Adaptive Management in Policy and Regulatory Regimes: A Study of Water and Wastewater Management for Shale Gas Development in Alberta and British Columbia

by

Chelsea Maksimovic

Master of Public Policy, Simon Fraser University, 2014

Bachelor of Arts (Hons.), University of Victoria, 2012

Thesis Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

Under Individualized Interdisciplinary Studies with

Graduate Studies and

School of Public Policy

Faculty of Arts and Social Sciences

SIMON FRASER UNIVERSITY

Summer 2023

Declaration of Committee

Name:	**Chelsea Maksimovic**
Degree:	**Doctor of Philosophy**
Title:	**Adaptive Management in Policy and Regulatory Regimes: A Study of Water and Wastewater Management for Shale Gas Development in Alberta and British Columbia**
Committee:	**Chair: Roxanne Panchasi** Associate Professor, History
	Nancy Olewiler Supervisor Professor, Public Policy
	Diana Allen Committee Member Professor, Earth Sciences
	Zafar Adeel Committee Member Professor, Sustainable Energy Engineering
	Sean Markey Examiner Professor, Resource and Environmental Management
	Deborah Curran External Examiner Professor, Law and Environmental Studies University of Victoria

Abstract

Adaptive management (AM) is an iterative resource management process designed to reduce uncertainty by aiming to continually improve environmental outcomes through rigorous up-front planning and modeling, supported by monitoring and evaluation of outcomes. The academic literature asserts that AM is important, and possibly essential in environmental management, while also highlighting implementation challenges that undermine its success. AM is pervasive at both project and regional scales in Canada and the United States. Ninety-one percent of the projects listed on the Canadian Environmental Assessment Registry invoke AM for one or more environmental issues, and AM is frequently a foundational tenet of regional plans and environmental management policies developed by government agencies. This dissertation uses case study and content analysis methodologies to investigate the prevalence of AM in a sample of 62 publicly available policies covering water and wastewater management for shale gas development in Alberta and British Columbia (B.C.), Canada. Shale gas is an ideal case study given the uncertain environmental and cumulative impacts its development can have in producing regions and watersheds. My findings indicate that AM is present in over half of the policies in the sample, demonstrating that the policies support or recommend an AM approach when mitigating potentially adverse environmental effects. The academic literature also finds that prescriptive administrative law regimes present significant, sometimes insurmountable, barriers for the implementation of AM. I used content analysis to analyze 7050 subsections of legislation with their underlying regulations under the 62 policies. My findings indicate that AM likely cannot be effectively operationalized under the regulatory frameworks associated with the policies in Alberta and B.C. and confirm that there is a significant disconnect between AM as construed in policy and AM that can be feasibly operationalized in the field. I conclude with recommendations for decision-makers to help mitigate risks of regulating under uncertainty. These include supporting mechanisms and incorporation of regulatory models such as outcome-based regulation to increase flexibility necessitated by AM. The results of my study can help inform regulatory approaches designed to mitigate adverse effects arising with industrial development across different sectors (e.g., mining, minerals, energy) as well as regional cumulative effects.

Keywords: adaptive management; energy regulation; policy analysis; content analysis; environmental management

Dedication

For Emilijana – you are my source of inspiration for wanting to solve the hardest problems.

Acknowledgements

This dissertation would not have been possible without the support and contributions of a number of key people. First, I would like to express my gratitude to my committee. I would like to thank my Senior Supervisor, Dr. Nancy Olewiler, and my Supervisors Dr. Diana Allen and Dr. Zafar Adeel. Thank you for your ongoing guidance and your thoughtful comments and questions on my research throughout this whole process. To Professor Deborah Curran and Dr. Sean Markey, thank you for your insightful feedback and questions during my defence. I would also like to thank Dr. Timothy McDaniel who provided important theoretical direction during the early stages of my research design.

I would like to thank Kate Elliot from SFU's Research Commons and Claire Davies who provided invaluable formatting and editing support during the final phase of drafting my dissertation.

I would also like to acknowledge the importance of one of my very first university professors, Dr. Ross Lambertson, who introduced me to the joys of solving policy problems and doing research.

While conducting research and drafting my dissertation, I was supported in part by funding from the Social Sciences and Humanities Research Council (SSHRC) and the Pacific Institute for Climate Solutions (PICS). I am appreciative of the contributions of these organizations who make it possible for me, and students like me, to pursue their academic passions.

Finally, I must acknowledge that without the support of my wonderful husband, Sasha, completing this dissertation would have been so much harder. Thank you for your unwavering support in this project. Throughout the hardest moments, you always reminded me of who I am and what I'm capable of. Now, let's go on vacation!

Table of Contents

List of Tables

List of Figures

List of Acronyms

ABMP	Area Based Management Plan
ACFN	Athabasca Chipewyan First Nation
AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
ALSA	*Alberta Land Stewardship Act*
AM	Adaptive Management
AMI	Adaptive Management Initiatives
AMP	Adaptive Management Plan (see Appendix C)
AREPS	Alberta Responsible Energy Policy System
B.C.	British Columbia
BCER	British Columbia Energy Regulator
CCA	Council of Canadian Academies
CE	Cumulative Effects
CEAA (2003)	*An Act to amend the Canadian Environmental Assessment Act* S.C. 2003, c. 9 (Repealed)
CEAA (2012)	*Canadian Environmental Assessment Act,* 2012 (S.C. 2012, c. 19, s. 52) (Repealed, 2019, c.28, s. 9)
CEM	Cumulative Effects Management
CLBR	Lower Athabasca Region Groundwater Management Framework Supporting Document for the Cold Lake – Beaver Region
DFO	Department of Fisheries and Oceans Canada
EA	Environmental Assessment
EAO	Environmental Assessment Office
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPEA	*Environmental Protection and Enhancement Act* (Revised Statutes of Alberta 2000, Chapter E-12)
EPL	End pit lake
FMMCA	Fort McKay Métis Community Association
IAA	*Impact Assessment Act*, 2019 (S.C. 2019, c. 28, s.1)
IAAC	Impact Assessment Agency of Canada

JRP	Joint Review Panel
LARP	Lower Athabasca Regional Plan
LUF	Land Use Framework
LUP	Land Use Plan
MAMPA	Model Adaptive Management Procedures Act
MOWP	Multi-Operator Water Plan
MRP	Management Response Plan
MSHF	Multi-stage Hydraulic Fracturing
NAOS	Lower Athabasca Region Groundwater Management Framework Supporting Document for the North Athabasca Oil Sands Area
OBR	Outcome-based regulation
OPS	Operational Policy Statement
OGAA	*Oil and Gas Activities Act*
OGC	B.C. Oil and Gas Commission[1]
OGCA	*Oil and Gas Conservation Act*
OGCR	*Oil and Gas Conservation Rules*
PLA	*Public Lands Act*
REDA	*Responsible Energy Development Act*
SAOS	Lower Athabasca Region Groundwater Management Framework Supporting Document for the South Athabasca Oil Sands Area
SSRP	South Saskatchewan Regional Plan
SWQMF	Surface Water Quantity Management Framework for the Lower Athabasca River
TBS	Treasury Board of Canada Secretariat
TDL	Temporary Diversion Licence
TEK	Traditional Ecological Knowledge
TMF	Tailings Management Framework for the Mineable Athabasca Oilsands
WMP	Water Management Plan
TRC	Truth and Reconciliation Commission

[1] In February 2023, the BC Oil and Gas Commission underwent a number of changes including changing its name to the British Columbia Energy Regulator (BCER).

UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
USGS	United States Geological Survey
WSA	*Water Sustainability Act*
WUP	Water Use Plan

Executive Summary

This dissertation investigates the theory and limitations of using adaptive management (AM) in the context of shale gas water and wastewater management in Alberta and British Columbia (B.C). In the context of this research, AM consists of a systematic 6-step approach that attempts to reduce uncertainty in environmental management by designing and implementing resource management options and learning from their outcomes. Over 90% of projects currently listed on the Canadian Environmental Assessment Registry invoked AM for one or more natural resource management problems.

This research is timely for three reasons. First, economic and political indicators suggest that shale oil and gas will continue to be central to energy strategies and energy security in Western Canada. This makes provinces such as Alberta and British Columbia ground zero for most of Canada's drilling and production. Second, AM continues to be identified both by governments and proponents as a viable resource management strategy for addressing uncertainty and mitigating adverse environmental effects that may be a result of development. Third, this dissertation explores the extent to which the underlying legislative and regulatory regimes in Alberta and B.C. conform to the findings in the literature that administrative law regimes are largely incompatible with AM implementation. My analysis and results indicate that Alberta and B.C. are not significantly different from other jurisdictions where this problem has been observed and noted.

AM is not suitable for every context. It is most appropriate in situations with high uncertainty, high controllability, and low risk. Uncertainty refers to unknown outcomes and knowledge gaps, controllability refers to a practitioner's ability to influence the system and control specific aspects or variables, and risk is the probability of a negative event times the consequences incurred. There are two kinds of AM – active and passive. Active AM refers to an approach where deliberate, planned, and proactive interventions or experimental treatments are employed to modify management strategies based on real-time monitoring and analysis of results, enabling adjustments to improve outcomes in dynamic resource contexts. Passive adaptive management involves a more hands-off approach, where management strategies are adjusted less frequently and success is

determined by meeting resource objectives and desired outcomes, with learning as a beneficial, but unintended by-product.

Shale gas is a timely case study given the uncertain environmental and cumulative impacts its development can have in producing regions and watersheds and AM has increasingly been recommended as an approach to managing the cumulative effects from its extraction. My research investigates the presence of AM as a recommended approach or tenet of environmental management in policy frameworks in Alberta and B.C. and tests the nature of the references to AM and its component parts (the 6-step cycle), and the kinds of details, requirements and parameters that may also be present. I evaluate the underlying legislative and regulatory frameworks to determine the extent to which they may be able to enable and operationalize the intended policy outcomes from these frameworks.

Qualitative and quantitative content analysis is the primary research methodology. Content analysis searches for words, themes, or concepts from texts related to the subject area and in this context, provides a basis to form inferences about the intent and use of adaptive management in shale gas regulation. Quantitative content analysis counts or measures the presence of concepts, while qualitative analysis examines meanings and context. This dual approach captures both statistical data and deeper meanings in the policies and employs an eight-step process that includes: defining research objectives, selecting units of analysis, selecting materials, building coding frames, testing reliability and validity, coding the dataset, and analyzing and interpreting the findings. The acts, rules and regulations were coded qualitatively according to what kinds of regulatory models they were and for the presence of AM-enabling features.

Within the sample (n=62), 34 policies (55%) made one or more references to AM. The emphasis on AM was particularly strong in Alberta where 18 out of 28 policies (64%) referred to or recommended AM as an environmental management strategy. The analysis indicated that 16 of 34 (47%) policies in B.C. made one or more references to AM. AM was more than twice as likely to be found in supplementary policies than foundational policies in both Alberta and B.C.

In the policies where the term AM was present, 97% of them had only a general reference to AM and did not address the component parts of AM as outlined in the six steps needed to systematically incorporate AM into policy development and application. Supporting information, such as a definition or a figure, to provide additional clarity and state expectations to proponents and licensees was less frequently observed. Definitions were provided in 11 policies (32%), and figures or process diagrams were provided in 4 policies (12%) in the sample. When the 6-step AM cycle was broken into distinct parts, I found that the continuity of the cycle was disarticulated across environmental management policy as a framework, as well as within individual policies. As a group, the policies tend to place significant emphasis on monitoring over any other step in the AM cycle. It should be noted that none of the policies contained evidence of all 6 steps.

Given the prevalence of AM in water-energy-environmental policies in Alberta and B.C., the next step was to undertake a systematic analysis of the content of the legislative and regulatory frameworks where the policies are implemented. In the Alberta legislative and regulatory content analysis, I reviewed 4275 individual subsections of text and coded them across two major categories:

1. The kind(s) of regulation(s) that the subsection is made up of, and

2. A qualitative analysis of indicators that would suggest the degree to which the subsection enables implementation of AM, including specific steps in the AM cycle, if applicable.

Using the same methodology, 2775 individual subsections of legislative and regulatory text in B.C. were examined.

The analysis indicates that legislation and regulations in Alberta and B.C. are overwhelmingly prescriptive, although the specified enactments in B.C. contain some unique features that make them highly adaptive. For example, the water sustainability plans and 30-year license review mechanisms in B.C.'s *Water Sustainability Act* are known to be the most robust adaptation mechanisms in water law in Western Canada. Terms and conditions and provisions for amending licenses and approvals also provide mechanisms by which AM could hypothetically be introduced, although that type of investigation was beyond the scope of the research. Flexible or "ends-based" regulatory models such as outcomes-based regulation (OBR) were less frequently present in

Alberta's regulatory design but represent a growing proportion (as much as 30%) in B.C.'s Acts and regulations. AM, or distinct phases of AM were not explicitly referenced with the notable exception of 'monitoring.' I used a hypothetical "*Model Adaptive Management Procedures Act*" drafted by American law professors to compare Alberta and B.C. acts with a model framework that could serve to implement AM. Although the model was designated for regulation in the United States, there are sufficient similarities with Canadian regulation and important hallmarks the framework develops such as the overwhelming emphasis on up-front AM planning.

The analysis finds that for shale gas regulation, Alberta and B.C. are recommending AM at the policy level with no additional regulatory requirements or parameters that would transparently communicate what is expected in a way that can also be enforced. These results support the literature's finding that implementation of full-scale active AM is extremely difficult under administrative law regimes, and it does not adequately address the resource management issues for which it is designed or, at the very least, there is not enough transparency to identify where it is successful.

Four broad themes comprise my recommendations to improve the practice of AM:

1. The risk context must be appropriate for an AM approach.
2. Legal and regulatory frameworks should be adapted to enable AM if it is to be a recommendation or component part of policy frameworks.
3. There are improvements that can be made to transparency and stakeholder engagement in AM contexts; and
4. AM endeavors and Indigenous involvement in AM contexts should be aligned with the recommendations of the Truth and Reconciliation Commission and the principles of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) in order to further decolonization of the environmental management space.

Despite the many implementation challenges, I conclude that by understanding the challenges with AM, reforms can be undertaken to use AM more effectively to address the complexity of resource management and environmental issues in the shale gas-

water context, as well as others. This research has confirmed that AM has emerged as a commonly used framework for regulation of shale gas. Reform is needed to make it a credible and accountable regulatory solution.

Chapter 1.

Adaptive Environmental Management: Possible or Pixie Dust?

> *The design of policies or economic developments implies knowledge – knowledge to develop alternative policies, and knowledge to evaluate their respective consequences. And indeed a significant part of [Adaptive Environmental Assessment and Management] is concerned with how to deal with qualitative and quantitative data, how to use this knowledge of fundamental processes to construct models that can serve as "laboratory worlds" for the testing and evaluation of intrusions, developments, and policies. How, in short, to better reduce uncertainty. But however intensively and extensively data are collected, however much we know of how the system functions, the domain of our knowledge of specific ecological and social systems is small when compared to that of our ignorance…*
>
> *Efforts to reduce uncertainty are admirable… But if not accompanied by an equal effort to design for uncertainty and to obtain benefits from the unexpected, the best of predictive methods will only lead to larger problems arising more quickly and more often. This view is the heart of adaptive environmental management – an interactive process using techniques that not only reduce uncertainty but also benefit from it. The goal is to develop more resilient policies.* –
> *C.S. Holling, 1978: 7, 8-9*

Between 2015 and 2017, Benga Mining Limited ("Benga") submitted an environmental impact assessment (EIA) (2015), an updated EIA (2016), and applications (2017) to the relevant federal and provincial regulators in support of its proposed Grassy Mountain Coal Project. As described in the Report of the Joint Review Panel (JRP), the project proposed to initiate full scale operations of an open-pit metallurgical coal mine in southwestern Alberta which would produce an estimated 4.5 million tonnes of coal per

year for approximately 23 years (Report of the JRP, 2021). Benga's EIA estimated that the project would contribute $350 million in provincial and federal corporate income taxes and approximately $195 million in provincial royalties over the project's 23-year operational lifecycle (Riversdale Resources, 2016). In the EIA, Benga asserted that Grassy Mountain was unlikely to result in significant adverse health effects and that mitigation measures would adequately control the numerous environmental impacts that were reasonably expected to occur across the mine's lifecycle from construction to closure, and potentially beyond. The proposed mitigation measures, as well as any residual uncertainty about Grassy Mountain's impacts, risks to environmental or human health, or the success of the proposed mitigation measures, were almost entirely dependent on successful implementation of adaptive environmental management [AM] – a resource management process characterized at its most basic level as "a planned and systematic process for continuously improving environmental management practices by learning about their outcomes" (Canadian Environmental Assessment Agency (CEAA), 2009).

Professor Martin Olzynski, an expert witness during the hearing proceedings, identified that Benga's EIA made 560 references to AM for 18 different environmental problems (Olszynski, 2020). Benga's reliance on AM as a central strategy proposed within the EIA or authorization process is but one data point on an upwards trend of project proponents invoking AM to mitigate potentially significant adverse environmental impacts posed by major projects, often erroneously (Olszynski, 2017).[2] This concern is well communicated in academic literature, particularly where natural resources law is concerned. The widespread appeal of AM as an option to reduce uncertainty and mitigate adverse environmental effects has led to AM being "thrown like a blanket on top of existing authorizations and requirements with little attention to how practitioners balance this new mandate in relation to other legal and institutional requirements" (Benson & Schultz, 2015: 39). Olszynki has found that this also applies to the Canadian context and his work suggests that AM is "being sprinkled like pixie dust" on project proponent submissions to obtain approvals while deferring responsibility for adverse effects to far later dates, often after impacts are irreversible (Olszynksi, 2017).

[2] Also see, for example, Teck Coal Ltd.'s Area Based Management Plan (ABMP) – The Elk Valley Water Quality Plan (2014) submitted to the B.C. Ministry of Environment pursuant to Ministerial Order No. M113, which makes 110 references to AM.

Therefore, it was notable when the JRP concluded that the project was not in the public interest and subsequently denied the provincial applications, partially on the basis that:

> *"We [the JRP] accept that not all relevant information may be available at this stage of the regulatory review process and that the environmental assessment process is not intended to eliminate all uncertainty. We also recognize that follow-up monitoring and adaptive management programs are common and accepted means of dealing with uncertainty. However, a commitment to adaptive management does not eliminate the need to provide sufficient information on the environmental effects of a project. Nor does it eliminate the need to describe the appropriate mitigation measures required to eliminate, reduce, or control those effects, or to describe the extent of the significance of those effects…*
>
> *Benga's reliance on future adaptive management meant that in some cases it did not provide important details regarding proposed mitigation measures. We also find that Benga's proposed adaptive management approach and plans were not sufficiently developed or detailed to make us confident that anticipated or unanticipated project effects would be effectively mitigated through adaptive management" (Executive Summary of the Report of the JRP, Benga Mining Ltd., Grassy Mountain Coal Project, page viii).*

In the last 50 years of environmental management in Alberta and British Columbia (B.C.), AM has become prominent in government policy as a desirable strategy. It is an inherently inter-and-multi-disciplinary approach that blends ecology and environmental science, management theory and the decision sciences, including probability modelling (Allan & Stankey (eds.), 2009; Kingsford & Biggs, 2012). This dissertation takes an inter-disciplinary approach by contemplating the issues through resource and environmental management, public policy analysis, and mixed-method research approaches that are both qualitative and quantitative.

The Benga decision is also important because it signals that, even if governments recommend AM as a management strategy in their policies, there may now be a parallel expectation from adjudicative bodies for proponents to go farther than rely solely on AM, to the exclusion of the precautionary principle, for adverse environmental

effect mitigation within their up-front EIA's and applications. It is difficult to determine if the Benga decision represents a permanent shift in environmental adjudication where judges and hearing commissioners are beginning to have higher expectations for how proponents use AM or if Benga's EIA was simply so deficient it could not satisfy the requirements for approval – the excerpt I have quoted (above) suggests that perhaps both cases may be true; however, the decision itself is significant. Indeed, the literature examined in this dissertation suggests that proponents have not historically been held to high levels of scrutiny for their proposed use(s) of AM. This ruling is an important response to the large body of concerned practitioners and academics who have argued that AM is frequently relied upon or even required, but is rarely implemented properly or successfully in the field (Allen & Gunderson, 2011; Gregory et al, 2006; Lee, 1999; National Academies of Science, Engineering, Medicine, 2011; Susskind et al., 2010; Walters, 2007; Williams & Brown, 2015).

AM has been used across resource and environmental management applications for many decades. Throughout the 1960s and 70s, environmental practitioners, policy makers, and resource managers recognized that traditional trial-and-error or reactive resource management practices were becoming increasingly unsustainable (Holling, 1978). There came a need to better comprehend how anthropogenic development interacts with natural ecological systems to predict, understand, and enable resource managers to respond to stress to preserve the resilience of ecosystems that interface with human activity. Since reducing the pace and scale of development, including resource extraction, was typically not considered an option, AM provided (and, when implemented in an appropriate context, continues to provide) a mechanism to cope with the uncertainty inherent in the outcomes of some of these interactions. Moreover, AM can, when implemented correctly, provide an opportunity for science and data to inform decision-making and resource management policy directly and beneficially in real-time (Holling, 1978; Lee, 1993; Walters,1986).

It has been widely suggested that AM is "important, *possibly essential*, in the search for a durable and sustainable relationship between humans and the natural world" (Lee, 1999: 12, emphasis, mine). Themes such as: "learning," "improving," "iterative," "systematic," "evaluating alternatives," "flexibility," "multidisciplinary," "reducing uncertainty," and "scientific experimentation" permeate the academic literature on AM. Not surprisingly, AM has been used by government and regulatory agencies in

some capacity on every continent and has been a central strategy within watershed and ecological management throughout the United States (U.S.) and Canada. Some of the most well-known case studies involving AM are set in world-famous watersheds and include but are not limited to: The Florida Everglades ("Comprehensive Restoration Plan"), the Missouri River Dam and Reservoir System (navigation improvements and flood control;), the Upper Mississippi River (navigation; ecological and recreational benefits), and coastal Louisiana (numerous objectives, but primarily flood control and navigation) (National Academies Press, 2004). The Glen Canyon Dam (recreation and endangered species protection) and Colorado River ecosystem (navigation, studies of dams on ecosystems) are also well-known cases, as there is a long record of applying AM principles, including various levels of collaborative co-management in the Colorado River Basin (Melis et al., 2010; National Academies Press, 2004; Susskind et al., 2010; USGS, web, no date). The Columbia Basin (management of salmon populations vis-à-vis management of dams for hydro power production under the *Northwest Power Act*) was the first time AM was explicitly applied as a policy option in 1984 and serves as an early case study of the sometimes-irreconcilable tension between science and politics (Lee, 1993).

Other common applications of AM include fisheries management (Armitage et al., 2007; Lee, 1993; Walsworth & Schindler, 2016); forestry (B.C. Government Forestry Website, 2021; Bell et al., 2008; Taylor, 1997; Wintle & Lindenmayer, 2008); endangered species revitalization projects (Allen & Gunderson, 2011; Susskind et al., 2010); watershed management (Doyle & Drew, 2008; Kingsford & Biggs, 2012; National Academies Press, 2004); vegetation and soil (Coon et al., 2021; Jansen et al., 2021), and more recently, oil and gas (energy) development (Benson, 2009; Olszynski, 2013 & 2017; Wurtzeback, 2015). AM has become so pervasive that in 2016, 91% of the projects listed on the Canadian Environmental Assessment (CEA) Registry contained one or more references to AM (Olszynski, 2017).

An investigation of AM in the context of oil and gas development is timely and important. AM has been proposed for a slew of major energy projects (including oil sands mines, coal mines, in situ oil sands recovery schemes, and so on), and as of late, stakeholders are increasingly proposing AM as a management strategy for operationalizing enhanced levels of water conservation and wastewater reuse in areas where there are intense levels of non-reviewable energy development projects (AER,

2017b). Craig & Ruhl (2014) suggest that AM may be even more appropriate for the latter kind of development since AM may not be well-suited "where decisions simply can't easily be adjusted once implemented, such as where to locate a completed highway intersection" (or a coal or oil sands mine) (Craig & Ruhl, 2014: 13). These smaller projects, particularly multi-stage hydraulically fractured (MSHF) natural gas and oil wells are likely to remain an important source of economic revenue for Alberta and B.C. for many years to come[3]. Moreover, natural gas has been identified as a key component of the energy transition given that it is considered efficient, clean, and now due to improvements in technology, is considered commercially viable and abundant, thus increasing its importance as a bridge fuel as jurisdictions develop climate policies and phase out coal (IEA, 2019a; Rivard et al., 2014).

The effects of individual projects, magnified by the cumulative footprint of localized industrial development, has a clear impact and interface with the environment in which it is situated. Therefore, the cumulative impacts of these smaller projects, and the opportunities for AM to be properly leveraged in appropriate circumstances, cannot be understated (Dubé et al., 2013; Noble, 2010). This environment – or a defined region – includes competing uses for water resources, vital habitat for numerous species, including those protected under threatened species legislation, ongoing anthropogenic disturbance, and other pressures on the environment – both naturally occurring and human-caused. Other regions experiencing similar challenges have often used AM within the context of regional land use planning or integrated watershed management planning to deal with competing priorities, mitigate adverse impacts and reduce uncertainty (Susskind et al., 2010; USGS, 2008). This is the case in Western Canada as well. Environmental policies in general, and watershed management policies specifically, rely heavily on AM. For example, the Guide to Watershed Management Planning in Alberta (2015) as well as specific plans developed for watersheds in both Alberta and B.C. (e.g., the Peace and Slave Watersheds and the Lower Athabasca Regional Plan (LARP) supplementary policy documents) prominently feature AM.

[3] In further support of this claim, B.C. has issued environmental assessment certificates (EAC) to a number of large-scale liquified natural gas (LNG) export facilities such as LNG Canada (under construction), Kitimat LNG (EAC issued), and Cedar LNG (EAC issued), which is owned by the Haisla First Nation. There are other LNG projects that are currently proposed or undergoing environmental assessment. Refer to the B.C. Government's EA webpage for a full listing of projects.

As pervasive as AM is across environmental management policy and subsequent applications in the field, there is evidence in the academic literature that the administrative law regimes in North America where AM is typically applied are not conducive to its successful implementation (Benson, 2009; Benson & Stone, 2013; Craig & Ruhl, 2014; Kwasniak, 2010; Raadgever et al., 2008; Ruhl & Fischman, 2010; Susskind & Secunda, 1999). This creates problems for AM implementation, performance, and outcomes, and is the focal point of this dissertation.

1.1. Research Questions and Scope

The scope and focus of this dissertation are largely directed by how the provinces of Alberta and B.C. construct regional plans and their accompanying policies that direct and influence oil and gas development. In both provinces, land use planning and regional plans are typically organized around major watersheds. This is particularly important in Alberta where the seven regions under the Land Use Framework (LUF) are defined by the major watersheds rather than any political or civic boundaries. Although only one Regional Plan (the Lower Athabasca Regional Plan (LARP)) has been published, the pre-eminence of the *Alberta Land Stewardship Act* (ALSA) over all other provincial enactments – including all regional plans drafted under its authority – has interesting implications for oil and gas development and AM (Harvie & Mercier, 2010). Therefore, the purpose of this dissertation is to explore to what extent and how AM is presented as part of water and energy policy in Alberta and B.C., and then to evaluate the extent to which legislative and regulatory regimes can support an AM approach.

The scope of this investigation is limited to the shale gas water cycle;[4] However, the approach and findings may be broadly applicable to other resource management contexts that intend to use AM, particularly within the energy development context.

[4] It should be noted that some wells in the Montney and Duvernay are “mixed” wells which may produce gas, oil, or condensate hydraulically fractured from shale rocks, or a mixture. As these wells are typically construed as gas, (particularly where gas and condensate are mixed) this dissertation will refer to multi-stage hydraulically fractured wells in this region as “shale gas wells.” This is appropriate when considering the expected terrestrial and environmental impacts, or water cycle implications, within local or regional watersheds as the extraction methodology is the same but would be inappropriate for research questions pertaining to royalties, geology or geophysical properties of the wells or the products derived, or reservoir characteristics.

Five main research questions are addressed in this dissertation. The first two research questions form the basis for Chapter 4:

1) To what extent is AM referenced in water and energy policies in Alberta and B.C.?

    a) How many policies out of a sample of environmental-water-energy policies reference AM?

2) Where is AM referenced in the policy, what is the nature of the reference?

    a) What kinds of details, requirements or parameters are included in the reference?

    b) How closely do the references conform to descriptions of AM and its phases provided in the academic and technical literature?

This introductory chapter notes that an overwhelming majority of major projects rely on AM as a strategy to mitigate adverse environmental effects. Additionally, pre-research done for this dissertation has identified that AM appears in many policy and planning documents produced by both federal and provincial governments. Canada's federal government has also included AM in key legislation for environmental impact assessments of major projects. The purpose of research questions 1 and 2 is to quantify the extent to which governments are nudging, or requiring, proponents to use AM as a management strategy within a defined sample. These questions are investigated through a content analysis where question 1 is tested through the presence or absence of AM in a policy, and its relative frequency or coverage across the policy document. Question 2 is investigated qualitatively and evaluates the overall message and level of detail provided in the policy, including whether AM is a suggestion or a requirement. The findings of the content analysis investigating Alberta and B.C. policies are presented in Chapter 4.

The findings of the content analysis of policies led to three more research questions. The academic literature on AM identifies a number of barriers and implementation problems inherent with AM. As alluded to in this introduction, legislative and regulatory frameworks are typically incompatible with the features AM requires to be successful (Benson & Stone, 2013; Doremus, 2002; Raadgever et al, 2008). The finding

that water and energy policy in Alberta and B.C. overwhelmingly mention AM as a management strategy led to the following questions:

3) If policy appears to be suggesting that proponents use AM, are the underlying legislative and regulatory frameworks built in such a way that would support the kind of flexibility and iteration that AM requires (i.e., can AM be implemented in the administrative law regimes found in Alberta and B.C.)?

