Pathway to Accountability:
A Strategic Framework for Evaluating Climate Adaptation Interventions

by

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Abstract

A key factor contributing to the success of climate adaptation interventions is the use of government-wide strategic evaluation processes that analyze the impacts of the various adaptation interventions used across government departments. There are currently no overarching strategic policies or frameworks for the cross-governmental evaluation of adaptation interventions in Canada. To find a potential solution to this problem, this study analyzes best practices in evaluation design for climate adaptation and government accountability assessments using a mixed-methodology approach. These methodologies are a literature review, theory-based approach, bowtie methodology, and understanding of jurisdictional issues. The findings are used to develop a scalable and replicable Climate Adaptation Accountability Framework that establishes a process governments' can use to evaluate whether they are meeting their adaptation commitments. To contextualize this issue in a pragmatic context, the study is centered on the provincial climate adaptation approaches employed by British Columbia in the transportation infrastructure sector.

Keywords: Climate Adaptation Policy; Policy Evaluation Methods; British Columbia; Transportation Infrastructure; Climate Change; Canadian Policy

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Table of Contents

Declaration of Committee ii
Abstract iii
Acknowledgements iv
Table of Contents v
List of Tables viii
List of Figures ix
List of Acronyms x
Executive Summary xi

Chapter 1. Introduction 1
1.1. Scope of Research 2
1.2. Definitions & Contexts 3

Chapter 2. The Pursuit of Climate Resilience in British Columbia 5
2.1. The State of Climate Adaptation Policy in British Columbia 5
2.2. Complexities of Climate Adaptation in a Provincial Setting 7
2.3. Climate Risks Facing British Columbia 8

Chapter 3. The Need for Climate Adaptation Interventions 11
3.1. Supply Chain Disruptions Due to Climate Change 11
3.2. Forgotten Communities 14
3.2.1. Disproportionate Impacts to Indigenous Peoples 14
3.3. Community vs. Government Capacity 15

Chapter 4. Methodology 18
4.1. Literature Review 18
4.2. Theory-Based Approach 18
4.3. Bowtie Methodology 18
4.4. Jurisdictional Issues 19
4.5. Limitations 19

Chapter 5. Key Considerations for Adaptation Evaluation 20
5.1. The Current State of Climate Adaptation Evaluation 20
5.1.1. Challenges to Adaptation Intervention Evaluation 22
5.2. Best Practices for Evaluation Design 23
5.2.1. Evaluation Purpose 23
5.2.2. Types of Evaluation Design 24
5.3. Theory-Based Evaluation Methodology: Theory of Change 25
5.4. Risk Management 28
5.4.1. Climate Risk Management 28
5.4.2. Risk Management in Theory Based Approaches 29
5.4.3. Risk Communication & the Bow-Tie Assessment 29
5.5. Indicators for Adaptation Evaluation 31

5.5.1. Process versus Outcome Indicators 31

Chapter 6. Climate Adaptation Accountability Framework – An Overview 32
6.1. Why a Framework? 32
6.2. Climate Adaptation Accountability Framework 32
6.3. Components of a Successful Framework 35
6.3.1. Risk Assessment and Management 35
6.3.2. Indicators 35
6.3.3. Adaptive Co-management 37
6.3.4. Standardizing the Evaluation Process 38

Chapter 7. Climate Adaptation Accountability Framework – Detailed Description 39
7.1. Immediate, Intermediate, and Ultimate Outcomes 39
7.2. Adaptation Goal 39
7.3. Organizational Goal 40
7.4. Adaptation Policy Objective 40
7.5. Adaptation Interventions & Outcomes 43

Chapter 8. Applying the Climate Adaptation Accountability Framework Scenario: An Illustration 47
8.1. Adaptation Goal 47
8.1.1. Provincial Climate Risk 47
8.2. Organizational Goal 48
8.3. Adaptation Policy Objective 49
8.3.1. Regional Climate Risk 50
8.4. Adaptation Intervention 50
8.4.1. Regional/Localized Risk Considerations 51
8.4.2. Intended Outcomes 52
8.4.3. Indicators 54
8.4.4. Actual Outcomes 54
8.5. Interpreting the Evaluation Results 56

Chapter 9. Analysis of Framework 59
9.1. Objectives & Criteria 59
9.2. Effectiveness 59
9.3. Adaptive Capacity 60
9.4. Adaptive Co-management 60
9.5. Process & Intervention Improvement 61
9.6. Accountability 61
9.7. Administrative Ease 62
9.8. Final Rating 62

Chapter 10. Conclusion 64
10.1. Future Research 64
10.2. Next Steps and Concluding Thoughts 64

References **67**

Appendix A. Nine key expectations from *Resilient Infrastructure Engineering Design* policy **73**

Appendix B. BCMOTI Infrastructure Assessment Practices **74**

List of Tables

Table 2.1 – Summary of Top 15 Climate Risks Facing B.C. 9
Table 3.1 – Potential impacts of Climate Change on Transport Systems 12
Table 5.1 – Key Challenges to Evaluating Adaptation Interventions 22
Table 5.2 – Summary of Evaluation Purposes 23
Table 5.3 – Summary of Evaluation Types 24
Table 5.4 – GoBC “Climate Risk Assessment Framework Overview” (B.C. Ministry of Environment, 2019a, p. 9) 28
Table 6.1 – Framework Guiding Principles and Objectives 33
Table 6.2 – Proposed Indicator Buckets for Assessing GoBC Adaptation Interventions 36
Table 7.1 – Phases & Interpretation of Outcomes 44
Table 8.1 – Provincial climate risks anticipated to impact provincial transportation infrastructure 48
Table 8.2 – Summary of Bella Coola & Pine Pass Highway Flood Impact Incidents 51
Table 8.3 – Vulnerability Assessment (VA) Results for Bella Coola and Pine Pass 52
Table 8.4 – Example of Indicator Use in Applied Framework 54
Table 9.1 – Assessment of Effectiveness 59
Table 9.2 – Assessment of Adaptive Capacity 60
Table 9.3 – Assessment of Adaptive Co-management 61
Table 9.4 – Assessment of Process and Intervention Improvement 61
Table 9.5 – Assessment of Accountability 62
Table 9.6 – Assessment of Administrative Ease 62
Table 9.7 – Overall Rating of Framework 63

List of Figures

Figure 5.1 – Theory of Change Evaluation – Senegal Stormwater Management and Climate Change Adaptation Project 27
Figure 5.2 – Bowtie Diagram 30
Figure 6.1 – Climate Adaptation Accountability Framework Schematic 34
Figure 6.2 – Relationship between process and outcome-based indicators 37
Figure 7.1 – Feedback Loop 1 42
Figure 7.2 – Feedback Loop 2 – Adaptation Policy Objectives to Outcomes 43
Figure 7.3 – Side-by-side Comparison of Intended and Actual Outcomes 45
Figure 8.1 – Adaptation Goal for Applied Scenario 47
Figure 8.2 – Summary of Organizational Goals 49
Figure 8.3 – Adaptation Policy Objective 50
Figure 8.4 – Adaptation interventions 51
Figure 8.5 – Intended Outcomes of infrastructure Adaptation Interventions 53
Figure 8.6 – Actual Outcomes of Infrastructure Adaptation Interventions 55
Figure 8.7 – Fully Applied Climate Adaptation Accountability Framework 58

List of Acronyms

B.C.	British Columbia
BCMOTI	British Columbia Ministry of Transportation and Infrastructure
CCAA	*Climate Change Accountability Act*
CCAR	Climate Change Accountability Report
CRA	Climate risk assessment
GoBC	Government of British Columbia
IIU	Immediate, intermediate, and ultimate outcomes
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organization
LHS	Left-hand side
MRE	Monitoring, reporting, and evaluating
OAGBC	Office of the Auditor General of British Columbia
OECD	Organization for Economic Co-operation and Development
PCIC	Pacific Climate Impact Consortium
PICS	Pacific Institute for Climate Solutions
PIEVC	Public Infrastructure Engineering Committee
RCP	Representative concentration pathway
RHS	Right-hand side
SML	Short, medium, and long-term outcomes
TOC	Theory of Change
VA	Vulnerability assessment
VRA	Vulnerability risk assessment

Executive Summary

In a climate adaptation context, monitoring, reporting, and evaluation (MRE) frameworks are used to ensure continuous improvement of knowledge and thus demonstrates that an adaptation evaluation can be both a planning and assessment tool. However, the inability to standardize metrics to measure the effectiveness of government adaptation interventions has made developing adaptation MRE frameworks a complex issue. As a result, there are currently no provincial cross-governmental adaptation evaluations underway in Canada. The gap in evaluation practices has made it exceptionally challenging for internal and external government actors to determine whether provincial governments are meeting their climate adaptation commitments. Existing academic and grey literature demonstrates that focusing on a standardization of adaptation evaluation processes rather than metrics, can serve as a solution to this problem. This study proposes a Climate Change Accountability Framework to help government move forward on implementing and assessing adaptation interventions.

The proposed Accountability Framework is ultimately meant to be transferable to any provincial government; however, to contextualize the identified policy problem and recommendation, British Columbia (B.C.) is used as a sample jurisdiction that the framework could be applied to. This paper begins by exploring climate adaptation practices in the B.C. context, which includes a discussion of B.C.-specific climate risks, disproportionately impacted populations due to climate change, and the Government of B.C.'s current adaptation practices. It is beyond the scope of this paper to cover the broad reach of climate change impacts across regions and sectors of B.C. Therefore, this study discusses climate vulnerabilities to B.C.'s transportation road infrastructure as an illustration of how the framework could be applied to adaptation initiatives in a particular subject matter.

The study uses a mixed methodology approach, which includes a literature review, theory-based approach, bowtie methodology, and an understanding of jurisdictional issues. The findings identify best practice evaluation approaches and key considerations for the evaluation of adaptation interventions. This information is then used to establish building blocks for a scalable and replicable evaluation framework with standardized guidelines. The study concludes by demonstrating the use of the proposed framework using a specific road infrastructure example.

Chapter 1. Introduction

Local, regional, and federal governments in Canada have recognized that building a climate resilient society is not only about mitigating the effects of climate change but also adapting to its unavoidable impacts. Despite this recognition, numerous commitments, and millions of dollars of investments, the process to achieving a climate resilient future continues to be arduous. Numerous obstacles have slowed the pace of change needed to enact substantive climate adaptation interventions[1]. Nevertheless, these obstacles have not stopped governments and society-at-large from developing and implementing ambitious interventions. Therefore, the next step for government and the public must be to determine whether adaptation interventions are achieving their intended outcomes, and if not, the question must focus on how the interventions can be improved.

Informative and successful assessments ideally involve rigorous investigations that use detailed monitoring processes and fulsome datasets. The evaluation process for climate mitigation policies is generally intuitive; benchmark indicators for measuring greenhouse gas emissions are a direct and universally accepted way of determining the impact and effectiveness of most mitigation policies. Climate adaptation interventions have no such equivalent or standardized metric, which typically results in government ministries/departments taking a siloed approach when evaluating the effectiveness of interventions. This barrier has been identified by global climate policy experts as a significant deterrent to developing strategic, cross-governmental evaluation processes. This is despite the fact that evaluation approaches with high-levels of cross-governmental coordination are viewed as essential to the long-term success of adaptation interventions (Leitner et al, 2020; Vallejo, 2017; Huitema et al, 2011).

Despite this, several nations have recently demonstrated that it is possible to develop feasible evaluation approaches for regional and federal governments (Huitema et al, 2011; Vallejo, 2017). Nations such as the Netherlands, Scotland, and Australia have established cross-governmental adaptation monitoring, reporting, and evaluation

[1] Adaptation intervention is used as an umbrella term for any adaptation-related policies (i.e. regulatory, strategic, and operational), programs, and physical measures.

(MRE) frameworks (Huitema et al, 2011; Leitner et al, 2020). These governments have been able to evaluate their adaptation interventions without standardized metrics because they have targeted their efforts towards the standardization of the evaluation process instead.

1.1. Scope of Research

This study analyzes and provides a pathway for Canada to fill the existing policy gap that has resulted from the absence of provincial or federal-scale evaluation processes for climate adaptation interventions. Climate adaptation is a very broad subject matter. Thus, I narrow my scope in three ways. The first is that the evaluation process focuses on government accountability. Accountability evaluations are generally used as a tool to facilitate an increase in public trust but in the climate adaptation context, accountability assessments can have significant co-benefits as planning tools for improving adaptation interventions as well as governance practices (Leitner et al, 2020).

The second way to focus my analysis is through location and geography. The development and implementation of climate adaptation policies, and associated interventions, are highly influenced by their regionality (Baynham & Stevens, 2014). Therefore, the province of British Columbia (B.C.) is being used as an illustration of the applicability of the framework. In February 2018, B.C.'s Office of the Auditor General (OAGBC) released the report *Managing Climate Change Risks: An Independent Audit.* The report states that the Government of British Columbia's (GoBC) climate adaptation policies lacked rigour and had limited-to-no discernable monitoring and evaluation criteria for measuring their impact (Office of the Auditor General of British Columbia [OAGBC], 2018). The GoBC then published a provincial climate risk assessment (CRA) in 2019, which identifies aggregated provincial climate risk events from present to 2050 and aligns these findings with the GoBC's "existing provincial long-range planning horizons" (Ministry of Environment and Climate Change Strategy [B.C. Ministry of Environment], 2019a, p. 30; B.C. Ministry of Environment, 2019b). The CRA supports the ongoing development of B.C.'s climate preparedness and adaptation strategy – these developments indicate that it is an opportune time for the GoBC to implement a complementary adaptation MRE process to the strategy.

Finally, the third scoping aspect is the use of a specific example of how the framework could be applied by to a sector by examining B.C.'s transportation road and bridge infrastructure, which is vulnerable to climate impacts.

My paper presents this research by beginning with framing the issue of climate adaptation from the B.C. perspective in Chapters 2 and 3. This is done by providing an overview of provincial climate risks and a summary of the GoBC's current approach to climate adaptation. Chapter 4 outlines the methodologies used to conduct this study and Chapter 5 presents findings on best practices for evaluation design and key considerations for adaptation intervention assessments. These findings, and the background material presented prior to the methodology, ultimately inform my analysis and development of an accountability framework for assessing climate adaptation interventions – this is presented in Chapters 6 to 9. Chapter 10 is comprised of the study's conclusion.

1.2. Definitions & Contexts

This section outlines working definitions and interpretations of key terms used in this paper. The first term is **climate adaptation**, which is defined as "adjusting our decisions, behaviours, and activities to account for existing or expected changes in climate and adaptation measures [that] can be taken either before or after we experience the effects of a changing climate" (Government of Canada [GOC], 2019a). This definition was developed by the Government of Canada and aligns with the current Intergovernmental Panel for Climate Change's (IPCC) definition of adaptation[2].

Climate resilience is defined by the OAGBC (2018) as "the capacity of a community, business, or natural environment to anticipate, prevent, withstand, respond to, and recover from, climate change-related disruption or impact" (OAGBC, p. 29-30, 2018). When framing the relationship between adaptation and resilience, Dinshaw (2018) describes adaptation as a process or action that is meant to increase resilience. It

[2] The GoBC's 2008 *Climate Action Plan* has a definition for climate adaptation based off of the IPCC's 2001 definition of the term. However; the IPCC definition has since been updated and B.C.'s 2008 definition has not been formally changed to reflect this update therefore the GoBC's 2008 climate adaptation definition is not used in this study.

is important to note that there is a distinction between climate resilience and adaptive capacity. **Adaptive capacity** “refers to the ability of individuals, institutions, and systems to adjust and respond to potential damage” and can be interpreted as a subset of climate resilience (Dinshaw, 2018; Intergovernmental Panel for Climate Change [IPCC], 2014, p. 118)

Chapter 2. The Pursuit of Climate Resilience in British Columbia

2.1. The State of Climate Adaptation Policy in British Columbia

In 2008, the GoBC publicly acknowledged that parts of the province were warming at rates more than twice the global average (Drolet, 2012; OAGBC, 2018). These alarming statistics propelled B.C. to the forefront of climate change policy in Canada – a position the province has held for over a decade (Drolet, 2012). This early acknowledgment by political leaders of the seriousness of climate change has led BC to implement significant climate policies. These policies include North America's first carbon tax and the 2018 CleanBC initiative, which is arguably one of Canada's most comprehensive and ambitious climate mitigation strategies (B.C. Ministry of Environment, 2018). However, until this point, most of the significant cross-governmental policy actions taken by the GoBC have been focused on mitigation, and not adaptation.

One of the first major adaptation policies produced by the GoBC is their Climate Change Adaptation Strategy, implemented in 2010. The strategy focuses on increasing the GoBC's adaptive capacity by promoting knowledge on adaptation tools, integrating adaptation into government planning and decision-making, and assessing climate risk (Gregg, 2010). This adaptation strategy has not been publicly updated since its release and there are few publicly available documents describing its implementation (OAGBC, 2018). However, some initiatives can potentially be linked to the 2010 strategy, such as adaptation education materials. For example, the GoBC produced the report *Preparing for climate change: an implementation guide for local government*, which focuses on increasing the knowledge capacity of local governments by presenting best practice approaches for the development of adaptation interventions at the local level and also describes how to apply adaptive management practices (Carlson, 2012). Despite the availability of these materials, the OAGBC (2018) concluded that there were not enough indicators to discern the effectiveness of the 2010 strategy, and other adaptation interventions produced by the GoBC (OAGBC, 2018).

