

Understanding What Works and What Doesn't to Improve Decision Making



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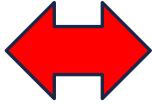
Andrew Thrift, Teck Resources Ltd, Canada



Introduction

Uncertainty and Risks in Large Mining Projects:

- Technical
 - Financial
 - Environmental
 - Social
- Technical risks carry environmental and social risks and viceversa



In BC

- Only 1 out of 2 approved mines are built
- Only 1 out of 4 approved mines are built on schedule

Globally

- During recent years, construction of mining projects average cost overruns of ~40%



Quebrada Blanca, Chile (from ~\$5B to ~\$9B)



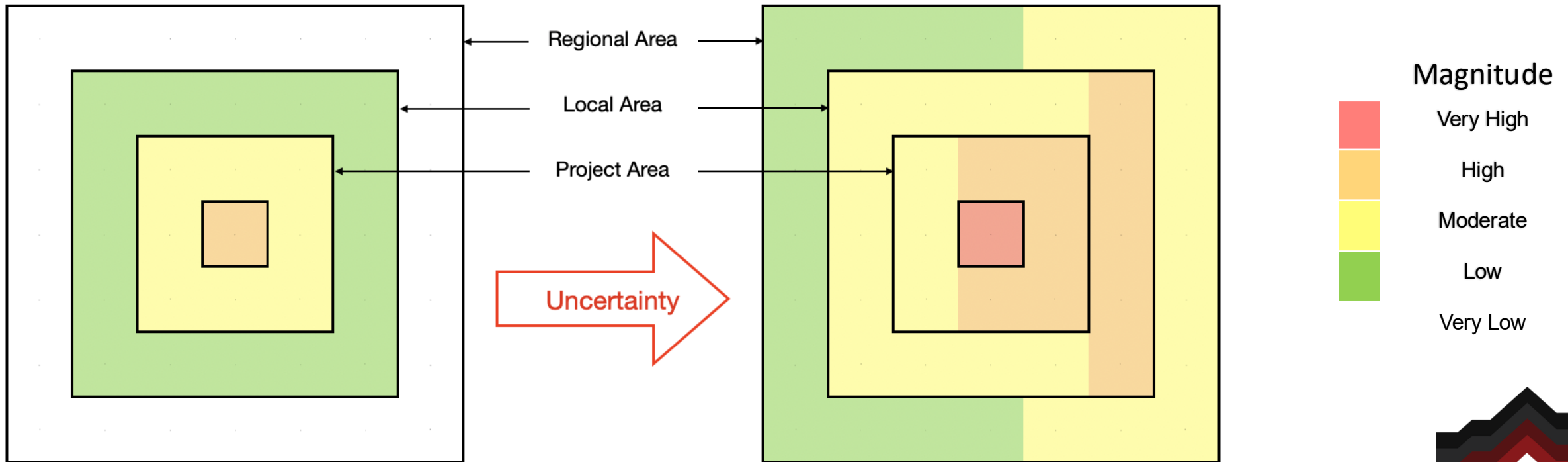
The Site C dam and generating station. PHOTO BY B.C. HYDRO

Site C, Canada (from ~\$9B to ~\$16B)

Introduction

Uncertainty amplifies the residual effect; creating the potential for it to be of higher magnitude; larger geographic extent or longer duration; potentially generating a more severe consequence.

Uncertainty also delays the environmental assessment process



\$1M in environmental degradation becomes \$100M

Navigating Uncertainty

Improving confidence on mitigation effectiveness has been recognized as a need by regulators and practitioners

2011/2015

RECOMMENDATION 5:

We recommended that the Environmental Assessment Office conduct post-certificate evaluations to determine whether environmental assessments are avoiding or mitigating the potentially significant adverse effects of certified projects.

OAG Assessment:

● Partially implemented

Auditor General of British Columbia | May 2015 | Follow-up Report: Environmental Assessment Office

2025

Report to Impact Assessment Agency of Canada
From the Working Face: Consulting Practitioners' Insights

January 9, 2026
Page 39

Recommendation 11: Document effective mitigation and management measures and use that information to improve assessment quality and efficiency.