4) Do legislative and regulatory instruments contain provisions that either require AM or its component parts to be followed, or are compatible with AM principles in general?

5) Do legislative and regulatory instruments contain provisions that would prevent AM or its component parts from being followed or that are incompatible with AM principles in general?

The practical potential of AM may be limited, supported, or amplified by the legislative and regulatory frameworks under which it is implemented. The analysis of Alberta (Chapter 5) and B.C. (Chapter 6) as detailed case studies led to conclusions about the coherence across and within the legislative and regulatory regimes, similarities and differences in provincial approaches, observations about the feasibility of implementing AM at the regional and/or project level, and recommendations that are provided in Chapter 8. Recommendations are targeted towards policy-making and regulatory agencies within the water-energy sector but could have broader implications if the sample of policy, legislative and regulatory instruments that are reviewed are taken to be representative of the environmental management space. Finally, while this study is useful in identifying some of the challenges in Alberta and B.C. that are commonly discussed in the academic literature, this dissertation makes no comment on the extent to which the legislative and regulatory regimes actually result in AM (or not). Rather, my work contributes to the discourse on which kinds of improvements can be made that might increase the likelihood of effective implementation.

This dissertation will be of interest to:

- Consultants, proponents, licensees, or permit holders who wish to include AM as part of an application for a project, licence or authorization where the activity or infrastructure proposed may have adverse or unknown environmental impacts.

- Provincial governments and regulatory agencies responsible for creating or implementing policy, legislation or regulations that may support or recommend an AM approach, influence AM implementation, or agencies who adjudicate applications, the granting of permits or licences where AM may be cited as a management strategy. This dissertation may offer insight into opportunities for collaboration between agencies who design environmental and energy policies and agencies who are responsible for the implementation and technical oversight of those policies on the ground to improve policy and regulatory performance.

- Academics and researchers in the field of adaptive management and environmental law.

1.2. The "Golden Age" of Shale Gas Development in Western Canada

Shale gas is natural gas (primarily methane) that is found trapped in rock formations. Where "conventional gas" is found in large accumulations, or pools, and can be pumped to the surface easily, unconventional or shale gas is dispersed throughout low-permeability rock. Hydraulic fracturing (HF) provides a mechanism to break up rocks and create enough space within the formation to enable gas flow to the surface. As HF has become increasingly common, it has been made more efficient and productive through technological innovations. Directional drilling has had the largest impact on improving the efficiency shale gas production, while introducing several impacts – both positive and negative – including increasing volumes of fresh water required for HF and thereby increasing the waste stream (Kondash et al, 2018), and significantly reducing the surface footprint previously required to produce the same amount of gas (i.e., multiple directional or horizontal drills off one single vertical well have significantly lower surface impacts because only one well pad is required for operations, rather than multiple well pads for multiple vertical wells). At the time of writing, an increasing amount of shale gas extraction is accomplished through multi-stage hydraulic fracturing (MSHF). This is largely due to improved technologies, the abilities of MSHF to extend the life of

existing wells, and significantly improved economics of resource recovery for plays that were previously considered marginal, at best (Dusseault, 2017).

This dissertation uses the shale gas water cycle as a case study and limitation on scope for several reasons that will be described throughout this subsection. It should be noted that, in most cases, the policies, laws and regulations that are analyzed in this dissertation apply to both oil and gas, and conventional as well as unconventional oil and gas. Shale gas was selected as a research topic to manage scope while identifying a sector that is equally important in both provinces, and likely to be so in the future. The ongoing interest in water management opportunities and challenges for MSHF was another reason for its selection (see AER 2017b). Effective management of water resources, particularly for competing consumptive users, is an important priority for Canadian governments as prolonged over-use or degradation of water quality can have catastrophic impacts for local users. As discussed in Chapter 2, AM has frequently been applied to watershed management contexts, including watersheds that are under pressure from cumulative effects (CE), further making shale gas development in Alberta and B.C. an interesting and important case study.

In 2011, the International Energy Agency (IEA) predicted that the world was about to enter a “Golden Age of Gas” (EIA, 2011). Since then, its projections have largely come to pass. Natural gas consumption increased by 4.6% in 2018, thus accounting for almost half of global energy demand (IEA, 2019). Since 2010, natural gas development in the U.S., China, and the Middle East has accounted for 80% of growth, and 2019 saw record-breaking investment poured into developing new liquefied natural gas (LNG) infrastructure to further safeguard supply (IEA, 2019). Canada has been largely excluded from the shale gas bonanza despite holding world-class reserves in most of its provinces and territories. The scope of this research is limited to Alberta and B.C., which includes the Horn River Basin and Montney Shales in northeastern B.C. (and to a lesser degree the Liard Basin and Cordova Embayment, which are still in early development), the Colorado Group in Alberta (which extends into Saskatchewan) The Deep Basin, and the Duvernay formation in west-central Alberta (see Rivard et al. (2014), for a map of shale gas basins in Canada).

Canada is the fourth largest global producer (5%) and sixth largest exporter (7%) of natural gas (NRCAN, 2020). Canada’s natural gas reserves are an estimated 1,220

trillion cubic feet (Tcf)[5] of natural gas, 71% of which is from unconventional sources. Of the total unconventional resource base, 69 trillion cubic feet are proved reserves (just under 6%), or where gas is known to exist and can be recovered using existing technology and under current economic conditions.[6] In 2018 Canada produced an average of 16.7 billion cubic feet of marketable natural gas per day from Alberta (69%), B.C. (29%), Saskatchewan (2%), and Nova Scotia (1%) (NRCAN, 2020). According to 2018 data, more than 80% of proved reserves in BC (5% have been extracted since 2016 data were made available) and 88% in Alberta have yet to be recovered (AER, 2019; BCOGC, 2018).

Shale gas is important to the economies of Alberta and B.C. I conducted an analysis of historical budgets and fiscal plans for B.C. and Alberta to review the last 20 years of royalties earned from natural gas (not including bonus bids, rents on drilling rights and leases) and found that on average per year Alberta has earned $2.4 billion in natural gas royalties, and B.C. has earned $720 million. It should be noted that splitting out unconventional wells from conventional wells and calculating the royalties paid on shale gas only is beyond the scope of this paper; however, the Alberta Government notes that since 2013, 80% of wells put on production have used multistage hydraulic fracturing (MSHF) as the primary stimulation technology. Royalties for unconventional gas average ~$700 million per year in Alberta and $197 million per year in B.C over the last 7 years. In the future, changes in natural gas consumption in Asia may enable Canada to capitalize on exporting significant volumes of liquified natural gas (LNG). By 2018, 13 LNG projects had been proposed along the coast of B.C.[7] The Conference

[5] A unit used to estimate gas and coalbed methane production volumes. According to the US Department of Energy 1 Tcf is the approximate volume of gas used by twelve million American households in one year.

[6] In 2020, the global economy, and the oil and gas industry, experienced a significant crash caused by COVID-19. Data used in this research will not include 2020 as the implications of this downturn for shale gas are far from being seen or understood. Previously, operators have had concerns about the feasibility of developing unconventional resources under low gas prices (50% lower in 2013 than 2008) and where higher production costs are often observed in Canada than in other shale jurisdictions. The ~6% figure cited above could change if gas prices were to improve or development costs were reduced. More recent data saw a resurgence in prices, followed by their softening. Thus, market cyclicity and hence uncertainty in prices adds to the complexity of the industry.

[7] At the time of writing, 3 of the proposed projects have received an Environmental Assessment Certificate (EAC) from the B.C. Environmental Assessment Office (EAO), 3 applications are in progress, 5 have been withdrawn, and 2 have had their EAC expire.

Board of Canada published a report in 2016 suggesting that developing the LNG export opportunity in B.C. could add $7.4 billion per year to the Canadian economy, for the next thirty years, with $5.3 billion of that staying within B.C.'s economy. The report estimates that LNG could add 65,000 jobs annually to national employment (Coad et al., 2016). The significant economic prize at stake, coupled with the value of natural gas as a transition fuel suggests that development may be enabled for many years to come (IEA, 2019a). However, increasing stringency of greenhouse gas policies federally and in B.C. could significantly curtail production and continued resource development over the coming decade.[8]

Shale gas extraction is known to introduce hazards to the landscape throughout its lifecycle – MSHF is only one phase where there is risk of adverse environmental impacts. Distinct phases include site preparation, drilling, MSHF and well completion, gas production, and well closure and remediation. Hazards are introduced at numerous, often overlapping, phases and are generally distilled into 5 categories: Impacts to surface and groundwater quality and quantity; impacts caused by wastewater storage, transport, treatment and disposal, including accidents and loss of containment events; Greenhouse gas (GHG) emissions; induced seismicity, and; terrestrial impacts to biodiversity and habitat (Becklumb et al., 2015; Buono et al., 2020; Council of Canadian Academies, 2014; Canadian Water Network, 2015; Scientific Review of Hydraulic Fracturing in British Columbia, 2019). The literature has found that all the hazards may be further complicated by lack of understanding and agreement pertaining to the risks and their severity. There are also concerns raised by First Nations and residents of shale gas producing regions about impacts to human health and safety, cultural considerations, and the adequacy of consultation with First Nations (Council of Canadian Academies, 2014; Yahey v. B.C., 2021 BCSC 1287). Shale gas development, and projects associated with its distribution, have frequently been the source of significant opposition and protest (see the Coastal Gas Link and Transmountain Pipeline projects

[8] Canada and the provinces have instituted both federal and provincial emissions caps on oil and gas. The Federal 2030 Emissions Reduction Plan will require the oil and gas sector to reduce methane emissions by >75% by 2030 and achieve net zero by 2050. Moreover, the Clean BC Plan, introduced in 2021, strives to reduce emissions by 40% in 2030. It is unknown how shale gas development, including B.C.'s suite of LNG terminals will be affected by the 2019 Impact Assessment Act which, as noted by the Canadian Government's Strategic Assessment of Climate Change Revised, October 2020 (web, paragraph 3) "requires proponents of projects with a lifetime beyond 2050 to provide a credible plan that describes how the project will achieve net-zero emissions by 2050."

as examples). Most hazards are addressed to some degree by regulations currently in place in Alberta and B.C.; however, because of the existence of knowledge gaps and cumulative effects of the shale gas industry, it is difficult to discern how well the existing regulatory frameworks are managing cumulative effects and risk. Moreover, the nature of temporary (short-term) diversion licenses (TDLs) that are frequently issued under provincial water legislation have made it difficult to consider their long-term cumulative impacts or for decision-makers to develop a cohesive strategy around their use. Some scholars have referred to this regulatory strategy as “death by a thousand cuts.”

The scope of the “shale gas water management cycle” applies only to water acquired for the purposes of MSHF and management of the wastewater (produced and flowback waters) emanating from the MSHF process. Water may be acquired from surface (fresh, non-saline) or groundwater sources (fresh or saline), or from alternative sources (one operator treating and reusing wastewater or one operator sourcing wastewater from another operator or third party operating in the same region). The shale gas water management lifecycle investigated in this dissertation does not pertain in any way to any other lifecycles pertaining to water or water management (i.e., the hydrologic cycle). The shale gas water management cycle includes the following phases shown in Figure 1-1. These phases may have regional impacts (e.g., during water acquisition) or localized impacts (e.g., an onsite spill that occurs during onsite chemical mixing or handling produced or flowback water.

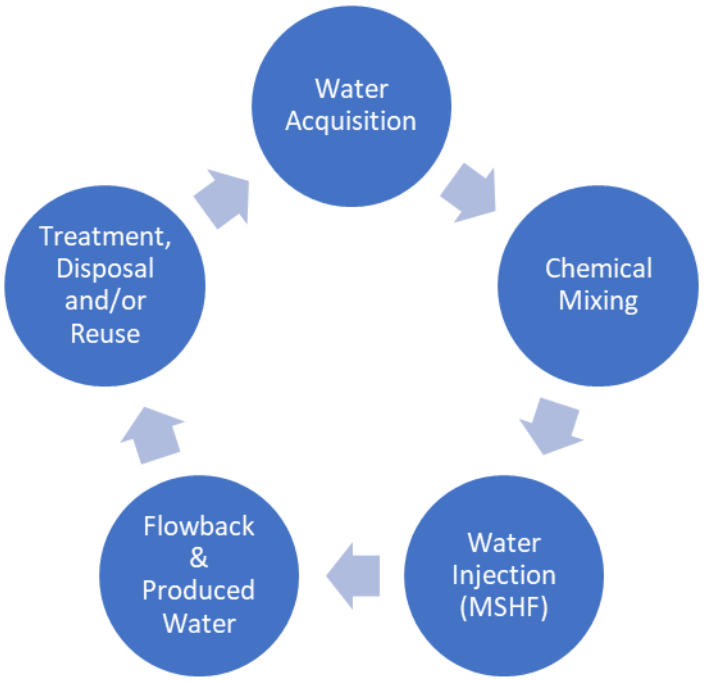

Figure 1-1 The Shale Gas Water and Wastewater Management Cycle
Figure Adapted from EPA, 2016.

Each phase of the MSHF water cycle is situated within a broader development context, particularly where regional watershed planning for consumptive use identifies competing water users and licences, or where there may be uncertainties inherent with best practices for handling, management and treatment (including recycling or reuse) of large volumes of contaminated or non-saline water; in some of these contexts, AM has already been applied, for others, it may be in the future (AER, 2017b; Benson, 2009; National Academies Press, 2004).

1.3. Personal Acknowledgement

I have had the privilege of studying at Simon Fraser University (SFU) which is on the Traditional Coast Salish Lands, including the Tsleil-Waututh (səl̓ilw̓ətaʔɬ), Kwikwetlem (kʷikʷəƛ̓əm), Squamish (Sḵwx̱wú7mesh Úxwumixw) and Musqueam (xʷməθkʷəy̓əm) Nations. I acknowledge that the lands where most shale gas extraction takes place in Western Canada is in Treaty 8 territory which is the traditional and ancestral territory of the Cree and Dene. This territory is also home to the Métis Settlements and the Métis Nation of Regions 1, 4, 5 and 6 within the historical Northwest

Métis Homeland. Finally, I live and work in the traditional territories of the Niitsitapi (Blackfoot) and the people of the Treaty 7 region in Southern Alberta, which includes the Siksika, the Piikuni, the Kainai, the Tsuut'ina and the Stoney Nakoda First Nations, including Chiniki, Bearpaw, and Wesley First Nations. The City of Calgary (which the Blackfoot call "Mohkinstsis") is also home to Métis Nation of Alberta, Region III. There are differing Indigenous and Western perspectives on resource and land management. I will not explore these themes in-depth in my dissertation, nor can I claim any expertise in Indigenous studies. Rather, I recognize the limits of my own perspective. Nevertheless, I make these acknowledgements as an act of reconciliation and gratitude to those whose territories I have studied, live and work.

At the time of writing this dissertation, I also work for the Alberta Energy Regulator (AER). I share this in the interest of transparency. In this dissertation, my thoughts and words are my own and I do not represent the AER or speak on its behalf in any way. I should also note that, although I apply principles of statutory interpretation in my methodology, I am not a lawyer. Nevertheless, my research embodies the commitments I make in my professional life at the AER. My dissertation examines some of the critiques of energy and environmental management, with particular reference to the implementation of AM, in a way that has salience for decision makers. The goals of this research are the same as my professional goals: better policy implementation and better regulatory outcomes.

1.4. Summary

This research is timely for three reasons. First, economic and political indicators suggest that shale oil and gas will continue to be central to energy strategies and energy security in Western Canada. This makes provinces such as Alberta and British Columbia ground zero for most of Canada's drilling and production. Second, adaptive management (AM) continues to be identified both by governments and proponents as a viable resource management strategy for addressing uncertainty and mitigating adverse environmental effects that may be a result of development. As Olszynski (2016) has identified, 91% of projects listed on the federal EIA registry invoke AM for one or more issues. That is not to say that AM is appropriate for all circumstances or that AM can be liberally invoked in cases where its effectiveness is not known (e.g., the Benga decision), but that AM can have important implications for reducing uncertainty and improving long-

term environmental and policy outcomes where it is used appropriately. For that reason, as confirmed by this research, governments seem inclined to recommend AM as a central strategy for environmental and resource management in their written policies. Finally, this dissertation explores the extent to which the underlying legislative and regulatory regimes in Alberta and B.C. conform to the findings that administrative law regimes are largely incompatible with AM implementation. The findings indicate that Alberta and B.C. are not significantly different from other jurisdictions where this problem has been observed and noted in the literature.

Chapter 2 of this dissertation provides an overview of the relevant literature on AM, including case law where AM has been interpreted in an energy development context. The chapter also introduces regulatory models and introduces the kinds of regulations that are compatible with AM implementation and those that are not. Chapter 3 describes the content analysis methodology I used to conduct my research. Chapter 4 presents the analysis of foundational and supplemental policies in Alberta and B.C. Chapters 5 and 6 use the content analysis methodology to investigate the composition of the legislative and regulatory regimes where AM is implemented in Alberta (Chapter 5) and B.C. (Chapter 7). Chapter 7 discusses the findings and presents a comparative analysis of the Acts investigated in the study with a theoretical “Model Adaptive Management Procedure Act” (Craig & Ruhl, 2014) to further discuss the nature of the challenges inherent with using AM for energy development mitigation measures in Alberta and B.C. Finally, in Chapter 8 I conclude with key takeaways from the research and some recommendations that may be of interest to policy makers and regulators.

Chapter 2.

Theory and Limitations of Adaptive Management in the Western Canadian Context

This chapter is divided into two major sections. The first describes AM, what it is and what it is not, and attempts to provide an overview of the opportunities and challenges inherent with AM as presented in the extensive academic literature. The second part describes Canadian environmental management and its associated regulatory regime. The hierarchy of laws and their interaction with regulatory theories and associated models is explored to provide the basis for understanding the environmental regime in which this study is set. Much of this body of research is exclusively focused on Western Canadian governments specifying policy solutions to address and control the adverse effects of industrial development. The Canadian context has an additional layer of complexity when one considers that there are two levels of government (Federal and Provincial) who, notwithstanding their Constitutional division of powers, must work together to coordinate large-scale initiatives (e.g., environmental assessments for major projects or those that cross-cut major jurisdictional borders) and ensure that there is cohesion throughout the regime.

2.1. A Brief Primer on Adaptive Management

Adaptive Management (AM) is described in the academic literature as a systematic and rigorous process for reducing uncertainty, characterized by deliberately designing and implementing one or more resource management options to experimentally solve a particular problem in environmental management (Stankey et al., 2005; Taylor et al., 1997; Walters & Holling, 1990; Williams et al., 2009). Table 2-1 provides a selection of definitions quoted in the literature.

Table 2-1 Definitions and Operational Descriptions of Adaptive Management in the Academic Literature

Definition	Source
AM is an integrated, multidisciplinary, and systematic approach to improving management and accommodating change by learning from the outcomes of management policies and practices.	C.S. Holling, 1978

Definition	Source
AM is a structured process of learning by doing that involves more than simply better ecological monitoring and response to unexpected management impacts. It should begin with a concerted effort to integrate existing interdisciplinary experience and scientific information into dynamic models that attempt to make predictions about the impacts of alternative policies.	Walters, 1997
AM is a formal process for continually improving management policies and practices by learning from their outcomes. Management policies are deliberately designed to increase understanding about the effect of management activities on the system being managed.	Taylor et al., 1997
Typically, adaptive management begins by bringing together interested parties (stakeholders) in workshops to discuss the management problem and the available data, and then to develop computer models that express participants' collective understanding of how the system operates. The models are used to assess the significance of data gaps and uncertainties and to predict the effects of alternative management actions. The stakeholders develop a management plan that will help to meet management goals and will also generate new information to reduce critical data gaps and uncertainties. The management plan is then implemented along with a monitoring plan. As monitoring proceeds, new data are analyzed and management plans are revised as we improve our understanding of how the system works.	Johnson, 1999
AM is an approach for proceeding *despite* uncertainty regarding the best course of action . . . AM is a logical, systematic process to help managers gain confidence in their decisions and improve the chances of achieving the desired objectives.	Murray and Marmorek, 2004
Adaptive Managers emphasize experimentalism, taking actions capable of reducing uncertainty in the future.	Norton, 2005
AM is a systematic approach for improving resource management by learning from management outcomes.	Williams et al, 2009
In general, adaptive management is a planned and systematic process for continuously improving environmental management practices by learning about their outcomes. Adaptive management provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project. Planning for adaptive management should commence as early as possible in the EA process. While specific adaptive management measures may not be identifiable at that point, a strategy or plan should be developed to provide context on when, how and where adaptive management may be used. Decisions to adopt specific adaptive management measures can be identified later during the project life-cycle as a result of the analysis of data generated by a rigorously implemented follow-up or monitoring programme.	Canadian Environmental Assessment Agency, 2009 "operational policy statement"
"Adaptive management" means a decision-making process based on the structured and iterative implementation of management measures, with comprehensive monitoring of relevant system indicators, in the attempt to achieve specific management goals or objectives, reduce uncertainty, or increase knowledge about the system that an agency is charged with managing.	Craig and Ruhl, 2014
Adaptive management is supposed to be an iterative process in which decision outcomes are continually monitored and evaluated to determine whether they are achieving objectives. The feedback loops rely on goal establishment, model building, performance standard setting, outcome monitoring, and recalibration. Over time, feedback and adjustments provide flexibility in the face of uncertainty while simultaneously reducing uncertainty through systematic learning.	Fischman & Ruhl, 2016

AM involves the following six-step iterative cycle, with each step including sub-steps. Figure 2-1 shows the six basic steps in the AM cycle, as well as the ongoing feedback loop of new information and changing elements both from the experiment itself as well as factors outside of it. Stankey et al. (2005) also note the importance of 'inventory.' Depending on the AM context explored, inventory might mean the growth of new trees or fish stocks. Within the context of this dissertation, we might consider new wells, facilities or pipelines, and their associated infrastructure as being inventory. We might also consider that water and wastewater volumes are also a kind of inventory. Appendix A (adapted from Murray & Nelitz, 2008) provides a detailed summary of each of the elements that might be found within each step of the AM cycle.

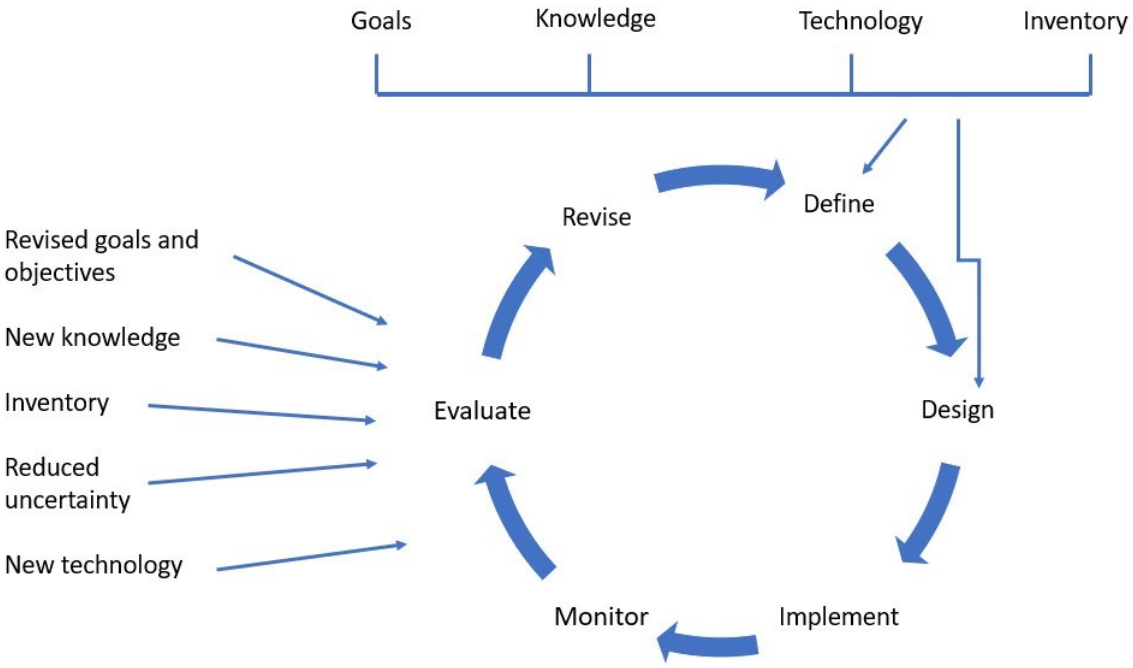

Figure 2-1 Adaptive Management Cycle
Figure adapted from: Murray & Marmorek, 2004; Stankey et al., 2005.

In his influential book, *Adaptive Environmental Management,* Holling (1978) emphasizes that the AM cycle is different from traditional trial-and-error learning by doing. Rather, Holling and many others, stress the importance of deliberate planning, problem formulation, research design, and clear articulation of hypotheses (and alternative hypotheses), objectives and goals prior to conducting any activities or implementing AM in the field (Holling et al., 1978; Murray & Nelitz, 2008; Walters, 1986; Walters & Holling, 1990). In the United States' Department of Interior Technical Guide for implementing

AM, Williams et al. (2009) propose the following broadly applicable criteria and measures for measuring the success of projects using AM: “1) Stakeholders are actively involved and committed to the process illustrated in Figure 2-1; 2) Progress is made toward achieving management objectives drafted in the ‘define’ phase; 3) Results from monitoring and assessment are used to adjust and improve management decisions; and 4) Implementation is consistent with applicable laws” (Williams et al. 2009: 49). For AM to be successfully implemented, all four criteria must be met during the life of the project.

2.1.1. Passive Versus Active Adaptive Management

The literature differentiates between two kinds of AM – active AM and passive AM. With passive AM, resource management can benefit from the learning that occurs, but management is not motivated and guided by the pursuit of learning alone:

> *Though there is considerable ambiguity in the use of these [active or passive AM] terms, in general they are distinguished by the way uncertainty is recognized and treated. As suggested by the wording, active AM actively pursues the reduction of uncertainty through management interventions, whereas passive AM focuses on resource objectives, with learning a useful but unintended by-product of decision making.*
>
> *Williams, 2011b: 1373*

For example, a passive AM model may state a research objective such as ‘revitalizing caribou populations’ in a particular region, but not go so far as to design specific, measurable experimental interventions that might have an effect on the desired outcome, and then monitoring and measuring their effectiveness (e.g., controlling motorized vehicle access to habitat, predator culls, or reforesting/revegetating ‘seismic lines’ or other industrial pathways). Passive AM, even when associated with positive outcomes, may lack the ability to state why or which treatment was responsible for the observed effects. In other words, passive AM prioritizes outcomes over learning, but acknowledges that learning about the resource system is useful, whereas active AM necessarily prioritizes an experimental approach due to its focus on reducing knowledge gaps and uncertainty. This inherently makes active AM more easily replicable than passive AM given the record of treatments and actions taken as part of the experiment.

Both passive and active AM follow the six-step cycle illustrated in Figure 2-1. The primary difference is one of scale. Active AM will compare multiple interventions, presumed best practices, treatments, or policies that are deemed appropriate for the context simultaneously, and evaluate each case as an experiment. Passive AM recognizes that an active approach may not always be feasible and applies the six-step cycle to one case, or experiment. In both forms scientific rigour remains critical. Passive AM can be effective where the outcomes of learning are consistently used to revisit decisions and alter management actions in light of what is learned (Allan & Curtis, 2005). Theoretically, passive AM could become more active over time provided that subsequent phases of assessing and defining the problem (phase 1) and research and experimental design (phase 2) were more explicitly integrated into the process.

Passive AM has been criticized as devolving into “AM-lite.” Without strong oversight throughout the process and focus on implementing what is learned, “the agency [or proponent] can pepper its rules, permits and policies with promises to employ adaptive management while making no firm commitments to do anything in particular” (Craig & Ruhl, 2014: 11). This is precisely what Olszynski (2017) argues has happened in the Canadian energy sector. This leads to cases where, at best “AM-lite simply supplements agencies’ front-end decisions with bold promises to adapt unspecified parameters of the decision in the unspecified future through unspecified methods when unspecified conditions arise. At its worst, AM-lite allows agencies to defer hard decisions indefinitely by shifting them into the adaptive management black box” (Craig & Ruhl, 2014:11). Later chapters of this dissertation will illustrate the contribution of policy and regulatory design to the front-end of this problem of AM-lite-implementation where AM plans, if drafted at all, are completed as a check-box exercise, and never looked at again during the life of a project.

2.1.2. Appropriate Contexts for Adaptive Management Implementation

It has been argued that Adaptive Management is not an appropriate tool for every context. AM is a poor fit for solving problems that are intricate and complex, involve long time frames, high external influences (e.g., diverse and powerful stakeholder groups), inability to exert control over dynamic factors within the system, and where confidence cannot be established for baseline data (Allen & Gunderson, 2011: Gregory et al., 2006). Rather, there are three criteria that should be satisfied when

considering AM as an option for a resource management context. For AM to be appropriate, the case should be high uncertainty, high controllability, and low risk (Allen & Gunderson, 2011; Peterson et al., 2003). 'Uncertainty' means that the outcomes of a particular management experiment or action may be unknown, or that there are knowledge gaps about an action's success over time, interactions with other ecological features or variables, potential for unpredictability or surprises, and so on. High uncertainty indicates that the management, or problem, context will benefit the most from the iterative decision model characterized by AM (Craig & Ruhl, 2014). From a definitional perspective it is important to clarify that "uncertainty" within the context of AM does not mean that it is uncertain that a particular mitigation measure under AM will address a particular environmental impact. Nor does it mean that the current proposed AM measure is not currently economically or technically feasible, but could be in the future (Chalifour, 2009). Rather, uncertainty under AM is characterized by the impossibility of predicting the inevitable surprises that may be encountered throughout the life of a particular resource management initiative. Nyberg (1998) summarizes these as:

- "natural environmental variability (e.g., weather, fire, earthquakes, avalanches, volcanoes, stream flows, genetic composition of species, animal movements);
- human impacts on the environment through global climate change, new technology, and the growing population;
- lack of knowledge about most aspects of the ecosystems being managed; and
- variations in social and political goals expressed as varying budgets, shifting policy directions, and changing demands for commodities, services, and aesthetic values from forests" [or other managed resources] (Nyberg 1998: 3).