Subsequent to the OAGBC's 2018 report, the GoBC began a multi-phase adaptation initiative and released the province's first *Preliminary Strategic Climate Risk*

Assessment (the CRA) in 2019. The CRA is ultimately meant to inform the GoBC's new adaptation strategy, which was to be released in 2020 but has been delayed due to the COVID-19 pandemic and is expected in Spring 2021.

The 2019 CRA was a significant step towards strengthening B.C.'s adaptation interventions; however, it does not fully address another of the OAGBC's (2018) findings, regarding how adaptation "coordination across government needs improvement" (OAGBC, 2018, p. 43). Although the 2019 CRA was a collaborative process that was led by the Ministry of Environment and Climate Change Strategy and supported by eight other GoBC departments and two external organizations, the lack of a unifying mandate is still a barrier to achieving the long-term success of B.C.'s adaptation initiatives (B.C. Ministry of Environment, 2019b). Whereas the CleanBC initiative brings the GoBC together behind provincial mitigation goals there are currently no specific unifying goals or objectives for adaptation thereby impeding cross-governmental coordination (OAGBC, 2018).

Current signs are that the GoBC is moving away from the siloed adaptation practices previously mentioned and is laying the groundwork for more collaborative approaches. For instance, the impending release of the GoBC's climate preparedness and adaptation strategy should rectify the issue pertaining to the lack of provincial adaptation mandate (B.C. Ministry of Environment, 2020a). There has also been an increase in coordination mechanisms, such as through the GoBC's Climate Action Secretariat, which has an adaptation-focused working committee with a cross-ministerial/sectoral membership. Committees such as this provide multiple benefits, such as a forum for adaptive co-management and opportunities to learn from ministries that are further along in mainstreaming climate adaptation into their decision-making processes. An example of a department that has mainstreamed adaptation considerations is the B.C. Ministry of Transportation and Infrastructure (BCMOTI). In 2019, the ministry developed a technical policy that requires climate adaptation criteria to be used in the development and assessment of all BCMOTI infrastructure projects (Ministry of Transportation and Infrastructure [BCMOTI], 2019).

Following B.C.'s 2020 election, two notable commitments were made to further provincial adaptation initiatives. The first is outlined in every 2020 ministerial mandate letter, which states how pandemic recovery involves the consideration of climate

resilience policies and actions[3] (Government of British Columbia [GoBC], 2020). The second commitment was made in the *2020 Climate Change Accountability Report* (CCAR) regarding the implementation of the province's new adaptation strategy (B.C. Ministry of Environment, 2020a).

This strategy is expected to be supported by the 2007 *Climate Change Accountability Act* (CCAA), which makes the annual production of the CCAR a legislative requirement. The CCAR documents the GoBC's progress towards achieving its major climate change-related commitments and as the annual publication of the CCAR is mandatory, the GoBC will likely require a structured MRE process when reporting on its adaptation-related initiatives.

2.2. Complexities of Climate Adaptation in a Provincial Setting

From a policy perspective, climate mitigation has historically been at the center of climate-policy discussions (Huitema et al, 2011; Picketts et al, 2015; Berrang-Ford et al, 2011; Larsen et al, 2012; Picketts et al. 2014). Although there have been significant technical advances that have eased the development and monitoring of adaptation interventions, from a governance perspective, there are several barriers to proposing, implementing, and maintaining adaptation interventions that will be further discussed in Chapter 5. This section briefly highlights the primary political barriers to intervention development.

Due to the unpredictable nature of when major climate events will occur, it is difficult for governments to justify the high upfront investment required for the implementation of adaptation interventions (Huitema et al, 2011; Dinshaw, 2018; Picketts et al, 2015; Berrang-Ford et al, 2011; Larsen et al, 2012; Picketts et al. 2014). This upfront cost makes it difficult to secure and sustain long-term political support, especially through changing political and economic climates (Burch, 2010; Störbiork, 2010; Measham et al, (2011). B.C. typifies other jurisdictions that struggle to obtain the same support that mitigation policies receive (Leitner et al, 2020; Picketts et al, 2015). Climate risk assessments, such as the 2019 CRA, can help mitigate against this cost

[3] The B.C. Ministry of Environment is the lead department for climate change-related initiatives (GoBC, 2020).

issue. If a climate event is classified as high likelihood and high risk, governments can more readily make the business case that the large upfront intervention costs warrant the investment. However, even with this assessment, governments are still at risk of implementing interventions that may never be used in the climate scenario they were intended for (Huitema et al, 2011). From an evaluative perspective, an assessment process, therefore, needs to address these limitations by finding a way to demonstrate the intervention's necessity even if it has not been fully tested during its lifetime (Dinshaw, 2018).

A second issue is the fragmentation of jurisdictional authority for securing adaptation investments. Municipal governments and their control over local public works to provincial and federal roles in approving, funding, and undertaking major infrastructure investments as well as ascertaining risks at different levels can lead to confusion and conflict over what level of government is responsible for specific adaptation interventions and who will fund them.

2.3. Climate Risks Facing British Columbia

The GoBC has been working with research institutes, such as the Pacific Climate Impact Consortium (PCIC) and the Pacific Institute for Climate Solutions, to develop adaptation tools that contribute towards a better understanding of climate risks facing B.C. The climate projections developed by these institutes are used in the provincial CRA and are grounded in Representative Concentration Pathway (RCP) 8.5 outlined by the IPCC (B.C. Ministry of Environment, 2019b). RCPs are descriptions of the possible future outcomes based on atmospheric concentrations of greenhouse gases – RCP 8.5 is a "high global emissions scenario" (B.C. Ministry of Environment, 2019b, p. 2; IPCC, n.d.).

Using PCIC's climate data, the 2019 CRA ultimately identified 15 significant provincial climate risk events that are anticipated to occur in an RCP 8.5 scenario in two time frames: present day (2000-2019) and mid-century (2040-2059) (B.C. Ministry of Environment, 2019b, p. 2). Table 2.1 is a summary of the 15 climate risks ranked from most severe and highest likelihood to least severe and least likelihood. The methodology used to determine these climate risks was based on a pre-existing GoBC risk assessment process established by the Government Chief Risk Office (B.C. Ministry of

Environment, 2019a). The consequence rating for the severity of a natural disaster due to climate change was based on the evaluation of nine categories representing health, social, environmental, infrastructural, and economic consequences (B.C. Ministry of Environment, 2019b, p. 2). The consequences from the climate hazards are also divided into eight categories: loss of life; loss of social cohesion; loss of infrastructure services; morbidity, injury, disease, or hospitalization; loss of natural resources; cost to the provincial government; psychological impacts; and loss of economic productivity (B.C. Ministry of Environment, 2019b).

Table 2.1 – Summary of Top 15 Climate Risks Facing B.C.

Risk Event	Present-Day Likelihood	2050 Likelihood	Consequence	Confidence Level
High Risk Rating				
Severe Wildfire Season	3	4	4.5	High
Seasonal Water Shortage	4	5	3.4	Medium
Heat Wave	3	4	3.6	High
Ocean Acidification	2	5	2.8	Low
Glacier Mass Loss	1	5	2.5	Medium
Long-Term Water Shortage	3	3	4.0	Low
Medium Risk Rating				
Reduction in Ecosystem Connectivity	3	4	2.6	Low
Saltwater Intrusion	1	4	2.5	Low
Loss of Forest Resources	1	3	3.3	Low
Increase in Invasive Species (Knotweed)	4	5	1.8	Medium
Moderate Flooding	2	3	2.9	Low
Severe Riverine Flooding	1	2	4.3	Medium
Severe Coastal Storm Surge	1	2	4.1	Medium
Extreme Precipitations and Landslide	2	3	2.3	Low
Low Risk Rating				
Increased Incidence of Vector-Borne Disease (Lyme Disease)	1	2	2.1	Medium

"Consequences are rated on a scale of 1 to 5 (Insignificant to Catastrophic)" – catastrophic is defined as climate-related damage that is beyond the GoBC's contingency fund (B.C. Ministry of Environment, 2019c, p. 24). "Likelihood is rated on a scale from 1 to 5 (Almost Certain Not to Happen to Almost Certain)" (B.C. Ministry of Environment, 2019c, p. 16).

Many of the forecasted events for the 2050s are already occurring today and, for example, are impacting B.C.s transportation infrastructure. In 2014, a report by the GoBC stated that one of the most significant vulnerabilities for transportation infrastructure are precipitation-related events which are exacerbated by temperature increases (BCMOTI, Nodelcorp Consulting Inc. & Pacific Climate Impacts Consortium, 2014; Drolet, 2012; B.C. Ministry of Environment, 2019a). Warmer temperatures resulting from climate change have led to a decrease in winter maintenance costs for roads. However, there have also been increases in temperature fluctuation, which has resulted in shortened intervals between freezing and thawing thereby causing an increase in potholes and surface damage (Vermeulen et al, 2012; Daskalis & Pappis, 2013; US Environmental Protection Agency, n.d.). How climate events further impact transportation infrastructure is further explored in Chapter 3.

Chapter 3. The Need for Climate Adaptation Interventions

As outlined in section 1.1, to illustrate a practical adaptation scenario, I focus on the climate and societal impacts that relate to B.C.'s transportation infrastructure. This chapter begins with an overview of how climate vulnerabilities affecting transportation infrastructures can negatively affect supply chains of food and other goods – interventions that affect transportation thus have social and economic considerations. Following this, is a high-level overview of populations most disproportionately impacted by climate change. The chapter then concludes with a discussion of the constraints local governments face when dealing with climate adaptation. This chapter support this study's final policy recommendation – a Climate Change Accountability Framework presented in Chapters 6 to 8.

3.1. Supply Chain Disruptions Due to Climate Change

Supply chain actors, in public and private spheres, recognize the severity of consequences associated with disruptions caused by seasonal conditions, episodic extreme weather events (EWEs), and future climate change events (Surminski, 2013). As a result, adaptation interventions are broadly accepted as an essential consideration in the development and maintenance of supply chain management logistics (Vermeulen et al, 2012). The GoBC, and municipal governments around B.C., have already started mainstreaming adaptation interventions into road and bridge infrastructure to adapt to seasonal conditions; however, resilience against EWEs and climate variability still presents a challenge (Picketts et al, 2015).

The "interruption of access to emergency, medical and education services, delays in delivery of goods and services and lost productivity" have significant societal and financial implications (BCMOTI, Nodelcorp Consulting Inc., & Pacific Climate Impact Consortium, 2014, p. 4). Although these incidents are not frequent, the consequences of their occurrence are severe enough that precautionary measures are deemed worthwhile (BCMOTI, Nodelcorp Consulting Inc., & Pacific Climate Impact Consortium, 2014; Mirza, 2007; Pickets et al, 2015). An example of economic risk is shown in B.C.'s reliance on trade corridors facilitated by ground transportation. Supply chains are

dependent on these corridors to support industries significant to B.C.'s economy, such as timber. In 2019, the forest sector was responsible for 27.4% of B.C.'s total exports, making any disruption to the transport of timber supply detrimental for the sector (Natural Resources Canada, 2020; Forest Innovation Investment, 2020).

From a societal perspective, Gregory, Ingram, & Brklacich (2005) emphasize how shocks to the food supply chain, as a result of climate change, have direct impacts on food security, distribution, and access. Daskalis & Pappis (2013) summarized the impacts of climate change on supply chain links and identify specific vulnerabilities in transportation. Their findings, and other identified vulnerabilities, are summarized in Table 3.1 below.

Table 3.1 – Potential impacts of Climate Change on Transport Systems

Supply Chain Link	Typology of Climate Change Impacts/Risks
Transportation	• Increase in buckled rails and rutted roads • Overhead cables brought down because of strong winds • Problems related to coastal defenses • Drainage issues • Landslides, avalanches, and washouts due to extreme weather events (e.g., heavy snow or rainfall) resulting from heavy rainfall causing road closures or other transportation infrastructure damage • Additional stress on bridge joints (US Environmental Protection Agency, n.d.) • Road closures due to extreme weather events (blizzards, increased precipitation) • Temperature fluctuation resulting in asphalt expansions and contractions thereby causing potholes and severe rutting (US Environmental Protection Agency, n.d.)

Modified from table develop by Daskalis & Pappis (Daskalis & Pappis, 2013, p. 1144)

Adaptation interventions impacting B.C.'s supply chain-related transportation infrastructure are primarily developed and maintained by the BCMOTI[4]. In 2014, BCMOTI produced a best practices document titled *Considerations for addressing climate adaptation for transportation infrastructure in highway management, design, operation and maintenance in British Columbia.* The results of the report laid the

[4] BCMOTI has collaborated with various partners to develop a suite of standards and processes contributing to the increase of climate resilience in fixed route infrastructure. Partners include, Public Infrastructure Engineering Vulnerability Committee (PIEVC), Engineers and Geoscientists British Columbia (EGBC), and PCIC.

groundwork for many of BCMOTI's current adaptation interventions. However, BCMOTI's policies are technical in nature and are limited in their inclusion of the social dimensions of adaptation.

For example, the 2014 BCMOTI report presents the findings of Climate Change Engineering Vulnerability (CCEV) Assessments conducted on five major BC Highways (BCMOTI, Nodelcorp Consulting Inc., & Pacific Climate Impact Consortium, 2014). CCEV assessments, and other BCMOTI initiatives, approach climate resilience by focusing on climate impacts and vulnerabilities faced by the physical structures; however, the consideration of adaptive capacity for the populations dependent on these highways as general transport and supply routes are minimal (BCMOTI, Nodelcorp Consulting Inc., & Pacific Climate Impacts Consortium, 2014). These technical considerations were further emphasized in 2019 when BCMOTI implemented the *Resilient Infrastructure Engineering Design* policy, which outlines mandatory climate resilience and adaptation considerations in all B.C. infrastructure projects (BCMOTI, 2019). The policy lists nine key expectations that are listed in Appendix A and further details on BCMOTI's adaptation practices can be found in Appendix B.

The positive impact of this policy should not be overlooked as its use officially mainstreams adaptation into all BCMOTI infrastructure projects. There are also indications that subsequent work will be more inclusive of qualitative factors. For example, in the summer of 2020, MOTI released the report, *Developing a climate adaptation interdependency process with economic considerations*, which was produced with the support of Natural Resource Canada's Climate Change Adaptation Program. The report is one of the first public documents released by BCMOTI that underscores the necessity of having a mixture of quantitative and qualitative indicators when conducting infrastructure design assessments (BCMOTI, Nodelcorp Consulting Inc., & Pacific Climate Impact Consortium, 2020). The report does not explicitly cover the social dimensions of infrastructure adaptation interventions but helps create a potential pathway for the incorporation of social and economic indicators in future climate resilience assessments.

3.2. Forgotten Communities

The United Nations Department of Economic and Social Affairs (2016) has stated that there is an interdependence between climate change and social vulnerability. “Climate hazards aggravate the socio-economic inequalities that underpin exposure and vulnerability, leading to high-risk groups experiencing disproportionate losses in terms of their lives and livelihoods” (Expert Panel on Climate Adaptation and Resilience [Expert Panel], 2018, p. 21; United Nations Department of Economic and Social Affairs [UNDESA], 2016). This theory is corroborated by the Government of Canada in a 2014 national climate assessment, which concluded that all Canadians are at some level of risk to climate change impacts. However, Indigenous peoples and residents of northern, remote, and coastal communities, are likely to be the most disproportionately affected by climate change (Expert Panel, 2018; Environment and Climate Change Canada, 2016, p.33).

The impact of a specific adaptation intervention can vary significantly depending on how it is framed and measured (Dilling et al., 2019; Leitner et al, 2020). The GoBC’s CRA report states that since climate risks to the province are measured in aggregate, significant threats to specific regions, sectors, and populations are not discernable (B.C. Ministry of Environment, 2019b). Therefore, if an adaptation intervention is developed using only the CRA climate data, the intervention may be biased towards B.C.’s Lower Mainland since that is where the majority of the province’s population lies. The intervention may provide some value-add to Vancouver Island, the Interior, or Northern B.C., but the benefits derived from the intervention will likely be significantly less than the Lower Mainland’s if measured in terms of populations affected. This inequity in adaptation intervention application is a common issue that is also acknowledged in the GoBC’s CRA. Unique and perhaps catastrophic threats facing remote, isolated, and Indigenous communities are not yet specified but the conclusion of the CRA states that Phase II of the CRA process will involve Indigenous engagement, and other actions, that should remedy some of these limitations (B.C. Ministry of Environment, 2019b).

3.2.1. Disproportionate Impacts to Indigenous Peoples

According to the 2016 Canada Census, approximately 88.4% of B.C.’s population resides within Census Metropolitan Areas (CMAs) and Census

Agglomeration (CAs), while just under 11.6% reside outside of CMAs and CAs (Statistics Canada, 2016) [5]. B.C. has an Indigenous population of approximately 270,585, making up about 5.9% of B.C.'s total population. Approximately 55% of the total Indigenous population reside in B.C.'s top ten CMAs/CAs, while the remaining 44% reside in smaller or more rural areas throughout the interior and coastal regions of the province (Statistics Canada, 2016). Remote interior and coastal areas are especially vulnerable to climate risks and hazards thereby making Indigenous peoples one of the populations most disproportionately impacted by climate change in B.C. (Indigenous Services Canada, 2019; Expert Panel, 2018, p. 25).

It is important to acknowledge that this study will not be able to address all of the unique considerations and issues impacting these communities (Dinshaw, 2018). Building climate resilience for these populations requires a holistic approach that addresses social and economic vulnerabilities such as access to clean drinking water, health care, energy, and is consistent with B.C.'s commitment to reconciliation and the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) (Expert Panel, 2018; UNDESA, 2016).