In addition to data about environmental conditions and effects, practitioners participating in the research emphasized the potential benefits to assessment (including CEA) of having access to well-documented information about mitigation effectiveness.

Ventus Development Services Inc. © 2026



“Mitigation Effectiveness” is not being documented. Evidence is lacking

Navigating Uncertainty

Factors Influencing Uncertainty	Sources of Uncertainty for Effects of Water Quality Causer to Mining Projects
Knowledge of the Valued Component	Hydrology and hydrogeology are well developed scientific fields
Mitigation Effectiveness	Water treatment technologies are well known; but performance of existing water treatment is information not publicly available.
Modelling of the Effect	Water balances carry high levels of uncertainty because of the complexity associated to predicting multiple variable involved in water balanced (i.e. precipitation, evaporation, runoff, seepage, etc, etc.)
Data Used to Feed Models	It is not feasible to collect all information to feed models; but data collection over periods of more than one year to capture seasonal trends is required
Interpretation of Results	Senior Reviewer and Qualified Professionals are involved

What is the Level of Uncertainty for Water Quality Effects
Low
Moderate
High
Moderate
Low

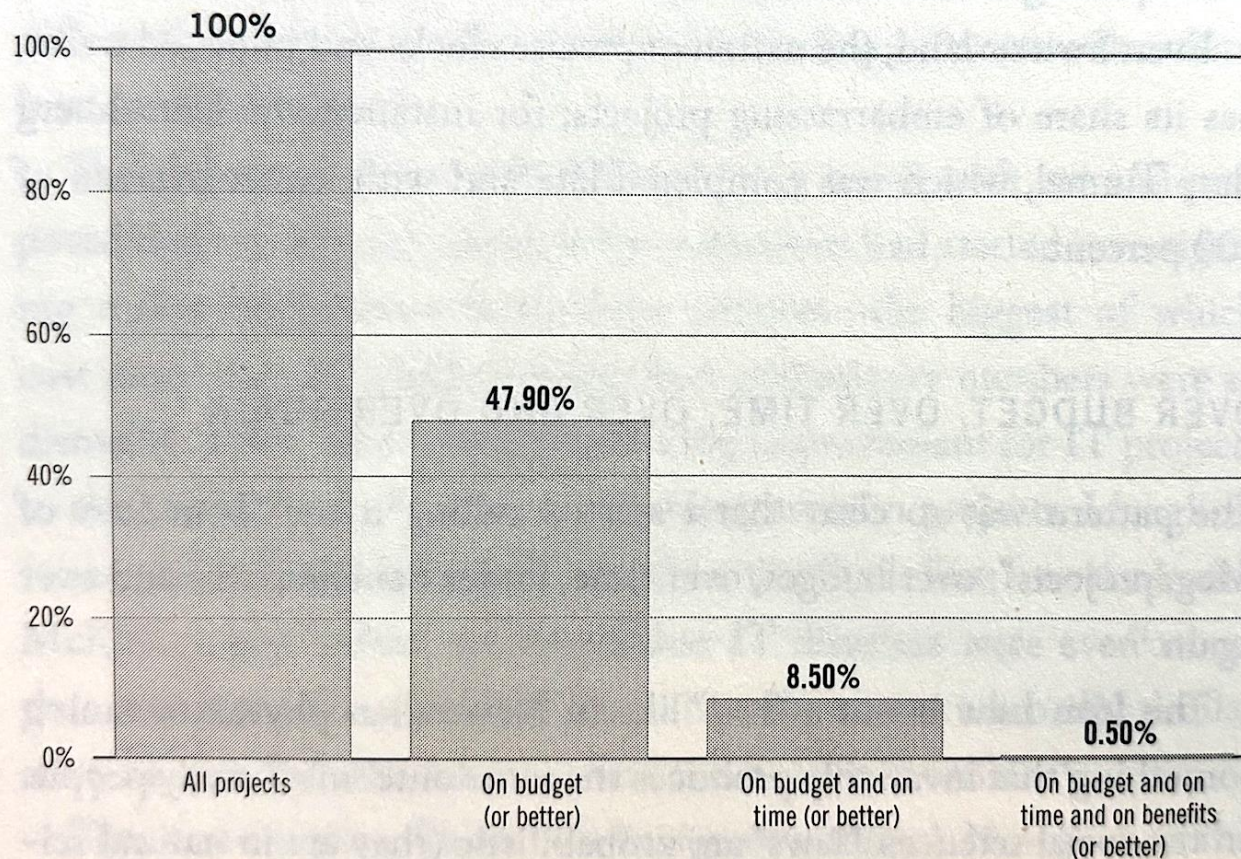
Source: BC EAO Effects Assessment Policy, 2020

