
Highland Valley Mine TSF,
west of Kamloops, B.C.

28 Taxes and Royalties from: Mineral, Oil and Gas Revenue Branch Mineral Tax Section, Mineral Resource Tax/Coal Royalties/Mineral Tax Historical Revenue Summary; XLS 2021-06-04. Online: <https://www2.gov.bc.ca/assets/gov/taxes/natural-resource-taxes/mining/publications/mineral-tax-historical-revenue-summary.pdf>.

29 These taxes include: Mineral Resource Tax (none collected since 1990); Coal Royalties (phased out:1990); Mineral Tax - Metals (phased in: 1990); Mineral Tax - Coal (phased in: 1993); Mineral Land Tax, and Mine Health & Safety (introduced: 1995).

Primary and Secondary Benefits

Data for Primary and Secondary Benefits are derived from the Statistics Canada Input/Output tables 15-211-MQOG for B.C.

Primary benefits include the wages, salaries, and employers' social contributions; as well as the government's taxes on products, subsidies on products, subsidies on production and taxes on production, from the Statistics Canada Input/Output ("I/O") tables "Ratios of Government Revenue and Household Income to Total Revenue for the Extraction Industry (Mining, Quarrying, and Oil and Gas)" ("MQOG"). They also account for the secondary benefits which are based on purchases made by the MQOG sector from the diverse collection of immediate suppliers of goods and services in B.C. These result in wages, salaries, and employers' social contributions made by these suppliers and the taxes, net of subsidies, paid by these suppliers.

They do not include tertiary (third-order) effects on B.C. purchases made by these suppliers (i.e., suppliers of the suppliers), or fourth-order, because the impacts become smaller and smaller, and also farther and farther in the future, which makes them more susceptible to other effects beyond the original impact of the MQOG sector. We also do not consider the downstream benefits, i.e., the wages and taxes paid by buyers of the mining ore, since most of these customers are outside of B.C. For example, most copper mined in B.C. is shipped to Asia as concentrate for smelting and refining, so there is no downstream benefit of this order to B.C. households or government.

Input/output tables take enormous effort, time, and care to compile and ensure correctness; and are always about 3-years behind.[30] Many countries produce them only every 5-years, but some, like Canada, have been producing them annually. MQOG data is accessible from 2005. Statistics Canada was unable to produce data for 2012, 2013, and 2014. The most recent data we obtained for this report is from 2015, and was completed in 2018.

Compared to the Impact Area Values, the Primary and Secondary data reveal (along with Taxes and Royalties, and Value of Shipments), that all of the so-called "spin-off" benefits of mining a) do not compensate for the damage sustained by the environment, and b) have been obtained by the irreversible sacrificing of lands and waters solely for the benefit of the immediate generation. The Impact Area Value negates Primary and Secondary benefits, Taxes and Royalties, and even some Value of Shipments for every year on record.

Sludge from the Equity Silver mine, 2007.