Administrative complexity and conflict of jurisdictional authority between the Government of Canada and provincial governments over Indigenous communities is an ongoing issue that can have significant adverse impacts on these communities. B.C., like other provinces, is working on making space for Indigenous Knowledge and developing adaptation interventions that respect and support Indigenous peoples' right to self-determination. Further exploration of these important issues is beyond the scope of this study. However, an evaluation process analyzing government accountability can contribute, in a small way, towards supporting the tenants of UNDRIP.

3.3. Community vs. Government Capacity

Local governments have allocated time and resources to the development of adaptation strategies and policies, especially in the transportation infrastructure realm (Picketts et al, 2015). Despite their best efforts, "many communities do not have the

[5] CMAs and CAs are areas "consisting of one or more municipalities situated around a core. A CMA must have a total population of at least 100,000, or which 50,000 or more live in the core. A census agglomeration must have a core population of at least 10,000" (Statistics Canada, 2018).

capacity to implement their climate change considerations into infrastructure planning and management" (Picketts et al, 2015, p. 1109). The high cost of adaptation-related infrastructure improvements requires localities to seek financial support from provincial and/or federal governments (Picketts et al, 2015; Burch, 2019; Measham et al, 2011; OAGBC, 2018). The City of Vancouver released a comprehensive Climate Change Adaptation Strategy in 2018 that committed to multiple adaptation policies and projects, including the "adoption of federal guidelines regarding infrastructure adjustments" (City of Vancouver, 2018, p. 49). But even larger municipalities such as Vancouver still require fiscal support from federal and provincial governments, particularly when there are economies of scale and multi-region investments in adaptation infrastructure (Burch, 2010).

Studies conducted on climate vulnerability facing interior, northern, and/or coastal community transportation infrastructure systems have produced tangible adaptation solutions to reduce climate risk but the implementation of many interventions, physical or not, is costly and makes it difficult to both attain and maintain long-term funding commitments (Picketts et al, 2015). For example, Picketts et al (2015) conducted a study on adaptation strategies for transportation infrastructure in Prince George, B.C. Prince George is "dependent on two major highways (Highway 16 and Highway 97)," which are severely impacted by frequent freeze-thaw cycles that compromise road quality and accessibility (Picketts et al, 2015, p. 1111). Although Prince George received funding from Natural Resources Canada to produce a Climate Adaptation Strategy in 2009, very little of it was implemented. Soon after the release of the strategy, a new local government that ran on a platform of restrained spending came into power and halted many of the adaptation interventions identified in their 2009 strategy due to their significant costs (Picketts et al, 2015). The City of Prince George estimated that flood adaptation measures, including those required for infrastructure, would require an additional $35 million of funding, on top of what had already been received by Natural Resources Canada (City of Prince George, n.d.). There is no indication as to whether this funding request was approved.

Pickett et al (2015), proposed that one of the reasons for the lack of willingness to commit funding to adaptation interventions is the absence of detailed documentation and correspondence that can be used as evidence to justify the need for the interventions. They framed this in the context of inadequate knowledge mobility,

specifically regarding the communication of climate risks and hazards from climate change experts to municipal government officials and the public. That lesson is highly relevant as well in an evaluation context. Clear, detailed, and standardized documentation around the implementation of adaptation interventions can be used as evidence in future decision-making as well as garner potential support from public and political officials. If a standardized evaluation process addresses this issue at the provincial level, the process could act as a model for local governments. These localities could then eventually implement their own evaluation processes so that they can independently demonstrate both the effectiveness of interventions and the need for future adaptation investments.

Chapter 4. Methodology

I used a mixed-methodology approach that looks at all aspects of the evaluation development process. This included four methodologies that are qualitative in nature and incorporate information from academic, international, and government organizations.

4.1. Literature Review

This is the primary methodology used in this study's background, findings, analysis, and recommendation. Academic and government literature was used to gain an understanding of best practices and limitations in climate adaptation-related evaluations. The review includes an overview of different components of evaluation design, including adaptation indicators, evaluation objectives, and different evaluation types. This information helped inform the development of an evaluation process and policy tool for a scalable and replicable.

4.2. Theory-Based Approach

Theory-based approaches are a common and frequently utilized methodology when designing and evaluation process. Several theoretical theory-based models help support the development of a framework for evaluating adaptation interventions.

4.3. Bowtie Methodology

Risk management analyses and methodologies are considered an essential decision-making tool in climate adaptation (Travis & Bates, 2016; Moss, 2019). The GoBC has a pre-established strategic climate risk assessment framework therefore an actual risk assessment process is not included as part of the scope for this paper. Instead, this methodology is focused on understanding risk communication and how results from risk assessments can be utilized in an evaluation process.

4.4. Jurisdictional Issues

Many existing studies on climate adaptation governance practices have conducted meta-analyses or general jurisdictional scans on the various adaptation-related evaluation programs that have been created around the world. As this is an area within adaptation research that has numerous sources available, there are no individual jurisdictional case studies explored in this paper and I rely on the jurisdictional information from existing academic and grey literature. The information from these studies is blended throughout my findings, analysis, and recommendation.

4.5. Limitations

The discussions in this paper regarding the need for a cross-governmental evaluation process, particularly in the B.C. government, was informed by informal conversations with B.C.'s Ministry of Environment and BCMOTI; however, there were no formal interviews with the organizations mentioned throughout this paper. All analysis was based on publicly available information. It would have been desirable to extend my work through direct engagement with local government, Indigenous, and community-based perspectives. A general understanding of their views was derived from available literature, but this should not be considered as a substitute for direct engagement or consultation.

Chapter 5. Key Considerations for Adaptation Evaluation

This chapter explores the key components of evaluation design as it relates to climate adaptation. It begins with identifying specific challenges to developing evaluation processes for adaptation interventions and is then followed by a summary of key best practice approaches and considerations for evaluation design. This leads into a discussion on theory-based approaches in evaluation, risk communication methods, and adaptation indicator development.

5.1. The Current State of Climate Adaptation Evaluation

In the climate adaptation context, evaluations are as much planning tools as they are assessment tools. MRE frameworks are used to ensure continuous improvement of knowledge – this can also be interpreted as an adaptive management approach (Carlson, 2012). Adaptive management can be summarized into a six-step cycle that involves: assessing the problem; designing the adaptation intervention; implementation; monitoring; evaluation; and adjustment (Carlson, 2012, p. 24). When this approach is integrated into a formal evaluation process, the outcomes of the assessment can provide updated information on climate change impacts and adaptive capacity as well as identify policy gaps, challenges, and opportunities (Leitner et al, 2020). These benefits of formal evaluation or MRE processes are recognized by the United Nations Framework Convention on Climate Change, Organization for Economic Co-operation and Development (OECD), and other organizations as an essential component for the long-term success of adaptation interventions (Vallejo, 2017).

As noted in Chapter 1, despite this recognition climate adaptation is a policy area that nations and sub-nations continue to struggle with due to the high complexities associated with adaptation policy and evaluation design (Dinshaw, 2018; Vallejo, 2017). A meta-analysis conducted by Huitema et al (2011) studied this issue by evaluating 259 climate policy evaluation programs in the United States, European Union, and the United Kingdom. The study concluded that, up to the date of the study, most of the assessed nations had fairly rigorous adaptation policies and strategies, but the resources allocated

towards a cross-governmental evaluation of these interventions were typically minimal (Huitema et al, 2011).

A criticism of adaptation evaluation methods brought up by Huitema et al (2011) and the Treasury Board Secretariat of Canada (2012) is the gap between theoretical and practical evaluation design. This gap was more recently discussed in a report by Vallejo (2017) at the OECD. Vallejo (2017) found that governments find establishing an evaluation process "methodically challenging…because adaptation policies and programs often lack measurable targets or clearly defined expected outcomes" (Vallejo, 2017, p. 25). Given the complexities of designing and implementing an adaptation-related MRE process, many jurisdictions contract universities and research institutions to create the process on their behalf (Huitema et al, 2011). Although these are beneficial, sometimes the proposed evaluation designs that are recommended are too experimental or abstract to be viewed as feasible options by governments.

Another issue often faced during evaluation development is scale. Many jurisdictions, experts, and scientists believe adaptation evaluation frameworks and/or methodologies need to be regional-specific (Expert Panel, 2018). However, there are some methodologies and processes that are required for the success of any evaluation and can therefore act as pre-determined building blocks for the creation of a scalable and replicable evaluation framework with standardized guidelines (Huitema et al, 2011).

Successful adaptation MRE frameworks typically have eight elements that are considered necessary for a robust monitoring and evaluation program or framework. These include "effectiveness (objectives achieved), efficiency (adaptation through most appropriate means) of adaptation, accountability (action justification), assessing outcomes (risk reduction), learning (about adaptation response), equity ([equal and proportionate distribution of risk]), transparency (disclosure of adaptation results), and engagement (effective communication)" (Expert Panel, 2018, p. 59). These elements are present in varying degrees throughout the remainder of this chapter and inform the analysis and recommendations discussed in Chapters 6 to 8.

5.1.1. Challenges to Adaptation Intervention Evaluation

There are multiple barriers and limitations that must be accounted for within an adaptation MRE process as summarized in Table 5.1.

Table 5.1 – Key Challenges to Evaluating Adaptation Interventions

Climate versus non-climate stressors	Climate change influences economic and social stressors but it is not always the root cause of an issue and may actually be a compounding factor exacerbating the issue (Dinshaw, 2018). Distinguishing between climate and non-climate stressors defines the limits of adaptation intervention impacts. Indicators are a method that can be used to clarify impacts that are climate and non-climate related.
Shifting baselines	Due to changing socio-economic contexts and ever-updating climate data, the baseline conditions used to initially develop adaptation interventions can lose their validity (Dinshaw, 2018). Therefore, evaluations must also assess these baselines to verify the interventions' continued relevance.
Lack of counterfactual	All policies require some type of counterfactual to demonstrate that the policy is a necessity. For adaptation interventions, the counterfactual is related to measurements of avoided loss (Dinshaw, 2018). There are many cases where interventions are developed to prevent events that have not been previously seen or recorded. The lack of counterfactual in this situation is therefore unavoidable, so evaluation processes must re-envision what constitutes a "successfully" implemented intervention in order to mitigate against this challenge (Dinshaw, 2018).
Attribution and contribution	Attribution relates to understanding what events or occurrences can be attributed to climate change and identifying how the negative impacts caused by the climate-related events could have been minimized through the contribution of adaptation interventions. This challenge is partially dependent on establishing a viable counterfactual and indicators.
Context	There is a misconception that adaptation interventions are a "black box" and that the context of their development and application is irrelevant to their impact (Centre of Excellence for Evaluation, 2012). Considering the influence of external factors on climate events and interventions allows for the more accurate measurement of intervention impacts.
Long-time horizons	The EWE or climate event may occur in a time-frame outside of the expected life of the adaptation intervention. This is particularly impactful for structural adaptation measures as physical improvements have a finite life and may need to be replaced, regardless of whether the EWE or climate event has occurred.

5.2. Best Practices for Evaluation Design

5.2.1. Evaluation Purpose

An evaluation purpose guides what methods are best suited for the evaluation design. Without identifying the 'purpose' or 'objective', the outcomes of an evaluation may be vague and result in overly broad interpretations (Policy and Operations Evaluation Department, 2009). There can be more than one evaluation purpose and they can also have overlapping assessment criteria. Once chosen, the purpose can act as a guiding principle during the development of the evaluation design and allow for the evaluator to better define the assessment's scope. Commonly chosen evaluation objectives for adaptation evaluations are summarized in Table 5.2, below (Pringle, 2011; Dinshaw, 2011; Huitema et al, 2011).

Table 5.2 – Summary of Evaluation Purposes

Evaluation Purpose	Evaluation Purpose Description
Effectiveness	• Evaluates whether the intervention outcomes and outputs are adequately achieving their intended purposes.
Efficiency	• Efficiency can be defined in terms of cost, benefits, risks, and timeline of actions.
Equity	• Evaluates whether there is an equitable distribution of the intervention's impacts. • Requires the inclusion of qualitative factors to adequately estimate equitable distribution of benefits and burden of cost for the intervention.
Accountability	• Usually, an evaluation purpose that is contractually required and is most commonly used as a transparency mechanism for publicly funded policies and projects. • Can overlap with any of the purposes listed within this summary.
Compliance	• Meant to determine if the evaluation object is complying with statutes, regulations, and any other legally binding obligations.
Improve Learning	• This evaluation purpose runs in tandem with other purposes. • Answers the question "what works or does not work and why?" • Meant to inform larger organizational learning about climate adaptation intervention implementation and coordination. • Can occur "within and between organizations, communities and sectors" (Pringle, 2011). • This evaluation objective is not reliant on outcomes and can be used mid-way through an ongoing project.
Transferability	• Assesses how a specific adaptation interventions impact different regions and populations.

This table was populated with information from Pringle (2011) and Dinshaw (2018).

5.2.2. Types of Evaluation Design

A report on evaluation approaches by the Government of Canada's Treasury Board Secretariat (2012) stated that one of the biggest challenges to evaluations is: "measuring the expected results from an intervention and attributing those results to the activities of the intervention" (Centre of Excellence for Evaluation, 2012). An evaluation 'type' or 'methodology' needs to attempt to address this challenge.

Once the purpose of an evaluation is established, that information helps determine what evaluation type best meets their organization's assessment needs (Centre of Excellence for Evaluation, 2012). Some evaluation types are flexible enough to be combined with other types, such as the theory-based approach. This means that the ideal aspects of multiple evaluation types can be combined to create an evaluation design unique and specific to an organization. Table 5.3 is a summary of four evaluation types that are considered best suited for assessing adaptation interventions.

Table 5.3 – Summary of Evaluation Types

Evaluation Type	Evaluation Description
Process Evaluations	• Documents how the implementation of an intervention is progressing and how well the intervention is adhering to policy design (Dinshaw, 2018, p.43). • Puts an emphasis on course-correcting throughout the life of the policy therefore not requiring the policy to have been fully tested in order to undergo an evaluation. • Approach is dependent on continuous monitoring throughout the course of the adaptation intervention and does not pre-determine the final outcomes of the intervention and therefore requires no outcome-based indicators (Dinshaw, 2018).
Impact Evaluation	• Establishes causality of changes (positive or negative, expected or unexpected) caused by an intervention. • Meant to focus on answering the question "what would have happened in the absence of the intervention?" (GIZ, 2015). • Requires a specialized expertise, more funds, and can takes years to conduct. • Not as conducive to evaluating long-term impacts of an intervention, which makes it less desirable to use in assessments that are meant to understand broader organizational and societal impacts.
Theory-based Evaluations	• Theory-based evaluations generally focus on the way in which certain interventions are expected to yield specific outcomes. • This characteristic makes this evaluation distinctly different from process evaluations because it allows for the consideration of pre-determined outcomes and analyzes how these outcomes are being achieved (Centre of Excellence for Evaluation, 2012).

	• Ideal for adaptation interventions as it best accommodates the complex nature of climate adaptation (Dinshaw, 2018). • It examines all assumptions that underlie the casual chain of results – from inputs to outcomes to impacts.
Real Time Evaluations	• Not based on a specified methodology but is based on when an evaluation is conducted. • Produces findings that are timed to coincide with key intervention milestones or decision points, with the ultimate intention of adjusting an intervention for improvement (Dinshaw, 2018, p. 45). • Strong learning orientation and usually produces a large value add to adaptation initiatives – particularly if an organization is in the middle of deciding where to allocate funding or is trying to determine the scale of an adaptation intervention. • Less rigorous than a summative evaluation and generates limited evidence of an interventions' demonstrable results. • Difficult to conduct unless provided details regarding internal organizational operations. • If all limitations are addressed, it could likely produce results leading to formative changes.

This presents information from Dinshaw, 2018, p. 43-46.

5.3. Theory-Based Evaluation Methodology: Theory of Change

Theory of change (TOC) is the foundation of the theory-based approach. TOC makes it possible to draw conclusions about the outcomes of an adaptation intervention before the outcomes are achieved (Centre of Excellence for Evaluation, 2012). It is a broad scope approach that can be used in the context of almost any subject matter, which is why it is utilized by many organizations, including the Government of Canada, as both a planning and evaluation tool. TOC is a flexible method that can be used as a standalone process or be integrated with other types of evaluation design (Centre of Excellence for Evaluation, 2012). The basis of TOC is a logic model, which establishes a sequence of events and results. These results are disaggregated into immediate, intermediate, and ultimate outcomes (Centre of Excellence for Evaluation, 2012; Dinshaw, 2018). The full TOC approach builds on the logic model "by outlining the mechanisms of change, as well as the assumptions, risks, and context that support or hinder the theory from being manifested as observed outcomes" (Centre of Excellence for Evaluation, 2012).

The full TOC map can allow anyone to visualize the relationships between the various factors impacting the adaptation intervention and vice versa. Figure 5.1, below,

is a modified example of an adaptation-specific TOC model used in an evaluation process conducted by the World Bank in Dakar, Senegal (Dinshaw, 2018, p. 18; World Bank, 2012). This TOC model was modified by the evaluators to start with macro-level development and adaptation goals, which then progressively narrow in scope as the model reaches the final adaptation activities at the bottom of the figure.

The overarching 'development goal' is based on the Government of Senegal's mandate to reduce poverty and decrease vulnerability to natural disasters in Dakar's most impoverished areas – this can also be translated as the TOC model's ultimate outcome (Dinshaw, 2018; World Bank, 2012). The development goal is achieved through the intermediate outcome or 'adaptation goal,' which is resilient infrastructure for vulnerable residents. The adaptation goal is then achieved via the 'adaptation project objective,' which is the improvement of stormwater drainage and flood prevention (Dinshaw, 2018). Finally, the adaptation project objective is the immediate outcome the adaptation activities are supporting, in an effort to achieve the remainder of the goals identified in the model.