**One source of uncertainty which is not listed is the “Execution Effectiveness”
The general assumption is that Projects will be executed “Successfully”**

Navigating Uncertainty

THE IRON LAW OF PROJECT MANAGEMENT:

"Over Budget, Over Time, Under Benefits, Over and Over Again"



The Iron Law

"The probability that any big project will blow its budget and schedule and deliver disappointing benefits is very high and very reliable"

Source: Flyvberg B., Gardner D. 2023, "How Big Things Get Done"



Navigating Uncertainty

Optimism Bias

A cognitive predisposition found with most people to judge future events in a more positive light than is warranted by actual experience

Strategic Misrepresentation

Proponents deliberately and strategically overestimate benefits and underestimate costs to increase likelihood of approval and funding

Uniqueness Bias

The tendency individuals have to think they are more unusual than they actually are

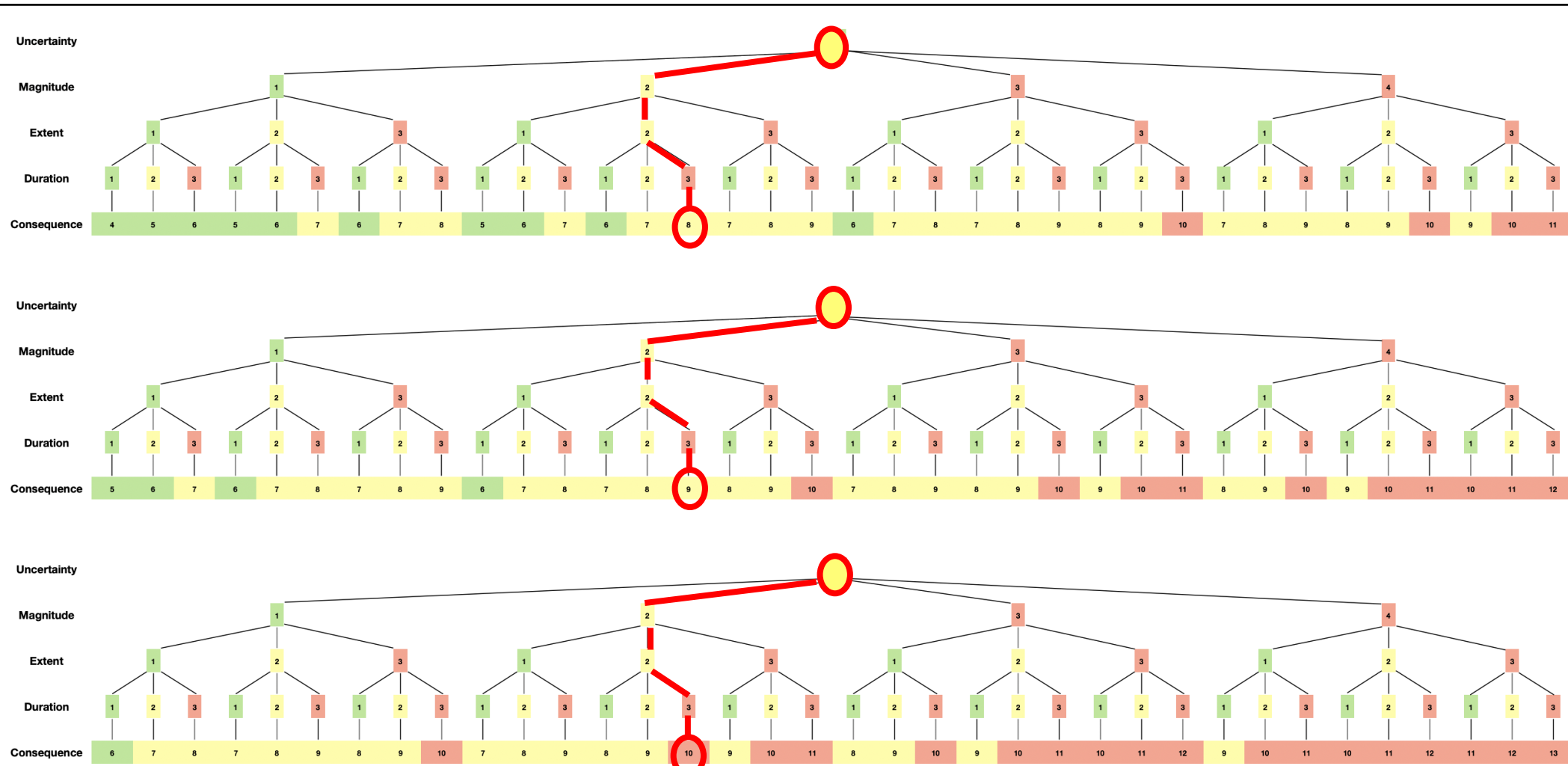
Reference Class Forecasting is a method for predicting future performance of projects by analyzing the actual outcomes of similar projects