It should follow, then, that policy or resource management contexts that prioritize learning, reducing uncertainty, and closing knowledge gaps should be accompanied by requirements for proponents to implement active AM programs.

'Controllability' refers to the resource manager's level of influence and ability to affect the management process, including variables such as climate, or exposure levels of toxins or chemicals. For example, experiments conducted in a lab environment typically exhibit a high level of controllability. Ecosystems exhibit a high degree of dynamism. This can create challenges for controllability and monitoring for uncertainty,

particularly when environmental dynamism is further complicated by the constant technological change and innovation typically demonstrated by commercial industrial sectors such as oil and gas. Figure 2-2 illustrates four different scenarios based on levels of uncertainty and controllability. Climate change is a well-documented example of an environmental problem where there is significant uncertainty about the range and severity of impacts, coupled with the relative impossibility of developing a controlled experimental approach to test the veracity of the assumptions and models. As such, scenario planning has become a common response and planning tool for governments and agencies.

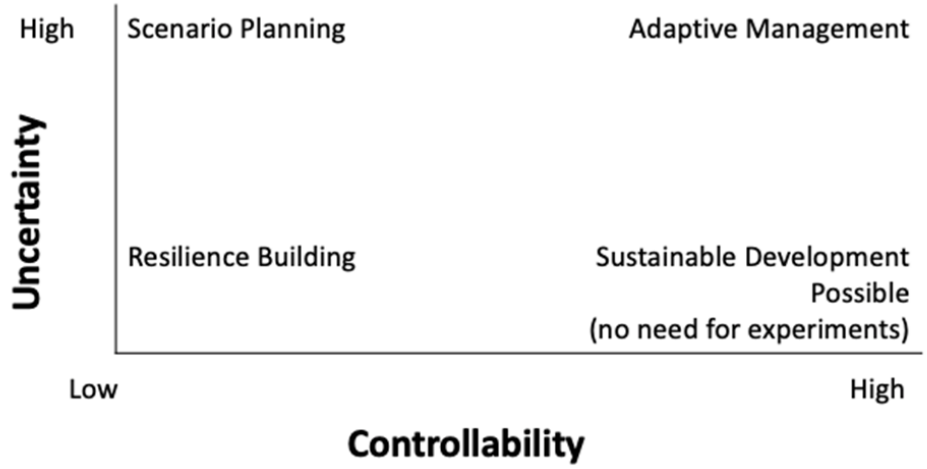

Figure 2-2 Management Responses Under Scenarios for Uncertainty and Controllability

Figure adapted from: Allen & Gunderson, 2011 and Peterson et al., 2003.

Determining AM's suitability may be further guided by the following questions adapted from Murray and Nelitz's *Review of the Diavik and EKATI Adaptive Management Plans* (2008):

- Is there significant uncertainty about the outcomes of management actions and which one(s) may be most effective at achieving a particular end? Figures 2-2 and 2-3 illustrate that AM is best utilized under scenarios where uncertainty is high.
- Is the best way to reduce uncertainty an experimental approach? For example, Murray and Nelitz (2008) note that other methodologies (e.g., retrospective analysis using existing data) may be equally effective and potentially lower risk than conducting a full-scale management experiment in the field.

- If an experimental approach is optimal, is it possible to sufficiently control enough variables to have relative certainty about cause-and-effect? (Figure 2-2).

'Risk' is the third critical component for determining the appropriateness of AM for a given management context. 'Risk,' at a very high level, is typically defined as: probability X consequence – particularly a negative consequence. It is beyond the scope of this dissertation to provide an extensive overview on the characteristics of risk and risk management; however, Cullen and Small (2004) note that there are quantitative (probabilistic and scientific) and qualitative (values, judgements, and social norms) elements that ultimately determine risk perception, tolerance and options for risk management that have been collected from across the risk literature. These characteristics include:

- The magnitude of risk
    - Probability
    - Severity
- Uncertainty and knowledge about the risk
- Distribution of impacts
    - Across species
    - Across time
    - Across one or more human populations/regions
- Time frame
    - Catastrophic
    - Chronic
    - Generational
- Alternatives for avoidance
    - Feasibility: technical, political, etc.
    - Cost
    - Legal and regulatory regimes
- Newness/familiarity/dread/voluntary acceptance/reversibility
    - Objective and subjective aspects
- Process and options for risk management/mitigation (list adapted from Cullen & Small, 2004: 187)

It should be noted that the distribution of impacts and externalities across those who benefit from a particular risk and those who pay for it should be considered as an ethical

matter. It is commonly observed in extractive resource development contexts that species and people groups (often Indigenous Peoples) experience the worst effects of development (loss of land base to practice traditional activities, environmental degradation, social harms associated with work camps, etc.) without reaping the benefits (e.g., royalties or other economic benefits associated with development).

Risk characterization and management may follow a similar iterative approach as AM, as defined in Figure 2-1 with well-defined steps for understanding the problem(s), collecting data, analysis, stakeholder engagement and consultation, decision-making, monitoring and revisiting management actions. Given the complexity of variables and potential for adverse outcomes inherent with risk definition and mitigation, AM is typically best suited for contexts that are low risk (see Figure 2-3). Allen and Gunderson (2011) use the example of managing declining populations of the California Condor to illustrate a case where AM is too risky to implement as a management strategy. Resource managers found that attempting to establish a second population for experimentation had significant risk and ethical implications, particularly once the population reached critical endangerment and there were only a few individuals left; moreover, assessing the efficacy of management actions for critically endangered species is nearly impossible as small sample sizes are unlikely to produce sufficient data for the purposes of experimental learning. Climate change – the same example as used for Figure 2-2 – can be considered here where uncertainty is high, as are the stakes. Therefore, AM is less viable as an option to successfully address both uncertainty and risk.

Figure 2-3 Management Responses Under Scenarios for Uncertainty and Risk
Figure adapted from: Allen & Gunderson, 2011.

As we have explored in this section, AM has significant potential when applied to appropriate contexts and problems. Craig & Ruhl (2014) further summarize this as: “If a regulatory [or policy] problem is dynamic rather than static, the fundamental question is whether we know enough about the dynamic processes [both ecological and technological innovation] (uncertainty) to manipulate them (controllability) without messing things up (risk)” (Craig & Ruhl, 2014: 19). An implicit assumption, or condition added to the former criteria for suitable AM application (high uncertainty; high controllability; low risk) is that the system or management context under consideration is also dynamic, which may also be an underlying factor in its high uncertainty. Later sections of this literature review will illustrate the challenges inherent with applying fixed, or non-stationary, regulatory models and systems to highly dynamic and uncertain management contexts.

2.1.3. The Precautionary Principle

The precautionary principle is considered a fundamental component of sustainable development. That is, its intent is to facilitate inter-generational equity by allowing development for consumptive needs of today, without jeopardizing the needs of the future. This is simplified as “prevention is better than cure” and “it is better to be safe than sorry” in the literature. In other words, the precautionary principle should theoretically apply whenever there is an unknown likelihood that the risks of taking a particular course of action are unacceptable.[9] This is particularly important within the study of AM implementation given that there are contexts where the precautionary principle should perhaps have been applied, but AM may have been relied upon as a counterbalance to enable a particular project or development to move ahead with permitting and approvals (Kwasniak, 2010). There are several versions of the precautionary principle that can be found in international treaties and declarations. The most famous of these are the Rio Declaration (United Nations, 1992) and the European Union (EU) Communication on the Precautionary Principle (EU, 2000). The Rio Declaration (1992) states:

[9] Note that the determination that a risk is unacceptable is a subjective and value-driven standard which depends on the interpretation of those who are affected. As such, there is an implicit ethical component in deciding whether to use AM to mitigate or override such risks.

> *In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.*

The EU Communication (2000) states:

> *The precautionary principle applies where scientific evidence is insufficient, inconclusive or uncertain and preliminary scientific evaluation indicates that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen by the EU.*

Note that the Rio Declaration includes qualifying language around "according to [States'] capabilities" whereas intervention is a requirement in the newer EU version. Nevertheless, the literature generally agrees that the precautionary principle is triggered when there are credible and significant uncertainties about causality, probability, degree and nature of risk; furthermore, the judgement of plausibility must be grounded in scientific analysis, whereas the judgement of whether or not the risk is considered unacceptable tends to be rooted in more value or ethically-driven analyses (EU, 2000; UNESCO, 2005). It follows, then, that actions (anticipatory measures) should be proportional to the aforementioned factors.

Similarly, the IAA entrenches the precautionary principle as part of its mandate which stipulates:

> *(2) The Government of Canada, the Minister, the Agency and federal authorities, in the administration of this Act, must exercise their powers in a manner that fosters sustainability, respects the Government's commitments with respect to the rights of the Indigenous peoples of Canada and applies the* ***precautionary principle*** *(Section 6 (2)).*

Furthermore, the IAA cites "precautionary manner" in two places pertaining to the purpose of the IAA:

*(d) to ensure that designated projects that require the exercise of a power or performance of a duty or function by a federal authority under any Act of Parliament other than this Act to be carried out, are considered in a careful and **precautionary manner** to avoid adverse effects within federal jurisdiction and adverse direct or incidental effects (Section 6 (1)(d)); and*

*(l) to ensure that projects, as defined in section 81, that are to be carried out on federal lands, or those that are outside Canada and that are to be carried out or financially supported by a federal authority, are considered in a careful and **precautionary manner** to avoid significant adverse environmental effects (Section 6 (1)(l);*

Given that AM is most appropriate where controllability and uncertainty are both high, but risk is appropriately low (Figures 2-2 and 2-3), the literature indicates that AM and the precautionary principle are not two poles on a scale of possible interventions. Rather, they are opposite sides of the same coin. Both AM and the precautionary principle fit the same set of criteria outlined in the CEAA Operational Policy Statement (OPS) for cases where AM might not be appropriate (section 2.1.2). AM literature (and the OPS) has noted that AM is not contingency planning. Rather, the OPS specifically notes that Section 16 of the previous CEAA (and now Section 22(1)(b) of the IAA) that EAs are required to "consider measures that are technically and economically feasible, and that would mitigate any significant adverse environmental effects . . . Therefore, it is insufficient to assert that implementation of an unidentified future measure, developed because of adaptive management, constitutes mitigation of a predicted adverse environmental effect" (Adaptive Management Measures under the *Canadian Environmental Assessment Act*, 2009). If AM is not appropriate for cases where mitigation is not identified or if there is significant uncertainty about significant adverse environmental effects (unacceptable risk) then the precautionary principle should automatically apply. For cases where AM is used to override the precautionary principle, special care should be taken to ensure that AM is appropriate for the context (see Figures 2-2 and 2-3) and legitimately constitutes a 'safe fail.'

2.2. Adaptive Management and Administrative Law

AM is typically implemented under administrative legal and regulatory regimes. However, many legal scholars and academics have noted that AM is not conducive to the legal and regulatory regimes in which it is implemented (Benson, 2009; Benson & Stone, 2013; Craig & Ruhl, 2014; Kwasniak, 2010; Raadgever et al., 2008; Ruhl & Fischman, 2010; Susskind & Secunda, 1999). Professor Ruhl (2008) makes an interesting observation about AM:

> *The disconnect between adaptive management in practice and adaptive management in law is quite palpable. Today's practitioner of natural resources law is bombarded with adaptive management. It is firmly entrenched in natural resource management agency practice from headquarters to field level. It shows up in land management plans, resource development permits, and agency guidance documents. Yet, it appears almost nowhere as codified statutory and regulatory text, and it is dealt with significantly in only a handful of judicial opinions. Agencies can practice adaptive management because their organic statutes are sufficiently vague to allow it, but few statutes mention adaptive management and even fewer require it. No other principle of natural resources management has so deeply permeated the practice on the basis of so little mention in the law. J.B. Ruhl, 2008: 11-3.*

While Professor Ruhl is writing about the United States, the same can be said for Canada.[10] To what extent AM is entrenched in government agency plans and guidance documents is one of the main research questions of this dissertation.

2.2.1. Adaptive Management in Canadian Law

AM was introduced federally into the *Canadian Environmental Assessment Act,* 1992 (CEAA) in 2003 through amendments to subsection 38(5) which provided for: The results of follow-up programs may be used for implementing *adaptive management*

[10] When conducting a search through the Canadian Legal Information Institute (CanLII), I found that AM is referenced only 19 times in Canadian acts, regulations, and orders, some of which have now been repealed and/or replaced (e.g., the CEAA).

measures or for improving the quality of future environmental assessments (emphasis, mine). The CEAA was repealed in August 2019 and replaced by the *Impact Assessment Act* S.C. 2019, c. 28, s. 1 (IAA). The IAA provides continuity for AM via follow up programs. In the first occurrence of AM in the IAA, if the Impact Assessment Agency of Canada (IAAC) determines that a project is in the public interest and will proceed, they may implement mitigation measures for adverse environmental effects as well as:

> *4(b) the implementation of a follow-up program and, if the Minister considers it appropriate, an **adaptive management plan** [Section 64 (4)(b)] (emphasis, mine).*

The second mention of AM is at Section 156 (2)(e) which pertains to the Canadian Environmental Assessment Agency's ("the Agency") powers which include:

> *(e) establish[ing] research and advisory bodies for matters related to impact assessment and monitoring committees for matters related to the implementation of follow-up programs and **adaptive management plans**,[11] including with respect to the interests and concerns of Indigenous peoples of Canada and appoint as a member of any such bodies one or more persons [Section 156 (2)(e)] (emphasis, mine).*

The Acts themselves are silent on what the AM process is or what an AM plan entails, and on the expectations of regulatory agencies, and on the responsibilities of proponents in how they implement AM. This has been widely considered problematic. For example, in considering the proposed Whites Point Quarry and Marine Terminal Project in Nova Scotia (rejected in 2007), the Joint Review Panel (JRP) found that there was considerable confusion about AM and recommended that the federal government develop a guidance document to provide clarity. The ensuing "Adaptive Management Measures under the Canadian Environmental Assessment Act" operational policy statement (OPS) was published in 2009. In addition to providing a definition, the document provides best practices guidance on when AM might be appropriate and when AM might not be appropriate. Specifically, AM may not be appropriate in the following

[11] The IAAC has not provided further detail regarding what is expected content within an AMP; however, there is considerable literature on the topic as well as working examples. Carol Murray and Marc Nelitz (2008) provide a detailed overview of what an AMP entails as an appendix to their "Review of the Diavik and EKATI Adaptive Management Plans." Also, refer to Appendix C of this dissertation.

contexts: mitigation is not identified; where there is uncertainty about significant adverse environmental effects; there is a likelihood of significant adverse environmental effects; and where there will likely be a lack of follow-up results.

The OPS fails to meaningfully address field-level implementation of AM in two ways. First, an OPS is not legally binding, and is intended for informational and guidance purposes only. This is advantageous in the sense that the OPS provides a best-practices guide for proponents aspiring to the gold-standards of "good" development, but on the other hand, the document can be largely ignored without penalty. The second issue is that the OPS may have come too late to provide critical direction during the formative cases of AM jurisprudence. As will be discussed further in Subsection 2.2.2, two of the first Canadian cases that dealt with AM for major projects seemed to mischaracterize some of the fundamental attributes of AM. This issue of timing and unenforceability becomes particularly important when considering the results in Chapters 4-6 of this dissertation which illustrate that there are very few documents – either enforceable or not – that provide additional guidance for agencies, adjudicators or proponents looking for information and expectations with respect to AM.

Finally, Kwasniak (2009) writes with respect to the CEAA and using the results of follow-up programs for implementing AM that "if this provision is to be used, it is critical that either authorizations be flexible enough to require alternative environmental management strategies, or the applicable legislation authorizes the regulator to revisit authorizations in this manner" (Kwasniak 2009: 9). Most legislation is theoretically flexible enough to enable decision-makers to amend or change the terms of licences, permits and approvals, if warranted, although this has not always been the case. For example, historically, there was no ability under the *BC Water Act*, originally enacted in 1909, to amend a licence unless there was an error in the original licence, the licensee applied to have the licence revised in some way, or to remove a provision that was inconsistent with the Act.

2.2.2. Adaptive Management Before the Courts in Canada

The lack of clarity within statutory law regarding what AM is or what it requires from policymakers, regulators and proponents has occasionally required the Courts to serve as interpreters. Craig and Ruhl (2014) note that there may be several advantages

from judicial interpretation of AM. For example, it may prevent regulatory capture and ensure that development is in the public interest, it may ensure that well-reasoned (and reasonable) decisions are made with respect to development, and it may further serve to ensure that legislation is revisited occasionally to ensure that it continues to meet the test of changing societal norms and values (Craig & Ruhl, 2014). At times the Courts have permitted development in the face of great uncertainty about significant adverse environmental effects and viable mitigation measures. The legacy of precedent (both in jurisprudence and the precedents set by review panels) continues to direct how AM is leveraged in major project planning. In short, the more AM is shown to be an acceptable environmental strategy, the more it is used as such. Ambiguity around the requirements of AM have led to a small but important collection of legal cases that have sought to articulate some aspect of AM. The cases discussed here in some detail include:

- Canadian Parks and Wilderness Society (CPAWS) v. Canada (Minister of Canadian Heritage), 2003 FCA 197, [2003] F.C.J. No. 703; (Referred to hereafter as “CPAWS).

- The Pembina Institute for Appropriate Development, et al. v. Attorney General of Canada and Imperial Oil Resources Ventures Limited 2008 FC 302; (Referred to hereafter as “Pembina”).

Each of these cases presents some aspect of resolving one or more instances where the practice of AM has caused confusion, or where it has been apparently irreconcilable with the precautionary principle. The outcomes of the cases provide insight into one of the reasons for the diversion of AM in practice from AM in theory.

In CPAWS, the Canadian Parks and Wilderness Society was concerned that construction of a particular road would cause environmental harm. The Minister involved in the decision, and later the Justices deciding the case, believed that AM would be capable of providing effective mitigation. Furthermore, Justice Evans stated in the decision that:

> *The concept of "adaptive management" responds to the difficulty, or impossibility, of predicting all the environmental consequences of a project on the basis of existing knowledge. It counters the potentially paralyzing effects of the precautionary principle on otherwise socially*

> *and economically useful projects. The precautionary principle states that a project should not be undertaken if it may have serious adverse environmental consequences, even if it is not possible to prove with any degree of certainty that these consequences will in fact materialize. Adaptive management techniques and the precautionary principle are important tools for maintaining ecological integrity [Para. 24].*

The Justice's interpretation of the precautionary principle seems to have had important implications for how proponents across various kinds of major projects interpret their environmental obligations. Since the precautionary principle requires foresight and preparation – not only caution – the existence of scientific uncertainty should always, among other things, trigger some level of precautionary measures. This has been taken by some, including Justice Evans, as an indication that the precautionary principle stifles innovation and progress. Rather, the precautionary principle reverses the onus of proof so that proponents, rather than decision-makers (and by extension the public), bear the burden of demonstrating that they, or a proposed project, are in the public interest (Peel, 2004). In other words, it is up to the proponent to demonstrate that a development project poses more benefits than costs and associated externalities (positive and negative), rather than the public having to prove the inverse. This is particularly important since stakeholders and Indigenous Peoples may be disadvantaged with respect to time, money, and other resources in obtaining and presenting the necessary information, or whether they are involved at all (Irwin & Kennedy, 2009). CPAWS was the first major decision that established that AM can be used to bypass full consideration of this burden. The extent to which this balancing act has become distorted is a source of criticism from the legal community. Kwasniak (2009) argues that this is problematic given that AM "must not be used as a 'substitute for committing to specific mitigation measures.' So it cannot [theoretically] be used to cover a situation where a proponent is not sure how to mitigate a negative environmental impact, but commits to finding the technology or science in the future, if a problem arises" (Kwasniak 2009: 2) This case, in particular, opened the door to an alternate line of reasoning.

Imperial Oil filed its environmental impact assessment (EIA) relating to the Kearl Oil Sands Project in July 2005. Fisheries and Oceans Canada (DFO), Environment Canada, Health Canada, and Natural Resources Canada reviewed the material as part

of a joint environmental assessment conducted with the Province of Alberta. In 2006, the DFO recommended that the Kearl Project be referred to a review panel due to the likelihood that the project could cause "significant adverse environmental effects, including cumulative effects, over large areas and on a number of valued ecosystems" (Para 8). The Kearl Project underwent a Joint Review completed in 2007. The Joint Review Panel (JRP) recommended that the DFO approve the Project according to its assessment that the Project would not cause significant adverse environmental effects if the mitigation measures and recommendations made by the JRP were implemented. The argument of the Appellants who brought Pembina to the Federal Court was that the environmental assessment conducted by the Panel did not comply with terms of the CEAA, specifically the inclusion of follow-up programs (in other words, AM) and the precautionary principle.

In Pembina, Justice Tremblay-Lamer cited Paragraph 24 of the CPAWS decision and wrote in her decision:

> *[32b] Thus, in my opinion, adaptive management permits projects with uncertain, yet potentially adverse environmental impacts to proceed based on flexible management strategies capable of adjusting to new information regarding adverse environmental impacts where sufficient information regarding those impacts and potential mitigation measures already exists.*
>
> *[33] Accordingly, the scope of the duties incumbent upon a panel must be viewed through the prism of these guiding tenets: the precautionary principle and adaptive management. As an early planning tool, environmental assessment is tasked with the management of future risk, thus a review panel has a duty to gather the information required to fulfill this charge.*
>
> *[34] . . . To this end, [the CEAA] mandates early assessment of adverse environmental consequences as well as mitigation measures, coupled with the flexibility of follow-up processes capable of adapting to new information and changed circumstances. The dynamic and fluid nature of the process means that perfect certainty regarding environmental effects is not required.*

The major issue with the Pembina decision is that in using AM (as construed by section 32b, above) to mitigate risk, proponents are permitted to practice contingency planning (or AM-lite) and not AM for decisions on the landscape that are almost certainly irreversible. Moreover, in considering sections 33 and 34 in the context of the rest of the decision in Pembina, it is implied that providing very little information ("perfect certainty regarding environmental effects is not required" para 34) about the nature of a future risk is acceptable to the court. Justice Tremblay-Lamer is seemingly enabling AM-lite through her decision.

Imperial Oil invoked AM to address two significant issues: the first was reclamation of peatlands, and the second was the use of end pit lakes[12] (EPLs) as a final repository of mature fluid fine tailings. The argument made by the Appellants for both issues was similar: that tested technologies or established science do not exist for either of the issues and that the proposed approach was likely not economically feasible as a mitigation measure, a condition laid out in the CEAA [16(1)(d)]. The Court rejected these arguments in Pembina as it has in other cases. Mitigation, as defined in the CEAA is: "the elimination, reduction or control of the adverse environmental effects of the project and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means" (CEAA Glossary, 2012: online). Paragraph 16(1)(d) further notes that such measures must be "technically and economically feasible." Kwasniak (2010) extends this definition to include those

[12] "End pit lakes" are a commonly used reclamation methodology used for open-pit or surface coal, quarry, and metal mine operations globally. They become features of the post-reclamation landscape for the permanent storage of mine process affected wastewater and tailings. They have been proposed as a solution for tailings management and reclamation of disturbed lands in Alberta's Athabasca oil sands region to meet the intent and requirements for reclamation set out in the Environmental Protection and Enhancement Act (EPEA). In the oil sands context, it has been proposed that EPLs can permanently contain fine fluid tailings and wastewater under a surficial layer of fresh water. The technology has yet to be proven at a commercially viable level (see argument in Pembina). Moreover, the scale at which the technology has been proposed for use in the oil sands region is unique. The Cumulative Environmental Management Association (CEMA) and the Canadian Oil Sands Innovation Alliance (COSIA) together with Pathways Alliance have written numerous reports and conducted research on EPLs in the Alberta context. CEMA (2012) describes the approach (including AM) planners and engineers might take in turning the proposed 30 EPLs into functioning aquatic ecosystems over time. See "End Pit Lakes Guidance Document" (2012) written by CEMA for more information. It should be noted that, given the extensive research that is currently being applied to the test pit lakes in the Athabasca region, some experts have noted that they may well be one of the better, and more suitable, AM experiments that is underway in Alberta (Olszynski, 2017).

measures that must also be known to work and be implementable, a condition which has been noted by other legal scholars.

Nevertheless, in Pembina, Justice Tremblay-Lamer took a much broader approach to the technical and economic feasibility of both mitigation measures and using AM principles to achieve them. The decision rendered in Pembina lowers the standard of quality accepted from "technically feasible" to "technically possible" (Chalifour, 2009); however, according to Justice Tremblay-Lamer, uncertainty regarding EPLs "in the oil sands region is understandable given that they will only become operational upon mine site closure." (Para 57). Similarly, with respect to peatlands, Justice Trembly-Lamer was confident that AM could be applied to reclamation (Sections 60 & 62) notwithstanding the Pembina Institute's concerns that peatland restoration is "not even known in general terms" (the Pembina Institute for Appropriate Development was joined in filing their application for judicial review by the Prairie Acid Rain Coalition, Sierra Club of Canada, and the Toxics Watch Society of Alberta).

CPAWS and Pembina continue to be cited by proponents of projects with significant potential environmental impacts to justify their reliance on AM as a mitigation for serious adverse environmental effects. Notably, many of these projects fall into the category where it is very difficult to undo decisions once they are made (e.g., "where to locate a completed highway intersection") (Craig & Ruhl, 2014: 13).[13] While there do not appear to be any major jurisprudence developments involving AM since CPAWS and Pembina were decided (apart from the hearing process), there are numerous projects that have become the subject of litigation where AM forms a part of their management approach. Legal scholars and non-industry stakeholders have become highly critical of what they call a "buy-now-pay-later" approach to green lighting reviewable projects. Indeed, there is a broad and growing body of literature that takes issue with the

[13] It should be noted that in the Pembina case, the issue is less to do with water management *per se*, but rather, the waste stream emanating from the mine. Questions about how much water should be diverted from the Athabasca River, and how this water should be allocated among consumptive users, is one that makes a better candidate for AM given that, should certain triggers be met, the overall approach can be revisited. It seems that for other cases (i.e., up-front mine siting), development is a foregone conclusion where AM can be used to help manage the mess and justify impacts to the landscape that are not easily mitigated. It should not be surprising that AM is less desirable in these instances, notwithstanding the reality that AM may end up being the only appropriate management strategy for ongoing management and remediation of the sites once they are on the landscape.

decisions themselves (including but not limited to AM) as well as follow-up as the project gets underway. These challenges with the environmental project judiciary and adjudicatory model serve to make the Benga decision that much more important as it could serve as a course-correction to some of the previous decisions where AM was erroneously interpreted. As the discourse around approving major projects with significant adverse environmental effects continues to be political and polarized, the role of the courts (and hearing commissioners) will remain one of interest, particularly with respect to delivering new or different interpretations of AM's role in addressing environmental impacts.

2.2.3. Regulatory Models under Administrative Law Regimes

Policy is important for setting strategic direction and outcomes that inform the content of its legislative and regulatory regimes; however, it is the laws and regulations themselves that specifically demand a particular behaviour (or inhibit a particular behaviour) from regulated parties. Figure 2-4 illustrates the relationship between policy, legislation, and regulations. It should be noted that, in Canada, policy influences can come from either the federal or provincial government, or both. As shown in Figure 2-4, federal Acts supersede provincial Acts. Sections 91 and 92 of the Constitution of Canada explicitly delineate the division of powers between the federal and provincial governments. Resource management (including energy and water) typically falls to the provinces who are empowered to create and administer their own legislative and regulatory frameworks, although, in some cases (e.g., trans provincial or international pipelines), energy development falls under federal jurisdiction. Regulating the water-energy nexus is inherently complex. For the purposes of Figure 2-4, "ownership" of an instrument is meant to indicate the agency who possesses the power to draft or amend it.

Water management in shale gas contexts provides a particularly fascinating case study given the complexities of the various levels of governments who are involved in the regulatory process. Curran (2020) provides an overview of the features of water and natural gas regulation in Canadian provinces, noting some important similarities between Alberta and B.C.: 1) the existence of a "one stop shop" regulator, 2) the centrality of the

notion of “first-in-time, first-in-right” for water licensing regimes in Alberta and B.C.,[14] and 3) there is a great deal of flexibility in how regulatory agencies chose to implement and oversee their water-energy legislative regimes (Curran, in Buono et al., 2020: 315-317). This is not to suggest that the flexibility afforded by provisions in law is always leveraged; however, the option being available to regulators and statutory decision makers is a powerful option indeed. It should also be noted that the conventional understanding of the hierarchy of law (Figure 2-4) ignores the existence of Indigenous nations and their governance structures. This issue is discussed in section 2.2.5 of this Chapter and is a recurring theme throughout my dissertation.

[14] “First-in-time, first-in-right” means that the *Water Act* and *Water Sustainability Act* (and predecessor *Water Act* in BC) offer licensees and permit holders certainty of access to water resources necessary for development based on when they received their water license. This concept becomes particularly important for companies that have older licenses with priority over newer licenses during times of drought or responding to system stress when some licenses may be suspended or modified, beginning with those that are most junior.