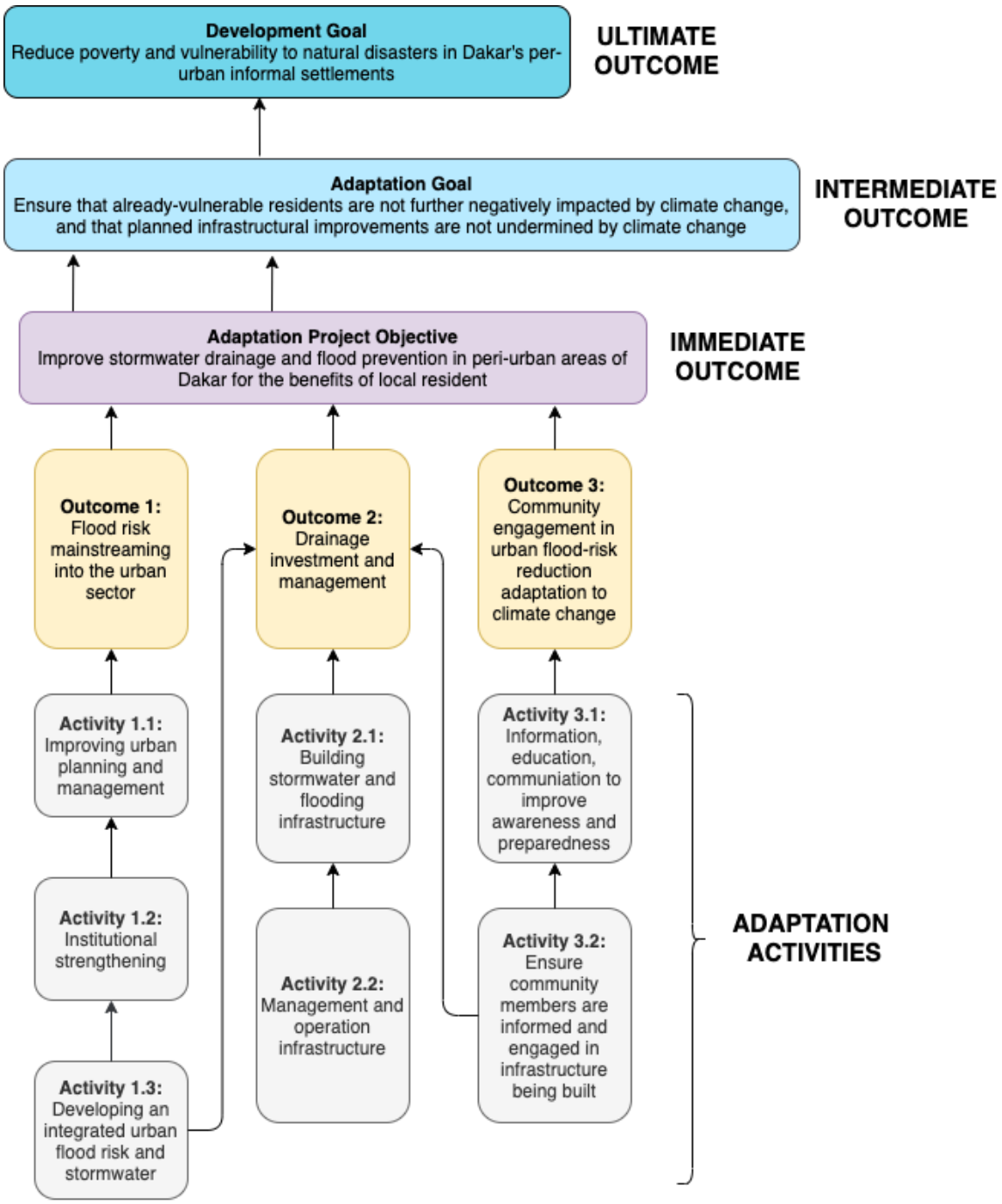

Figure 5.1 – Theory of Change Evaluation – Senegal Stormwater Management and Climate Change Adaptation Project

This figure is modified from a TOC model originally produced by Dinshaw (Dinshaw, 2018, p. 18).

5.4. Risk Management

5.4.1. Climate Risk Management

In 2009, the World Bank stated that defining risk management in respect to climate change is foundational to the development of climate adaptation policies (May & Plummer, 2011). “Climate Risk Management is a process for incorporating knowledge and information about climate-related events, trends, forecasts, and projections into decision making to increase or maintain benefits and reduce potential harm or loss” (Travis & Bates, 2014, pg. 1). From an evaluative perspective, climate risk is the evidence that justifies the requirement for the adaptation intervention.

The GoBC and the federal government are certified in International Standards Organization (ISO) 31000: Risk Management. In the climate risk management context, the ISO 31000 is used to “understand, assess and manage climate related risks; increase capacity to prepare for and adapt to a changing climate; develop adaptation strategies and policies; and prioritize climate resilience planning and decision-making” (Government of British Columbia, n.d.). These risk management principles have informed various provincial infrastructure projects and climate strategies, including the GoBC’s 2019 CRA and the *Strategic Climate Risk Assessment Framework for British Columbia* (B.C. Ministry of Environment, 2019b). The risk assessment framework was originally developed by the B.C. Climate Action Secretariat as a tool for the strategic assessment of provincial climate risk through a transferable and scalable process, which can be distilled into four key steps, which are listed in Table 5.4, below.

Table 5.4 – GoBC “Climate Risk Assessment Framework Overview” (B.C. Ministry of Environment, 2019a, p. 9)

Steps	Description
1. Understand the context	Determine the scope and objectives as well as audience
2. Identify risk events	Using necessary methodologies to identify climate risk events
3. Analyze risk	Determine likelihood of the risk’s occurrence and any potential consequences
4. Evaluating risks	Assign risk rating and assess adequacy of existing risk mitigation

Each step of the framework involves thorough documentation of climate risks, including how these risks can be contextualized in specific scenarios. Within these risk event scenarios, consequences relating to health, social functioning, cultural resources, natural resources, economic viability, cost to provincial government, and other categories are identified (B.C. Ministry of Environment, 2019a).

5.4.2. Risk Management in Theory Based Approaches

Risk can be viewed as a barrier to achieving outcomes and as such should be a part of a TOC model (Moss, 2019). The Government of Scotland recently adopted an adaptation monitoring and evaluation framework that outlines how risk can be incorporated in theory-based approaches such as TOC. The framework examines "the relationship between risk and outcomes" by acknowledging the interdependencies that can exist along the causal chain (Moss, 2019, p. 6; Holman et al, 2016; Committee on Climate Change, 2017). The inclusion of risk in the TOC model also acts as an additional mechanism that encourages intervention adjustments as well as demonstrates the need for an iterative evaluation process.

5.4.3. Risk Communication & the Bow-Tie Assessment

There are four categories of risk management – prevention, loss control, risk shifting, and risk spreading (Olewiler, 2020). These risk management factors can be summarized and communicated to non-technical audiences by using the bowtie methodology (refer to Figure 5.2). The left-hand side (LHS) of the assessment focuses on prevention considerations for the anticipated hazards while the right-hand side (RHS) focuses on loss control and accounts for resilience, management of poor outcomes, and risk reduction (Olewiler, 2020; Zipp, 2015).

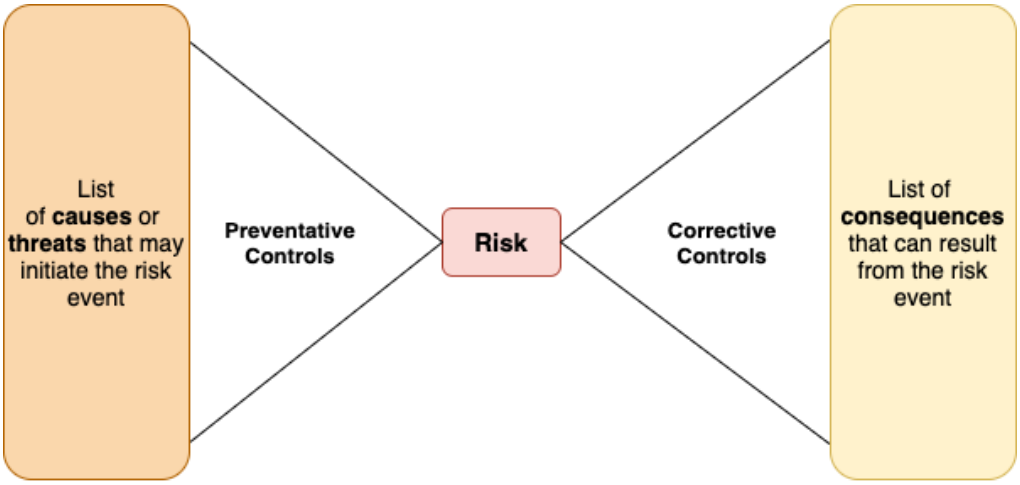

Figure 5.2 – Bowtie Diagram

As previously mentioned, the likelihood of occurrence for BC-specific climate risks are already accounted for in the GoBC's provincial CRA. The bowtie method can be used as a communication tool that simplifies the risk assessment outcomes thereby making the information more adaptable for policy analysis, evaluation, and decision-making (Zipp, 2015).

The order of operations for the bowtie method is to start with the identification of risk, which is at the centre of the bowtie (Zipp, 2015). The next step is to start on the LHS of the bowtie and determine causes that may trigger the identified risk. The relationship between the causes and the risk is linked by preventable controls. From a climate change perspective, the preventable controls may end up being a combination of both mitigation and adaptation measures.

The RHS focuses on resilience and is predominantly where adaptation considerations take place. The consequences are the "unwanted scenarios that could be caused by the top [risk] event" that are "realistic and specific" to the identified risk. The corrective controls are the actions that are required to "prevent the [risk] event from resulting in unwanted consequences or mitigate further consequences" (Zipp, 2015, p. 9). From an adaptation perspective, the corrective controls are meant to minimize loss. An example of such a control could be increasing the height of flood barriers to accommodate for rising sea levels or heavy rainfall events.

5.5. Indicators for Adaptation Evaluation

Indicators facilitate the “ongoing collection, management and analysis of data” and are an essential consideration in any climate change policy (Dinshaw, 2018, p. 22). Indicators must be targeted and specific to be effective, therefore those who develop them usually require detailed knowledge of the adaptation intervention and environment the intervention is implemented in (Expert Panel, 2018). From an evaluation design perspective, it is not the responsibility of the evaluator to come up with each individual indicator. Instead, the evaluator must determine whether the suite of indicators selected is representative of impacts caused by the intervention. A means of doing this is through the creation of categories or ‘buckets’ of adaptation indicator-types that can help guide indicator development. The Expert Panel on Climate Change Adaptation and Resilience Results (2018) did this by developing five broad indicator categories that are representative of “five key areas of action” required to achieve climate resilience and adaptation (Expert Panel, 2018, p. 6). These categories were then used to guide the creation of 54 qualitative and quantitative adaptation indicators (Expert Panel, 2018).

Indicator categories can be diverse and accommodate a combination of qualitative and quantitative measurements that can also support prioritizing the inclusion of social indicators, such as those relating to Indigenous Knowledge. The Expert Panel did this in a few ways, one of which was by having a dedicated category to “translating scientific knowledge and Indigenous Knowledge into action” (Expert Panel, 2018, p. 6).

5.5.1. Process versus Outcome Indicators

Adaptation interventions require an assortment of both outcome and process indicators. Outcome-based tracking, sometimes referred to as key performance indicators, reveals changes that occur as a result of adaptation interventions (Hamden and Associates, 2017; Expert Panel, 2018, p. 59). Outcome-based indicators are required for interventions; however, the limitations posed by long time horizons and the lack of counterfactuals also require the inclusion of process indicators (Dinshaw, 2018; Pringle, 2012). Process indicators can be used to track the progress of the implemented adaptation intervention and forecast whether the intervention is on trajectory to achieving its intended outcome (Pringle, 2012; Olivier, Leiter, and Link, 2013; Expert Panel, 2018, p. 58).

Chapter 6. Climate Adaptation Accountability Framework – An Overview

6.1. Why a Framework?

Requirements for a thorough and detailed evaluation vary between organizations, regions, and communities. This variation in evaluation requirements makes a framework the ideal policy tool for a diverse and complex subject like climate adaptation. Frameworks are broad and have the ability to be replicable and scalable while keeping certain principles or factors constant (GoBC, 2019). A framework's malleable nature also makes it well suited for subject matters that are constantly incorporating and adapting to new information or data – such as climate adaptation. Therefore, I am presenting a framework that consolidates the commonalities found in adaptation assessment practices to create an instructive guide outlining how to evaluate accountability as well as the effectiveness of adaptation interventions.

A key co-benefit of a framework is the influence it can have on an organization's governance practices. The wide adoption and regular use of a framework has the potential to become a normalized standard of practice and can therefore result in the government-wide mainstreaming of climate adaptation considerations. Frameworks can also promote cross-ministerial and cross-sectoral collaboration, which is essential for the long-term success of adaptation interventions (Vallejo, 2017).

I develop a framework that is applied to a provincial government; my example is the Government of B.C. as noted in section 1.1. The intent is that the framework could apply in principle (and be modified as needed) to other levels of government in Canada.

6.2. Climate Adaptation Accountability Framework

The GoBC currently has legislative support, via section 4.3 of the *Climate Change Accountability Act*, to produce an adaptation-focused accountability report – similar to the current mitigation-focused *Climate Change Accountability Report*. This legislative backing coupled with the anticipated release of the 2021 climate preparedness and adaptation strategy, indicates that the GoBC has a policy window open for the development and implementation of an adaptation evaluation tool (B.C.

Ministry of Environment, 2020a). This makes the province well poised for adopting a tool such as the Climate Adaptation Accountability Framework (the Accountability Framework).

The Accountability Framework was developed using a theory of change approach combined with lessons learned from this study's background sections and findings discussed in Chapter 5. The framework focuses on establishing linkages between adaptation interventions, broader adaptation goals, government mandates, and key adaptation considerations (climate risk assessments and indicators). The Accountability Framework was developed using five objectives, presented in Table 6.1, as guiding principles. These principles were chosen because they were identified as key traits of a successful adaptation evaluation process.

Table 6.1 – Framework Guiding Principles and Objectives

Accountability	The framework allows for the organization to transparently measure its progress on developing, implementing, and maintaining climate adaptation intervention commitments. The success of this objective is partially dependent on all other objectives being met, with the exception of Administrative Ease.
Effectiveness	The framework emphasizes processes that determine if the adaptation intervention has achieved, or is on target to achieving, the intended immediate, intermediate, and ultimate policy outcomes.
Adaptive Capacity	The framework has mechanisms that can determine how adaptation interventions specifically contribute to the climate resilience of communities, populations, and institutions that are impacted by climate change. Additional attention should be paid to populations that are disproportionately impacted by climate change and EWEs (i.e., Indigenous peoples, coastal, northern and remote communities).
Adaptive Co-management	Aspects of the framework provide opportunities for horizonal and vertical collaboration with interest groups and partners. The framework itself should have clear points where the organization can collaboratively work with Indigenous peoples, localities and other interest groups on determining the effectiveness of adaptation interventions.
Process & Intervention Improvement	The outcomes of the framework provide the organization with learnings that can lead to the improvement of governance processes related to adaptation as well as current and future adaptation interventions.
Administrative Ease	The framework does not require substantial additional resources than what is already being allocated towards climate change accountability reporting.

Figure 6.1 is a visualization of the proposed Accountability Framework. The framework is ultimately a circular and interdependent process where each step of the process builds on the last and informs the next. The framework is meant to be read from

top to bottom. The recommended approach for how to operationalize the framework also corresponds to how it is read – this is further described in Chapters 7 and 8. The remainder of Chapter 6 describes factors that must be considered throughout the entirety of the framework while Chapter 7 describes each component of the framework. This description is then followed by an example of how to implement the full Accountability Framework using an infrastructure-related scenario in Chapter 8. Finally, Chapter 9 evaluates the framework against the six objectives described in Table 6.1.