It should be used in the assessment of residual impacts and in the assessment of risk derived from uncertainty

Navigating Uncertainty

How much risk
is acceptable on
the face of
uncertainty?

We define the
criteria for risk
tolerance



Mitigation Case Studies

Environmental

High elevation grasslands at Fording River Extension

Ministry of Water, Lands and Resources Stewardship, Memo July 22, 2022

- 5) No evidence of high elevation grassland recovery after reclamation: Evidence shows that generalized approaches to mining exploration road reclamation in Gg16 result in significantly different ecosystems that do not resemble undisturbed Gg16, irrespective of time since disturbance and are likely related to alteration in site and soil conditions (Cameron et al., In Prep.). Road recovery areas were consistently different from undisturbed adjacent grasslands at sites located at Turnbull Mountain, Ewin Ridge, Todhunter, Castle Mountain, Horseshoe and Burnt Ridge Extension, so reclaimed mining area does not contribute to high elevation grassland area (Cameron et al. in Prep).

EAO Reasons for Decision, October 10, 2025

Considering the information provided in the 2021 DPD, and during the 2022 Dispute Resolution process, the CEAO concluded that both the severity of effects and the ability to mitigate potential effects are uncertain but did not conclude that the Project would cause extraordinarily adverse effects.

While the CEAO identified several deficiencies for which additional information was required in the form of a revised DPD, they also held the view that the Act does not intend that the EAO carry out an assessment of the severity of effects to conclude if a project will cause extraordinarily adverse effects (e.g. a “miniature environmental assessment”) to inform a readiness decision. The CEAO also concluded that assessing the effectiveness of mitigation measures is generally a matter for environmental assessment, not the Readiness Decision.



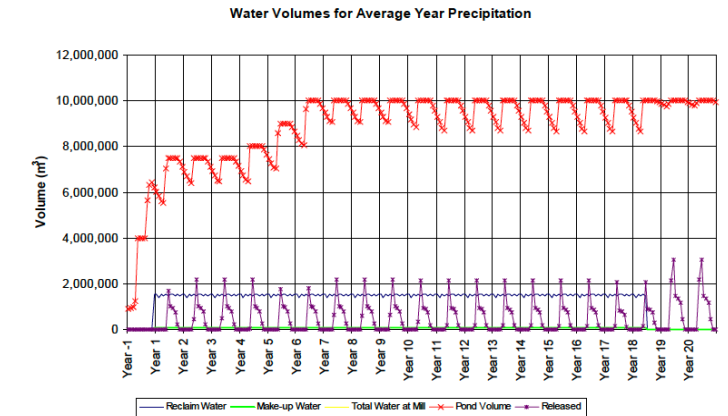
High Uncertainty because of the complexity of this mitigation and lack of evidence of success in the past