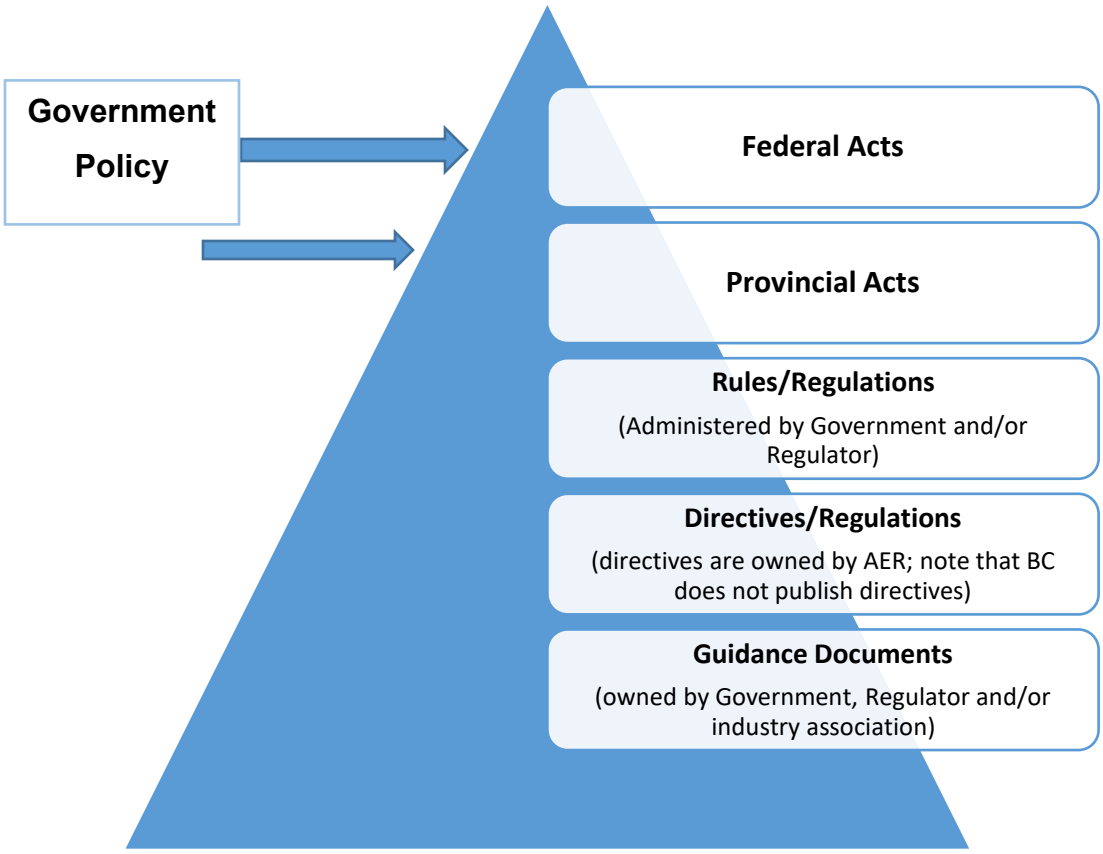

Figure 2-4 Hierarchy of Law[15,16]

Regardless of the specific type of regulatory requirement drafted, all regulatory requirements generally adhere to Baldwin et al.'s (2010) discussion of the different variations of regulatory definitions that exist in the literature. 'Regulation is an act of governments and regulatory agencies and as such, regulators intentionally and deliberately exercise their control by imposing standards and specific sets of commands that are backed by sanctions up to the level of criminal charges to individuals (Baldwin et

[15] Note that when B.C. publishes "directives" they are analogous to orders in Alberta where the decision is typically a one-off command from the regulator or government directed at a specific licensee or issue. For example, the BCER issued DIR 2022-07 which suspended water withdrawals from the Liard River watershed under section 10 of the WSA due to drought conditions. As such, B.C.'s directives are out of scope for this analysis.

[16] The Canadian Constitution sits at the top of the hierarchy of laws in Canada. As such, Section 35 of the Constitution of Canada (1982) pertaining to the rights and title of Indigenous peoples should be applied to the legislative regimes that are situated under the Constitution. However, as discussed further in section 2.2.5 of this dissertation, the constitutional obligation to consult is often notably absent in industrial development and environmental management on Indigenous lands. The legislative and regulatory instruments that are the subject of later chapters of this dissertation must be read alongside the processes that ought to be animated by section 35, and, as the courts have found, are inherently colonial in nature by design.

al., 2010). Hodges (2015) identifies two fundamental principles at play when considering the purposes of regulation:

1. The underlying activity – or subject of the regulation – is desirable and assumed to be encouraged since it has some beneficial implication to economic or social welfare, or both.

2. The government or agency tasked with regulating the activity is responsible for setting performance of aspects of the underlying activity – both positive and preventative – and attempts to maximize the benefits of the activity while minimizing adverse impacts or externalities.[17]

In other words, "the message that the state is sending is 'we like what you are doing, but we don't want you to do it this way'" (Hodges, 2015: 162). Western Canada's experience with energy development has largely illustrated why the fundamentals of regulation continue to be relevant. Oil and gas exploration and development in the early 1900s was largely unregulated. Over time, regulations were imposed and further developed to address externalities such as water and air pollution and negative impacts to reservoir pressure. Notwithstanding the economic benefits, negative environmental externalities also had undesirable effects for stakeholders living in proximity to energy development. Now, regulations are used to drive regulated parties' behaviour in managing negative impacts and consequences of energy development as well as incentivise desirable behaviour and best practices, even when desirable behaviour may not be mandated by requirements. There are now thousands and thousands of requirements within the regulatory landscape in Western Canadian energy development that stipulate how governments and regulatory agencies expect licensees and approval holders to undertake energy development activities.

There are two major types of regulatory requirements that are of interest to this study: prescriptive requirements, and outcomes-based requirements, which may also be referred to as 'performance-based' requirements. Each kind of requirements has various sub-groups that belong to it; however, the two families can generally be grouped

[17] Garret Hardin's paper "Tragedy of the Commons" provides a very simple introduction to the notion of using regulation to manage externalities. He uses the example of over-grazing cattle on commonly held property.

according to those that are ‘means-based’ (prescriptive) and those that are ‘ends-based’ (outcome or performance). The literature generally considers these broad categories of regulation to be “command-and-control” regulations where there is a required action that the regulated party must do or a standard is imposed (the command), followed by some kind of action to punish or apply criminal sanctions, or reward the behaviour (the control) (Baldwin et al., 2010). The means-based regulations focus to varying degrees on precisely what the regulated party must do, as well as what they must (or must not do) in order to achieve it and emphasize control and accountability (May, 2003). Typically, prescriptive regulations are ‘black-and-white, with little opportunity for interpretation or flexibility, including experimentation, in the regulated party’s approach to maintaining compliance. In that respect, prescriptive requirements can be incredibly effective. Furthermore, prescriptive requirements may identify or be tied to a particular compliance or policy objective, although, this is not always the case. It should be assumed, however, that where requirements contravene a new policy or a change in policy, the legislative and regulatory frameworks associated with the policy regime will likely be amended to be aligned.

Ends-based regulations focus on the outcome, whereas the methodology or actions taken by the regulated party are less important provided they adhere to all applicable laws and standards in the process. Unlike prescriptive requirements, outcomes-based requirements focus on what objectives or performance target a regulated party must meet, but not necessarily how they should do it. The literature also identifies ‘management-based regulation’ (or self-regulation) as a topic of interest, which, from the perspective of this dissertation, is ultimately a subset of a kind of ends-based regulation. Traditionally, “self-regulation can be seen as taking place when a group of firms or individuals exerts control over its own membership and their behaviour … A host of arrangements can be seen as self-regulatory and variations in the characteristics of self-regulatory regimes can be identified" (Baldwin et al., 2012: 137-138). The literature notes that self-regulation may be supplemented by overarching government regulations or policies, and functions especially well for sectors where there are questions about the regulatory agencies’ technical expertise or ability to meet outcomes efficiently (Baldwin et al., 2012; Black, 1996; Ogus, 1995). In the Canadian context, pipeline integrity management programs (IMPs) are a common form of self-regulation by pipeline companies, which are further strengthened by provincial regulations as well as highly

technical guidelines (which are sometimes incorporated by reference into regulations) by technical standards associations. For example, the Canadian Standards Association's (CSA) pipeline standards and regulations (CSA Z662) has been broadly adapted into Alberta's pipeline regulations published by the Alberta Energy Regulator.

The academic literature also discusses other regulatory and non-regulatory approaches and strategies, such as: information regulation, 'nudge strategies' (see Thaler and Sunstein, 2008), smart regulation, economic instruments,[18] equivalency and waiver clauses, co-regulation, and others. While an important subject of study in the academic literature, this dissertation does not comprehensively consider these approaches given their relative lack of representation within the legislative and regulatory regimes that are assessed by my research. This is not to say that these regulatory models *could not* be effectively used in implementing AM for energy development projects throughout the lifecycle, but rather that there is sufficient evidence from the samples in my content analysis to conclude that they *are not* present or effectively used.

Table 2-2 provides definitions of the sub-groups of prescriptive and outcome-based regulation, as well as their relative advantages and disadvantages. Table 2-3 provides several examples of different kinds of requirements. As Table 2-2 illustrates, there are trade-offs inherent with choosing a particular regulatory approach, as well as the specific drafting and design of the final requirement. Performance-based approaches are typically considered more flexible than design or technology-based regulation. Management-based approaches, although a means-based regulatory approach, provide regulated parties with greater flexibility than design and technological-based approaches and may offer equal or even greater flexibility than performance-based approaches. Design-based or other highly prescriptive approaches offer the most clarity and certainty for both the regulator and regulated parties; however, these approaches have also been criticized that they may also inhibit technological innovation and become out-of-date very

[18] Economic and financial instruments can be highly effective at driving desired behaviour for regulated parties. Carbon taxation is one example of a relatively successful application of economic instruments, provided the 'tax' is set at an appropriate level to drive behaviour. However, economic instruments are less applicable to this study since the regulatory agencies (Alberta Energy Regulator and the BC Energy Regulator (formerly the BC Oil and Gas Commission) do not have the authority to broadly leverage all economic instruments as part of their rule-making powers.

quickly (Baldwin et al., 2012). However, outcome-based regulation may also introduce a perverse incentive for regulated parties to ‘game the system’ to produce the desired results under pressure, while avoiding the desired behaviour (Pritchett, 2016). For example, in 2015, the American branch of Volkswagen outfitted its cars with emissions systems that would falsely register as compliant with federal emissions standards when tested, even when the vehicles were exceeding the EPA-mandated thresholds. These nuances and tradeoffs between approaches become important in later chapters in this dissertation where I will evaluate the features of different regulatory approaches and their ability to facilitate, or inhibit, a robust implementation of full-cycle AM.

Table 2-2 Types of Regulation

Type of Regulation	Definition	Advantages	Disadvantages
Prescriptive Regulation – Means-based			
Design or technology-based regulation	Regulated parties are required to adopt a particular action or designed process, or technology to meet a regulatory outcome. For example, design-based regulation is common and effective in the medical profession in cases where there is widespread agreement about what good medical practice looks like and a particular procedure can be legislated for all circumstances (Yeung and Dixon-Woods, 2010).	Ease of application. Certainty of intent. Predictability and clarity for regulator and regulated parties. Most enforceable when compared to other approaches. Easy to codify and easy to reflect in permit requirements. Detailed rules can be better in dealing with ill-intentioned or ill-informed firms.	May not prove as effective as other means, or for some regulated parties because the requirement is narrowly focused and may not be responsive to new risks or changes in the system. May prove to be more costly than other equally effective means. Can inhibit innovation toward more effective or cheaper ways to achieve the same outcomes by "freezing" technology. May fail to consider risk of human control and may lead to increase risk taking behavior. May have built in redundancy, gaps, inconsistencies and be prone to creative compliance. May become outdated quickly.
Management-based regulation (self-regulation)	Regulated parties are required to engage in their own planning and rulemaking to achieve regulatory outcomes and objectives.	Provides considerable discretion for regulated parties, changes internal decision making within regulated industries. Information sharing between regulated and regulator and information comparison across regulated entities.	No specified level of performance is required (in more extreme cases). In many cases regulated parties aren't required to follow their own mandated internally constructed plans. Smaller companies are less likely to see environmental benefit from planning effort and may lack the capacity to design and enact measures. Difficult to determine if regulated party is planning responsibly, and enforcement of "good management can be challenging. Information gap can disadvantage regulator and allow regulated parties to do the minimum or be non-compliant without intervention before 'it's too late.'

Type of Regulation	Definition	Advantages	Disadvantages
		Can be effective in reducing chemical releases. Allows regulated parties flexibility to design plans around their specific operations. Assigns the risk assessment and control to the decision makers with the most information – namely the regulated party's management. May reduce employee resistance to the associated reforms.	
General prescriptive regulation	Regulated parties are instructed of precisely what they must do (or are prohibited from doing) in certain circumstances.	Creates certainty and predictability (Pritchett, 2016). Easy for regulator to observe and evaluate, and determine compliance.	May impose higher operational and compliance costs. May stifle innovation. May become out of date quickly.[19]
Outcome-based or performance-based regulatory models – Ends-based			
Outcome-based regulation (performance-based regulation)	Regulated parties are required to meet an outcome or 'end.'	Encourages regulated parties to find cheaper ways to achieve regulatory goals. More flexible. Encourages innovation. Regulators don't require a rule for every situation.	When applied uniformly, regulated parties do not have incentives to exceed regulatory goals. When applied uniformly, regulatory goals may target the wrong outcome (e.g., a cap on output from oil & gas production versus a cap on emissions). Flexibility may not benefit all regulated parties equally as costs for searching for ways to meet performance standards can be an additional burden on smaller companies.

[19] Commercial viability of shale and unconventional oil and gas is an excellent example of a case where prescriptive requirements became out of date quickly. Given the significantly higher water requirements for MSHF activities, and the increasing storage volumes required to contain water and produced/flowback water, storage and water transport requirements that were appropriate for conventional oil and gas were unsuitable for unconventional contexts (i.e., storage devices and impoundments were simply not big enough).

Type of Regulation	Definition	Advantages	Disadvantages
	The performance standard can be tightly specified such as thresholds, rates, concentrations, and quantities which allows regulated parties to achieve the outcome or standard using their method of choice.		The innovation that performance standards can induce though flexibility may also make it difficult for the regulator to determine if regulated parties are in compliance with standards. Disagreement over what goals and performance standards should be. May create perverse incentive to cheat or game the system to achieve results.
General duty clause	Regulated parties are required to meet an outcome or 'end.' The performance standard can be loosely specified such as principles or general duties which allows regulated parties to achieve the outcome using their method of choice.	Flexible, cost effective, can help facilitate international trade and facilitate innovation, and enhance competitiveness. Can improve substantive compliance rather than checking boxes. Regulators don't require a rule for every situation. Principles are durable, reduce need for constant amendment, and are hard to manipulate making creative compliance difficult. Can lead to 'decluttering rule book'.	Lacks certainty, predictability and may have a chilling effect prompting regulated parties to be more conservative. Can be challenging for small companies who lack resources. Elaboration in the form of guidance can lead to increasing prescription, complexity, and risk of inconsistency. Proliferation of internal regulatory guidance increases uncertainty. Regulatory creep and blurring the distinction between minimum standards and best practice. Risk of overzealous/hindsight driven enforcement; it may be very difficult to determine compliance until 'it's too late.' Requires significant change in the skills and judgement of the regulator and regulated parties.

Table 2-3 Examples of Types of Regulation

Type of Regulation	Example
Prescriptive Regulations	
Design or technology-based regulation	Directive 077: Pipelines – Requirements and Reference Tools (2011) contains prescriptive requirements for licensing, constructing and operating bimodal high-density polyethylene (HDPE) pipe materials for oil and gas industry use.
Management-based regulation	7 (1) A licensee shall prepare and maintain a manual or manuals containing procedures for pipeline operation, corrosion control, integrity management, maintenance and repair and shall on request file a copy of each manual with the Regulator for review. (2) A licensee shall include in the appropriate manual referred to in subsection (1) provision for evaluation and mitigation of stress corrosion cracking when the licenced pipeline has disbonded or non-functional external coatings. *Pipeline Rules* 7(1, 2)
General prescriptive regulation	A licence shall not be transferred without the consent in writing of the Regulator. *Oil and Gas Conservation Act 24(1)* Class IA wells which receive fluids generated within the upstream petroleum industry as well as waste fluids generated within other industries (downstream), must segregate the upstream fluids from the industrial fluids. The surface facilities used for the receipt of industrial wastes, the industrial waste streams, and the plans to manage any residuals must be approved by AEP. Directive 58, 13.4: Class IA Wells Accepting Upstream and Downstream Fluids
Outcome-based or performance-based regulatory models	
Outcome-based regulation (performance-based regulation)	As per Directive 085: Fluid Tailings Management for Oil Sands Mining Projects, "An operator must submit a summary of fluid tailings management activities during the reporting period, including fluid tailings treatment and placement operations (showing alignment with the reclamation plan), technology development, and contingency or mitigation actions initiated in response to fluid tailings volume profile deviations or threshold exceedance, if any… [and] show in a figure the approved new and legacy profiles with the actual fluid tailings volume and the three thresholds (profile deviation, total volume, and total volume limit) (Section 6.2). The Regulator may take enforcement actions and/or intervene where performance thresholds are not achieved, including requiring additional reporting, requiring the operator to bring fluid tailings volumes in line with the approval, application of financial tools (including security or compliance levies), communication with

	stakeholders, etc. See pages 32-33 of the Tailings Management Framework for further examples.
General duty clause	No person shall knowingly release or permit the release into the environment of a substance in an amount, concentration or level or at a rate of release that causes or may cause a significant adverse effect. (*Environmental Protection and Enhancement Act* 109(1))

2.2.4. Challenges for Adaptive Management in Administrative Law Contexts

The academic literature provides many examples of why and how AM has often failed. These reasons include, but are not limited to: institutional challenges including lack of resources – both human and economic; poor or fragmented leadership and/or responsibility; inability or inflexibility to admit or react to uncertainty; the challenge of controlling variables or effective experimentation in large complex systems; AM and experimentation can be expensive which leads to prioritizing desired results rather than learning for the sake of learning; lack of integration and collaboration; prioritizing action over learning; decision makers may be risk adverse; poor documentation of results and incomplete data collection practices; failure to gain support from stakeholders; and the inherent difficulty of operationalizing what has been learned (Allen & Gunderson, 2011; Doremus, 2010; Gregory et al., 2006; Lee, 1999, National Academies of Science, Engineering, Medicine, 2011; Walters, 2007; Williams & Brown, 2016). While considerable attention could be given to any of these problems, and has been in the academic literature, I focus attention in this dissertation on one problem that is central to my research questions: Administrative law regimes, and their supporting legislative and regulatory frameworks, are largely incompatible with AM implementation (Cosens et al., 2020; Craig & Ruhl, 2014; Fischman & Ruhl, 2010 & 2016; Kwasniak, 2009; Raadgever et al., 2008; Susskind & Secunda, 1999). In fact, Craig & Ruhl (2014) argue that under the current administrative law models and associated environmental and operational challenges, AM-lite, or passive AM, is as far as government and regulatory agencies will ever be able to effectively go.

Much of the literature regarding AM implementation in administrative law regimes is situated in American case studies and contexts. It is important to note that the federal

legal regime in the United States imposes additional barriers to implementation of AM that Canada does not. Specifically, American property rights are protected under the Fifth and Fourteenth Amendments of the U.S. Constitution. This means that AM implementation may lead to legal challenges and litigation from property owners who may be entitled to compensation (Blake, 2003; Meidinger, 1995). This is a key barrier that does not apply to Canada and may indicate that Canadian jurisdictions could be better suited for AM implementation. However, there are several key features of the design of administrative law and its implementation which are common across many regimes and prevalent in Canada which are not conducive to AM. Specifically, the literature includes discourse on four problems for AM that are commonly observed in Canadian contexts:

1. legal and regulatory frameworks are based on finality and certainty which typically does not allow for ongoing adaptation and the kind of experimental approaches required by AM (Allen et al., 2011; Susskind & Secunda, 1999). Moreover, legal regimes themselves presume upon finality and certainty.[20]

2. the nuances of meaningful stakeholder engagement coupled with the finality of agency decisions make the decision context and ability to practice AM challenging. Stakeholders may have different goals and values, or have different expectations of decision-making processes (Akamani, 2016; Armitage et al., 2007; Craig & Ruhl, 2014; Irwin & Kennedy, 2009; Ruhl & Fischman, 2010)

3. the legal and regulatory process itself, including the ability to revisit decisions. That is to say that “two primary criticisms are that traditional legal regimes are premised on an ecological steady state within legal, not ecological boundaries, and the legal regimes are too inflexible to respond in a timely manner to environmental change” (Curran & Mascher,

[20] Sirota notes, with respect to Canadian administrative law that “decision-making processes are, in themselves, of limited value; what matters, from the perspective of good governance, is that administrative decisions be substantively sound, and not merely be reached in the right way. An administrative system that somehow managed to follow proper processes and yet to reach consistently perverse conclusions — unlikely though the idea seems — would not be anyone’s idea of good administration” (Sirota, 2018: 292). This necessarily implies consistency of the outcomes derived from the process.

2016:187). (Cosens et al., 2020; Craig & Ruhl, 2014; Kwasniak, 2009); and,

4. lack of explicit definition or delineation of what is expected from regulated parties or what compliance looks like can result in significant regulatory uncertainty and impact compliance and performance (Olszynski, 2017; Winter et al., 2019)

Regulatory certainty is an issue of key importance. In the Alberta context, the University of Calgary's School of Public Policy published an article entitled "The Importance of Certainty and Stability in Regulatory Processes" (2015, online) which notes: "… consider the needs that the companies being regulated have of a regulatory system…If there is one need that I have heard expressed by companies and their associations much more often than any other over more than 40 years, it is the need for the system to have certainty and stability. Although the companies have a long list of needs, the importance of the need for certainty and stability seems to be so important that I have heard companies say, "While we may not like a particular regulation or process, tell us clearly what the requirements are and we will meet them". The companies' need for certainty appears to stem largely from the desire to be able to plan and respond effectively."

In addition to the challenges identified in the literature, surveys of practitioners working to implement AM in the field have confirmed that the regulatory regimes under which they operate pose legal and institutional constraints for AM (Benson & Stone, 2013). These problems form the basis of the investigation into the policies adopted by Alberta and B.C. governments (Chapter 4) and the legislative and regulatory frameworks that implement them (Chapters 5 and 6).

2.2.5. Indigenous and Traditional Ecological Knowledge and Environmental Management

Much of the AM literature fails to acknowledge that across Canada there are also Indigenous nations who possess their own governments, who have Constitutionally afforded rights and title to their traditional lands, many of which were never ceded to colonial powers, particularly in B.C. Because the energy development activities discussed in this dissertation are almost exclusively overlaid by Indigenous territory (predominantly Treaty 8, in this case), discussing the role and inclusion of traditional

ecological knowledge (TEK) within the context of environmental management is both timely and potentially an often-ignored Constitutional requirement. It is important to note that natural resources and environmental law is inherently colonial in nature, as is all Canadian law. As such, the policy and regulatory frameworks examined by my dissertation largely fail to meaningfully integrate Indigenous peoples into environmental governance. This is a significant problem given that section 35 of the Canadian Constitution recognizes and affirms the existing rights of Indigenous peoples and requires that there be consultation alongside provincial policy and laws.

In 2015, The Truth and Reconciliation Commission of Canada (TRC) concluded their review of the experiences of the survivors of residential schools, including their families and communities and issued 94 calls to action. This included specific calls for all levels of governments to adopt and implement the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) which includes mechanisms for shared decision-making between the provincial government and Indigenous governments. There are a number of Articles in the UNDRIP that could be relevant in resource development contexts, such as Article 29 which states that: “1) Indigenous peoples have the right to the conservation and protection of the environment and the productive capacity of their lands or territories and resources. States shall establish and implement assistance programmes for Indigenous peoples for such conservation and protection, without discrimination. 2) States shall take effective measures to ensure that no storage or disposal of hazardous materials shall take place in the lands or territories of Indigenous peoples without their free, prior and informed consent” (UNDRIP, 2007: Article 29). The articles of UNDRIP have broad application and raise questions about the implications for resource development contexts; moreover, in 2019, the B.C. government committed to implementing UNDRIP and enacted the Declaration on the Rights of Indigenous Peoples Act that requires BC law to be brought into consistency with UNDRIP. Since then, the government has released a 2022-2027 “Declaration on the Rights of Indigenous Peoples Act Action Plan.” Theme 2 of the plan, which deals with title and rights, including the rights to develop and control lands and resources within their territories, is of particular interest given the recent Yahey decision (discussed later in this section).

In many AM cases, management goals and values differ considerably between First Nations, Indigenous, Metis, and Inuit, and other parties (Owens, 2009). Nyberg

(1998) highlights the importance of integrating scientific data and evidence within the AM cycle, but it is critical to note that it is local resource users and managers who must share ownership over processes, values, and objectives. The Federal government began to acknowledge this issue through the environmental assessment (Bill C-69) review process (2018 and 2019) which considered an expanded role for stakeholders in general, but especially for First Nations and Traditional Ecological Knowledge (TEK). Currently science and technology, and their processes, are primarily understood and applied through a male-dominated Western worldview. Meaningfully changing that reality requires a significant paradigm shift. Failing to adequately integrate local expertise in major project decisions in Alberta and B.C. has frequently been the source of frustration for affected parties who feel shut out of the process or included as an afterthought or a 'checkbox' exercise.

Cosens et al. (2020) highlighted the importance of having multiple perspectives and local knowledge included in governance structures engaged in complex problem solving. My study, and other, indicate that while there are some references to stakeholder involvement, collaborative planning, and, to a lesser degree, involvement of Indigenous peoples and traditional knowledge at the policy level, the policies themselves and ensuing practice could likely go much farther in order to be congruent with section 35 of the Constitution. To that end, in 2021, the Blueberry River First Nation, whose traditional territory is over the Montney gas basin, won a landmark court case against the Province of British Columbia (*Yahey v. British Columbia,* 2021 BCSC 1287) where they successfully argued that "the cumulative effects of industrial development have had significant adverse impacts on the meaningful exercise of their treaty rights, breached the Treaty, and infringed their rights" (Yahey v. B.C. at para. 2). This decision is important for three reasons: 1) the Courts agreed with Blueberry River First Nation that the regulatory framework for oil and gas development is inadequate for considering treaty rights (paras 1195-1208). 2. The decision highlights the inadequacy of the regulatory framework in considering cumulative effects. Blueberry River argued that B.C.'s cumulative effects (CE) Framework is "fundamentally flawed as it does not set thresholds, alter existing decision-making processes [a critical component of AM], or create any new legal requirements" (para. 1619). This is an important concept, particularly since the CE Framework refers to "components," "benchmarks," "indicators," and "objectives" like many of the AM policies and proponent plans that are observed in

Alberta and B.C. This decision seems to indicate that perhaps indicators and objectives are not enough, particularly for something so complex as CE. Finally, 3) Justice Burke makes a point of making the ruling accessible. She notes that there are “acronyms that are typically used by the participants in the forestry, oil and gas and other natural resource industries, as well as in government… The persistent use of acronyms creates a closed community in which others cannot easily participate. It impedes understanding and impacts on communication with others outside these communities” (paras. 7, 8). This case makes it clear that Indigenous peoples may be doubly disadvantaged when operating in a regulatory system designed to prioritize development over treaty rights, while also speaking a language that they do not understand.

Additionally, Indigenous groups in Alberta have raised concerns about the lack of inclusion in AM. The Fort McKay Métis Community Association (FMMCA) expressed concerns that there are limited opportunities to be engaged on tailings research and planning. Specifically, they noted “that there is currently no engagement of Métis and other aboriginal groups on tailings and reclamation research and feels it is essential to be engaged in a meaningful way in research and reclamation planning. FMMCA also noted Suncor did not provide discussion on involving FMMCA in aquatic monitoring plans for [dedicated waste disposal area] DDA3 or on what types of active management will be implemented during the pit lake filling period (AER 20171025A, para. 35). Moreover, the Fort McKay First Nation has critiqued the approach the frameworks developed under LARP. It is their view that “the division of the management frameworks into media-specific guidelines [i.e., groundwater, surface water quality and surface water quantity are addressed under different frameworks] will create a major gap in the management of cumulative effects and the protection of Fort McKay’s Constitutional rights. The narrow focus on the Athabasca River leaves gaps for culturally important tributaries and lakes. Furthermore, the groundwater framework does not fully address groundwater-surface water interactions, and there is no framework linking land disturbance to water quality or quantity.” (Fort McKay First Nation, 2015: 58). The Athabasca Chipewyan First Nation (ACFN) has also submitted criticism to the AER on the engagement of Indigenous peoples and “raised concerns with its limited ability to be included in the planning, monitoring, research, follow-up, and adaptive management of tailings and that there was a lack of consultation with the community on the aquatic closure of DDA3. ACFN also noted a need for greater transparency and access to

information, and that there was no discussion on involving the ACFN in aquatic monitoring plans for DDA3 or on what types of active management will be implemented during the pit lake filling period" (AER 20171025A, para. 36). If the experience of the Blueberry River First Nation, FMMCA and Athabasca Chipewyan First Nation are taken to be representative of the inclusion of Indigenous peoples in energy development, it appears that significant change is needed in how natural resources are regulated in treaty lands.

There is academic work that finds traditional knowledge can be compatible, or even beneficial, for enhancing scientific knowledge. Academic research provides many examples of TEK enhancing research programs by serving as an important baseline for data, or by helping to generate new insights and hypotheses (Gagnon & Berteaux, 2009; Rist et al., 2010); moreover, some researchers have done extensive work on TEK as being a beneficial form of AM (Berkes et al., 2000; Dudgeon & Berkes, 2003; Whyte, 2013). Also, there are case studies where Indigenous management practices and TEK have been used as part of adaptive co-management to greatly improve AM outcomes. See Armitage et al., 2009, and the Indigenous-led approaches to the Great Bear Rainforest on B.C.'s Pacific Coast, and the protection of salmon in the Broughton Archipelago off Haida Gwaii.

2.3. Conclusion

This literature review has provided an overview of what AM is and the contexts in which its use is most appropriate. Also, the literature has noted that AM is not typically fully implemented, even in cases that are considered successes. While the AM literature proposes many reasons for the implementation challenges observed, this research focuses on the disconnect between AM""in practice and AM in law" described by Ruhl (2008). As noted by Susskind and Secunda (1999): "Indeed, because administrative law drives agencies toward finality, that body of law has little place for continual agency experimentation and adaptation, as adaptive management requires." Subsequent chapters of this dissertation describe how I have tested that conclusion in Alberta and B.C.