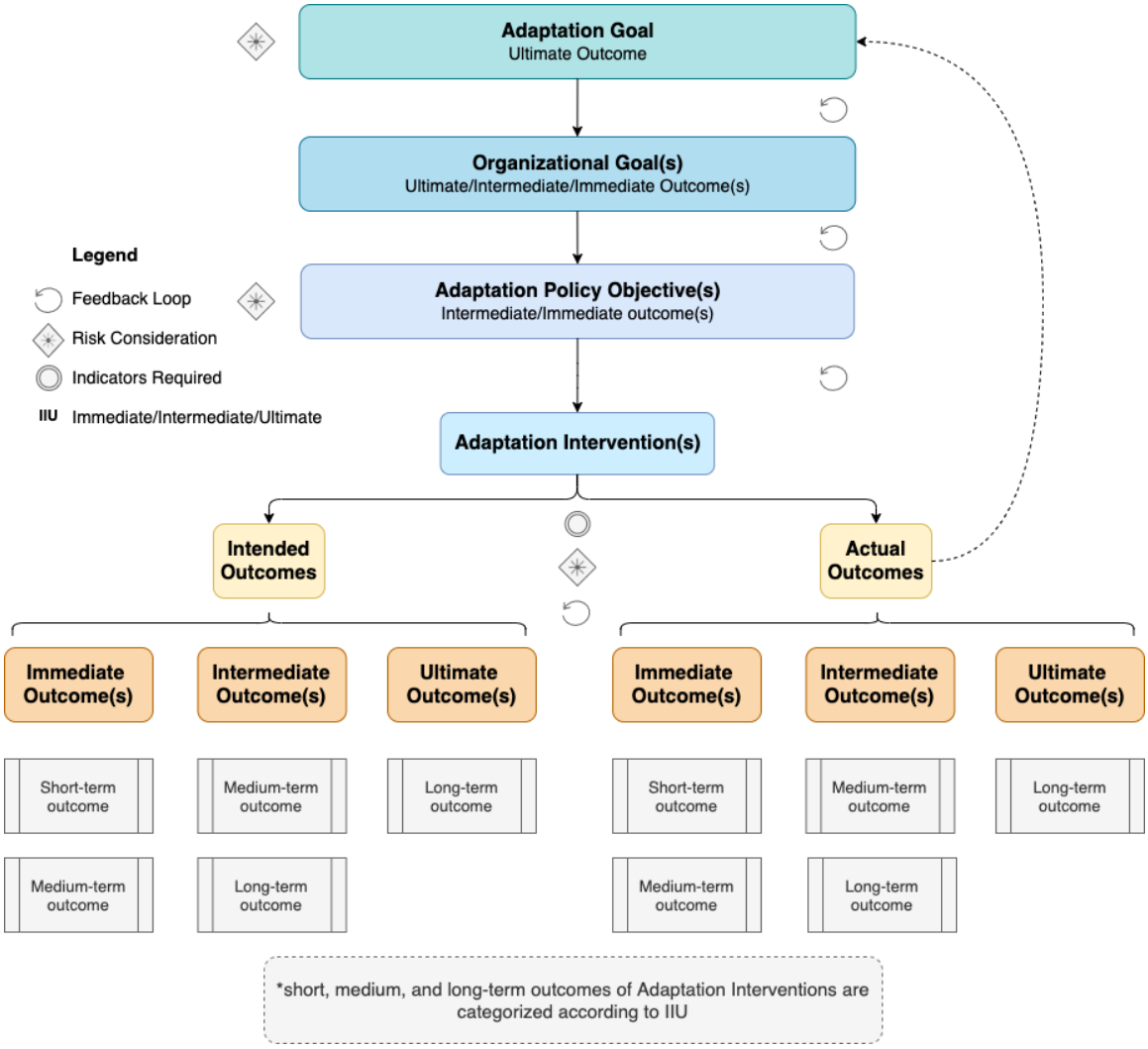

Figure 6.1 – Climate Adaptation Accountability Framework Schematic

IIU – immediate, intermediate, and ultimate outcomes

6.3. Components of a Successful Framework

6.3.1. Risk Assessment and Management

As discussed in section 5.4 risk assessments provide the tangible evidence required to justify the need for an adaptation intervention. The Accountability Framework puts a focus on incorporating risk considerations throughout the evaluation. The scope of risk being assessed must be reflective of the goal, objective, or outcomes at each step of the framework. For instance, if the adaptation intervention is localized in scope, the climate risk considerations should be localized as well. The top portion of the framework starts with a broad Adaptation Goal that continues to narrow in scope until the Adaptation Intervention(s) is reached at the bottom of the framework – the scope of risk also adjusts accordingly.

The process is ultimately meant to establish a relationship between various levels of risk to ensure that the goals, objectives, and interventions are all complementary of each other. It is likely that during the initial development of the intervention(s), risk assessments were conducted; however, the evaluation provides an opportunity to ensure that climate risk data is up-to-date and relevant thereby verifying the continued need and effectiveness of the intervention.

6.3.2. Indicators

Indicator development is a vital and challenging aspect of adaptation policy (Dinshaw, 2018). Adaptation interventions are best evaluated through a mixture of qualitative and quantitative indicators, which allows for the opportunity to utilize an interdisciplinary assessment approach. Determining specific indicators is beyond the scope of this research and should ultimately be developed in collaboration with subject matter experts, Indigenous peoples, and directly impacted communities and sectors. However, the organization leading the evaluation should use its internal knowledge and expertise to guide the indicator development process. This can be done using the indicator ‘buckets’ approach discussed in section 5.5. This approach can result in the development of a suite of indicators that includes those focused on assessing adaptive capacity and adaptive co-management (Expert Panel, 2018; Pringle, 2011).

Indicator buckets do not have to remain static and are meant to act as a starting point for discussion and planning – the indicator buckets can, and should, evolve as new information arises. The indicator buckets proposed in Table 6.2 are adapted from the indicator categories developed by the Expert Panel on Climate Adaptation and Resilience (2018).

Table 6.2 – Proposed Indicator Buckets for Assessing GoBC Adaptation Interventions

Indicator Bucket	Indicator Considerations
Protecting and Improving Human Health and Well-Being	• Measures progress toward increasing the resilience of people, communities, health practitioners, and institutions to a broad range of health impacts associated with climate change.
Supporting Disproportionately Impacted Regions and Populations	• Focuses on Indigenous peoples and populations residing in BC's northern, coastal, and remote regions; • Measures the resilience of these vulnerable regions to rapid- and slow-onset climate change impacts (e.g., permafrost thaw, coastal erosion, increased precipitation rates) and EWEs.
Reducing Climate-Related Hazards and Disaster Risks	• Reducing impacts from rapid-onset climate-related events (e.g., floods, wildfires, and other events); • Aligns with the four components of emergency management: prevention, preparedness, response, and recovery.
Building Climate Resilience through Infrastructure	• Measures the resilience of BC's traditional, cultural, and natural infrastructure; new and existing infrastructure; critical and non-critical infrastructure; and the interdependencies of infrastructure systems.
Translating Scientific Information and Indigenous Knowledge into Action	• Respectful and consensual use of Indigenous Knowledge Systems and science to co-develop information related to climate change impacts; • Build the capacity of those involved in developing, monitoring, reporting, and evaluating adaptation interventions to act on this information.

This table is a modified version of the indicator categories and descriptions proposed by The Expert Panel (2018). The categories and have been adjusted to be more applicable to the BC context.

As discussed in section 5.5.1, due to the probabilistic nature of climate impacts, adaptation interventions inevitably require 'process' indicators to help determine whether the intervention is on track to achieving its intended outcome (Moss, 2019; Dinshaw, 2018; Pringle, 2011). Figure 6.2 outlines how process indicators are incorporated into the Accountability Framework through a method that was inspired by Moss (2019).

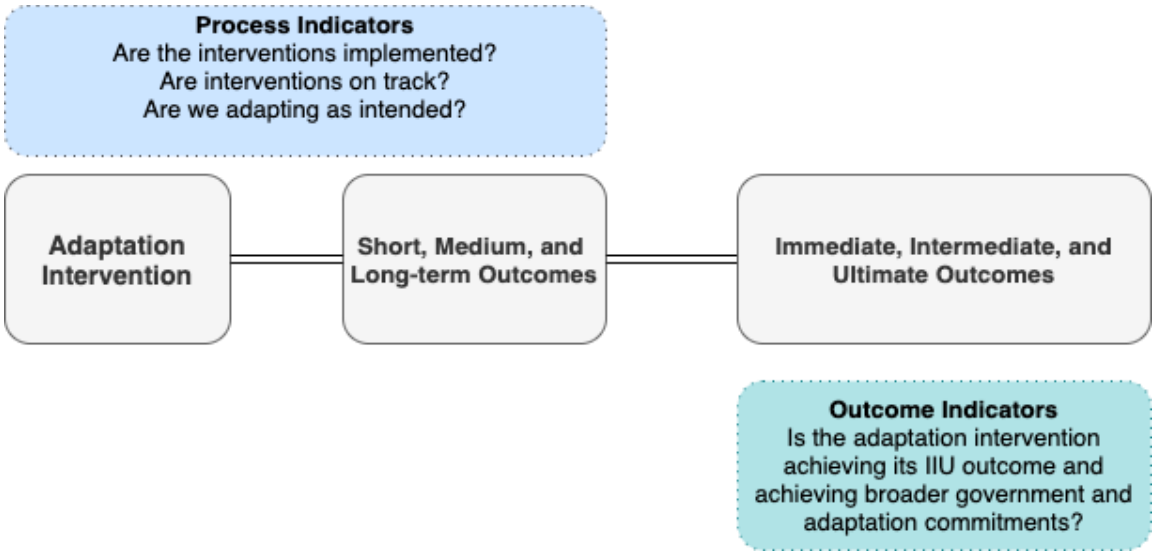

Figure 6.2 – Relationship between process and outcome-based indicators
The differences between short, medium and long-term outcomes and immediate, intermediate, and ultimate (IIU) outcomes are explained in section 7.1.

6.3.3. Adaptive Co-management

Adaptive co-management is “a governance system involving networks of multiple heterogeneous actors across various scales that solve problems, make decisions and initiate actions” (May & Plummer, 2011, p. 5; Fennell, Plummer & Marschke, 2008; Carlsson & Berkes, 2005; Berkes, 2009; Schultz, 2009). This objective assesses the degree of collaboration between horizontal (parallel government and non-government organizations) and vertical (federal and local governance structures) groups. The assessment of how a singular ministry or department implements an intervention is important, but the literature indicates that horizontal co-management through organizational cohesion can significantly contribute to the success of adaptation interventions.

Vertical assessment of adaptive co-management can be a means of verifying collaboration and engagement with organizations outside of the GoBC. The impact of interventions cannot be measured without working with partners that have first-hand knowledge of the successes and challenges of the interventions that are implemented in their regions. Without incorporating an adaptive co-management lens during the overall evaluation process, the organization at the centre of the assessment is at risk of:

- Misunderstanding or inaccurately measuring the impacts of the interventions on affected and/or target populations.
- Misaligning adaptation and climate risk management processes (i.e. indicator development, decision-making criteria, etc.) with other partners and interest groups.
- Missing opportunities to collaborate and engage with multiple partners and interest groups – this is also essential to informing the overall effectiveness of the intervention(s).

6.3.4. Standardizing the Evaluation Process

Large scale evaluation processes must be conducted in an organized and methodical manner as the many components of the evaluation can be difficult to keep track of – this is especially important for an assessment involving the evaluation of policies and interventions from multiple departments (BCMOTI, Nodelcorp Consulting Inc., & Pacific Climate Impact Consortium, 2014). Methods that can ease the administrative complexity of the process should be prioritized when implementing the Accountability Framework. One way to do this is through a general reporting template that all departments involved in the evaluation are required to follow. This type of process has some barriers as different subject matters and sectors have varying approaches to climate adaptation due to the unique climate impacts facing each area. However, implementing such a requirement is not unprecedented. The GoBC uses a similar approach with Enterprise Risk Management, which standardizes the risk management processes for all provincial organizations across B.C. (Government Chief Risk Office, n.d.)

Another area of potential standardization is terminology, such as climate resilience or adaptation. Although open-ended interpretations of these terms are common, they can also result in confusion when collecting the inputs required for a cross-governmental evaluation. Establishing consistent terminology is not a necessary step for the success of the framework but it would likely ease its implementation as well as assist in standardizing reporting processes.

Chapter 7. Climate Adaptation Accountability Framework – Detailed Description

Chapter 7 provides a detailed explanation of how each segment of the Accountability Framework is meant to be interpreted as well as an overview of the interdependencies and considerations for each stage. Following this, Chapter 8 applies the framework using a B.C. transportation infrastructure example.

7.1. Immediate, Intermediate, and Ultimate Outcomes

Each segment of the Accountability Framework is associated with immediate, intermediate, and/or ultimate (IIU) outcomes. IIU outcomes are not required to be achieved in a certain timeframe. This is in contrast to short, medium, and long-term (SML) outcomes that are time-bound and can be interpreted as the duration over which an intervention impact is observed. For example, a medium-term outcome does not necessarily mean an intermediate outcome is being achieved. Depending on the adaptation goals or objectives set for the Accountability Framework, the medium-term outcome may instead have achieved the immediate outcome. Another key distinction is that IIU's may require the use of multiple interventions while SMLs are representative of the impacts from a single intervention. The relationship between SMLs and IIUs will be further discussed in section 7.5.

7.2. Adaptation Goal

This segment captures the broad, high-level, or strategic Adaptation Goal the organization is seeking to achieve. This goal is representative of at least one of the Accountability Framework's ultimate outcomes that should be achieved through the impacts of the adaptation interventions. Once the Adaptation Goal is chosen, it will dictate the scope of the rest of the framework, including what adaptation policy objectives and interventions are chosen for the assessment. There is no fixed way of determining the Adaptation Goal; it can be determined by sector (i.e., infrastructure, agriculture, etc.), societal issue (i.e., food security, health, etc.), climate risk (i.e., flooding, wildfire, etc.) or be a goal that is an intersection of the aforementioned factors.

An example of an Adaptation Goal, and its various considerations, is provided in the applied framework scenario in Chapter 8, section 8.1.

Risk Consideration

This is the first of three risk consideration points that are identified in the framework. Since the Adaptation Goal is strategic and captures an adaptation consideration impacting the whole province, this is a natural area to integrate aggregated climate risks covering a large region.

Feedback Loop

The Adaptation Goal is both the beginning and end step of the Framework. This goal can be interpreted as the overall scope of the assessment which means that, technically, all segments of the framework feedback to the Adaptation Goal as it is the ultimate outcome for the interventions assessed in the evaluation.

7.3. Organizational Goal

The Organizational Goals are the government commitments/priorities supporting the achievement of the Adaptation Goal. Organizational priorities can include ministerial mandates, initiatives, or budgetary/resourcing commitments. There can be multiple Organizational Goals identified and should be categorized according to immediate, intermediate, and ultimate outcomes – this will help create linkages between this goal and both the Adaptation Goal and Adaptation Policy Objective(s).

This segment is also an opportunity to identify any priorities or initiatives that overlap multiple departments. This consideration of departmental overlap can be used to eliminate redundancies and inform what department should be leading certain adaptation actions if jurisdictional responsibility has not already been established. An example of an Organizational Goal is provided in the applied framework in 8.2.

7.4. Adaptation Policy Objective

The Adaptation Policy Objective justifies and enables the development of the adaptation intervention and embodies the immediate and intermediate outcomes of the interventions being assessed. It also supports the larger Adaptation Goal the

organization is trying to achieve. Whereas the Adaptation Goal is broad and strategic, the Adaptation Policy Objective typically outlines a more specific reason for the adaptation intervention and associated outcomes. An example of an Adaptation Policy Objective is provided in the applied framework in 8.3.

Implementation

The Adaptation Policy Objective guides the evaluator in determining what adaptation interventions should be chosen for the assessment. The Objective should ideally identify the target population(s) for the interventions and should use a positive statement that identifies a general method or means to achieving the objective. An example of such a statement would be, “improve drainage and flood prevention of Interior and northern BC highways for the benefit of isolated communities who require these highways as supply chain routes.” Using a selection of key indicators, the evaluator will determine whether the immediate and intermediate outcomes of the Policy Objective are being achieved. This is further explored in section 7.5 on Adaptation Interventions.

Risk Consideration

The specificity of the Adaptation Policy Objective indicates that the scope of risk likely incorporated in this segment will be a mix of regional and localized risk criteria. Even if the risk assessment was conducted prior to the development of the Policy Objective, it is recommended that the risk assessment is re-evaluated. This is to verify the accuracy of the Policy Objective using a risk assessment that has incorporated the most relevant and up-to-date information. This verification is important as the risk assessment occurring at this stage can have a direct influence on both the top and bottom ends of the framework.

A way to ensure the Policy Objective is being achieved is by comparing and aligning the risk levels assigned to the other steps of the framework. For instance, the regional/localized climate risks associated with the Policy Objective should be complementary to the provincial-level climate risks associated with the Adaptation Goal. A tool that can be used to communicate these risks is the bowtie method previously discussed in section 5.4.

Feedback Loop

This segment of the framework is critical as it is the intersection between two major feedback loops within the framework. The first feedback loop (Figure 7.1 – **Feedback Loop 1**), is the connection with the Organizational and Adaptation Goals. The adaptation policy objective must align with the goals and risk considerations discussed in prior steps. Depending on the alignment, the results of the evaluation may require adjustment of the Policy Objective to better reflect the ministerial priority or the Organizational Goal may need to be redefined to better achieve the Policy Objective.

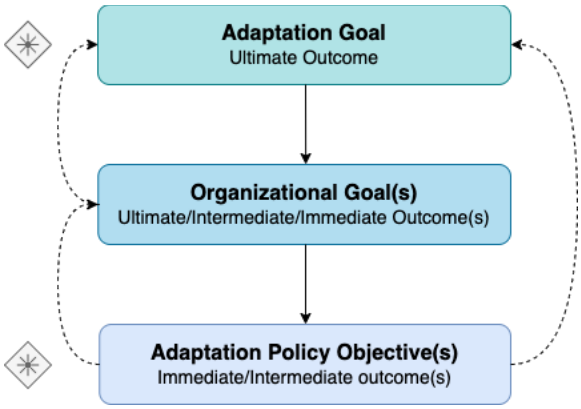

Figure 7.1 – Feedback Loop 1

Feedback Loop 2 is presented in Figure 7.2, below. The Adaptation Policy Objective provides the policy justification for the Adaptation Interventions while the Actual Outcomes inform whether the Policy Objectives are being achieved. The feedback loop demonstrates that a Policy Objective is not meant to be static but instead should be verified and/or adjusted according to the results of the Actual Outcomes. It should be noted that after the Policy Objective is updated, the Adaptation Interventions and Intended Outcomes may need to be altered accordingly.