Mitigation Case Studies

Environmental

Water quantity and quality at Red Chris

- Original water balance predicted the need for treatment and release of water from the Tailings Management Facility (TMF)
- Mine hasn't discharged water from the TMF up to date
- TMF not performing as designed or expected
- Seepage flow from the TMF is higher than anticipated
- Adaptive management measures were implemented to recover seepage
- Plume of seepage currently migrating downstream of TMF



PROJECT No.	VM00347	DATE	September 1, 2004
Tailings Impoundment Water Volumes for Average Precipitation by Year		amec	Figure 3.7.13

Water balances carry a high level of uncertainty in mining projects

Mitigation Case Studies

Environmental

	Eskay Creek Revitalization		Fording River, Greenhills, Line Creek & Elkview	
	 Appendix 1-7 Water Treatment Preliminary Design Considerations for the Eskay Creek Revitalization Project			
Water Treatment During Operations	Predicted in EIA	800 lps	Current Capacity	900 lps
Water Treatment Facilities	Proposed in EIA	1	Existing	6
Metals of Concern Requiring Treatment	Identified in EIA	Al, Se, Sb, Co, Mn, Li, As, Mb, Cu, Pb, Ni, Zn, Cd	Identified by Monitoring	Se
Mine Footprint	Declared in EIA	731 ha	Declared in Reclamation Reports	16,203 ha
	lps	m3/d	lps	m3/d
Construction	210	18,144		
Operations	800	69,120	897	77,500
Closure & Post-Closure	925	79,920		

EA Process is supported by feasibility level information, but the engineering of all Project components are not developed to the same level. Engineering focus is on the components that generate product; not on the mitigation measures.

Sources of uncertainty when water treatment is proposed as mitigation:

- **Water balance**
- **Treatment capacity**
- **Capital expenditures**
- **Operating expenditures**

Mitigation Case Studies

Environmental



Jan 8, 2026

Insufficient water treatment capacity

Peace River Hydro Partners ordered to pay \$1.1 million for deposit of contaminated drainage water into the Peace River

August 2, 2023 – Fort St. John, British Columbia – Environment and Climate Change Canada

On July 31, 2023, Peace River Hydro Partners pleaded guilty in the Provincial Court of British Columbia in Fort St. John to one charge of depositing a deleterious substance into water frequented by fish, in contravention of the federal *Fisheries Act*. It was fined \$1.1 million, which will be directed to the Government of Canada's Environmental Damages Fund to support projects that have a positive impact on Canada's natural environment.

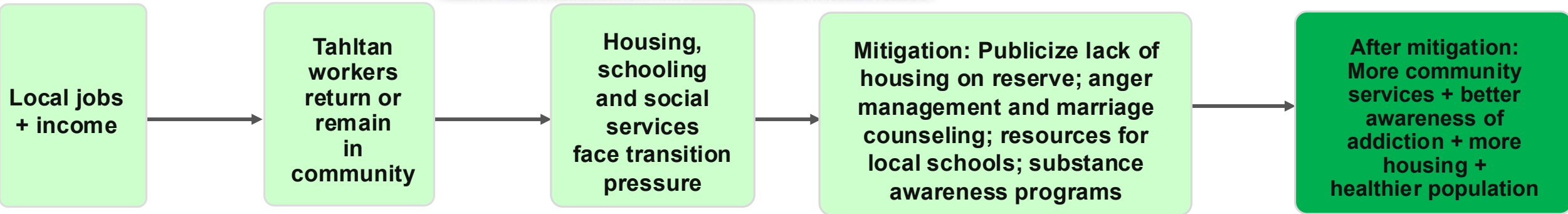
The charge stemmed from an investigation by Environment and Climate Change Canada enforcement officers into the discharge of 3,300 m³ of contaminated drainage water into the Peace River on September 9 and 10, 2018. The investigation determined that, during a high rainfall event, the water management infrastructure at the Site C Clean Energy Project near Fort St. John, British Columbia, had insufficient available capacity to treat the additional drainage, and a mix of treated and untreated drainage was released into the Peace River. The contaminated drainage water had a low pH (acidic) and a high concentration of metals. A sample of the drainage water collected on September 9, 2018, determined that it contained a concentration of aluminum that was acutely lethal to fish. This unauthorized release was contrary to subsection 36(3) of the *Fisheries Act*.