Chapter 3.

Content Analysis Methodology and Rubric

The primary methodology I used to examine the energy-water-environmental policy and regulatory framework in Alberta and British Columbia (B.C.) is qualitative and quantitative content analysis. Content analyses, generally, provide a systematic and objective research technique for extracting data, and/or descriptions of subject matter from a wide variety of media that has ranged from written documents such as court case decisions to Saturday morning cartoons (Altheide, 1987; Krippendorff, 2004). Shapiro and Markoff (1997) propose an encompassing definition of content analysis that is widely accepted across the social sciences: “any methodological measurement applied to text (or other symbolic materials) for social science purposes” (Shapiro & Markoff, 1997: 14). Quantitative content analyses count or measure the presence of certain concepts and the “units of space” that they inhabit a means to produce objective, repeatable, measurable results deemed “reliable” or “valid.” (Altheide, 1987). Higher frequencies are associated with the relative importance or centrality of a concept or theme. Other researchers have noted that the field of content analysis methodology has been broadened and strengthened by adding a qualitative dimension to examine meanings, intentions, outcomes, and context – both obvious and underlying (Downe-Wamboldt, 2009; Duriau et al., 2007).

Content analysis is highly systematic but can also afford the researcher considerable flexibility (Schreier, 2013). Duriau et al. (2007) note there are numerous advantages associated with conducting content analyses comprised of qualitative and quantitative parts. For these reasons, content analysis has been successfully used across numerous applications and a wide range of disciplines (Schreier, 2013). Many of the benefits are realized in this study. First, by adopting a dual approach, I was afforded considerable analytical flexibility to combine both concept and data-driven categories. Distinct and individual concepts emerging as frequencies could be captured as statistics with an emphasis on reliability and verification of hypotheses (Altheide, 1987; Duriau et al., 2007). At the same time, in this study, I was able to discover and interpret less evident patterns and deeper meanings presented in the data, allowing for discovery and verification, with an emphasis on validity (Altheide, 1987). Using both kinds of content

analysis enabled an approach that is both inductive and deductive, thereby addressing two central criticisms of the methodology: First, often content analysis is presumed to be overly reductive, particularly when relying solely on word counts, and often ignores the context in which a term within text is used, thereby missing important underlying meanings and their implications (See Colorado State University Writing Department, 2020). Second, because this study relies on publicly available documents directly connected to my research questions (e.g., policies, laws and regulations which are publicly available on government and regulator websites) and source materials it is considered nonintrusive. The use of nonintrusive documents combined with a robust coding scheme enables my research to avoid confirmation and research biases that may be inherent with other approaches that have a qualitative research component.

Duriau et al. (2007) find in their literature review that content analysis presents three significant methodological advantages: 1) the coding scheme can be corrected at any point during the study, thus making content analysis a relatively “safe” methodology, albeit potentially very time-consuming; 2) it enables replication, and therefore creates reliability and validity within the study; 3) content analysis can be complimentary to other research methods studying the same phenomenon to “triangulate” or increase the credibility of the findings. The academic literature notes that content analysis has been made increasingly easier and more cost-effective given the widespread availability of computer software providing analytic functions, data storage, word counts, and the ability to manipulate large volumes of text and raw data (Duriau et al., 2007; Wolfe et al., 1993). These capabilities have enabled the average researcher working alone to take on significantly more ambitious content analysis projects than was previously possible. Wolfe et al. (1993) showed that using computers for qualitative data analysis enabled significantly more comprehensive analyses and increased the overall strength and validity of a study.

There is no single set of rules for conducting a content analysis. However, when considering a broad cross-section of the content analysis literature, the same steps tend to emerge as being central to producing a reliable or valid research process, with equally defensible findings. I used the steps outlined by Schreier (2013) and Downe-Wamboldt (1992) to define the following research process for my study:

1. Define the research objectives and select the unit(s) of analysis.

2. Select material; create and define categories of study.
3. Build the coding frame (both concept-driven and data-driven, see Schreier, 2013).
4. Test the reliability and validity of the category definitions and rules with a trial run.
5. Evaluate and revise, if necessary.
6. Test the revised categories and/or codes to determine reliability and validity.
7. Code the entire dataset.
8. Analyze and interpret the findings.

Applying the 8-step process rigorously to this study provides a number of opportunities to increase the reliability and validity of the results. Part 1 and Part 2 employ different kinds of content analysis with varying degrees of complexity. The content analysis methodology in Part 1 is very simple: a straightforward keyword search for the term “Adaptive Management” was conducted, using MS Excel tables to sort and store data. Coding was not necessary. The content analysis methodology for Part 2 was more complex, and employed the rigorous methodology described by Schreier (2013) and Downe-Wamboldt (1992). Each section describes the methodological process in more detail, organized in sections identified by the steps. However, due to the straightforwardness of Part 1’s approach, not all the steps in the research process defined for this study were necessary. For example, it was not necessary to build a coding frame for Part 1, thus making other steps irrelevant.

3.1. Research Methods for the Content Analysis of Policies found in Chapter 4

3.1.1. Define the Research Objectives and Select the Units of Analysis

This research was guided by the following objectives:

- Examine the content of policies, legislation and regulations that make up the shale gas water and wastewater management framework in Western

Canada to evaluate their coherence, overall message, and the extent to which they enable (or hinder) the practice of AM.

- Understand the extent to which the regulatory frameworks require or enable other management models (other than AM) and the level of coherence and consistency within the design of the requirements across the broader regulatory framework.

The first unit of analysis investigated by Part 1 of this chapter was a frequency study of the term “Adaptive Management” within policies. I assumed that If AM is a tenet, objective, or central methodology cited within a policy it should follow that acts and regulations drafted to carry out the policy intent should broadly enable, and not hinder AM. Additionally, each document was read to understand the context in which AM was used. The sentence or subsection where AM occurred was used as the unit of analysis (Krippendorff, 2004).

3.1.2. Select Material and Define the Categories of Study

The scope of documents included all policies that were central to regulating the oil and gas water and wastewater management cycle (Figure 1-1) including: water acquisition; chemical mixing; water injection (multi-stage hydraulic fracturing); flowback and produced water and/or liquid oilfield waste, and treatment, disposal and/or reuse. The same policy may apply to one or more phases of the cycle. For example, invoking AM in the context of the groundwater management policy could be applicable from a water acquisition perspective (groundwater withdrawal could impact an aquifer from a ‘quantity’ perspective), while other phases of water and wastewater management are largely applicable from a water ‘quality’ perspective (a loss of containment of chemicals and wastewater could contaminate the aquifer). Moreover, a loss of containment of saline water acquired from a saline aquifer prior to chemical mixing could contaminate the local environment if a release were to happen. In addition to considering energy development and water and wastewater policies, land use and environmental policies were also considered in the scope of the analysis. Part 2 illustrates in more detail how water management activities in energy development are governed by overlapping acts and regulations and may require multiple licences and approvals for the same activity, thus falling under overlapping policy frameworks.

Policies were identified by searching government websites and specific ministries for publications in the public domain that belonged to the policy frameworks described in Table 3-1 and generally conformed to the description of "policy" provided in the introduction to this chapter. Some ministries and department webpages contained links to documents specifically called "policies." Any policy that loosely fit the criteria presented in Table 1. For example, all related documents under the "Water Planning and Strategies" section on the B.C. Environmental Protection and Sustainability website were collected given their likelihood of being relevant to one or more phases of shale gas water management. However, *The Wildlife Policy* under B.C.'s Environmental Guidance and Policy, for example, was not selected. There are components of the wildlife, biodiversity and forestry policies in both provinces that may be occasionally or incidentally relevant to the scope of research conducted by Part 1 of the analysis; however, the pertinent parts of the overlapping objectives are duplicated across other environmental management, water, and energy related policies. Moreover, the scope of research is to investigate if AM is leveraged in the context of water or wastewater management related to oil and gas extraction, not forestry or wildlife. Policies were subdivided into those that are foundational and those that are supplementary to foundational policies. Some archived and out-of-date policies were included if they were in force from 1995-2010 as they were likely to coincide with the shale gas boom of the mid 2000s and provide important policy direction as the shale gas industry developed.

Jurisdictions do not always have clearly articulated policy frameworks for certain activities or publicly governed priority areas. For example, Alberta and B.C have not always had a distinctly enumerated energy policy since energy resource extraction has been central to economic development for over one hundred years. In Western Canadian provinces, energy policy has tended to be a priority reaffirmed in myriad government publications and statements such as budgets, Throne Speeches, mandate letters to Ministers,[21] and legislative proceedings over the course of many years. In such jurisdictions, associated laws and regulations have often followed the lead of policy, albeit reactively, to manage environmental and social externalities, and maximize potential of the resource. Delving into decades of government documents (e.g., budgets,

[21] While mandate letters to Ministers can signal important policy positions, and changes in policy positions where new mandate letters are issued, they are typically too high-level to be considered useful to the level of detail and context explored here.

Alberta Legislative Assembly Hansard transcripts) to investigate the history of energy policy was beyond the scope of this dissertation; however, the author notes that such an analysis would be an interesting contribution to Canadian policy studies.

The review for Alberta utilized the Alberta Responsible Energy Policy System (AREPS), which contains links to all policies and strategies for energy development in Alberta as well as searching the Ministry webpages belonging to Energy, and Environment and Parks (AEP).[22] Alberta's Land Use Framework (LUF) provides for seven regional plans to be completed and implemented to balance economic growth through land and resource development with environmental stewardship (AEP, 2016). At the time of writing, the regional plans under the LUF are not complete for any of the regions currently extracting shale gas. In their place, the Lower Athabasca Regional Plan (LARP) and the South Saskatchewan Regional Plan (SSRP) (the only plans that have been completed) were used as proxies for what could be reasonably expected in the Lower Peace, North Saskatchewan, Upper Athabasca, and Upper Peace regions with respect to the presence or absence of AM as a strategy.

The list of policies collected and analyzed are listed in Appendix B.

3.1.3. Coding Rubric and Sample Rules for Chapter 4

Sixty-two policies were selected for evaluation – 34 from B.C. and 28 from Alberta (Appendix B). The policies selected encompass a range of foundational and supplementary policies belonging to the broad range of policy frameworks mentioned in Table 4-1 (Oil and Gas Water Management Policy Frameworks in Chapter 4). The foundational policies include provincial-level direction on energy, environmental management and water management that are important to one or more phases within the cycle of shale gas water and wastewater management (Table 4-1 and Figure 1-1). Supplementary policies include provincial as well as regional directions relevant to the shale gas context. Land and resource management plans (LRMPs), pertaining to areas where oil and gas are currently extracted in B.C., were assessed. LRMPs have not been developed for the shale gas producing regions in Alberta; therefore, the evaluation used existing LRMPs as proxies for content. The policies are a mix of those considered to be

[22] Now called Alberta Environment and Protected Areas (AEPA).

foundational ("policy frameworks") and those considered to be supplementary to the policy frameworks ("policies"). This paper examined 9 foundational and 25 supplementary policies for B.C. (34 total), and 14 foundational and 14 supplementary policies for Alberta (28 total) that are relevant to the scope of this investigation.

The evaluation considered only the term "Adaptive Management (AM)." Other terms, regardless how close, were excluded. The policies were analyzed to determine if the six phases of AM – Define, Design, Implement, Monitor, Evaluate and Revise–- (Figure 2-1) were individually present (see Appendix A for a more detailed overview of each step in the AM cycle). The full table of rubric rules is found in Table 3-1. Depending on the wording of the subsection it is possible for AM to be invoked in overlapping categories (for example, a reference to monitoring and evaluation would correspond with steps 4 and 5 of the AM cycle in Figure 2-1). The analysis did not indicate the number of hits of AM, but rather the different ways in which AM is used within the documents.

Table 3-1 presents the evaluation rubric used in this analysis and the abbreviations found along the X-axis of the figures found in Chapter 4.

Table 3-1 Evaluation Rubric for Chapter 4

Assessment Category	Description
Foundational or Supplementary policy (F or S)	Specifies whether the policy document is foundational or supplementary.
Gen.	AM is used as a general strategy or objective, with few or no additional descriptive details or requirements. This includes references to "learning by doing," or reducing uncertainty (and related concepts) using AM, without providing details that would situate the reference within one of the AM steps. Note that policies can use AM as a general strategy in one subsection and provide a specific reference in another.
Definition	The subsection includes a definition of what AM is/what it entails.
Figure	A process map or figure of the AM cycle or steps is provided.
S1: Assess/ Define	Evidence of Step 1 of the AM cycle: Assess and define the problem including: stating management goals and objectives; identify alternative options; build conceptual models, and articulating hypotheses. See Appendix A.

Assessment Category	Description
S2: Design	Evidence of Step 2 of the AM cycle: Design including: Developing data management, monitoring and AM Plans, using active AM and considering next steps under alternative scenarios. See Appendix A. Does not include general references to creating plans (i.e., "action plan").
S4: Monitor	Evidence of Step 4 of the AM Cycle: Monitoring and Data collection including both baseline and effectiveness monitoring. See Appendix A. Monitoring is used in a passive sense, rather than being tied to an explicit purpose for the results of the monitoring or using data to adjust actions (see step 6R, below).
S5: Evaluate	Evidence of Step 5 of the AM Cycle: Evaluation of Results including monitoring results are compared against assumptions, objectives, and uncertainties, and validity of the results is evaluated. See Appendix A.
S6C: Communicate	(Step 6: Communicate) Evidence of Step 6 of the AM Cycle: Revise, where the results of AM will be communicated to decision-makers as well as stakeholders and the public (where appropriate). See Appendix A.
S6R: Revise	(Step 6: Revise) Evidence of Step 6 of the AM Cycle: Revise, where the results of AM are used to revise, adjust, or update existing plans and management strategies. Indicates that meaningful learning occurred. See Appendix A.
CEM	Used in the context where AM is used to mitigate or address cumulative effects management (CEM)
WMP	AM is specifically used in the context of a water management/use plan for maintaining water quality objectives, water quantity objectives, or both. Water quality/quantity may also be used as "catch-all" phrases for priorities such as: high quality drinking water supply; healthy aquatic ecosystems; reliable supply for economic development; etc. A WMP is distinct from an AMP, but the two may share common elements.
MG	Mitigation in a general sense, or mitigation measures. Adaptive management is used as a strategy for mitigating localized environmental impacts (other than CE).
SE	Stakeholders and stakeholder engagement are specifically mentioned as part of AM.
ITEK	Adaptive management is used in conjunction with Indigenous and traditional ecological knowledge (TEK).

3.2. Research Methods for the Legislative Content Analysis found in Chapters 5 and 6

3.2.1. Define the Research Objectives and Select the Units of Analysis

In addition to identifying where policies, acts, and regulations specifically require AM, I developed a list of AM-related key terms and concepts (including antonyms) from the literature review, that included breaking the 6-step AM cycle into related terms and

concepts. Looking at broad AM terms as well as the presence (or absence) of discreet components of the AM process enabled me to determine where and how AM is being used and implemented, and if there are breakdowns that happen at certain points within the cycle. Extending the analysis to include terms beyond only “AM” enabled me to avoid some of the problems identified by other key studies in the AM field. For example, Olszynski’s (2016) content analysis of the use of the term “Adaptive Management” within permits, approvals, and licences issued in Alberta under the *Environmental Protection and Enhancement Act* and the *Water Act* was critiqued on the basis that AM might be identified as a resource management strategy, but the prescribed activities carried out as part of AM might be called something else; moreover, the study was limited to statutory law and did not consider that AM could serve as a concept within the architecture of the environmental management framework. By casting a broad net to capture AM-like activities, concepts, and qualities under other terminology my approach is more inclusive of actions that could broadly be construed as AM.

I found that in addition to themes that can be identified within the context of a policy or law that may serve to facilitate or inhibit AM, the kind of law or regulation also may serve to facilitate or inhibit the practice of AM. For example, numerous authors have noted that AM requires a certain kind of flexibility that most legislative and regulatory frameworks do not provide for (Kwasniak, 2010; Craig & Ruhl, 2014). For this reason, the content analysis employed in Chapters 5 and 6 investigates what kind of regulatory model(s) an act or regulation is made of, as evaluating the “regulatory make-up” of the law in question may serve to identify opportunities where AM could be applied, or where regulatory modernization, or increased flexibility may be warranted. The mapping exercise also serves the research objective by identifying where legislation is inconsistent within itself or with other parts of the regulatory framework.

3.3. Coding Rubric and Sample Rules for Chapters 5 and 6

When developing my approach to coding the legislation and underlying regulations, I applied the principles of statutory interpretation to determine how the instrument could be understood in relation to AM. First, I read each act or regulation in its entirety, focusing on a plain language understanding of the text and its literal meaning. The coding schemes (described in subsequent subsections) enabled me to identify and interpret the applicability of different subsections in relation to my research

questions and also in relation to other legislative and regulatory instruments in the sample. Additionally, I examined latent meanings, and underlying purposes of the act or regulation by considering the overarching policy framework and other regulatory instruments.

Finally, in Chapter 7 I apply the same methodology described here to a theoretical Act. Given the large body of research that has identified the challenges inherent with implementing AM in administrative law regimes, Robin Craig and J.B. Ruhl, two American professors of law, have designed a theoretical "Model Adaptive Management Procedure Act" (MAMPA) that attempts to resolve some of the problems observed with legal and regulatory implementation of AM while still working in the administrative law framework. In their words, the MAMPA "represents the first effort in adaptive management theory to go beyond complaining about the handcuffs imposed by administrative law and suggest a solution" (Craig & Ruhl, 2014: 14). In Chapter 7 I conduct a comparative analysis of the legislation and draw conclusions that inform my recommendations in Chapter 8.

3.3.1. Regulatory Coding

There were two main categories of coding: "Regulatory" and "Adaptive Management." The Regulatory category was designed to capture the regulatory makeup of entire Acts, Rules, Regulations and Directives to explore the likelihood of the regulatory makeup being suited for implementing robust AM. The Regulatory category was subdivided into the subcodes described in Table 3-2. Legislative and Regulatory instruments were evaluated at the subsection level. 4275 discrete subsections were analyzed for Chapter 5 (Alberta) and 2775 subsections were analyzed for Chapter 6 (British Columbia) The table categories provide the code ascribed to a subsection, denoting what kind of regulation it is and the regulatory category it falls under (e.g., "prescriptive/command-and-control" regulations or "performance-based").

The analysis discovered a small number of regulations that belonged to multiple categories. For example, it was not uncommon for regulatory instruments to include lists of prescriptive requirements as well as a performance expectation. Separate categories capturing the multi-faceted nature of these regulations were created and are included in the statistics and ensuing discussions within Chapters 5 and 6. Table 3-2 also shows an

“other” category. While initially intended to capture regulations that very infrequently appeared within instruments, this category almost exclusively represents the proportion of regulatory instruments that has been repealed or redacted.

Table 3-2 Evaluation Rubric for Chapters 5 and 6

Code	Regulatory Category	Definition
P: Gen P	General Prescriptive	A class of regulations that relies on specifically enumerated permissions, prohibitions, actions that must be taken/not taken, standards that must be met and enforcement action for non-compliance.
P: Tech	Prescriptive: Tech or Design	Subsection prescribes a specific technology, methodology or design requirement which cannot be deviated from.
P: PB	Performance or outcome-based regulation	Subsection specifies an outcome or "ends" that must be achieved. This category includes thresholds, rates, quantities and/or concentrations. Methods or actions to achieve compliance may be left up to the regulated party.
P: OBR	General duty clause	A kind of performance-based regulation where the standard, or outcome, is loosely specified, enabling the regulated party to determine what actions will achieve compliance.
C: F	Coercive: Fine or Penalty	Monetary fines are levied in the event of non-compliance. Most fines and penalties are situated within prescriptive or command-and-control regulatory models.
C: Tax	Coercive: Tax[23]	Regulated parties can decide how they respond to a given price signal or tax – they may choose to pay a higher penalty or modify behaviour accordingly. In the event they choose the latter, they are also able to exert control over the type of behaviour modification(s) employed to achieve the outcome (see Gunningham & Grabosky, 1998). Coercive economic regulatory instruments often take the form of incentives, tradeable credits, or other mechanisms to enhance economic efficiency.
Info	Information	Subsection provides information, background, context, or reasoning behind the content of the regulatory instrument.

[23] Given the results of the coding exercise, both coercive categories (fines and penalties, and taxes) were combined into a single "economic" category for the purposes of discussion in Chapters 5 and 6. In Alberta, the AER does not have the power under the Acts to apply incentives, subsidies, credits (including markets to trade credits) or other market-based approaches (other than administrative fees, fines or levies), see Environmental Protection and Enhancement Act section 13. To simplify the results, all economic-type regulatory instruments have been combined.

Code	Regulatory Category	Definition
Ex.	Exemption	The Minister or Regulator may exempt certain activities or infrastructure from regulations under certain circumstances.
Amend	Amendments to authorizations	Authorizes certain offices and individuals to make changes to authorizations or permits under certain circumstances.
Waive	Waivers	Subsection grants or enumerates the authority to grant waivers or vary terms and conditions of authorizations.
O/BP	Optional or Best Practice	Subsection provides recommendations for optional actions on the part of industry or identifies non-mandatory best practices.
Other–- R		Used, in this case, to illustrate a placeholder for a section of an Act or regulation that has been repealed, but the section number remains in the text.

3.3.2. Adaptive Management Coding

The Adaptive Management categories looked for the presence of the AM cycle, or components thereof. For example, numerous subsections refer to monitoring programs, which were flagged as a singular hit for the monitoring phase of AM. Other sections, particularly the preambles and “Purpose of Act” sections in laws could be construed as potentially supporting full-cycle AM. Finally, a third AM analysis section was included for concepts that were AM-constraining or would cause problems for AM implementation. Codes were ascribed to entire subsections after evaluation to ensure that discreet concepts were captured, and double counting did not occur. This avoided the challenges inherent with word frequency searches. For example, Directive 058 makes 172 references to “monitor/ing,” 16 references to “inspect” and variations, 1 reference to “observation,” and 91 references to “assess/ment.” Despite the high frequency of monitoring-related words, only 41 subsections were coded as the kind of “monitoring” that would fit the criteria established in this chapter. The predominant reason for this was the frequency of the same words within sections; thus, the idea was counted once rather than the words to avoid double-counting.

The coding exercise considered terms that were directly relevant to each of the AM steps in the 6-step cycle. Additionally, synonyms and related terms that could apply to the elements in each step (see Appendix A) were also captured. For example, in considering whether a particular section of text could support Step 1: Assess and define the problem, I would have noted that any requirements or guidance to state management goals and objectives, explore alternative actions and/or options, build models, articulate hypotheses, involve scientists or stakeholders, etc., would also broadly support AM Step 1, as defined in the academic literature. Expanding the scope of my search terms enabled my study to capture a broader range of activities than might have been captured with solely focusing on AM.

3.4. Limitations of the Study

Using both qualitative and quantitative content analysis enabled an approach that is both inductive and deductive, thereby addressing two central criticisms of the methodology: Often content analysis, particularly quantitative content analysis, is

presumed to be overly reductive, particularly when relying solely on word counts, and often ignores the context in which a term within text is used, thereby missing important underlying meanings and their implications (Colorado State University Writing Department, 2020; Graneheim et al., 2017; Schreier, 2013). Observing my sample enabled me to generalize based on what I saw in the text; however, my research is not able to make conclusions about the functioning of environmental management regimes in general. Nevertheless, the conclusions drawn from this study may produce hypotheses that would be worth testing in other jurisdictions or regulatory contexts.

Second, as noted in section 3.1.2, because this study relies on publicly available documents and source materials, it is considered nonintrusive; thus, the research is less prone to validity issues arising from researcher biases transferring to participants or selection biases in recruiting participants for interviews or surveys. However, it should be noted that nonintrusive approaches are not a failsafe if the key terms selected support a confirmation bias. In addition to reducing potential issues with bias, using a publicly available data set enabled significant stability and continuity of access to the data. A limitation encountered in this study was determining to what extent the dataset was complete. It is possible that relevant policy or regulatory documents may be outdated and therefore not available online or via archives, and older documents are typically not ‘searchable’. As such, it is possible that I may have missed a term or important contextual data point while I was reading the text and was unable to cross-reference later with the ‘find’ tool. This study represents a contemporary snapshot in time. Moreover, governments and regulatory agencies must ensure that their guidance and requirements are easy to find by their stakeholders. Therefore, the documents most relevant to my study, and its conclusions, are widely available on the web.

Another significant limitation of my study was that I did not conduct interviews or consult with stakeholders, or AM experts and practitioners. In the initial phases of my research, I conducted scoping interviews with a small subset of experts to determine the relevance of my study and research questions. My original intent was to pursue a research approach based on a survey methodology like the one conducted by Benson & Stone (2013) and supplemented by interviews with practitioners (regulators, government policymakers, consultants, and employees of companies who have an AM strategy), and academics. However, I had significant difficulties contacting and accessing the practitioners who are implementing AM in Alberta and B.C. Given that my sample size

would not have been large enough from which to draw robust conclusions, I pivoted to using the content analysis methodology on publicly available documents. It is very likely that some of the operational AM approaches are internal to the agencies and entities that are involved in implementing AM, particularly with respect to field-level practitioners and are thus not available in the public domain. As such, my dissertation presents the first step in a research process that would be significantly strengthened by consultation and interviews. Moreover, taking such an approach would offer a way to validate and supplement my findings and I offer this as a recommendation in my concluding chapter as an opportunity for future research.

The qualitative and qualitative content analyses were conducted between January 2019 and May 2021. Legislative and regulatory changes occurring after January 2021 for Alberta and after May 2021 for B.C. were not included in this study. Since then, some of the regulations under review (e.g., the *Pipeline Rules*, the *Oil and Gas Activities Act* and Directive 055) have been amended. Moreover, the B.C. Oil and Gas Commission has had both a name (now the B.C. Energy Regulator) and a mandate change. While there is no guarantee that the results of my study will remain relevant as policies and regulatory frameworks evolve and undergo amendments, including modernization, this study provides important insights into the extent to which AM is required by policy and, if it is, whether it can be implemented in the underlying legislative and regulatory frameworks. It would be interesting for future studies to revisit the laws and requirements that have changed and to determine if there are any applicable trends. That is, a future study could observe the extent to which an administrative law framework becomes more or less likely to become the kind of legal framework that could facilitate AM implementation over time.

Finally, it is important to note that there is not a widely accepted taxonomy for different regulatory and non-regulatory approaches in either academia or practice (Coglianese, 2017). Coglianese notes that:

> *"the field of regulation sorely lacks a clear and widely accepted conceptual taxonomy of regulatory design, which has impeded research and unfortunately has too often clouded policy judgment. Widespread variation in terminology about regulatory instruments reveals that no system yet exists by which either government officials or researchers*

> *can classify regulations by their type – performance-based or otherwise – and thus begin systematically to measure and compare the impacts associated with the selection off different instruments. Further complicating the matter, rules often come in packages, with performance standards combined together with other types of rules to impose several different types of legal obligations on specific industries or economic practices. For researchers to discover how the choice of instrument type affects the benefits and costs of regulation, they must separate out performance-based rules from other types of rules. To progress, what is needed at the outset is a clearer and more widely-accepted definition and theoretical framework about … regulation" (Coglianese, 2017: 529).*

As predicted by Coglianese's (2017) research, I experienced difficulties in developing a consistent, well-defined approach for my research that aligned with the literature. As Coglianese (2017) notes, there is no single method for such an approach. The multiple synonyms and ways of classifying regulatory approaches across the literature made evaluation and comparison challenging. For example, some academics lump all types of outcome-based regulations together (performance, thresholds, general duty clauses and outcome-based regulations), as I have done in Chapters 5 and 6, while others refer to them as being distinctly different from each other. Additionally, I needed a way to consistently classify and measure Coglianese's (2017) second problem of rules "coming in packages," which I frequently observed and tried to account for in my own research in Chapters 5 and 6 (Coglianese 2017, 529). As described in this methodology section, I have attempted to be clear about both the definitions for my units of analysis as well as how I endeavored to be consistent in counting and categorizing how they are used.

Chapter 4.

Content Analysis of Adaptive Management in Shale Gas Water Policy Frameworks in Alberta and British Columbia

In this chapter, I discuss the findings of my content analysis of AM in Alberta's and B.C.'s environmental policies that are relevant to water acquired and wastewater managed within shale gas development. The policies were analyzed to determine if the term "adaptive management" is present, as well as to study the latent meanings and context in which the term is used. The objective of this chapter is to understand the coherence and theoretical soundness (within and across policies), overall message to proponents, and requirements (if any) that pertain to AM for shale gas water and wastewater management. The analysis also considers the extent to which harmonization exists across Alberta's and B.C.'s policies, since the provinces share productive plays and formations within the Western Canadian Sedimentary Basin and a number of industry licensees have operations on both sides of the Alberta-B.C. border.

4.1. Adaptive Management in Policy Frameworks

There are two levels of policy within Canada, relevant to this study of Alberta and B.C.[24] The Treasury Board Secretariat (TBS) of Canada notes that the foundational, or policy, frameworks are architectural for all other ensuing instruments. A foundational framework is a "formal statement that provides context and broad guidance with respect to policy themes or clusters. [It] also provides the supporting structure within which specific … policies and other instruments can be understood in strategic terms…. [and] explains *why* [the Government] sets policy in [a] particular area" (TBS, 2008: section 3.3; emphasis, mine). Supplementary, or policy, instruments are "formal direction that imposes specific responsibilities on departments. Policies explain *what* deputy heads and their officials are expected to achieve" and sometimes *how* they should achieve it (TBS, 2008: section 3.3; emphasis, mine). This architecture is necessary for providing

[24] It is important to note that Indigenous governance is a third level, although there is little in terms of legislative, institutional, or regulatory regime that allows (and certainly has prevented historically) First Nations to effectively exercise their treaty and traditional rights.

context, guidance, and cohesion across broadly connected policy areas so that a government's overarching strategy can be understood.