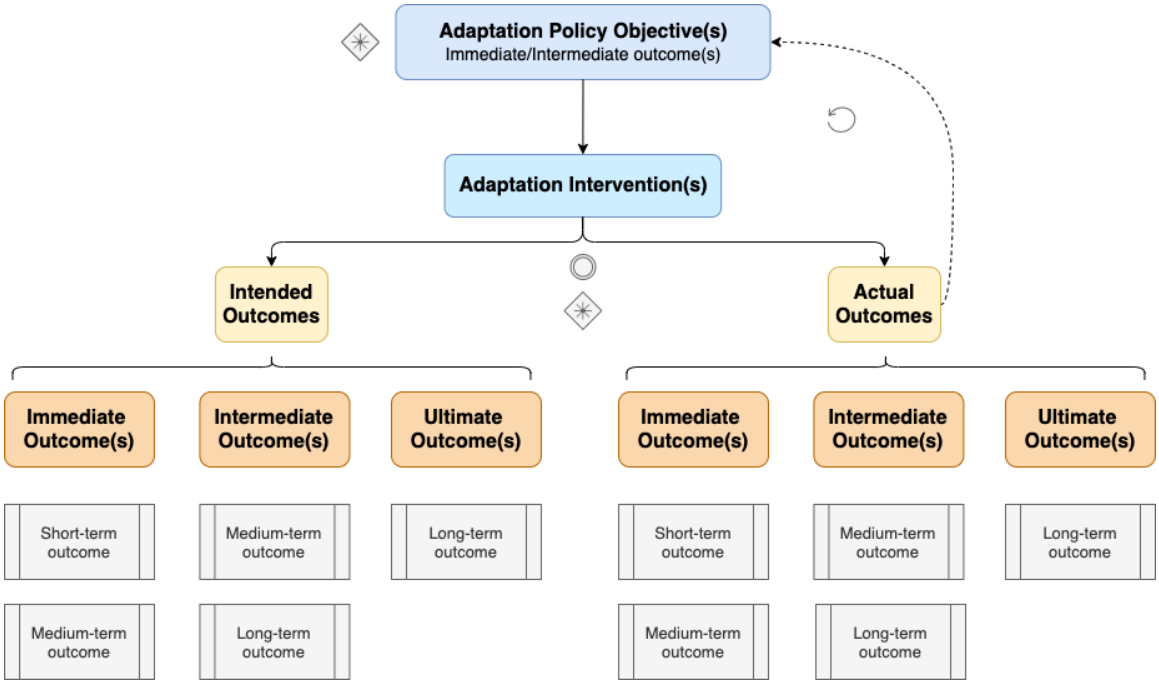

Figure 7.2 – Feedback Loop 2 – Adaptation Policy Objectives to Outcomes

7.5. Adaptation Interventions & Outcomes

Adaptation Interventions are considered to be operational (i.e., non-strategic) policies, programs, and/or physical measures. The number and type of interventions being assessed is dependent on the Adaptation Policy Objective being evaluated. After choosing the Adaptation Intervention(s), the framework then splits into two streams – Intended Outcomes and Actual Outcomes. The Intended Outcomes are the forecasted impacts that were determined during the Interventions' development and/or implementation. The Actual Outcomes are the real-world impacts of the Interventions that are being reported.

The impacts of the Adaptation Interventions are labelled according to short, medium and long-term (SML) outcomes. The interpretations of SML outcomes outlined in Table 7.1 are modified versions of the best practice SML definitions for measuring policy results as per a World Bank report on climate resiliency (World Bank, 2017, p. 82). As previously mentioned at the start of Chapter 7, SML outcomes are the time-bound impacts of specific Adaptation Interventions. The SML outcomes are then categorized

according to the IIU[6] outcomes they are achieving – the IIU outcomes are based on the previously set objectives and goals in the framework. It should be noted that more than one SML outcome will likely result from the Intervention being analyzed.

As outcomes move from short to long-term, the number of SML outcomes should decrease. This means that the long-term outcomes of both the Intended and Actual Outcomes should (ideally) closely align with the Policy Objective and the ultimate Adaptation Goal. An example of an Adaptation Intervention is provided in the applied framework in 8.4.

Table 7.1 – Phases & Interpretation of Outcomes

Timeline	Description
Short-term outcomes	• 1-3 years • The outcomes that can be directly achieved through an adaptation activity* – there will typically be more than one short-term outcome identified.
Medium-term outcomes	• 3-5 years • An outcome requiring a series or sequence of adaptation activities to be achieved.
Long-term outcomes	• >5 years • Typically coincides with the ultimate outcome the intervention is meant to support. The long-term outcome is ideally aligned with the objectives and goals identified in the framework.

*Adaptation activities are the individual actions required to achieve the adaptation intervention. The descriptions outlined in the table are modified versions of those originally created by the World Bank in a report on climate resilience evaluation methods (World Bank, 2017, p. 82).

Implementation & Feedback Loops

The two pathways, the 'Intended Outcomes' of interventions and the 'Actual Outcomes' of interventions, are meant to provide a side-by-side comparison of the progress and/or impacts of the chosen Adaptation Interventions. This comparison highlights the variation (or similarity) between government commitments and actions. The parallel pathways are presented in Figure 7.3, below.

The Intended Outcomes pathway is a baseline comparator for the Actual Outcomes pathway. The Intended Outcomes should have been pre-determined during the development or initial implementation of the assessed Adaptation Interventions. In

[6] Immediate, intermediate, and ultimate outcomes

the Actual Outcomes pathway, the real-life SML outcomes are categorized into IIU outcomes through the use of indicators. The results of the indicators inform how well the Interventions are contributing to the achievement of the Accountability Framework's goals and objectives. Once the Actual Outcomes are finalized, the 'end' of the Accountability framework has been reached and the feedback loop to the Adaptation Goal begins. The Adaptation Goal and other aspects of the Accountability Framework may or may not be adjusted based on these findings. The iterative process is continuous and ends at the discretion of the organization utilizing the framework. It is important to note that the evaluation cycle can be initiated even if the long-term or ultimate outcomes are not achieved. The feedback loop back to the Adaptation Goal is simply dependent on what the final SML outcome of the 'Actual Outcomes' pathway is.

The parallel pathways can also be used to assess milestones and timeline commitments made by the organization. The SML outcomes of the Intended Outcome should be reflective of the original timeline commitments made during the Intervention's development while the Actual Outcome will depict the reported progress of the Intervention.

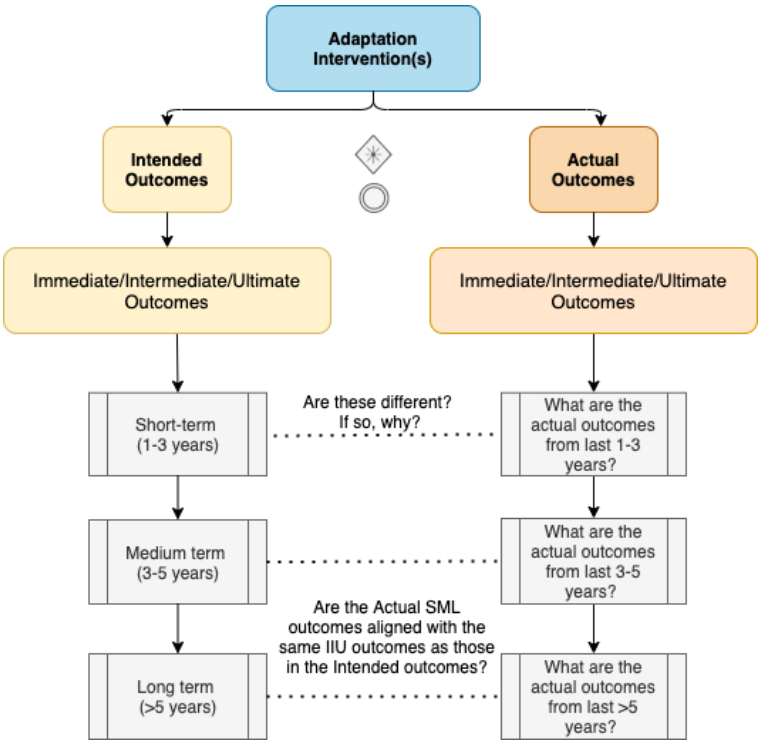

Figure 7.3 – Side-by-side Comparison of Intended and Actual Outcomes
SML – short, medium, and long-term; IIU – immediate, intermediate, and ultimate

Risk Considerations

Adaptation Interventions are usually targeted at specific localities or populations therefore the scope of risk will likely be localized (as is shown in the figures with the '  ' symbol). The results of this risk assessment should be complementary to the regional and provincial-level risk considerations assessed in the other segments of the framework. I turn next to an illustration of how the Accountability Framework could be applied to a transportation adaptation initiative.

Chapter 8. Applying the Climate Adaptation Accountability Framework Scenario: An Illustration

This chapter offers a step-by-step illustration of how the Accountability Framework can be implemented using the example of climate resiliency of transportation infrastructure investments, related adaptation interventions, and the communities reliant on them. I use publicly available government information, news releases, and consulting reports, as internal BCMOTI and GoBC documentation was unavailable, and identify when I use assumptions to fill the gaps in available data. While the actual implementation of the framework will be guided by the needs of the organization, the order of operations presented in this illustration is the recommended approach for implementation.

8.1. Adaptation Goal

The framework evaluates whether the adaptation interventions implemented by the GoBC support the Adaptation Goal depicted in Figure 8.1.

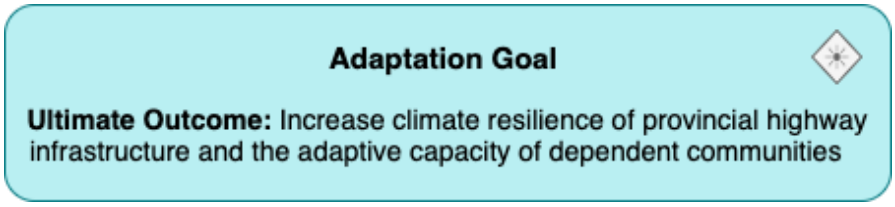

Figure 8.1 – Adaptation Goal for Applied Scenario
The ◈ signifies that a risk consideration is required at this step.

8.1.1. Provincial Climate Risk

The need for the Adaptation Goal is based on the results of the 2019 CRA, which identify multiple provincial climate risks that are anticipated to impact infrastructure resilience (B.C. Ministry of Environment, 2019a; Nyland & Nodelman, 2017). The most pertinent climate risks facing transportation infrastructure were identified in the CRA and are listed in Table 8.1 below.

Table 8.1 – Provincial climate risks anticipated to impact provincial transportation infrastructure

Risk Event	Likelihood of impact to infrastructure services (low, medium, high, extreme)	Anticipated severity of impact (insignificant, minor, moderate, major, catastrophic)	Description of potential losses
High Risk Events			
Heat Wave	Medium	Moderate to Major	Days-long disruptions to electricity and transportation systems (B.C. Ministry of Environment, 2019c, p. 16).
Severe Wildfire Season	Medium	Major	Months-long disruption in transport, electricity supply, telecommunications, water and wastewater treatment (B.C. Ministry of Environment, 2019c, p. 17).
Medium Risk Events			
Severe Coastal Storm Surge	Medium	Catastrophic	$1.8 billion in infrastructure and institutional losses; months-long disruption to transportation, electrical and other infrastructure services (B.C. Ministry of Environment, 2019c, p. 15).
Extreme Precipitation and Landslide	Medium	Moderate	Days-long disruption to transportation and utility infrastructure (B.C. Ministry of Environment, 2019c, p. 9).
Moderate Flooding	Medium	Major to Catastrophic	Week-long disruption to transportation, water, and other infrastructure services (B.C. Ministry of Environment, 2019c, p. 8).
Severine Riverine Flooding	Medium	Catastrophic	$4.7 billion in infrastructure and institutional losses; months-long disruption to transportation, water, and other infrastructure services (B.C. Ministry of Environment, 2019c, p. 7).

The table is a modified version of the information presented in the *Preliminary Strategic Climate Assessment for British Columbia – Summary of Results* (B.C. Ministry of Environment, 2019c)

8.2. Organizational Goal

The Organizational Goals chosen are a mixture of commitments from intergovernmental and ministerial priorities. Figure 8.2 provides an overview of the Organizational Goals.

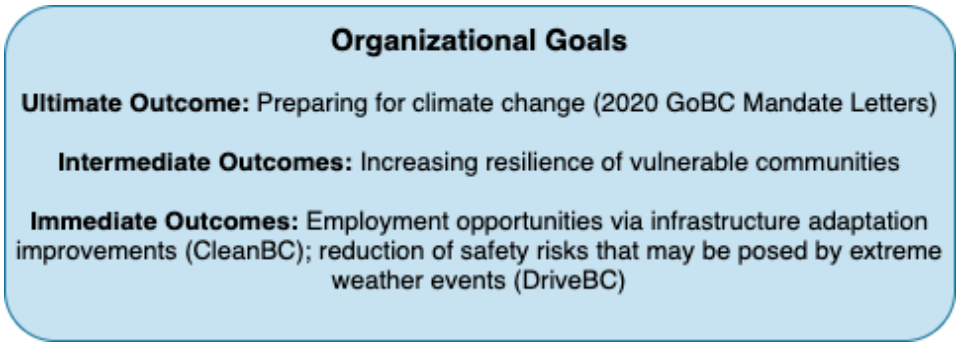

Figure 8.2 – Summary of Organizational Goals

Ultimate Outcome

"Preparing for climate change," is a means to better prepare B.C. against the future impacts of climate change (GoBC, 2020). This is a strategic commitment mentioned in all the 2020 Mandate letters from the Premier to the Ministers and is aligned with the framework's Adaptation Goal.

Intermediate Outcome

The Adaptation Goal is supported by the government's overall mandate of increasing community resilience – especially those that are considered particularly vulnerable in the face of climate change (Indigenous, northern, remote, and coastal communities).

Immediate Outcome

Two Organizational Goals were identified as immediate outcomes supported by the Adaptation Goal. The first is the CleanBC commitment to job creation, which is achieved through the implementation of adaptation-related Infrastructure improvement projects (BCMOTI, 2021). The second is BCMOTI's commitments to the prioritization of driver safety in the face of extreme weather events and climate hazards (Nyland & Nodelman, 2017, p. 86).

8.3. Adaptation Policy Objective

The Adaptation Policy Objective dictates what interventions will be included in the evaluation. Based on the Adaptation and Organizational Goals, two Policy Objectives were chosen (refer to Figure 8.3). The first pertains to the negative impacts

occurring from precipitation-related events as this is one of the most common climate hazards faced by transportation infrastructure (Nyland & Nodelman, 2017). The second outcome has to do with the consideration of adaptive capacity in an infrastructure resilience context. Both of these Policy Objectives can be interpreted as immediate outcomes; however, this step can also contain intermediate outcomes if it is appropriate. The ultimate outcome the Policy Objective supports should correspond to those outlined in the Organizational and Adaptation Goals.

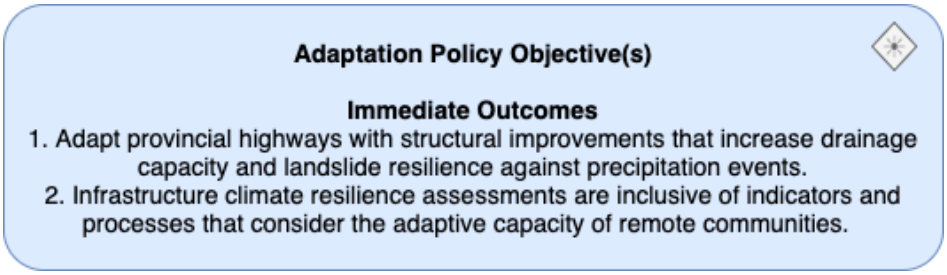

Figure 8.3 – Adaptation Policy Objective
The ◈ signifies that a risk consideration is required at this step.

8.3.1. Regional Climate Risk

The climate vulnerabilities facing transport infrastructure are determined according to the ecoprovinces[7] the infrastructure resides in. Almost all ecoprovinces containing major provincial highways are projected to continue to have increasingly warmer and wetter winters by the 2080s (as cited in Nyland & Nodelman, 2017, p. 74). Another assessment found that some B.C. highways are facing additional precipitation-related risks due to their placement along mountainous areas (Sobi & Murdock, 2014; Nyland & Nodelman, 2017). The highways in these specific regions are at risk to ice jams, debris flows and extreme temperature fluctuation (Nodelman, 2013; Sobi & Murdock, 2014; Nyland & Nodelman, 2017).

8.4. Adaptation Intervention

Two interventions within the scope of the chosen Policy Objectives are the infrastructure repairs that occurred due to heavy rainfall events in the Bella Coola region

[7] Ecoprovinces “are areas with consistent climate processes, oceanography, relief and regional landforms. There are 10 ecoprovinces in B.C.” (as cited in Nyland & Nodelman, 2017, p. 71)

(Highway 20) in September 2010 and Pine Pass region (Highway 97) in June 2011. The incidents resulted in millions of dollars' worth of damage and heavily impacted the communities connected to the highways. Table 8.2 is a summary of each incident and Figure 8.4 outlines the specific Adaptation Interventions being assessed in this framework.

Table 8.2 – Summary of Bella Coola & Pine Pass Highway Flood Impact Incidents

Bella Coola: Highway 20 Flood Impacts	On September 25th and 26th, 2010 a heavy rainfall event occurred that exceeded the 1-in-200 year rainfall event of 200mm.The event caused washouts, rock falls, and flooding, which caused the closure of 12.5km of highway thereby making the area between Talta Lake and Bella Coola impassable at 12 locations. Highway access was not fully restored for 17 days and required approximately $45 million in transportation repair costs. Local communities around this region faced additional hardship from road closures due to the heavy rainfall having caused disruptions in electricity and heat generation.
Pine Pass: Highway 97 Flood Impacts	On June 25th and June 26th, 2011, a 1 in 100 year heavy rainfall event occurred in Pine Pass and resulted in road washouts and flooding of bridges. This ultimately resulted in fifteen sites along Highway 97 being damaged along with a further 280 road and bridge-sites damaged in the Peace Region because of the event. The damage resulted in $80 million of infrastructure repair that required all of summer 2012 to complete. The damage caused road closures between Prince George and Alaska.