As a result of this conviction, Peace River Hydro Partners will be added to the Environmental Offenders Registry. The Registry contains information on convictions of corporations registered for offences committed under certain federal environmental laws.

Mitigation Case Studies

Social

2005 Red Chris Mine Social Impact Assessment



SIA wording

Return migration could put stress on “housing, schooling and social services.”

Expected Residual Effects

After mitigation: “more community services,” “increased housing stock,” and “a healthier population.”

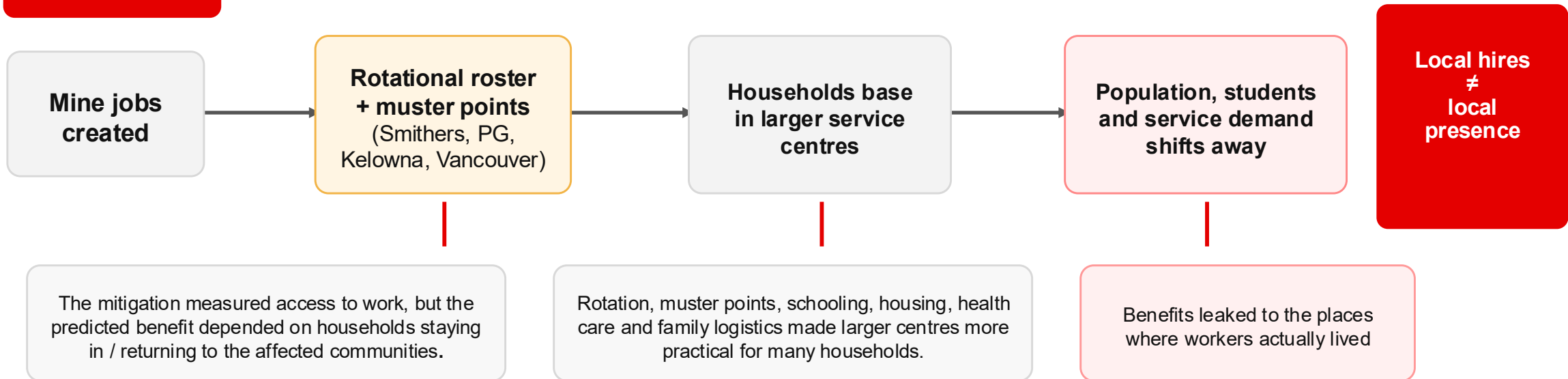
Mitigation Case Studies

Social

Red Chris: what actually happened?

EXPECTED: jobs and income keep / bring people home → local housing, schooling, social services and health improve

OBSERVED / LEARNED



Mitigation effectiveness must test the predicted social outcome — not just count the mitigation activity.

Mitigation Case Studies

Social

Other social mitigation examples worth testing for effectiveness

Local procurement: contracts captured by regional intermediaries, not affected communities.

Test: local ownership, local employees, payroll location, capacity retained after construction.

Training-to-employment: training counts look good, but conversion to stable employment is weak.

Test: hire rate, retention, progression, reasons for attrition.

Safe workplace / sexual harassment controls: policies exist but women and Indigenous workers still exit.

Test: reporting confidence, resolution time, retention, repeat incidents.

Housing and cost-of-living: benefits increase pressure on scarce housing and services.

Test: rent, vacancy, waitlists, displacement and worker household choices.

A mitigation measure should not be considered successful just because the company promised it, documented it or implemented the actions.

It should be judged by whether it actually changed the social outcome it was meant to improve.

Conclusions

- Little evidence that mitigation effectiveness evidence is being considered in environmental assessments. Reference class forecasting can improve the process.
- Investing resources conducting research on mitigation effectiveness will help navigate uncertainty and speed up the assessment of residual project effects.
- It doesn't matter how good an environmental assessment is done if the Project is poorly executed.



Let's continue the conversation!

Message me your questions or comments in the IAIA26 app.

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