Many policies with overlapping jurisdiction are applicable throughout the lifecycle of water and wastewater used for shale gas development (Figure 1-1; Table 4-1). Depending on the size and extent of the project's environmental assessment, energy-specific, land use and water policies and procedures may be applicable; therefore, this investigation is intentionally broad and considers policies that are directly associated with water and wastewater management as well as those that are incidentally associated. For example, I consider provincial Land Use Frameworks (LUF) within the analysis since activities and facilities associated with phases of the shale gas water management cycle are situated on public and private lands that are subject to specific legislation governing land management. This approach also addresses the historic tendency in many jurisdictions with an abundance of natural resources to view water as the "handmaiden of economic development," thus producing little in the way of water-centric policy until recently (Canada West Foundation, no date).

Table 4-1 Shale Gas Water Management Frameworks

Phase	Associated Activities	Policy Framework(s)
Water Acquisition	Water sourcing; on/off-site storage; conveyance; pre-treatment	Surface water/groundwater policy; water conservation policy; water use planning (WUPs); environmental management/protection policy; energy development policy; land use frameworks/ regional plans; wetland policy
Chemical Mixing	On-site storage	Environmental management/protection policy; energy development policy; land use frameworks/regional plans; wetland policy; hazardous materials management policy
Water Injection	Multi-stage hydraulic fracturing (MSHF); on-site storage;	Energy development policy; environmental management/protection policy
Flowback and Produced Water (i.e., Wastewater)	On/off-site storage; conveyance	Environmental management/protection policy; energy development policy; land use frameworks/regional plans; waste management policy; wetland policy
Wastewater Treatment, Disposal, and/or Reuse	On/off-site storage; conveyance; treatment; reuse/recycle; deep-well disposal	Environmental management/protection policy; energy development policy; land use frameworks/regional plans; waste management policy; wetland policy; surface water/groundwater policy; water conservation policy

Because policy frameworks generally provide overarching principles, context, and guidance for a government's strategy there is a reasonable expectation of cohesion across broadly connected policy areas. In this case, the "Policy Framework(s)" column in Table 4-1 identifies the policy categories that pertain to water used for shale gas development activities. The policies considered include those categorized as strategic policy, policy framework, program policy, government strategy, as well as the supplementary documents considered central to providing context, guidance or enabling cross-ministerial cohesion in interpreting the policy instruments.

As mentioned in Chapter 3, the Lower Athabasca Regional Plan is one of the only regional plans currently in place in Alberta. In this chapter, I have considered it as an appropriate proxy for other LUFs under development and assume that AM may be invoked in similar ways for environmental management. For that reason, some of the supplemental policies considered here are specific to mining and oil sands process affected water and tailings management, and would not be subject to all of the same legislative and regulatory frameworks as oil and natural gas.[25] However, I include them as useful examples of what one could reasonably expect policy makers to implement in other regions that are under intensive industrial development and may need comprehensive strategies for water and wastewater management, and cumulative effects.

4.2. Results and Analysis

4.2.1. Overview of Findings: Shale Gas Water Management-Related Policies in Alberta and British Columbia

The analysis found that 34 policies (55%) within the sample (n=62) made one or more references to AM. The emphasis on AM was particularly strong in Alberta where 18 out of 28 policies (64%) referred to or recommended AM as an environmental management strategy. The analysis discovered that 16 of 34 (47%) policies in B.C. made one or more references to AM; however, the significantly lower representation of

[25] For example, the *Environmental Protection and Enhancement Act* and the *Public Lands Act* broadly apply for all oil, gas, oil sands and coal activities. However, oil sands mining and other oil and gas activities are governed under separate legislative frameworks with associated rules and regulations (*Oil Sands Conservation Act* and *Oil and Gas Conservation Act*). Note that B.C.'s legislative framework is made simpler by not having bitumen reserves.

AM in water-energy-environmental policy documents in B.C. may be enhanced by important policy process documents that refer to AM.[26] Government regulators and proponents work together to support ongoing monitoring, compliance, and enforcement activities to ensure environmental sustainability" (FLNRO, 2014: 9). While AM is not specifically required, mentioning AM within process documents may have the power of suggestion for proponents who may interpret that AM is an expected component of a major project application. Similar regulatory process policies were not found for Alberta; however, the frequent appearance of AM in policy documents is likely to have a similar effect on the likelihood of AM being used in applications for major projects. Interestingly, the policies do not identify *who* is practicing AM – an agency or an industrial proponent or licensee. This could have interesting implications for what kind of AM is practiced and its likelihood of success.

Figure 4-1 illustrates several similarities and differences in how policy drafters have used AM in water-energy-environmental policies in Alberta and B.C.

Policies contain references to AM that are in the context of environmental assessment (EA). For example, the "Application Information Requirements" for project proponents supplied by the B.C. EAO requires that proponents' applications will "describe any measures to reduce uncertainty through monitoring, adaptive management or other follow-up programs" (EAO, 2016: 18). Another version of this is reiterated in the Major Projects Office's Overview of B.C.'s Regulatory Processes which states: "This [the process of authorizing major projects in the resource sector] overall strategy allows for the use of adaptive management, mitigation, as well as understanding long term cumulative effects. Although conceptually important, shale gas activities are typically not ever subject to EA.

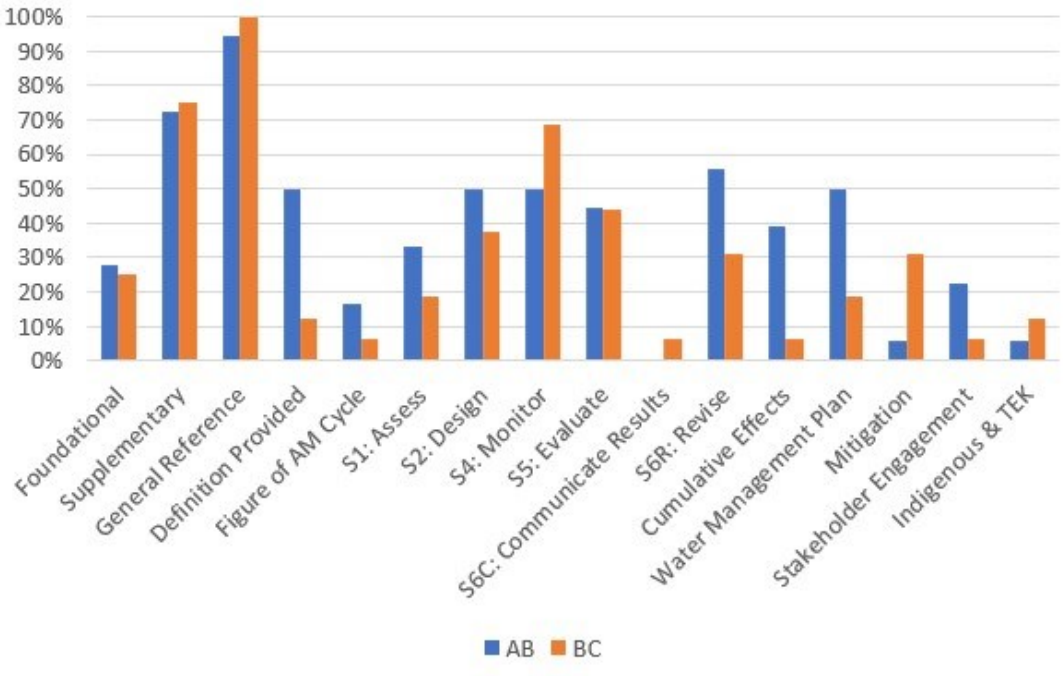

Figure 4-1 Adaptive Management Across Shale Gas Water Management Policies in Alberta and British Columbia.
Category definitions are provided in Table 3-1.

The results show an overwhelming reliance on using AM as a general strategy, as the term was present in 31 of the policies in the sample (97%). Supporting information, such as a definition or a figure, to provide additional clarity and state expectations to proponents and licensees was provided infrequently. Definitions were provided in 11 policies (32%), and figures or process diagrams were provided in 4 policies (12%) in the sample. Interestingly, when the 6-step AM cycle was broken into distinct parts, I found that the continuity of the cycle was disarticulated across environmental management policy as a framework, as well as within individual policies. As a group, the policies tend to place significant emphasis on monitoring over any other step in the AM cycle, particularly in B.C. Within the sample, monitoring was referenced 20 times (59%). Design, evaluate, and using results to revise plans and actions[27] were each referenced 15 times (44%) in the policies. Assessment and planning for AM was

[27] Revise and/or adjust hypotheses and management actions (step 6, see Appendix B) is broken into two parts to reflect the distinctness of the two actions specified within the step: Communicate findings (S6C), and Adjust/Revise (S6R). This reflects the research results which tend to include references to “revise,” but not “communicate.”

far less likely to mentioned in policy (9 times, or 26%) and communicating results was virtually non-existent (mentioned once, or 3%).

It should be noted that none of the policies contained all 6 steps (including both 6R and 6C). Removing “communicate results” from the analysis, 4 policies (12%) (all Albertan) referenced all 6 steps somewhere within the document, as being part of AM; however, the references were of a general nature and did not contain enough components of each phase in the AM cycle to be considered robust. For example, the three supplementary policies for the groundwater management framework (GMF) under the Lower Athabasca Regional Plan (LARP) (the Lower Athabasca Region Groundwater Management Framework Supporting Document for the Cold Lake – Beaver Area [CLBR], the Lower Athabasca Region Groundwater Management Framework Supporting Document for the North Athabasca Oil Sands Area [NAOS] and the Lower Athabasca Region Groundwater Management Framework Supporting Document for the South Athabasca Oil Sands Area [SAOS]) mention that the “Analyze [Assess] phase of the adaptive management process has been completed through background technical studies, including the compilation and assessment of monitoring data, risk mapping and numerical modeling, informing this, and other Supporting Documents” (CLBR, 2013: 26). This reference was sufficient to warrant acknowledgement of there being evidence of ‘Phase 1 of AM: Assess’ being adequately present in the policy; however, ideally assessment under AM would also include: articulating hypotheses, explicitly stating assumptions and key uncertainties, exploring alternative management actions and options, involving stakeholders, consulting with Indigenous peoples, and so on.

Despite the importance of involving stakeholders throughout the first two phases, at least, the results show that integrating Indigenous and traditional ecological knowledge (TEK), or stakeholder engagement was not strongly connected to AM in policies. Indigenous consultation and TEK was associated with AM in 3 (9%) of policies and stakeholder engagement was found in 5 (15%) of the policies that mentioned AM. This is concerning given the broad agreement within the academic literature that lack of Indigenous and stakeholder engagement is a frequently observed reason that AM fails in the field (Allen & Gunderson, 2011; Walters 1986, 1997; Wilson & Woodrow, 2009). Eight (24%) of the mentions of AM were in the context of general mitigations for cumulative effects management (CEM), and 12 (35%) of the mentions of AM were within the context of water management planning (WMP). Somewhat surprisingly, AM was not

frequently invoked in the context of general mitigation (MG) for environmental problems or surprises that may materialize in the future (present in 6 policies, or 18%, across both provinces); however, that may be evidence that policymakers tend to conflate AM with Adaptive Mitigation, or other environmental management strategies, when they invoke AM in a general sense. Some of the observations with more extensive implications for AM will be explored further in subsequent sections.

4.2.2. Foundational versus Supplementary Policies

When considered as a single data set, AM was found in 34 (~55%) of the 62 policies. AM was more than twice as likely to be found in supplementary policies than foundational policies in both Alberta and B.C. (see Figures 4-2 and 4-3. This is consistent with the TBS delineation of policy frameworks (what I call ‘‘foundational’) versus policy instruments (what I call ‘supplementary’) since AM is best described as a resource management methodology or strategy (a “what and/or how”) than an architectural feature or aspirational objective of environmental policy as a whole (a “why”). When considering the policies by province, the policies for Alberta were equally divided between foundational (14) and supplementary policies (14) (n=28). One hundred and seven (107) distinct hits for AM were found across 18 of Alberta’s policies, with 11 (~10%) found in foundational policy documents (policy frameworks) and 96 (~90%) found in supplementary policy documents (policy instruments) (see Figure 4-2). Interestingly, in Alberta, most of the steps in the AM cycle (with the exceptions of S6C) were represented in foundational policies as well as supplementary. It’s unclear as to why policy drafters saw the need for additional levels of detail in high-level policy frameworks or if there is any observed difference in how proponents implement the policy frameworks between provinces, particularly since B.C. takes a different approach.

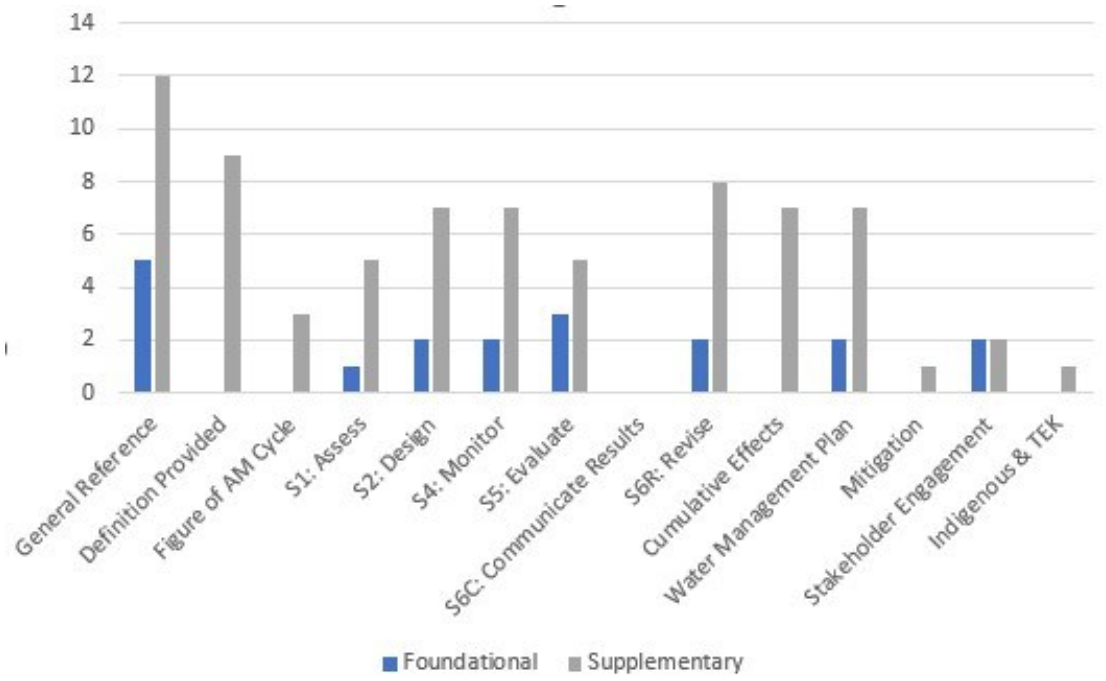

Figure 4-2 Foundational versus Supplementary Policies in Alberta

B.C.'s policies comprised 13 foundational policies and 21 supplementary policies (n=34).). Across the 34 B.C. policies, 74 distinct hits for AM were found across 16 policy documents, with 7 (~9%) found in foundational policy documents (policy frameworks) and 67 (~91%) found in supplementary policy documents (policy instruments) (see Figure 4-3). These findings further confirm that AM is most likely construed by policy drafters in B.C. as a component of how the objectives of environmental, water, and energy policies are to be realized, rather than a component of the policy architecture itself.

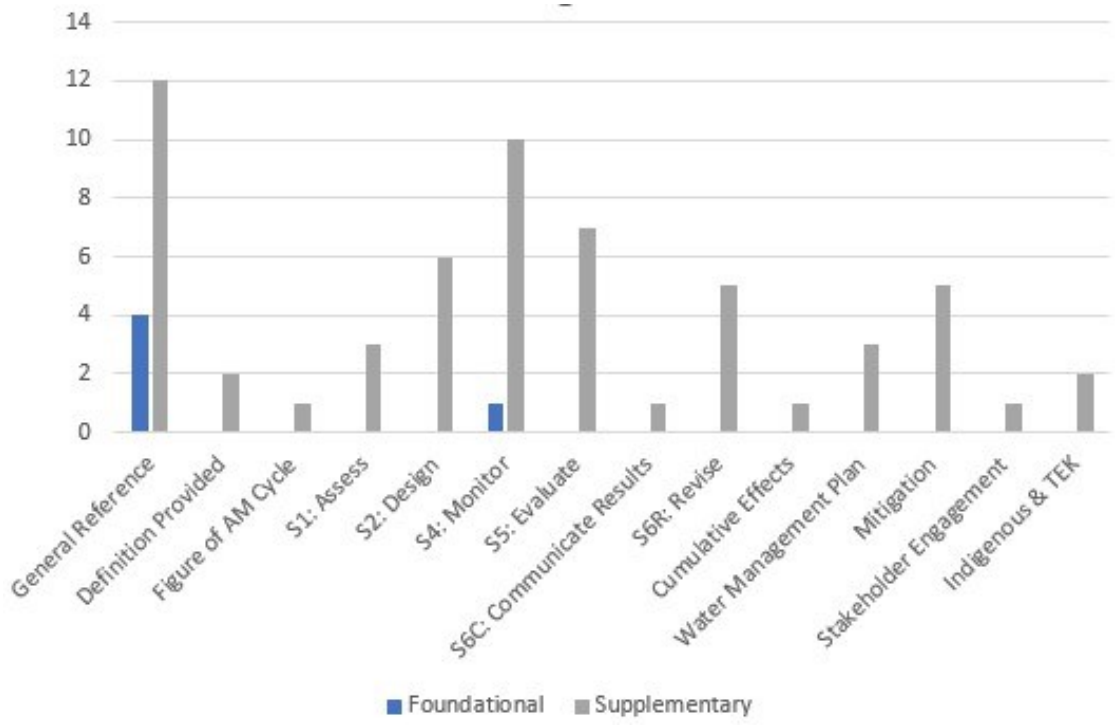

Figure 4-3 Foundational versus Supplementary Policies in British Columbia

If this selection of policies is taken to be representative of environmental policy as a whole, one could infer that AM might be present across ~64% of water-energy-environmental management policy documents in Alberta and ~47% of water-energy-environmental management policy documents in B.C. If the results are aggregated, it follows that the Western Canadian subset will have just over half (55%) of environmental policies that make one or more references to AM. Assuming that the results of this study are applicable to environmental policy in general, both governments are sending a strong message to proponents and licensees across a multitude of industries that AM is allowable, if not expected.

4.2.3. Definitions of Adaptive Management Across Shale Gas Water and Wastewater Management Policies

Defining key terms is a critical component of ensuring that there is a common understanding of rights, responsibilities and obligations levied by the policy. By providing a common understanding of what AM is, proponents and regulators have a clear and understandable description of what is to be undertaken, observed, and measured, such that different people collecting, using, and interpreting information, while adjudicating the

practice of AM as well as the results, will do so consistently. Nine definitions of AM were provided in Alberta's policies, and two definitions were found in B.C.'s policies. The data show that Alberta is significantly more likely than B.C. to include a definition of AM embedded in a policy document (9, or 50% of policies in Alberta versus 2, or 12.5%, see figure 3). Figures 4-2 and 4-3 show that, within the context of this study, definitions are found exclusively in supplementary policies.

All of Alberta's definitions prioritize learning and reducing uncertainty as a central focus, thus implying active AM is required (and the requisite elements required for robust *active AM* as construed by Appendix A) (see Table 4-3), whereas B.C.'s definitions most closely align with *passive AM* (see Table 4-4). One of the definitions provided in B.C.'s former Sustainable Resource Management Planning (SRMP) specifically notes that "SRMPs will make use of passive AM." This means that B.C.'s policies, in general, prioritize management activities and resource objectives over learning: The objectives in passive AM account explicitly for the effect of management actions on resources, but not necessarily the influence of management in reducing uncertainty. Williams (2011a&b) and Walters (1986) have identified, in passive AM, "learning is an unintended, but useful by-product of decision making" (Williams 2011b: 1350). If this is the case, as Williams (2011b) suggests, there should be more attention given to experimental design and the other elements requisite for rigorous AM as described in Appendix A and C. This distinction implies that at least some proponents, particularly those in Alberta, should be practicing active AM based on the way the term is invoked in policy.

Table 4-2 Definitions of Adaptive Management in Alberta Policies

Policy	Definition of Adaptive Management
Lower Athabasca Region Groundwater Management Framework Supporting Document for the Cold Lake – Beaver (CLBR) Area (2012); North Athabasca Oil Sands (NAOS) Area (2013); South Athabasca Oil Sands (SAOS) Area (2013)[28]	Adaptive management is defined as a structured, iterative process of optimal decision-making in the face of uncertainty with a focus on reducing uncertainty over time via system monitoring (Holling, 1978). Figure 5-1 [provided in the original documents] outlines the components of an adaptive management approach (analyze; plan; do; evaluate and adjust), and describes the corresponding activities undertaken for the development of regional groundwater management in the Lower Athabasca Region. The ANALYZE phase of the adaptive management process has been completed through background technical studies, including the compilation and assessment of monitoring data, risk mapping and numerical modeling, informing this, and other *Supporting Documents*. The PLAN phase consisted of the development of *The Framework* itself. The DO phase is currently being undertaken with the implementation of *The Framework,* and through the establishment of the NAOS monitoring network and execution of monitoring programs. The ADJUST phase will focus on refinement and finalization of threshold values, as additional experience is gained, new data is compiled and understanding of groundwater resources in the area increases. The EVALUATE phase will assess the effectiveness of the various components of *The Framework* and its overall implementation and develop strategies to incorporate outstanding groundwater issues into *The Framework*. (CLBR: 2013: 26; NAOS, 2013: 28; SAOS, 2013: 27).
Water Conservation and Allocation Guideline for Oilfield Injection (2006)	Project management that plans contingencies and actions to address uncertainty in environmental impacts, and variability in environmental conditions. Conjunctive use of surface and groundwater, and reduced water use in drought periods are examples of adaptive management of water resources (WCAGOI, 2006: Appendix F – Glossary).
Groundwater Management Framework (LARP) (2012)	It [CEM] also follows an adaptive management model, which means decision-makers learn from experience and new information, and adapt to changing social expectations and demands. Performance management, along with pollution prevention principles, is essential to providing information on environmental conditions and identifying the need for any adjustments and changes on an ongoing basis. The development of management frameworks is an important addition to accomplish this shift to a CEM system (GMF, 2012: 7).
Surface Water Quality Management Framework for the Lower Athabasca River (2012)	It [CEM] also follows an adaptive management model, which means decision-makers learn from experience and new information and adapt to changing social expectations and demands. Performance management, along with pollution prevention principles, is essential to providing information on environmental conditions and identifying the need for any adjustments and changes on an ongoing basis. The development of management frameworks is an important addition to accomplish this shift to a CEM system (SWQualMF, 2012: 8).

[28] In the interest of brevity, the 3 identical definitions provided in the CLBR, NAOS and SAOS are combined into a single table entry in row 1 of Table 4-2.

Policy	Definition of Adaptive Management
Tailings Management Framework for the Mineable Athabasca Oil Sands (2015)	It [CEM] also follows an adaptive management model, which means decision-makers learn from experience and new information, and adapt to changing social expectations and demands. Performance management, along with pollution prevention principles, is essential to providing information on environmental conditions and identifying the need for any adjustments and changes on an ongoing basis. The development of management frameworks is an important addition to accomplish this shift to a CEM system (TMF, 2015: 6).
Surface Water Quantity Management Framework for the Lower Athabasca River (2015)	The [GoA's] [CEM] system shows an adaptive management model, with decision-makers learning from experience and new information, and adapting to changing social expectations. Performance measurement is an essential element that provides information about environmental conditions and identifies the need for adjustments on an ongoing basis. As more knowledge becomes available, the framework's withdrawal limits can be adapted (SWQMF, 2015: 8).
South Saskatchewan Region Surface Water Quality Management Framework (2014) (SSRSWQMF)	It also follows an adaptive management model which means decision-makers learn from experience and new information and adapt to changing social expectations and demands. Performance management is an essential element providing information on environmental conditions and identifying the need for any adjustments and changes on an ongoing basis. The development of management frameworks is an important approach being used to accomplish the shift to a CEM system (SSRSWQMF, 2014: 5, 6).

The definition of AM in the three supporting groundwater management plans under LARP's Groundwater Management Framework (GMF) – the CLBR, NAOS and SAOS – broadly captures the phases within the 6-step AM cycle but misses some elements central to the process (Table 4-3, Row 1). The primary focus of the definition, and steps described therein, is within the context of the broader GMF and focuses almost exclusively on developing and monitoring threshold values. This narrowly construes AM activities within the context of *mitigation*, and only if thresholds are exceeded or if managing outstanding groundwater issues. There is little ability to enable system learning outside the AM triggers.

Within the GMF itself, AM is only mentioned once, in the context of a general mitigation for CE (Table 4-3). The three supporting documents for the GMF also include a figure (referenced as Figure 5-1 in the policy text) (4-4, below) that illustrates the process for AM. Although lacking in some of the detail provided in Figure 2-1 in this dissertation, Figure 4-4, provided in the policy documents provides an adequate representation of the process flow of the high-level actions required by the AM cycle.

Most importantly, it illustrates the importance of adjusting actions based on learning but neglects any emphasis on upfront design of AM actions.

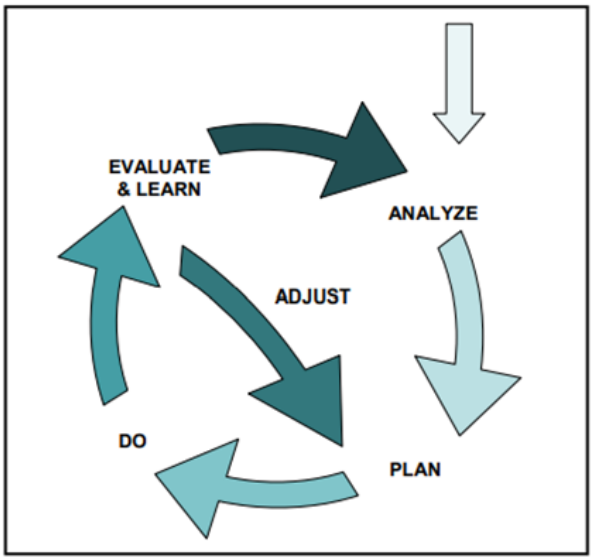

Figure 4-4 [Figure 5-1] Adaptive Management Approach for Groundwater in the Lower Athabasca Region

Figure Source: Lower Athabasca Region Groundwater Management Framework Supporting Documents for the Cold Lake – Beaver Area (CLBR), 2013: page 70.

The CLBR, NAOS, and SAOS description (GMF supporting documents), including the figure, provides the most detailed description found in the policies investigated; however, it fails to include details for some of the most important components of active AM, or their relative importance. The ‘Analyze’ and ‘Plan’ phases described in the GMF supporting documents (Table 4-3) make no mention of problem definition; management objectives; indicators of success; options; assumptions; major uncertainties; alternative hypotheses, actions to test hypotheses, or predicting outcomes based on available knowledge. The policy itself refers to involving stakeholders and Indigenous peoples in a public consultation process, but there is no indication if consultation will be at the level of “inform,” “involve,” or “collaborate.” It is unclear if there is room for AM co-management approaches described in the literature (Armitage et al., 2007). It appears that the GWF and supporting documents contain the elements that could be used to satisfy the first two phases (define and design) within AM decision-making throughout the body of the documents; however, none of the elements are specifically connected to or called AM; moreover, there is no requirement to prepare a formal AM Plan (AMP) in any of the GWF-related documents. Without specifically

connecting AM-activities to AM it unclear if the GWF will be successful in implementing AM, or if actions will resemble a less complementary management strategy, such as adaptive mitigation or contingency planning.

The remaining definition found in five of Alberta's policies is as follows: "It [Cumulative Effects Management and Management Frameworks] also follows an adaptive management model, which means decision-makers learn from experience and new information, and adapt to changing social expectations and demands" (GMF, 2012: 7; South Saskatchewan Region Surface Water Quality Management Framework, 2014: 5; Surface Water Quality Management Framework for the Lower Athabasca River, 2012: 8; TMF, 2015: 6). The definition provided, stating that an AM model "means decision-makers learn from experience and new information, and adapt to changing social expectations and demands", contains only one of the elements of AM (learning), and no guidance as to how decision-makers should learn or how what is learned will be used. Furthermore, there is no suggestion that adaptation or revisions will be driven by the results of experience and learning. Rather, social expectations and demands (and not science) will determine how the model will change. The terminology is so broad that it obfuscates how decision-makers will respond to new information and whose social expectations and demands will be prioritized in decision-making. There is no evidence of either phase 1 or 2 of the AM cycle, or an iterative phase.

Table 4-3 Definitions of Adaptive Management in British Columbia Policies

Policy	Definition of Adaptive Management
Sustainable Resource Management Planning Standards Guide (SRMP Policy) (2004 – Archived)	Adaptive management is a formal process of "learning by doing," where management practices are used to increase understanding about the impact of management on the ecological or human system being managed. At a minimum, SRMPs will make use of "passive" adaptive management, where management follows the best-known options given current knowledge, monitors outcomes, and improves planning and management based on those outcomes (SRMPSG, 2004: 24).
Technical Guidance 8: Framework for Development and Use of Freshwater Science-Based Environmental Benchmarks for Mines (2016)	Adaptive management is a systematic process for continually improving management and practices to meet objectives by learning from the outcomes of operational programs. An adaptive management cycle typically includes five steps: assessment, design, implementation, evaluation, and adjustment (Figure 1) (TG8, 2016: 8)

As previously noted in this section, B.C.'s definitions seem to favour a passive AM approach where the focus is on meeting objectives; one definition emphasizes the "learning by doing" aspect of AM, but also notes that SRMPs, at least, will make use of passive AM. Similarly, the SRMP definition relies on monitoring, but does not require other elements of the AM steps that would best facilitate a rigorous learning process. Although the SRMP Policy has been archived, the drafting date (2004) aligns with the beginning of the shale gas boom (mid/late-2000s). It would be reasonable to assume that this policy, and definition of AM therein, may have influenced proponent submissions of major projects associated with oil and gas (i.e., gas plants, water hubs, etc.) to B.C.'s EAO. Technical Guidance 8 (TG8) favours a passive approach by defining AM as a process that serves ultimate objectives, where learning is a means to an end (Table 4-5). Interestingly, the definitions provided within the policies are subdivided by province. Alberta's definitions of AM universally point to an active AM approach where the focus is on the importance of learning and reducing uncertainty.