All of the information in this table is cited and modified from p. 80-81 of Nyland & Nodelman's (2017) chapter on adaptation and transportation in British Columbia, which is a section of the larger report called *Climate Risks & Adaptation Practices – For the Canadian Transportation Sector 2016*.

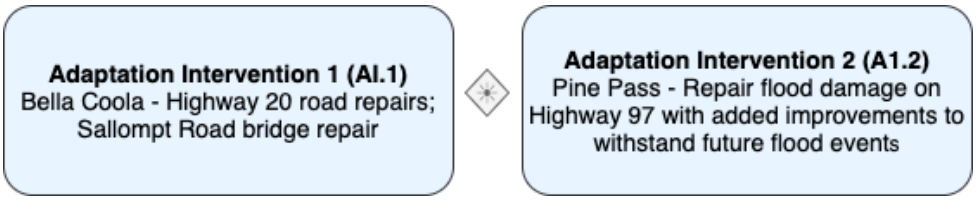

Figure 8.4 – Adaptation interventions
The ◈ signifies that a risk consideration is required at this step.

8.4.1. Regional/Localized Risk Considerations

The climate vulnerability assessments outlined in Table 8.3 were released after the Bella Coola and Pine Pass flood impact events. It is unclear whether the results of the vulnerability assessments (VA) were incorporated into the initial highway repairs that

occurred immediately after the events. For the purposes of this example, it is assumed that the results were incorporated, and that the VA acted as justification for the implementation of additional adaptation improvements in the Bella Coola and Pine Pass regions.

Table 8.3 – Vulnerability Assessment (VA) Results for Bella Coola and Pine Pass

Vulnerability Assessment	Summary of Findings
Bella Coola **VA completed September 2013**	• Higher climate vulnerabilities were associated with the impact of heavy precipitation events. • Bella Coola is classified in the medium vulnerability category. • The climate risks in this region challenge the protection works, stabilization works, and drainage elements in the area.
Pine Pass **VA completed September 2013**	• High vulnerabilities were associated with the impact of heavy precipitation events on protection works, bridge end fills, and third party utilities. • The climate risks in this region challenge the protection works, stabilization works, and drainage elements in the area.

All of the information is based on the information from p. 85 of Nyland & Nodelman's (2017) chapter on adaptation and transportation in British Columbia. This chapter is a section within a national report called *Climate Risks and Adaptation Practices – For the Canadian Transportation Sector 2016*.

8.4.2. Intended Outcomes

The Intended Outcomes pathway of the two Adaptation Interventions are presented in Figure 8.5. The short, medium, and long-term (SML) outcomes of the Adaptation Interventions are organized according to the immediate, intermediate and ultimate (IIU) outcomes identified throughout the Adaptation and Organizational Goals as well as the Adaptation Policy Objectives. The SML and IIU outcomes were chosen based on public reports regarding the Bella Coola and Pine Pass incidents. The IIU outcomes are defined according to the broader goals and objectives expressed throughout the first half of the framework. As previously mentioned in section 7.1, the SMLs described in the Intended Outcome are the time-related impacts that were forecasted and/or anticipated to occur during the development of the Adaptation Interventions[8].

[8] As most of the public reporting regarding the Bella Coola and Pine Pass incidents were developed and published are the incidents were resolved, the SMLs listed under the Intended Outcomes in Figure 8.5 were assumed based on the post-incident reporting.

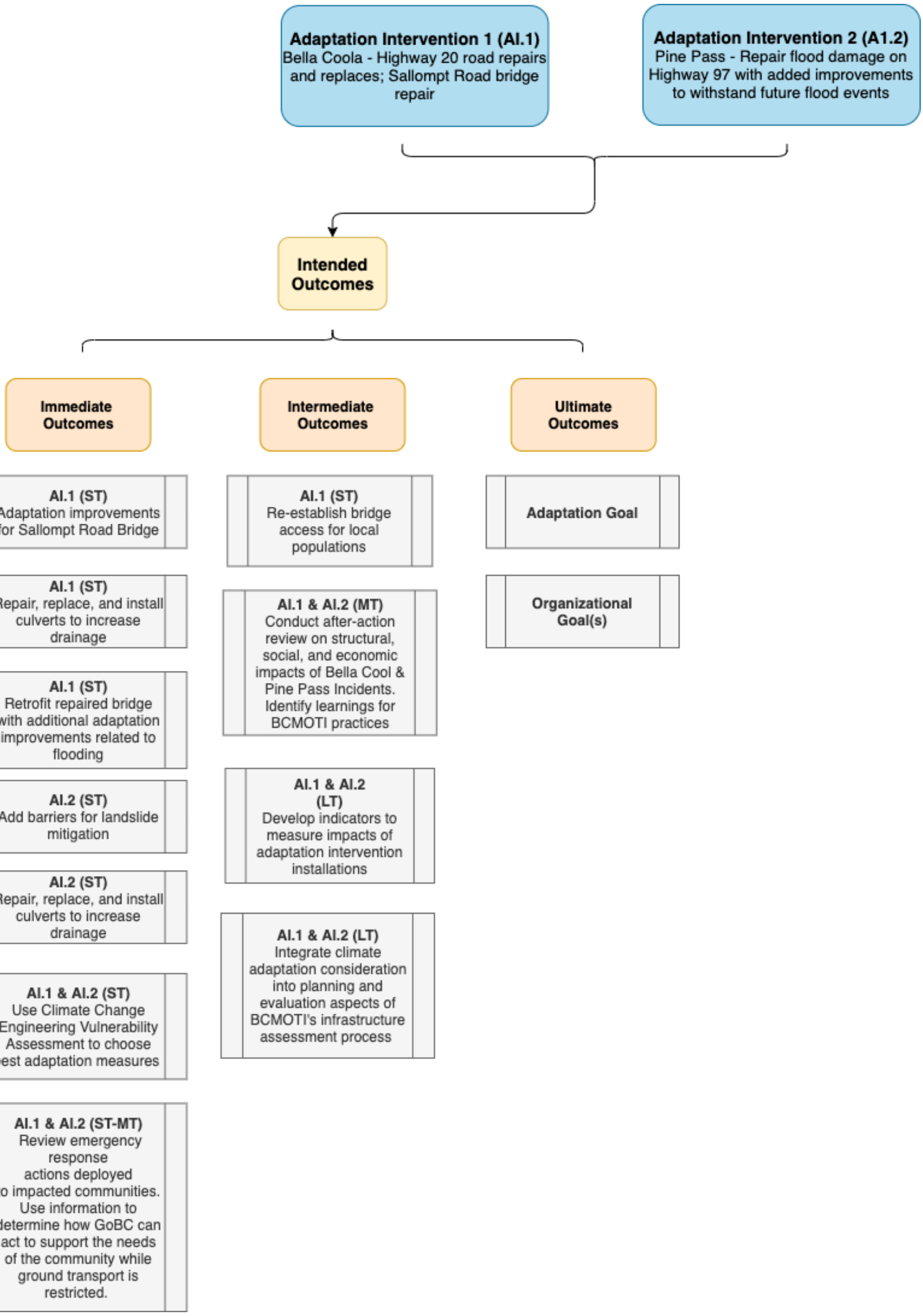

Figure 8.5 – Intended Outcomes of infrastructure Adaptation Interventions
ST – short-term; MT – medium-term; LT – long-term

8.4.3. Indicators

As denoted by the '◎' symbol from the larger framework (Figure 6.1, Chapter 6), before assessing Actual Outcomes, indicators must be determined. Outside of the indicators required to measure the impacts of the interventions, the indicators must also inform whether the various adaptation-related goals, objectives, and outcomes identified throughout the framework are in the process of or are currently being achieved. Once decided upon, the indicators chosen will be put into practice when determining whether the SML outcomes in the Actual Outcome pathway align with the IIU and Intended outcomes established throughout the framework. Table 8.4 is a list of potential qualitative and quantitative indicators that can be applied in this scenario. The indicators are categorized using the indicator buckets presented in section 6.3.2 in Chapter 6.

Table 8.4 – Example of Indicator Use in Applied Framework

Indicator Bucket	Specified Indicators
Reducing Climate Related Hazards and Disaster Risks	• Change in number of precipitation and landslide-related recreational transport disruptions. • Change in number of highway users. • Change in annual highway maintenances costs in the Bella Coola and Pine Pass regions. • Change in number of precipitation and landslide-related commercial transport disruptions.
Building Climate Resilience through Infrastructure	• Change in number of communities (regional, municipal, Indigenous peoples) that have natural and cultural asset management plans.
Supporting Disproportionately Impacted Regions and Populations	• "Percentage of Canadians living on low income in climate hazard areas" (Expert Panel, 2018, p. 8). • "Number of key members of community (e.g., police, firefighters, water technicians, harvesters) with safety training and equipment to adapt to changing conditions" (Expert Panel, 2018, p. 8). • "Percentage of total financial losses from climate event restored, making citizens whole" (Expert Panel, 2018, p. 42).

8.4.4. Actual Outcomes

The Actual Outcomes depicted in Figure 8.6 are based on post-incident reports, which analyze the repair and recovery processes of the Bella Coola and Pine pass incidents.

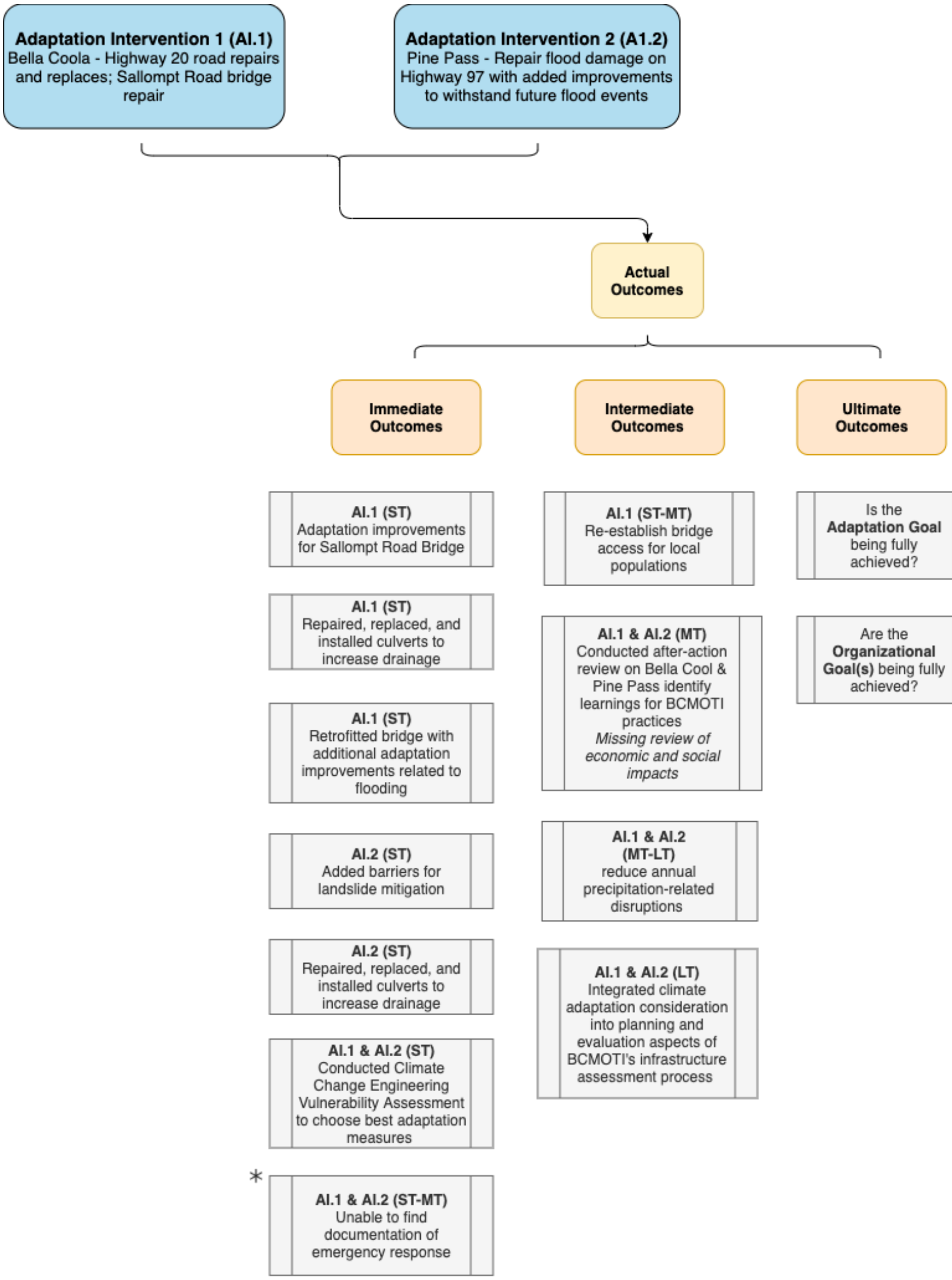

Figure 8.6 – Actual Outcomes of Infrastructure Adaptation Interventions

Descriptions of intervention SML outcomes denoted by an (*) are assumed as there was no public documentation found to corroborate whether that outcome was met.

ST – short-term; MT – medium-term; LT – long-term.

8.5. Interpreting the Evaluation Results

Figure 8.7, below, is a fully constructed schematic unifying all the figures presented throughout this chapter. As the figure shows, the Actual Outcomes feedback to the Adaptation Goal and begin the iterative evaluation process. This iterative process allows the users of the framework to verify how the goals and objective are being met and determine any adjustments and considerations that need to be made at each section of the framework.

Whether or not the goals and objectives identified in the Accountability Framework are being achieved is unlikely to be answered through a binary yes or no. There are multiple factors that must be taken into account when formulating the results, such as contextual considerations. Another consideration is if the Actual Outcomes do not match their corresponding Intended Outcomes, does this automatically mean that the impacts of the adaptation interventions are negative? This is where the learning aspect of the evaluation comes into focus and allows the framework's users' to utilize the evaluation's results as a planning tool for improving adaptation goals, objectives, and interventions.

Some general conclusions that can be made from the Accountability Framework example are that the GoBC has made significant strides in achieving infrastructure climate resilience. The vulnerability assessments (VAs) conducted on the Bella Coola and Pine Pass incidents served a larger purpose for BCMOTI and appear to have been the start of a series of initiatives that ultimately supported the mainstreaming of climate change adaptation considerations in current BCMOTI practices. Therefore, it is unlikely that any adjustments in goals, objectives, and interventions are required in regard to this aspect of the Adaptation Goal.

Whether the GoBC is meeting the adaptive capacity portion of the Adaptation Goal is still up for debate. The documentation outlining the emergency responses to the Bella Coola and Pine Pass incidents could not be located during the duration of this study. There also appears to be no after-action reviews that assess how the climate resilience of communities impacted by these incidents could be improved. This is in stark contrast to the readily available documentation regarding the climate adaptation considerations and improvements of the physical infrastructure impacted by the

incidents. Therefore, it may be worthwhile to include more departments in the Organizational Goals stage, such as those related to emergency response, municipal affairs, and Indigenous reconciliation. By using an adaptive co-management approach, the various departments could contribute to better understanding how adaptive capacity, in the face of climate-related infrastructure failures, could be increased. As a reminder, this is not to say that the theoretical adaptive capacity goal created for this scenario is not being achieved but instead is meant demonstrate how the framework can assist in identifying gaps in adaptation practices. As this is an example that does not benefit from knowledge of the internal workings of government, no definitive conclusions can be made as to whether the GoBC is achieving the theoretical Adaptation Goal. That assessment would be the role of internal GoBC staff.