30 Special thanks to Andreas Trau, Senior Economic Analyst, Statistics Canada.

Table 16

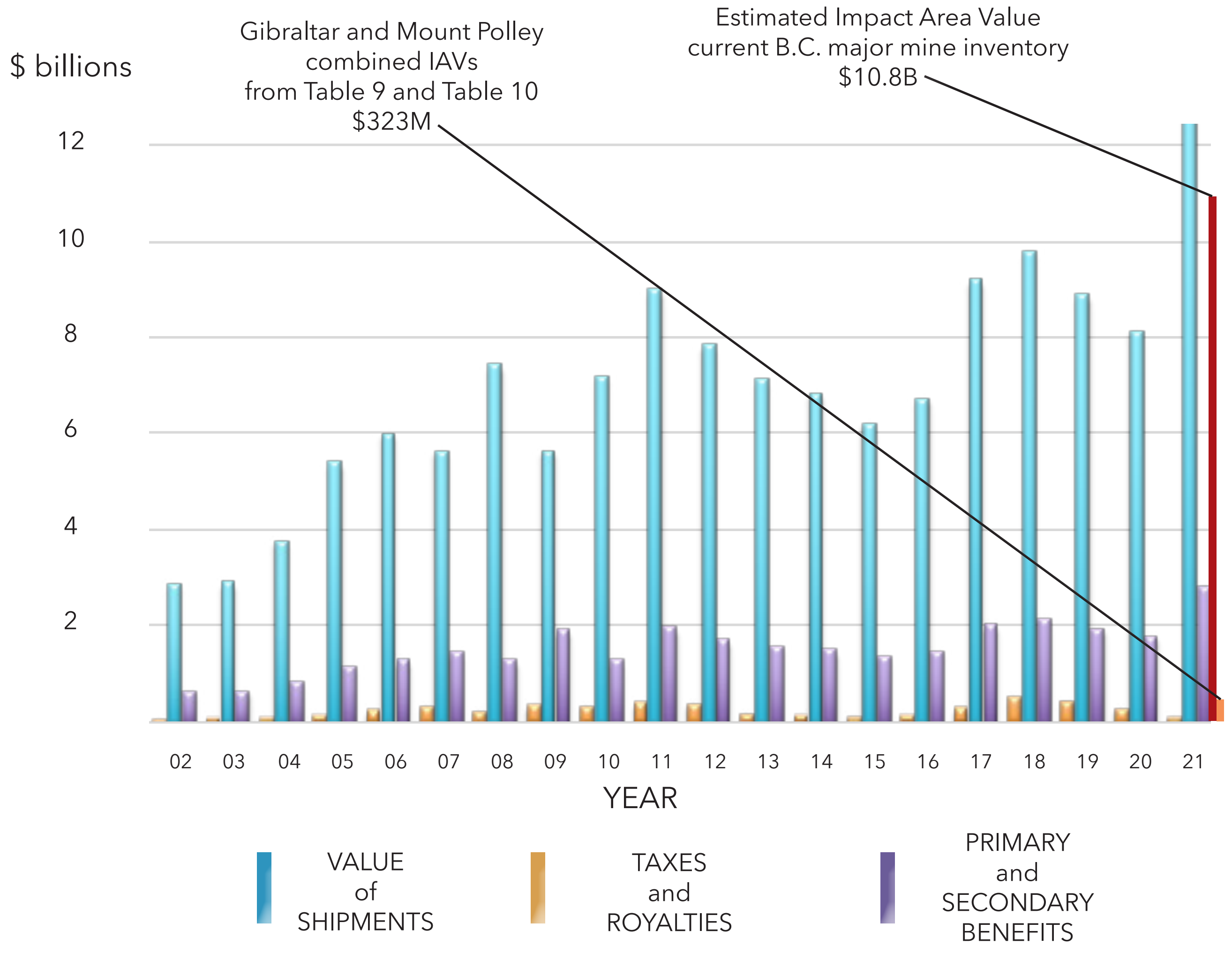
Statistics Canada Symmetric Input Output Tables 15-211-X - MQOG for B.C.									
Primary Benefits	2005	2006	2007	2008	2009	2010	2011	2015	Mean
Taxes on products	0.0055	0.0055	0.0066	0.0056	0.0112	0.0087	0.0061	0.0000	0.0062
Subsidies on products	-0.0005	-0.0005	-0.0017	-0.0014	-0.0006	-0.0020	-0.0017	-0.0086	-0.0021
Subsidies on production	-0.0001	-0.0001	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000
Taxes on production	0.0064	0.0066	0.0048	0.0036	0.0062	0.0054	0.0054	0.0167	0.0069
Total Government Income	0.0113	0.0115	0.0097	0.0077	0.0168	0.0121	0.0097	0.0081	0.0109
Wages and salaries	0.0901	0.0901	0.1092	0.0854	0.1013	0.0918	0.0983	0.1389	0.1006
Employers' social contributions	0.0150	0.0150	0.0124	0.0114	0.0132	0.0113	0.0104	0.0241	0.0141
Total Household Income	0.1051	0.1051	0.1216	0.0968	0.1145	0.1030	0.1086	0.1630	0.1147
Total Primary Benefits	0.1164	0.1166	0.1312	0.1045	0.1312	0.1151	0.1184	0.1711	0.1256
Secondary Benefits	2005	2006	2007	2008	2009	2010	2011	2015	Mean
Taxes on products	0.0039	0.0038	0.0047	0.0037	0.0076	0.0013	0.0007	0.0000	0.0032
Subsidies on products	-0.0007	-0.0008	-0.0009	-0.0008	-0.0036	-0.0013	-0.0008	-0.0009	-0.0012
Subsidies on production	-0.0001	-0.0001	0.0000	0.0000	-0.0002	-0.0014	-0.0008	-0.0002	-0.0003
Taxes on production	0.0134	0.0134	0.0167	0.0047	0.0154	0.0088	0.0050	0.0072	0.0105
Total Government Income	0.0165	0.0164	0.0204	0.0075	0.0191	0.0074	0.0041	0.0061	0.0122
Wages and salaries	0.0693	0.0693	0.0878	0.0535	0.1580	0.0459	0.0286	0.1059	0.0773
Employers' social contributions	0.0102	0.0103	0.0125	0.0064	0.0261	0.0071	0.0045	0.0170	0.0118
Total Household Income	0.0795	0.0796	0.1002	0.0599	0.1840	0.0530	0.0331	0.1229	0.0890
Total Secondary Benefits	0.0960	0.0960	0.1206	0.0674	0.2032	0.0604	0.0372	0.1289	0.1012
Total Primary and Secondary Benefits	0.2124	0.2126	0.2519	0.1720	0.3344	0.1755	0.1555	0.3001	**0.2268**

The Impact Area Value for all mines negates taxes, primary and secondary benefits, and even portions of Value of Shipments for every year on record.

Projected Impact Area Value
vs.
Value of Shipments, Taxes and Royalties, and
Primary and Secondary Benefits

2002 - 2021

FIGURE I



Projection based on the Ministry of Energy, Mines and Petroleum Rescoures' inventory of 67 coal, mineral, and aggregate mines; operating, closed, or in care and maintenance, at an average of $161.5M per mine. Online: <https://mines.nrs.gov.bc.ca/projects>. Figure does not include the historical mine inventory, nor the placer mine inventory.

The combined Primary and Secondary Benefits are reproduced from Table 16 for years 2005-2011 and 2015. The combined average mean of 0.2268 was applied to Figure I for years 2000-2004, 2012-2014 and 2016-2021.

FAIRMINING COLLABORATIVE

2022

ISBN 978-0-9921509-3-8