4.2.4. Consequences of Imprecise Definitions and Key Terms

There are several predictable outcomes derived from the definitions and process diagrams discussed above. First, the lack of clear delineation of obligations, rights and responsibilities under AM means that proponents are likely to interpret AM for themselves or use it in a general sense, in the same way that the policies under investigation do. Despite the nuances in wording between provinces that either favour active or passive AM, the implications are subtle enough that regulated parties can interpret the policy, and the associated expected behaviors, in a multitude of ways. The literature abounds with examples of how vagueness and ambiguity around AM cause problems in interpretation, decision-making and evaluating compliance and appropriate enforcement regimes for AM, which is particularly problematic since regulatory frameworks are designed to provide certainty and coherence (Frolich et al., 2019; Hasselman, 2017; Kwasniak, 2010). As it has in other jurisdictions, this has the potential to create problems for Albertan and British Columbian proponents and regulators alike, since most actions undertaken invoking AM could be broadly construed as in alignment (i.e., compliant) with the intent of AM because the term has been so vaguely defined, if at all.

For proponents, the lack of regulatory certainty surrounding AM could eventually result in significant economic impacts if adjudication panels, regulatory agencies or the courts later determine that they have incorrectly interpreted their obligations. The lack of harmonization between constructs of AM on both sides of the Alberta-B.C. border can only serve to complicate the matter for proponents who have operations in both jurisdictions and may be led to believe that AM has different requirements, if any, depending on the provincial context. For example, based on the policies investigated here, one may infer that B.C. pushes proponents towards practicing passive AM, whereas Alberta pushes proponents towards active AM – two resource management practices that look very different, notwithstanding the shared name. The lack of government direction in terminology and expectations creates scenarios where there may be no enforcement mechanism to address non-compliance or poor performance where AM is implemented in a way that does not reflect AM in the literature. Enforceability of AM in policies will be addressed later in this chapter.

Second, the lack of clear definitions means that decision makers may be unable to provide consistency and continuity across regulatory applications where AM is invoked because they may also interpret the obligations and activities imposed by AM for themselves. Finally, where a policy implies that a certain kind of AM is expected (active or passive) but fails to provide the necessary detail and direction for proponents and licensees, it should be expected that the version of AM implemented will likely be one that best serves the proponent, licensee, or approval holder. It is well documented that a barrier to active AM is the high, and potentially unsustainable, costs of running experiments and research trials for the sake of learning about the ecological system in which a resource is being managed (Convertino et al., 2013; Doremus, 2010). Therefore, the prevalence of studies that have found that active AM is rarely implemented, or that passive AM has devolved into something else (e.g., adaptive monitoring or contingency planning) should not be surprising. Rather, the volume of evidence that AM is failing could be a signal that the overarching policy and regulatory frameworks under which regulated parties operate encourage poor practice of AM to persist.

4.3. Representation of the Adaptive Management Cycle Steps

4.3.1. Findings from Alberta

Alberta's results show a balanced distribution across the 6 steps of AM. The data in Figure 4-1 show that the assess or define phase was present in 6 (33%) of the policies that mention AM; the design phase was present in 9 (50%) of the policies; the monitor phase was present in 9 (50%) of the policies; the evaluate phase was present in 8 (44%) of the policies; the revise phase was present in 10 (56%) of policies. The action of communicating results under the revise phase was not present (0%) in the policies. While Alberta does not show the same over-reliance on monitoring, there continues to be the same lack of emphasis on up-front assessment, problem definition, and research design (Step 1). With respect to the remaining steps of AM, they appear within policies only about half the time. It was beyond the scope of this analysis to determine the extent to which the significant monitoring and information-gathering activities are undermined by the lack of communicating results. This may provide some indication that there may be transparency issues within the Alberta environmental management framework, and certainly that one aspect of stakeholder engagement could be improved. The lack of representation of the AM cycle phases across policies is further complicated by the weak definitions provided for AM and its steps in Alberta, thus increasing the likelihood that proponents and licensees will not have a common understanding of what different steps entail, even if they are present within a policy.

4.3.2. Findings from British Columbia

In B.C. the data show that policies tend to place an over-reliance on monitoring when compared to other phases in the AM cycle (see Figure 4-1). Across all B.C. policies included in this analysis, the early phases of AM that focus on more deliberative actions (including definition, process diagram, assess and define stage, and design stage) was less than half as likely to be mentioned as a requisite component of AM. The data in Figure 4-1 show that the assess or define phase was present in 3 (19%) of the policies that mention AM; the design phase was present in 6 (37.5%) of the policies; the monitor phase was present in 11 (69%) of the policies; the evaluate phase was present in 7 (44%) of the policies; the revise phase was present in 5 (31%) of policies. Like the

findings in Alberta's policies, the action of communicating results under the revise phase was underrepresented and found in only 1 of the policies. This finding is concerning since one of the foci of Holling's (1978) early workshops on AM was to investigate how complex findings or recommendations can be best communicated to decision-makers and stakeholders once research and analysis is complete.

Both provinces seem to place less emphasis on the define stage when compared with any other step in the AM cycle. Lack of attention to problem definition and setting objectives and performance indicators at the outset of an environmental management endeavor has been written about extensively in resource management and decision analysis literature. Among the many problems associated with inadequately prioritizing the first phase of assessing the problem and designing accordingly, decision-makers who neglect this step often find at the end of their management endeavor that they may have solved the wrong problem (Gregory et al., 2012; Raiffa, 1968). Furthermore, AM is not a suitable strategy for every problem. Careful attention at the outset of the planning phase is the point at which AM could also be ruled out as being an appropriate part of managing a particular environmental problem or impact. As I have discussed in Chapter 2, AM is best applied to problems where there is high uncertainty and resource managers are also able to tightly control the conditions to successfully use the scientific method to close knowledge gaps. This can include conducting well-scoped experiments, where appropriate. The risks posed by conducting AM must also be appropriate (see Allen and Gunderson's (2011) example of managing critically threatened populations of the California Condor as discussed in Chapter 2). Poor assessment and design further contribute to undermining AM in the field by unnecessarily increasing the costs of resource management, contributing to the numerous AM programs that fail or do not meet expectations (Allen & Gunderson, 2011).

4.3.3. Monitoring as a Central Component of Adaptive Management in Alberta

Alberta's Surface Water Quantity Management Framework (SWQMF) accounted for half (49) of all references to AM in the Alberta policies selected for this study. AM is invoked in a general sense, but also to manage cumulative effects, mitigate other issues as they become known, and serve as "AM Triggers" for a defined set of seven triggers within the context of a Water Management Plan. The AM triggers include:

- Upstream water use;
- Changes to long-term seasonal low flows in the Athabasca River;
- Changes to Oil Sands water use;
- Changes to Oil Sands water use, relative to weekly flow;
- High water use during low summer or fall flows;
- Development of ecological indicators and triggers, including:
- The Fish Sustainability Index;
- The Index of Native Fish Integrity; and the
- Preliminary Aboriginal Navigation Index (ANI) (SWQMF, 2015: 30-40).[29]

Although the triggers are specific to consumptive water use in the Oil Sands region, they are a useful proxy for any jurisdiction considering implementing triggers where there are significant water withdrawals from surface water sources that may experience seasonal pressures (i.e., droughts or floods) or competitive use from a multitude of users (e.g., agriculture, hydraulic fracturing, etc.). The framework is illustrated in Figure 4-5, below.

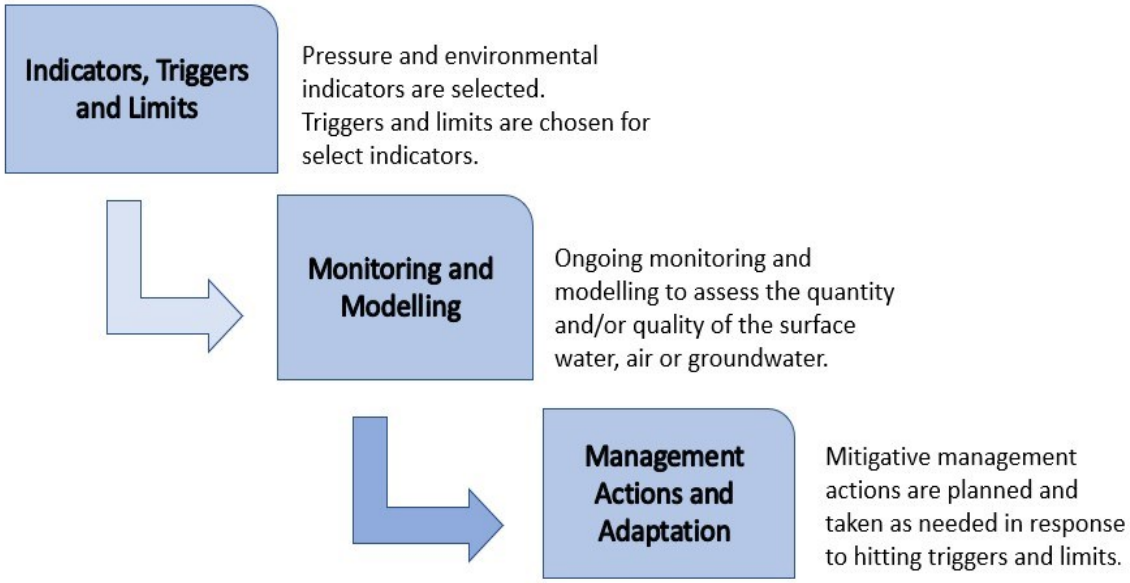

Figure 4-5 The Management Framework Approach for the Surface Water Quantity Management Framework
Figure Source: adapted from SWQMF, 2015: 8.

[29] It should be noted that the preferred term is “Indigenous” but “Aboriginal” is the terminology currently included in the SWQMF.

Figure 4-5 illustrates the central role that monitoring plays in the SWQMF. Interestingly, there is no feedback loop depicted where the results of monitoring inform the overall framework. It would appear that decision-makers may be uncertain as to the risk(s) posed to aquatic ecosystems and the Athabasca River from year-round consumptive use by the oil sands sector; therefore, “as more knowledge becomes available, the framework’s withdrawal limits can be adapted” (SWQMF, 2015: 8). Like the other Albertan policies under review, the SWQMF suggests that it will implement active AM based on the definition provided and the emphasis on system learning highlighted throughout the text; however, there are few corresponding citations that make reference to any of the other elements of active AM. Rather, the SWQMF commits to monitoring and mitigation in the event that an adverse effect becomes observable or detectable through the monitoring program.

The significant emphasis on monitoring and detecting changes in threshold values appears to be a significant opportunity to involve stakeholders and Indigenous peoples who have relevant experience directly and indirectly related to the AM triggers themselves. One of the triggers – the Preliminary ANI – specifically considers the extent to which the Athabasca River is navigable for First Nations and Métis communities throughout the year. The proposed metric was developed using academic research (see Candler et al., 2010) on the Athabasca River and through interviews with Indigenous peoples. The SWQMF (2015) notes that monitoring will be enhanced by a community-based monitoring system run by the Athabasca Chipewyan and Mikisew Cree First Nations to “facilitate enhanced understanding of the relationship between river navigability and stream flow. Through [the community-based monitoring system], community members will have the opportunity to contribute qualitative navigational and traditional activity information for the Athabasca River” (SWQMF, 2015: 39). Interestingly, Indigenous peoples are not a feature of monitoring for the other six triggers which may imply a false compartmentalization of the environment on the part of the policy. Depending on the extent to which Indigenous knowledge and monitoring are prioritized and integrated vis-à-vis the other triggers, the SWQMF could present a viable example of how TEK can be indispensable to AM. Failing to incorporate local knowledge of ecosystems has been a criticism of how AM has been implemented (Cosens et al., 2020).

There are claims that the SWQMF is equally motivated by political and scientific factors. Lee (1993) and others have provided examples of such cases where there is tension between environmental management principles and science, and the interests and complexities of practical politics and competing interest groups.[30] Critics have noted that the SWQMF is based on models that exclude several key indicators, most importantly, there was "no assessment of the capacity of the river [and associated flora and fauna] to tolerate reductions in flow" (Weber, 2014). This issue could diminish the opportunity for learning if the monitoring programs are not accurately accounting for the broader environmental system and if outside knowledge and expertise are not accepted. Furthermore, if the impetus for creating the SWQMF was both political and scientific, it is not clear that the design of the AM process and 'triggers,' as well as the ensuing management actions, would not also have dual political and scientific ends. This problem has been observed in other resource contexts where an unplanned event or a surprise occurs, but resource managers treat it as a consequence that must be suppressed (potentially at the risk of political consequences), rather than as an opportunity for learning (Allen and Gunderson, 2011; Williams and Brown, 2016). Furthermore, Allen and Gunderson (2011) have noted that politicians may use AM to give stakeholders a false sense of security that critical environmental objectives will be met. Predictably, if the intent of a policy is fragmented or bifurcated to meet conflicting objectives, and AM is also used as a vehicle to serve a political end, the potential for AM to be successfully implemented would likely be diminished.

4.3.4. Monitoring as a Central Component of Adaptive Management in British Columbia

The results, particularly in B.C., show an over-reliance on monitoring when compared with the other steps within AM. Williams et al. (2009) note that "monitoring provides data in [AM] for four key purposes: 1) To evaluate progress toward achieving objectives; 2) To determine resource status, in order to identify appropriate management actions; 3) To increase understanding of resource dynamics via the comparison of predictions against survey data; and 4) To enhance and develop models of resource

[30] Lee (1993) describes the tension between the scientific rigour required to implement an AM approach to managing declining salmon populations in the Columbia River Basin with multi-jurisdictional (international) interests in the multitude of dams required for power production in his book "Compass and Gyroscope."

dynamics as needed and appropriate" (Williams et al., 2009: 31). For the results of monitoring programs to be useful, there is a strong implication that resource managers should be working from a preliminary baseline where assumptions and uncertainties have been documented, models designed, and objectives set. In other words, monitoring programs should be a product of planning and design, with desired outcomes in mind. While there is some evidence that resource managers in Alberta and B.C. are indeed carefully designing their monitoring programs (i.e., setting clearly defined thresholds), there is less evidence that the monitoring is connected to other parts of the AM cycle. The overemphasis on monitoring has the potential to lead to ineffective monitoring, or passive monitoring for the sake of monitoring. The latter issue is particularly concerning since only 31% of policies refer to using the results of monitoring programs to revise policy and/or management actions. In other words, the value of monitoring in AM is derived from its contribution to decision-making. Not all information has value; therefore, in the interest of efficiency and effectiveness, policy in B.C. could emphasize the importance of the deliberative phases in AM.

4.4. Underrepresentation of Indigenous and Stakeholder Engagement

Neither Alberta nor B.C. strongly connects stakeholders or Indigenous involvement to AM. Only four policies (22%) in the Alberta data set and one from B.C. (6%) connect AM activities to stakeholders or stakeholder engagement (5, or 15% of the combined data set), whereas only one policy from Alberta (5.6%) and 2 polices from B.C. (12.5%) connect Indigenous peoples, TEK, or Indigenous consultation to AM activities (3, or just under 9% of the combined data set). Interestingly, the data show that the weakest representations of the AM cycle in policies are consistently those that deal with stakeholders and communication. Frameworks and processes for Indigenous consultation and stakeholder involvement exist within policy and statutory laws beyond the scope of this research; therefore, it is probable that the drafters of the policies under review here assumed that those protocols and obligations broadly belong to all policies under an overarching policy framework. However, since stakeholder engagement is frequently cited in the literature as being fundamental to AM it is perplexing that there are so few cases in the sample that deliberately make this connection. Given the provinces' Constitutional obligations towards Indigenous peoples it is surprising that

Indigenous consultation, accommodation and TEK are mentioned so infrequently. Furthermore, the AM triggers described in the LARP Surface Water Quantity Management Framework discussed in the previous section illustrate numerous missed opportunities to involve Indigenous peoples, TEK, and other relevant stakeholders in all AM activities, with reference to planning, implementation, monitoring, and evaluating the results of AM.

4.4.1. Alberta

Alberta's policies make 4 significant references to stakeholder engagement as being part of AM. All the references situate stakeholder engagement within the earliest phases of AM and give the impression that stakeholders will be an integral part of up-front planning and decision-making.

The South Saskatchewan Regional Plan (SSRP) notes that "watershed Planning and . . . stewardship groups bring key stakeholders together to *co-create* adaptive watershed management plans" (SSRP, 2018: 27, emphasis, mine). The Muskeg River Interim Management Framework (MRIMF) states that "using an AM approach, *all stakeholders should be engaged* during the development of sustainable management scenarios" (MRIMF, 2008: 47, emphasis, mine). The Water For Life Policy (2003) notes that "multi-stakeholder councils work with government in an AM cycle of basin planning and evaluation" (WFL, 2003: 17) which is elaborated on by the framework supporting documents where "the Government of Alberta will provide support . . . in exchange for the Council's commitment to a watershed approach and the *principles of inclusiveness and consensus-based decision-making*. Councils, with government and other stakeholders/partners, will follow an adaptive management cycle that includes *developing, implementing, assessing, and updating a watershed management plan* . . ." (Enabling Partnerships, 2005: 11, emphasis, mine). The focus on cooperation and inclusiveness in the references reflects an observation made by practitioners in the 1990s who saw that disengaged stakeholders were undermining the success of AM, leading to a widespread attempt to improve the process by blending AM with collaborative management approaches (Gunderson et al., 1995). The literature has highlighted several challenges with taking a collaborative approach. In particular, the results of collaborative AM may be disregarded by government decision-makers; processes may enfranchise some stakeholders, but not all; the ability to conduct AM

experiments may be limited; and disagreements and lack of consensus may undermine the clarity of AM objectives (Allen & Gunderson, 2011; Lee, 1993; Susskind et al., 2010).

Interestingly, Indigenous engagement or collaboration with First Nations is mentioned throughout the policy but is not overtly connected to AM or any of the other collaborative involvement activities (italicized, above); moreover, it does not appear that watershed stewardship groups are obliged to include members of local First Nations. If this is intentional and signals a diminished role for Indigenous people in the deliberative phase of AM, it is further exacerbated by the lack of references to Indigenous engagement or TEK in AM across energy and water policy. The one Albertan policy document mentioning Indigenous peoples' states that: "Alberta Environment and Fisheries and Oceans Canada believe that the phased, adaptive management approach presented in this framework is consistent with the Regional Sustainable Development Strategy for the Athabasca Oil Sands (RSDS):

> *The RSDS provides a framework for balancing development with environmental protection… First Nations and Aboriginal communities' requirements for a traditional lifestyle – Land, plants and animals will continue to be available to support a traditional lifestyle for current and future generations" (Water Management Framework, 2007: 7).*

Pursuant to constitutional obligations around the fiduciary duty for governments to meaningfully consult with Indigenous peoples, there is a general expectation that consultation will take place; however, divorcing consultation from AM specifically ignores the pre-requisite for stakeholders and Indigenous peoples to be involved in all phases of AM. Although the province of Alberta has not formally accepted the principles of UNDRIP, any new policy development in the water-energy-environmental management space would benefit from revisiting the current treatment of Indigenous peoples and TEK in environmental policy and ensuring that subsequent policy decisions do not perpetuate the systemic oppression of Indigenous peoples that has characterized environmental management in many jurisdictions, including Alberta.

4.4.2. British Columbia

In B.C., the Guidelines for Socio-Economic and Environmental Assessment (SEEA) note that “local knowledge and professional judgement are important”, while the EAO User Guide (2020) states:

> *“The EAO will work collaboratively with the Indigenous nation when considering Indigenous knowledge in the EA. Consensus-seeking processes between the EAO and Indigenous nations will allow for Indigenous nations to provide input into mitigation measures and recommended conditions. If there are conflicts between Indigenous knowledge and other western science-based information, the EAO will engage the proponent and the Indigenous nation to better understand the difference and where possible, seek to remedy the difference through a consensus-based process. Knowledge will be respected and treated on its own right, taking into consideration factors such as the length of observation of Indigenous knowledge. However, disagreement between knowledge systems could be an opportunity for establishing* ***adaptive management*** *for the topic of disagreement. If a resolution is not attained regarding how Indigenous knowledge and western science-based knowledge inputs are reconciled in the EA, the EAO or a participating Indigenous nation may trigger dispute resolution” (EAO User Guide, 2020: 42, emphasis, mine).*

There are several issues with applying AM as described in the EAO User Guide. First, suggesting that AM could be used to reconcile disagreements between western and TEK systems may imply that Indigenous peoples were not meaningfully involved in the first place. Since many of their traditional and cultural practices are inexorably tied to the land, failing to involve Indigenous peoples in project planning, the EAO User Guide may be perpetuating a system that has seen Indigenous people historically assume most, if not all, of a project’s risk while reaping few of the benefits. Second, there is an implied timing issue with the drafting of the User Guide that seems to indicate that a project proponent may already have a fixed plan in mind prior to engaging with Indigenous communities rather than seeking opinions, maintaining an open mind, and potentially altering plans, as was offered as an example of appropriate consultation in

the Haida Nation case (below). In *Haida Nation*, the SCC provided the New Zealand Ministry of Justice's *Guide for Consultation with Mäori* (1997) as a relevant example of consultation:

> *Consultation is not just a process of exchanging information. It also entails testing and being prepared to amend policy proposals in the light of information received, and providing feedback. Consultation therefore becomes a process which should ensure both parties are better informed . . . . genuine consultation means a process that involves . . .:*
>
> - *Gathering information to test policy proposals*
> - *putting forward proposals that are not yet finalized*
> - *Seeking Mäori opinion on those proposals*
> - *Informing Mäori of all relevant information upon which those proposals are based*
> - *Not promoting but listening with an open mind to what Mäori have to say*
> - *Being prepared to alter the original proposal*
> - *Providing feedback both during the consultation process and after the decision-process*
>
> *When the consultation process suggests amendment of Crown policy, we arrive at the stage of accommodation (Haida Nation, para. 46).*

Like Alberta, the B.C. government has a fiduciary duty to consult with, and where appropriate, accommodate First Nations where government actions or decisions regarding major projects may have a negative impact on Indigenous and treaty rights. Interestingly, the Supreme Court of Canada (SCC) has found that the duty to consult cannot be delegated to proponents, so the Crown cannot say that they do not have an obligation to consult if there was knowledge of a project (*Haida Nation v. British Columbia (Minister of Forests),* 2004 SCC 73 (CanLII), [2004] 3 SCR 511); furthermore,

while proponents are encouraged to engage with Indigenous peoples, they are not obliged to the same duty to consult under the Constitution.

Since the B.C. government has tried to be the first province to legally implement UNDRIP (in 2019), it is particularly surprising that environmental assessment policy drafted in 2020 would contravene almost all the articles in UNDRIP relative to environmental planning and management. Almost all the shale gas activity in B.C. happens in the lands overlaid by Treaty 8. Therefore, it is foreseeable that poor consultation and accommodation could initiate further litigation against the provincial government in the future.

4.5. Conclusions

This chapter has highlighted several issues with how AM is presented in policies in Alberta and B.C., including:

- It appears that policies overwhelmingly recommend or refer to AM as a suitable environmental management strategy.
- A tendency to suggest AM as a general or vague strategy (97% of the sample), most without further clarification of terminology or obligations held by any of the parties involved, particularly those of the proponent.
- A tendency to obfuscate and misconstrue different kinds of AM (passive or active), thus introducing vagueness that inhibits consistency of interpretation for proponents and regulators.
- Some steps in the AM cycle are over-emphasized to the detriment of others (i.e., an over-reliance on monitoring without a parallel commitment to communicate results or use them to change management decisions).
- The Crown's Constitutional obligations to consult with and accommodate Aboriginal peoples in major project decisions appears to be minimized, notwithstanding the recent commitments to UNDRIP by B.C., and to a lesser

degree, Canada. This further points to major opportunities to decolonize AM and how it is applied in the future.

- The role that Indigenous peoples and TEK could and do play in AM in B.C. and Alberta is severely constrained within the policies.
- The role that stakeholders could and do play in AM in B.C. and Alberta is constrained within the policies.

If the findings of Chapter 4 are taken to be representative of environmental policy in general, one could expect that AM might appear as a recommendation or allowable strategy in ~65% of policies in Alberta and just under 50% of policies in B.C. Given the problems with how AM implementation is constrained by administrative law as discussed in Chapter 2, it becomes particularly critical to examine the extent to which the underlying legislative and regulatory frameworks can operationalize the policy intent.

In Chapters 5 and 6, I describe the results of the content analysis of Alberta and B.C.'s legislative and regulatory frameworks to assess the magnitude of the problem described in the literature.

Chapter 5.

Content Analysis of Adaptive Management Indicators in Alberta's Water-Energy Legislative and Regulatory Regime

Chapter 4 demonstrates that policy frameworks in Alberta and British Columbia (B.C.) envision adaptive management (AM) as a key component of environmental management planning and implementation. The cross-section of environmental policies investigated in my research showed that 55% of policies in a 62-document sample made one or more references to AM. When assessed at the provincial level, the data show that 18 out of 28 policies (64%) in Alberta and 16 out of 34 policies (47%) in B.C. refer to or recommend AM as an environmental management strategy.[31] Notwithstanding the potential to use AM to address appropriate environmental problems, the academic literature, particularly articles published in law journals, has found that most legislative and regulatory frameworks in the western world are ill-equipped to facilitate a robust implementation of AM (see Chapter 1). This chapter investigates the extent to which Alberta's legislative and regulatory framework conforms to those findings.

5.1. Context and Approach

The legislative and regulatory content analysis described in this chapter included a legislative/regulatory analysis of 24 legislative and regulatory instruments relevant to the lifecycle of shale gas water/wastewater lifecycle (Table 5-1). Of the 24 regulatory instruments considered, 21 were considered within scope and were coded and analyzed. Three directives were considered out of scope after differing levels of review.[32]

---

[31] These findings are significant in that they suggest that proponents will ascertain through policy that AM is a viable and desirable option to use within the context of environmental impact assessments, mitigation strategies for adverse environmental effects, and major project planning. Thus, not surprisingly, AM is frequently invoked for large projects and regional developments assessed at both federal and provincial levels (Olszynski, 2016).

[32] 1) Directive 50: Drilling Waste Management was ruled out of scope since drilling waste is defined in the directive as: "The muds and cuttings generated while drilling a well and by directional drilling for the purpose of pipeline construction" (Appendix 7, Directive 50); 2) the Waste Control Regulation (WCR) (Alberta Regulation 192/1996 was ruled out of scope as waste and wastewater associated with an oil and/or gas wellsite, facility or pipeline is governed by AER

The Government of Alberta enacts legislation (Acts), whereas directives, specified enactment directions (SEDs), and subsurface orders (out of scope for this analysis) are under the purview of the Alberta Energy Regulator (AER).[33] In Alberta's case, 'Rules' are unique legislative instruments administered by the AER under the energy enactments (e.g., *Oil and Gas Conservation Act*, *Pipeline Act*, etc.).

Throughout the legislative and regulatory content analysis four thousand two hundred and seventy-five (4275) individual subsections of text across 1601 pages were analyzed and coded across two major categories:

1. The kind(s) of regulation(s) that the subsection is made up of, and

2. A qualitative analysis of indicators that would suggest the subsection is able or not able to enable implementation of AM, including specific steps in the AM cycle, if applicable.

As described in Chapter 3 outlining this study's methodology, different kinds of regulations and their associated level of prescription may be more or less aligned with the principles of AM and thus better suited to enable implementation. This research proposes that legislative and regulatory instruments that are highly prescriptive constrain key features of AM (such as flexibility and mechanisms to allow for iterative decision-making) and are likely to inhibit, if not prevent, the practice of AM in the field. Indeed, the drafting of the legislative and regulatory framework itself may be a significant one of many variables that contributes to underperformance.

Energy development is well known for being a dynamic industry, subject to frequent technological change and innovation. Regulatory instruments, regardless of where they exist in the hierarchy, tend to be far less able to exhibit the same kind of dynamism. Typically, regulatory instruments in Alberta increase in specificity as they descend through the hierarchy (e.g., from Acts down to guidance documents). This

---

directives pursuant to the Oil and Gas Conservation Act/Rules (OGCA/R). These regulatory instruments are similar and considered equal to the WCR; 3) Directive 058 (Addendum): Oilfield Waste Management Facility Approvals—Notification and Amendment Procedures was ruled out of scope because it is primarily administrative and does not directly pertain to wastewater.

[33] The AER was known as the Energy Resources Conservation Board (ERCB) before 2013. Some AER documents still reference ERCB or were created under its authorities, which have now transitioned to the AER along with a subset of powers under the specified enactments when applied to energy development contexts that were formerly held by the Government of Alberta.

analysis confirms that directives and specified enactment directions (SEDs) tend to be significantly more specific than Acts or rules/regulations. Requirements found in directives and SEDs commonly pertain to operations-level activities and conditions. Acts prescribe the administrative requirements of all aspects of the operational lifecycle under a particular enactment, whereas directives might specify the technical or operating conditions a licensee must abide by, or specific criteria that must be met. For example, the purpose of the *Oil and Gas Conservation Act's* (OGCA) (the top of the legislative hierarchy) is to provide for "safe and efficient practices in … the storage or disposal of substances" (section 4). The *Oil and Gas Conservation Rules* (OGCR) (enacted under the authority of the OGCA) makes 31 references to "storage," including section 8.150(2) which imposes a general duty for a licensee or operator to "use appropriate oilfield waste storage, treatment and disposal practices," and 8.150(3) which requires operators to "ensure that all required approvals are in place and operational requirements have been satisfied for all oilfield waste storage, handling, treatment and disposal methods."