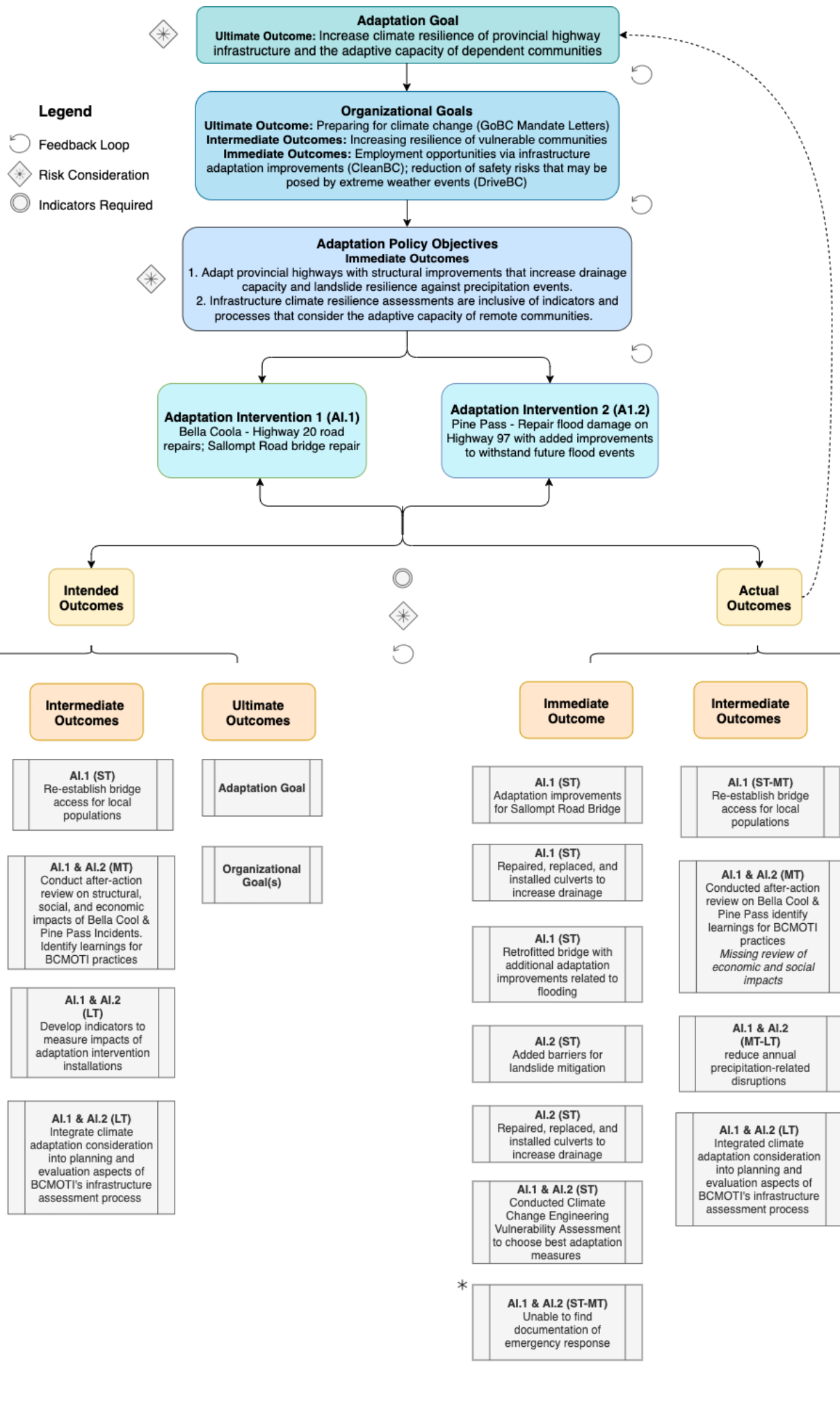

Figure 8.7 – Fully Applied Climate Adaptation Accountability Framework

The SML outcomes denoted by is (*) are assumed as there was no public documentation found to corroborate whether that outcome was met.

ST – short-term; MT – medium-term; LT – long-term

Chapter 9. Analysis of Framework

9.1. Objectives & Criteria

As previously mentioned, the guiding principles used to develop the Accountability Framework are made of up of six objectives. This chapter assesses whether the framework adequately represented each objective based on a list of criteria. The individual criterion are evaluated according to the following grading scheme:

- High – framework fully meets all aspects of the listed criteria
- Medium – framework meets some aspects of the listed criteria
- Low – framework meets little to no aspects of the listed criteria

The final overall rating of how the framework meets all the objectives is determined by averaging the high, medium, and low scores resulting from the individual objectives.

9.2. Effectiveness

Effectiveness in adaptation interventions looks at both the impact of the implemented intervention and the accuracy of the assumptions used during the intervention's development and/or implementation. To incorporate this consideration, the Accountability Framework continues to reiterate the need to re-assess any assumptions made during the development of the intervention. This is particularly emphasized at the points of the framework where risk considerations and indicators are required as well as through the side-by-side comparison of the intended and actual intervention outcomes. Table 9.1 represents the specific criteria that are being used to determine if this objective has been adequately achieved.

Table 9.1 – Assessment of Effectiveness

Effectiveness Criteria	
Process demonstrates whether adaptation interventions have achieved or are on target to achieving, the intended immediate, intermediate, and ultimate outcomes they were originally forecasted to produce.	High
Adaptation interventions support broader adaptation and government commitments.	High

The process contributes to increasing overall climate resilience for the province and its individual communities.	Medium
The adaptation interventions, policy objectives, and goals, are aligned with local, regional, and provincial climate risk assessments.	High
Effectiveness Rating	**High**

9.3. Adaptive Capacity

The framework provides opportunities to directly address the specific considerations of communities disproportionately impacted by climate change through the use of indicators and adaptive co-management. The inclusion of steps that require the evaluation of localized climate risks also contributes towards increasing adaptive capacity. Although the description of the Accountability Framework outlines how Indigenous peoples and other disproportionately impacted populations can be focused on within the evaluation process, there is room for improvement in this objective. The framework can strengthen its focus on adaptive capacity by incorporating more targeted mechanisms that assess whether the needs of Indigenous, northern, remote, and coastal communities are being met. In order for Indigenous peoples to fully benefit from the results of the framework, this may mean adapting parts of the framework, or even developing an extension that is better centred around Indigenous Knowledge Systems and the unique experiences of Indigenous communities.

Table 9.2 – Assessment of Adaptive Capacity

Adaptive Capacity Criteria	
The framework contains mechanisms that recognize and address the unique climate risks facing northern, coastal, remote, and Indigenous communities.	Medium
The framework has processes that can highlight the equitable access and distribution of adaptation interventions across different regions and populations.	Medium
Adaptive Capacity Rating	**Medium**

9.4. Adaptive Co-management

The framework practices adaptive co-management in multiple ways, such as indicator development, risk management and the Organizational Goals. If the framework is successfully implemented, it takes into account cross-ministerial implications and prioritizes engagement or direct collaboration with interest groups and Indigenous peoples outside of government. However, despite there being numerous opportunities

for adaptive co-management throughout the framework it is not a tool that can make collaboration mandatory – that responsibility is with those conducting the evaluation.

Table 9.3 – Assessment of Adaptive Co-management

Adaptive Co-management Criteria	
There are opportunities for horizonal (i.e., cross-ministerial) collaboration.	High
There are opportunities to collaborate with external actors.	High
Process for analyzing actual outcomes of adaptation interventions uses feedback from actors internal and external to government.	High
Climate risks are verified with the input of localized and regional governments and communities.	Medium
Space is being made for Indigenous Knowledge-based approaches when climate risks and impacts of adaptation interventions are being assessed.	Medium
Adaptive Co-management Rating	**Medium-High**

9.5. Process & Intervention Improvement

The Accountability Framework has integrated learning and improvement opportunities throughout each step and prioritizes improvement by making the framework an iterative process. It is important to note that whether these opportunities are acted upon is beyond the scope of the framework.

Table 9.4 – Assessment of Process and Intervention Improvement

Process and Intervention Improvement Criteria	
The framework has processes that identify whether an adaptation intervention must be modified. This includes verifying whether the use of the adaptation intervention is being supported by the most currently available climate data and information.	High
The framework's process ensures the identification of intervention gaps, challenges, and achievements that can contribute to future improvements.	High
Process and Intervention Improvement Rating	**High**

9.6. Accountability

Transparency is a key trait of organizations' that successfully demonstrate accountability (World Bank, 2017). One of the purposes of the framework is to strongly encourage the governing organization to clearly articulate their adaptation goals and objectives as well as provide evidence documenting the necessity of adaptation interventions. This then acts as a foundation for the side-by-side comparison of the Intended versus Actual Outcomes, which provides a clear depiction of what the

governing body has and has not achieved. It is not enough to present the achievements and progress made while implementing and/or developing adaptation interventions. It is equally important that the audience receiving the results of the accountability evaluation understand the data and information used throughout the evaluation process and are also informed of the challenges, barriers, and gaps that have been discovered along the way. The cumulative impact of all aforementioned objectives support evaluating government accountability.

Table 9.5 – Assessment of Accountability

Accountability Criteria	
There are mechanisms and/or processes that clearly identify gaps between government commitments and government practices.	High
The process uses transparency to facilitate accountability.	High
Accountability is demonstrated through determining intervention effectiveness, adaptive capacity, adaptive co-management, and intervention improvement.	High
Accountability Rating	**High**

9.7. Administrative Ease

To implement this framework in its entirety will likely require expansions of existing working groups or teams and as a result, may require more resources than what is feasible for certain organizations, thus leading to a relatively low level of administrative ease/higher administrative costs. It is unlikely that a government body can implement every aspect of such a framework, in the short run but they can approach the framework as aspirational and to be developed over time as resources permit.

Table 9.6 – Assessment of Administrative Ease

Administrative Ease	
Framework does not require a large number of additional resources than what is already being allocated towards climate change accountability reporting.	Low
Administrative Ease Rating	**Low**

9.8. Final Rating

Although adaptive capacity and administrative ease did not receive high ratings, it can be concluded that the grade for the overall framework is considered medium to high. As expressed in the explanations above, there are areas of improvement that can

be addressed in future research or must be addressed using separate policy tools. However, the assessment has shown that despite some of these issues the framework has the potential to be effective and provide value-add to an organization, if they choose to adopt it.

Table 9.7 – Overall Rating of Framework

Effectiveness	High
Adaptive Capacity	Medium
Adaptive Co-management	Medium-High
Process and Intervention Improvement	High
Accountability	High
Administrative Ease	Low
Final Rating of Recommended Framework	**Medium-High**

Chapter 10. Conclusion

10.1. Future Research

Although this study integrates analyses and lessons learned from the literature and theoretical insights, the lack of quantitative analysis means that there were certain issues that could not be fully explored and should be pursued in future research. Specifically, this research would have benefited from a discussion of the nuances behind public financing of adaptation interventions and the quantification of adaptation benefits. Before the COVID-19 pandemic, governments were constantly pressured to practice fiscal restraint and focus investments on imminent threats to society, which has made it difficult to solicit government support for adaptation interventions. This issue is now more prevalent than ever due to the public debt that has been incurred as a result of the pandemic. Therefore, it is understandable that governments are seeking ways to develop evaluation methods that focus on monetizing the benefits that are derived from interventions. This primarily involves calculating the cost of potential losses that could be incurred due to climate hazards. Although the value add of dedicated research in this area is substantial, it is important to keep in mind that financial costs should not be considered the only decision-making criteria for what is considered a 'successful' adaptation intervention. The extreme human and societal costs that can occur as a consequence of extreme weather and climate events must be an integral part of any analysis evaluating effectiveness of adaptation interventions.

Finally, further research must be conducted regarding the relationship between Indigenous communities, Indigenous Knowledge Systems (IKS) and climate adaptation. Not only are Indigenous communities most disproportionately impacted by climate change but they also have valuable expertise and historical experiences that make them natural leaders in adaptation. Space must be made for IKS and Indigenous voices, and more research needs to be done on evaluation methods that use an IKS approach.

10.2. Next Steps and Concluding Thoughts

The Accountability Framework is not necessarily pragmatic to conduct every year and, when used in its entirety, is a tool that is best employed for evaluations conducted

every three to five years. The implementation of the framework also requires high coordination and would take time to fully enact. Governments could evaluate how the framework best fits with their organizational practices by initially implementing it as a pilot project within two to three ministries and then scaled-up to cross-governmental use after assessing the outcomes of the pilot.

Regardless of whether an organization has the capacity to implement the full Accountability Framework, there are some ways to adapt it for the purpose of annual adaptation assessments. There are three specific aspects that would be feasible to implement in the short run that could also be compatible with existing evaluation practices and positively contribute towards an annual assessment.

The first is the use of **risk communication** tools in adaptation evaluations, such as the bowtie method explored in Chapter 5. Adaptation interventions are preventative measures that try to minimize the impacts of climate risks therefore making adaptation and risk management two subjects that go hand-in-hand. As risk management can be a technical subject, climate risk needs to be communicated in an accessible way for non-technical audiences.

The second is the use of **indicator buckets** and an **adaptive co-management approach** as a means to apply an intersectional lens to adaptation. Climate adaptation is an issue that impacts many areas – a siloed approach to adaptation evaluation will only lead to more difficulties in the long-run. The idea “that stakeholders across all policy areas should be consulted to ensure that the cross-sectoral linkages are understood and identified, and to identify existing/facilitate creation of linkages” is continuously reinforced in the existing literature on adaptation intervention management (as cited in, Moss, 2019, p. 6-7). Supply chains are an example of how co-management is essential in the evaluation process. Supply chain disruptions caused by climate events have rippling impacts on economic, social and environmental spheres. Each of the perspectives within these spheres have unique needs and views about the effectiveness of adaptation interventions that must be utilized.

A co-benefit of the adaptive co-management approach is the potential impact it can have on adaptive capacity. A limitation of the Accountability Framework is that it cannot directly improve adaptive capacity, separate policy tools are required for this.

Instead, indicators are an effective way to understand the current state of adaptive capacity and identify gaps that can facilitate the necessary actions required to increase it. If there are more localized actors directly involved in indicator development, the populations these actors represent can directly advocate for the provincial supports required to address the unique climate vulnerabilities facing their communities. This co-development of indicators will be particularly important for when provincial governments are addressing the needs of disproportionately impacted Indigenous, remote, northern, and coastal communities. However, it is important to keep in mind that there are limits as to how much indicators can measure. It is impossible to capture every single impact of an adaptation intervention, therefore it is up to the evaluators to exercise their best judgement and ensure that the indicator development process does not become a barrier to carrying out a full evaluation.

The third is prioritizing **transparency**. This paper has demonstrated that the complexities involved in evaluating adaptation interventions are arguably just as difficult as developing the interventions themselves. The side-by-side comparison of intended and actual outcomes conducted in the latter half of the Accountability Framework is a mechanism that is meant to encourage a transparent assessment of interventions that can benefit those internal and external to government. The comparison can facilitate strong reporting practices that could greatly influence the improvement of future adaptation interventions. Using this mechanism could also have larger implications beyond the governing body that is being evaluated. Climate adaptation is an area of policy that is still growing therefore any learnings gained from the evaluation of interventions would be a necessary addition to the existing adaptation literature.

There cannot be enough emphasis put on the fact that adaptation evaluations are just as much a planning tool as they are an assessment tool. With the limited data-driven evidence available on adaptation interventions “it is essential that we monitor what is important [to] [improve] our understanding, not only what is measurable (Pringle, 2011).” Provincial governments in Canada have an important role to play in setting the tone for policy priorities and practices on behalf of the local governments within their jurisdictions. By investing in the implementation of an evaluation framework, provincial governments, such as the GoBC, can not only improve their ability to address climate adaptation but they can also establish a best practice that can pave the way for others.

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Appendix A. Nine Key Expectations from *Resilient Infrastructure Engineering Design* policy

The following corresponds to a reference made in section 3.1. Listed below are the nine key expectations listed in the B.C. Ministry of Transportation and Infrastructure's policy, *Resilient Infrastructure Engineering Design* (Technical Circular t-04/19).

1. Reasonable consideration of the impacts of future climate change and weather extremes appropriate to the scale of the project (including new, rehabilitation and maintenance projects).

2. Using risk assessment methods and climate information for design work from sources such as those providers listed in Appendix 4 (and on the BCMOTI Climate Change and Adaptation website).

3. At the concept stages, the project designer will identify the design components at risk from the impacts of future climate changes and weather extremes over the expected project design life.

4. At the concept stages, the project designer will summarize changes in temperature, precipitation and other climatic variables over the expected project design life.

5. The project designer will identify the risks to project design components from these projected climate changes and summarize the risks in the *Climate Change Design Criteria Sheet for Climate Resilience.*

6. The project designer will develop adaptation design strategies to address climate change risks for the project.

7. Based on evaluation of future climate change effects and impacts, the project designer will develop a project-appropriate set of design criteria for event preparedness and resiliency.

8. Engineering design parameter evaluation and modification for adaptation to climate change will be summarized and listed on *BCMOTI Climate Change design Criteria Sheet for Climate Resilience* (Appendix 1).

9. The design team will implement the developed design criteria into the project.

Appendix B. BCMOTI Infrastructure Assessment Practices

BCMOTI has mainstreamed multiple technical adaptation practices into their regular departmental responsibilities such as the *Resilient Infrastructure Engineering Design*[9] policy. Another notable practice that has been adopted is the Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol. This protocol outlines best practices for adaptation considerations for infrastructure projects and is utilized by all Canadian provinces and territories (Public Infrastructure Engineering Vulnerability Committee, n.d.). At the national level, the committee provides guidance to Canada's engineers and geoscientists on how to address climate risk in infrastructure design for the purposes of producing "safe, reliable, and financially sustainable public infrastructure" (Public Infrastructure Engineering Vulnerability Committee, n.d.).

A significant component of the PIEVC protocol is the vulnerability risk assessment (VRA), which is an infrastructure adaptation evaluation tool looking at three key issues.

> "Exposure to the character, magnitude, and rate of change of climatic conditions.
>
> Positive or negative consequences due to sensitivities of infrastructure.
>
> Built in capacity of infrastructure to absorb any net negative consequences from the predicted change in climatic conditions" (BCMOTI, Nodelcorp Consulting Inc. & Pacific Climate Impacts Consortium, 2014, p. 8).

Since the VRA is meant to be performed by engineers, the outcomes of the VRA are focused on measuring the resilience of physical structures and not the adaptive capacity of communities dependent on the structures. A common theme from academic literature is that, regardless of jurisdiction, engineers are most involved in the incorporation of adaptation principals in infrastructure design. This is typically why adaptation evaluations are focused on assessing quantitative factors, such as the physical integrity of adaptation interventions rather than broader social, economic, and other characteristics (Picketts et al, 2015). However, as previously mentioned in section 3.1, the 2020 BCMOTI report, *Developing a Climate Change Adaptation*

[9] Also known as Technical Circular 04/19

Interdependency Process with Economic Considerations, indicates that the department is ready to begin expanding its evaluation practices to include qualitative assessments.