Importantly, the OGCR also allows the AER the discretion to "approve alternative storage, treatment and disposal methods … if the Regulator is satisfied that those alternative methods will not adversely affect air, soil, surface water or groundwater" (OGCR, section 8.152). Under the jurisdiction granted by the OGCA, both the AER and Government of Alberta have drafted numerous directives and other regulatory instruments (specified enactment directions) providing additional detail and requirements pertaining to wastewater management and disposal in the energy sector. This analysis has examined 11 AER directives that are central to regulating the lifecycle of water and wastewater in shale gas development. It should be noted that there are myriad other regulatory instruments that pertain to waste management, but these were out of scope for this analysis which was narrowly focused on shale gas extraction (e.g., fluid tailings management generated from bitumen mining). Table 5-1 identifies the legislative and regulatory instruments analyzed in this chapter. Assessing the extent to which a legislative or regulatory instrument is compatible with AM was explored in Chapter 2.

Table 5-1 Alberta Legislative and Regulatory Instruments Analyzed

Acts	Rules & Regulations	Specified Enactment Directions	Directives (AER & Government)
Alberta Land Stewardship Act (ALSA)	Conservation and Reclamation Regulation (CRR)	Specified Enactment Direction (SED) 002: Application Submission Requirements and Guidance for Reclamation Certificates for Well Sites and Associated Facilities	Directive for water licensing of hydraulic fracturing projects – area of use approach (2018) (AUHFD)
Environmental Protection and Enhancement Act (EPEA)	Oil and Gas Conservation Rules (OGCR)		Interim Directive 2000-03 Harmonization of Waste Management and Memorandum of Understanding Between the Alberta Energy and Utilities Board and Alberta Environment
Oil and Gas Conservation Act (OGCA)	Pipeline Rules		Interim Directive 2000-04 An Update to the Requirements for the Appropriate Management of Oilfield Wastes
Pipeline Act	Wastewater and Storm Drainage Regulation (WWSDR)		Directive 51: Injection and Disposal Wells – Well Classifications, Completions, Logging, and Testing Requirements
Public Lands Act (PLA)			Directive 55: Storage Requirements for the Upstream Petroleum Industry
Water Act			Directive 55 Addendum: Interim Requirements for Aboveground Synthetically-Lined Wall Storage Systems, Updates to Liner Requirements, and Optional Diking Requirements for Single-Walled aboveground Storage Tanks
			Directive 056: Energy Development Applications and Schedules
			Directive 58: Oilfield Waste Management Requirements for the Upstream Petroleum Industry
			Directive 77: Pipelines – Requirements and Reference Tools
			Directive 83: Hydraulic Fracturing – Subsurface Integrity
			Surface Water Allocation Directive (SWAD)

As expected, my research confirmed that Acts, Rules, regulations, and directives are composed differently and have varying abilities to support a robust implementation of AM.

5.2. Results and Analysis

5.2.1. Coding Results of Acts and Implications for Adaptive Management

The results from coding the ALSA, EPEA, OGCA, Pipeline Act, PLA and the Water Act show that these Acts are overwhelmingly made up of general prescriptive (or "command-and-control") regulations (Figure 5-1). This analysis found that 84%-91% of subsections in Acts can be categorized as "prescriptive in a general sense." That is, they typically stipulate a "must" or "shall" statement followed by a particular action that a licensee or regulated party under the Act must follow, lest the regulated party be subject to an enforcement action or penalty. There tends to be limited flexibility within prescriptive regulations unless provisions for terms and conditions, powers to review and amend licences or terms and conditions, exemptions, or other broadly enabling provisions are explicitly included by the drafters. Figure 5-2, where the y-axis is presented on a logarithmic scale, enable a more detailed representation of the non-prescriptive regulatory categories, which ranged from 0%-<7%.

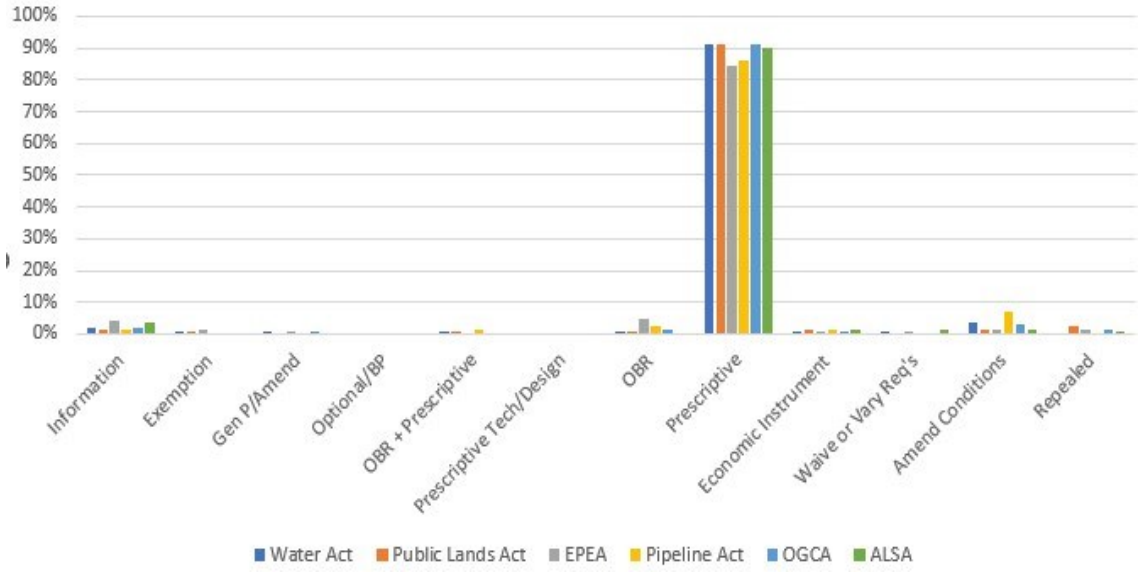

Figure 5-1 Regulatory Composition of Alberta Acts

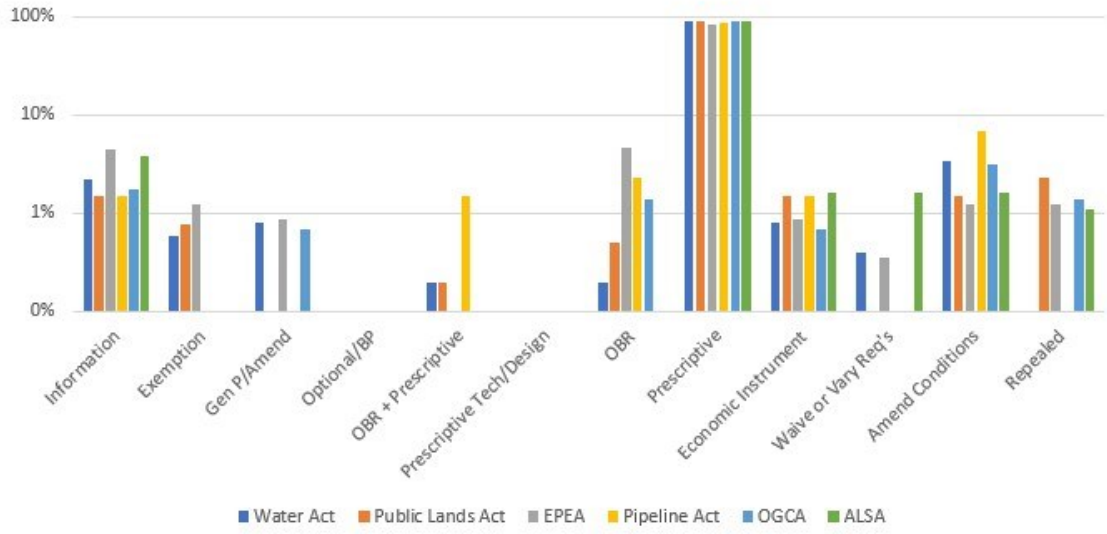

Figure 5-2 Regulatory Composition of Alberta Acts (Log Scale)
Y-axis is presented on a logarithmic scale. Refer to the Evaluation Rubric in Table 3-2 for a description of each code used on the X-Axis.

The “Prescriptive” category encompasses a medium to medium-high level of prescription on a Likert scale (1 being least prescriptive, 5 being most prescriptive). The most prescriptive types of regulations (those that specify a specific technology or methodology expected from a licensee (5)) are not typically found in Acts and will be

discussed at length in Section 5.2.3 that discusses directives and specified enactment directions. Although prescription and administrative law, in general, has been viewed as potentially constraining AM (see Benson, 2009; Benson & Schultz, 2015; Craig & Ruhl; 2014), there are broad opportunities presented in the Acts where information required at the application stage could include AM. Additionally, the provisions made for specific terms and conditions, as well as amending authorizations (discussed later in this section), are recognized as effective counter measures to the inflexibility often introduced by prescriptive administrative requirements.

Outcome-based Regulations (OBR), which belong to the class of general duty clauses or performance-based regulations, form a small but important part of the Acts under investigation (0% - 5% of the sample) (Figure 5-1). The highest proportion of OBRs are found in EPEA and include general requirements such as section 3.1 which requires a Minister or Director to act in accordance with any applicable ALSA regional plan, and prohibitions, such as section 155 which pertains to storage and handling of hazardous substances:

> 155 A person who keeps, stores or transports a hazardous substance or pesticide shall do so in a manner that ensures that the hazardous substance or pesticide does not directly or indirectly come into contact with or contaminate any animals, plants, food or drink.

OBRs are considered the least prescriptive regulation considered by this study. However, the degree of prescription within the OBR category ranges from a high-level end that must be achieved (e.g., a proponent must not pollute the environment) to a specific performance standard (e.g., specific thresholds or criteria that must be achieved). OBRs or outcome-based regulations could have beneficial applications for AM implementation as they generally permit flexibility or options for how an end is achieved. It should be noted that OBRs at the Act level may not translate into a high degree of flexibility across the entire regulatory regime. Using section 155 of EPEA as an ongoing example, we find that while the Act provides a great deal of discretion for how hazardous substances or pesticides are stored, the supporting rules and directives are highly prescriptive, often involving a high proportion of the most prescriptive categories of regulations which require a particular technology or methodology (P Tech in Figure 5-1). This issue will be explored later in sections 5.2.2 and 5.2.3. Not

surprisingly, the Acts considered in this research were found to have no subsections containing prescriptive technological or design requirements.

Preambles and mandate statements, commonly found under text headings such as “Purpose of Act,” could be viewed as highly complementary to the policy documents investigated in Chapter 4 that refer to or recommend AM. Interestingly, Alberta seems to be unique in this regard as the same, or equivalent sections, were not observed in B.C. (see Chapter 6). Furthermore, in some cases, the “Purposes of Act” statements could be viewed as broadly enabling AM, particularly where the specified enactments (EPEA and the *Water Act*) are concerned. Table 5-2 provides the purposes of the Alberta Acts under investigation. The *Pipeline Act* and the *Public Lands Act* do not specify a purpose and therefore were not included in this part of the analysis.

Table 5-2 Purpose of Acts Under Investigation

Act	Purpose of Act
ALSA	(2) The purposes of this Act are (a) to provide a means by which the Government can give direction and provide leadership in identifying the objectives of the Province of Alberta, including **economic, environmental and social objectives;** (b) to provide a means to plan for the future, recognizing the need to manage activity to meet the reasonably foreseeable needs of current and future generations of Albertans, **including aboriginal peoples**; I) to provide for the co-ordination of decisions by decision-makers concerning land, species, human settlement, natural resources and the environment; (d) to **create legislation and policy that enable sustainable development by taking account of and responding to the cumulative effect of human endeavour and other events.**
EPEA	2 The purpose of this Act is **to support and promote the protection, enhancement and wise use of the environment** while recognizing the following: (a) the protection of the environment is essential to the integrity of ecosystems and human health and to the well-being of society; (b) the need for Alberta's economic growth and prosperity in an environmentally responsible manner and the need to integrate environmental protection and economic decisions in the earliest stages of planning (c) the **principle of sustainable development**, which ensures that the use of resources and the environment today does not impair prospects for their use by future generations; (d) the **importance of preventing and mitigating the environmental impact of development and of government policies, programs and decisions**; (e) the need for **Government leadership in areas of environmental research, technology and protection standards**; (f) the shared responsibility of all Alberta citizens for ensuring the protection, enhancement and wise use of the environment through individual actions; (g) the opportunities made available through this Act **for citizens to provide advice on decisions affecting the environment**; (h) the responsibility to work co-operatively with governments of other jurisdictions to prevent and minimize transboundary environmental impacts; (i) the responsibility of polluters to pay for the costs of their actions; (j) the important role of comprehensive and responsive action in administering this Act.
EPEA	Purpose of environmental assessment process 40 The purpose of the environmental assessment process is (a) **to support the goals of environmental protection and sustainable development, (b) to integrate environmental protection and economic decisions at the earliest stages of planning an activity**, (c) to predict the environmental, social, economic and cultural consequences of a proposed activity and to assess plans to mitigate any adverse impacts resulting from the proposed activity, and (d) to provide for the involvement of the public, proponents, the Government and Government agencies in the review of proposed activities.
OGCA	4 The purposes of this Act are

Act	Purpose of Act
	(a) to effect the conservation of, and to prevent the waste of, the oil and gas resources of Alberta; (b) to secure the observance of safe and efficient practices in the locating, spacing, drilling, equipping, constructing, completing, reworking, testing, operating, maintenance, repair, suspension and abandonment of wells and facilities and in operations for the production of oil and gas or the storage or disposal of substances; (c) **to provide for the economic, orderly, efficient and responsible development in the public interest of the oil and gas resources of Alberta;** (c.1) to provide for the responsible management of a well, facility, well site or facility site throughout its life cycle; (d) to afford each owner the opportunity of obtaining the owner's share of the production of oil or gas from any pool; (e) to provide for the recording and the timely and useful dissemination of information regarding the oil and gas resources of Alberta; (f) to control pollution above, at or below the surface in the drilling of wells and in operations for the production of oil and gas and in other operations over which the Regulator has jurisdiction.
Water Act	2 The purpose of this Act is **to support and promote the conservation and management of water, including the wise allocation and use of water**, while recognizing (a) **the need to manage and conserve water resources to sustain our environment and to ensure a healthy environment and high quality of life in the present and the future;** (b) the need for Alberta's economic growth and prosperity; (c) the need for an integrated approach and comprehensive, flexible administration and management systems based on sound planning, regulatory actions and market forces; (d) **the shared responsibility of all residents of Alberta for the conservation and wise use of water and their role in providing advice with respect to water management planning and decision-making**; (e) the importance of working co-operatively with the governments of other jurisdictions with respect to trans-boundary water management; (f) the important role of comprehensive and responsive action in administering this Act.

EPEA and the Water Act, in particular, contain enabling descriptions and terms within their mandate statements that could theoretically support a robust implementation of AM. Provisions such as: “integrat[ing] environmental protection and economic decisions in the earliest stages of planning” (EPEA); “sustainable development” (EPEA); “sustain[ing] our environment” (WA); “flexible administration and management systems based on sound planning …” (WA); and broad references to co-operative and shared responsibilities across governments and stakeholders are in alignment with the academic literature describing what AM is (see Appendix A for more details). References to balancing environmental, economic, and social objectives necessarily imply a degree of stakeholder involvement, particularly for the successful integration of social objectives. Moreover, the ALSA states that its purpose is to “to provide a means to **plan** for the future, recognizing the need to manage activity to meet the reasonably foreseeable needs of current and future generations of Albertans, **including aboriginal peoples”** (emphasis, mine). Given the lack of detail provided in Acts, a deeper analysis of subsequent levels of regulation is necessary to evaluate the relationship between the enabling principles and AM.

At the same time, it should be noted that many of the Acts introduce a bifurcated mandate which can create situations where the parts of the mandate cannot be equally upheld at the same time. For example, both the *Water Act* and EPEA promote sustainable development, protection, enhancement and conservation of the environment and water resources while also noting that this end must be balanced with the need for economic growth and prosperity. There is ample evidence in the literature and the court cases discussed in Chapter 2 that AM has, at least, occasionally been used to green-light development in the face of significant adverse environmental effects. In many cases, it seems that economic development may be the *de facto* preeminent part of the mandate.

Economic instruments, while enabled under the Acts, are rarely used. EPEA provides for economic instruments in section 13:

> *The Minister may, in accordance with the regulations, establish programs and other measures for the use of economic and financial instruments and market-based approaches, including, without limitation,*
>
> *(a) emission trading,*

(b) incentives,

(c) subsidies,

(d) emission, effluent and waste disposal fees, and

(e) differential levies,

for the purposes of protecting the environment, achieving environmental quality goals in a cost effective manner and providing methods of financing programs and other measures for environmental purposes.

The spectrum of economic instruments enabled by EPEA are not found in the regulatory instruments investigated in this chapter, making up less than 2% of total regulatory instruments. Moreover, those that do appear are exclusively comprised of fines for non-compliance with sections of the Acts. Fines are typically construed as the “control” portion of “command-and-control” regulation. Also, not surprisingly, optional requirements, best practices, or guidelines are not present in Acts.

Within the Acts, there are numerous references to terms and conditions (Figure 5-2). Terms and conditions were less likely to be found in energy enactments than the specified enactments. EPEA contains more than twice as many references to terms and conditions than any other Act, likely because licences applied for under EPEA may need to accommodate more diverse or variable environmental contexts across the province and across different kinds of licensees. Terms and conditions allow for specific place or context-based factors to be accommodated under a common licensing regime, or for specific risks to be mitigated (e.g., the collection of a security deposit can be a common condition of approval). They are intended to provide an additional level of oversight where the Act may be sufficiently vague to encompass a wider range of activities. Thus, they could be one mechanism to provide both the flexibility and case-specificity to enable an AM approach that can address specific uncertainties as well as provide for a high level of controllability by the decision-maker or operator acting under a particular authorization. For example, implementing AM using terms and conditions could hypothetically provide for operators to consider specific thresholds and indicators within a region or watershed.

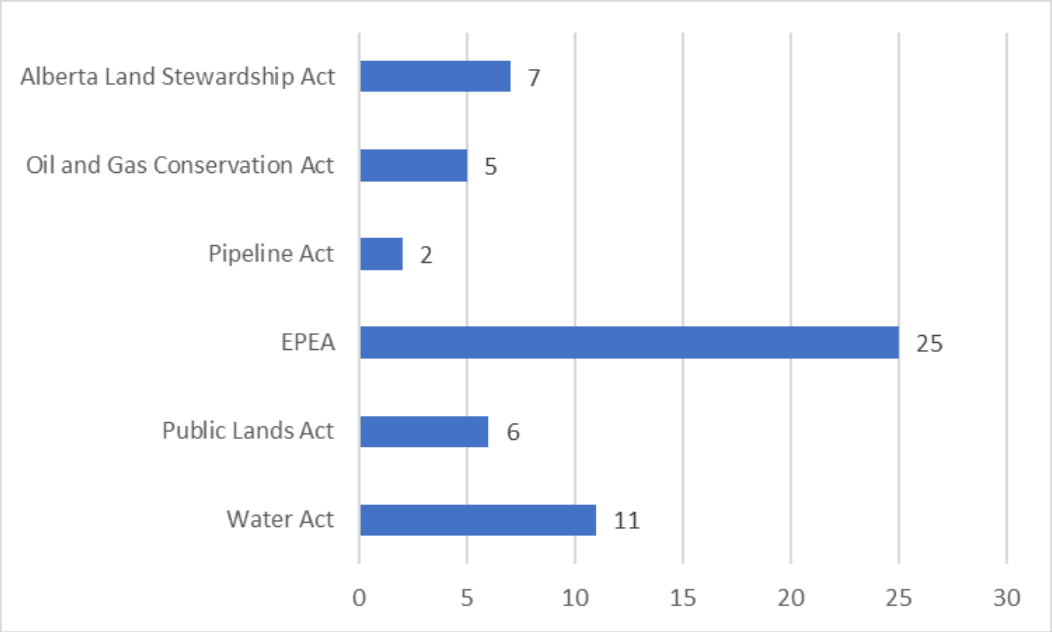

Figure 5-3 Number of References to Terms and Conditions in Alberta Acts

It was beyond the scope of this research to investigate the extent to which terms and conditions included in approvals and authorizations specifically include AM. At the time of writing, it is not possible to say that terms and conditions specifically refer to AM, or at what frequency. Rather, I reiterate that terms and conditions may be an existing vehicle for AM integration into projects that have an environmental impact in a way that meets unique site or project-specific factors. However, there are also disadvantages of using terms and conditions in this way: terms and conditions are not entirely transparent. They are not easily compared across the industry or between operators and licensees; moreover, the approach of using terms and conditions to integrate any kind of management approach, including AM, has been critiqued for being *ad hoc*, or having the potential to lack consistency and transparency of regulatory decision-making with respect to AM implementation. That is, there is a likelihood that AM could be differently interpreted across multiple internal reviewers or agencies, as well as by licensees receiving approvals, if the concepts are not well understood. If terms and conditions are used as a mechanism to include AM in energy resource management, it would be helpful to develop a common rubric and accepted methodology for AM beyond that which has been identified in policy (see Chapter 4). That way, regulatory agencies could provide a helpful level of consistency and detail as to what the expectations are.

In addition to terms and conditions serving as mechanisms to potentially implement AM, most Acts give authority to amend licences under certain conditions (see "Amend Conditions" in Figure 5-1). Kwasniak writes that "if [the results of follow up programs as described by the CEAA] is to be used as a mechanism to implement an AM program, it is critical that either authorizations be flexible enough to require alternative environmental management strategies, or the applicable legislation authorizes the regulator to revisit authorizations in this manner" (Kwasniak 2009: 9). Acts in Alberta, particularly the specified enactments, give broad powers for "the Director" to amend licences and approvals for several reasons. For example, section 42 of the *Water Act* and section 70 of EPEA allow "the Director" to amend an approval without the consent of the approval holder. Particularly, in EPEA, the amendment can be made if there is an emerging adverse effect, or if the term or condition relates to monitoring or reporting requirements. Both of these contexts could possibly provide for AM.

Interestingly, the OGCA's provisions for amending authorizations and terms and conditions and issuing authorizations subject to terms and conditions is granted to the Regulator (the AER), but with the approval of the Lieutenant Governor in Council. The provisions for amendments in the specified enactments are particularly important to the implementation of AM, as AM is most likely to be invoked for issues directly regulated by these Acts such as watershed management or preventing wastewater from migrating off an energy activity site. Frequently amending terms and conditions, or authorizations is not desirable in all cases. Doing so could have negative implications for regulatory certainty. It is unlikely that a regulated party would be amenable to operating under conditions that frequently change, nor would that be a desirable position for a regulatory agency. Nevertheless, enabling the results of experiments, monitoring, and data collection to inform project decision-making on an iterative basis is fundamental to AM. It follows that allowing authorizations to be amendable to incorporate new information, and then actually amending them to incorporate new information, would be a central component of enabling that feedback loop.

On a more general note, EPEA requires any Minister or Director acting under the Act to also act in accordance with any applicable ALSA regional plan. As discussed, the only regional plan that has been promulgated at the time is the Lower Athabasca Regional Plan (LARP). Recall from Chapter 4's investigation of Alberta's energy-environmental policies that a significant number of them (64%) recommend AM. Many of

the policies under LARP reference AM and some were heavily reliant on it as a methodology for environmental management, and particularly water/wastewater management. To reiterate, this dissertation considers the LARP to be a useful proxy for what might be expected in land use plans implemented in other oil and gas producing regions. In section 13, the ALSA states (emphasis, mine at subsection 2):

> *Legal nature of regional plans*
>
> *13(1) A regional plan is an expression of the public policy of the Government and therefore the Lieutenant Governor in Council has exclusive and final jurisdiction over its contents.*
>
> ***(2) Regional plans are legislative instruments and, for the purposes of any other enactment, are considered to be regulations.***
>
> *(2.1) Notwithstanding subsection (2), a regional plan may provide rules of application and interpretation, including specifying which parts of the regional plan are enforceable as law and which parts of the regional plan are statements of public policy or a direction of the Government that is not intended to have binding legal effect.*

The supplementary policy documents under LARP do not specifically include rules of application and interpretation in all cases; moreover, some of them (e.g., the frameworks for managing surface and groundwater) contain procedural direction for activities to involve AM. In particular, the LARP Surface Water Quantity Management Framework (SWQMF) for the Lower Athabasca Region contains numerous references for using AM and thresholds for 'Adaptive Management Triggers.' Although this has not been tested in the courts, it would be interesting to determine if the oversight of AM by governments and regulatory agencies might change if it were determined that it is indeed a requirement under LARP (or any other regional plan yet to be enacted).

The legal connection between the supplementary policies investigated in Chapter 4 and the ALSA is not entirely clear; however, one could make a case that in the

absence of clear delineation (per section 13(2.1) of ALSA) of the rules of application and interpretation of the regional plan documents, and if the policy documents are indeed requiring AM (as they seem to be, at least in the SWQMF for the Lower Athabasca River), then there may be a regulatory obligation for operators and licensees to undertake AM as a management strategy, or at least, where AM is chosen as a management strategy, implement AM appropriately.[34] This question warrants investigation, particularly since the policy document notes that "adaptive management triggers will direct a management response process, led by Alberta Environment and Sustainable Resource Development"[35] (SWQMF, 2015). While the supplementary policy does not specifically tie the triggers to enforcement, it would be interesting to follow up this study with a legal review of licensee's regulatory obligations that are binding under ALSA and EPEA with respect to AM.

5.2.2. Coding Results of Rules and Implications for Adaptive Management

The analysis considered relevant rules under the authority of the Acts investigated in the previous section. Those rules include: 1) the Oil and Gas Conservation Rule (OGCR); 2) the Pipeline Rules; 3) the Wastewater and Storm Drainage Regulation (WWSDR, under the authority of EPEA), and 4) the Conservation and Reclamation Regulation (CRR, under the authority of EPEA).

The rules show a similar trend as the Acts, where the regulatory composition tends to be overwhelmingly prescriptive (~50%-~80%) (Figure 5-3). Interestingly, the data show a new category – the proportion of the instrument that has been repealed, where the section number has been left in place. I have included the repealed category as a standalone category so as not to skew my results. This becomes particularly important in analyzing the OGCR, which shows a comparatively low proportion of general prescriptive subsections when compared with other rules and a disproportionately high proportion of repealed sections (~21%). This is not surprising since the OGCR was originally drafted in 1971 and has seen numerous amendments since then. When the statistics are adjusted for removing the redacted subsections, the

[34] If the latter is the case, it should be noted that assessing compliance would be a significant challenge under the status quo.

[35] Now called Alberta Environment and Protected Areas.

OGCR's regulatory make-up becomes more like the other rules: the distribution of general prescriptive rises to ~64%, and both technical prescription and general duty clause subsections (OBR) rise to just over ~10% of the regulatory composition.

The results show that the energy enactments contain the most prescriptive kinds of regulation (P Tech), whereas the regulations associated with specified enactments do not. The technical or design-based regulations included in the OGCR include specific instructions for technologies primarily to maintain well integrity. Similarly, the *Pipeline Rules* have several similar highly prescriptive technical requirements for specific testing methodologies, stress level limitations, acceptable materials or liquids that are permissible for pipeline operation or transport, and other issues that may warrant a highly technical approach.

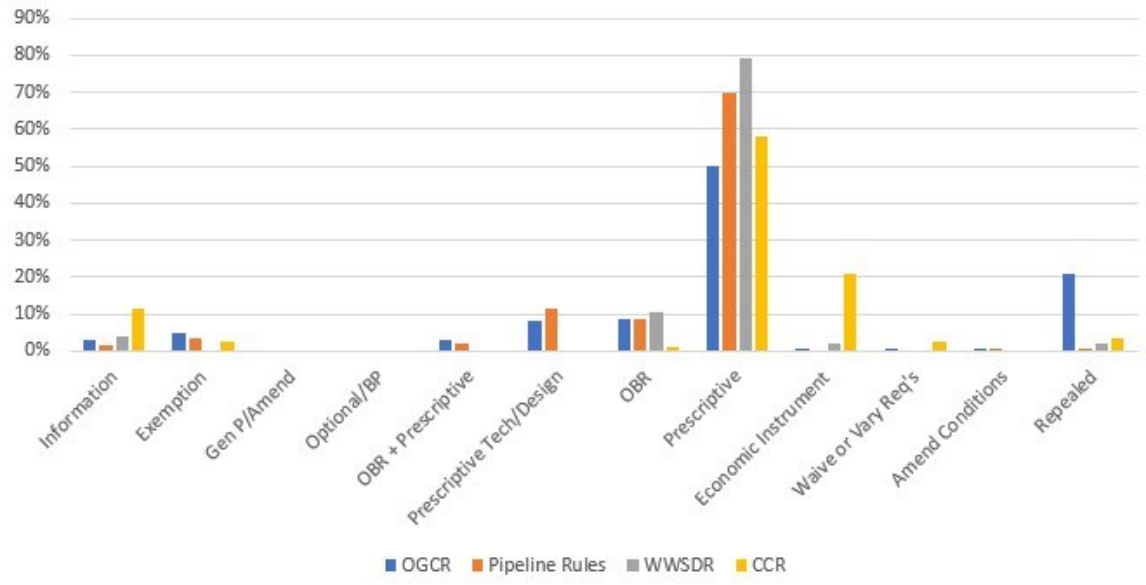

Figure 5-4 Regulatory Composition of Alberta Rules and Regulations
Refer to the Evaluation Rubric in Table 3-2 for a description of each code used on the X-Axis.

There is a small sample in the OGCR and the *Pipeline Rules* that are hybrids of prescriptive and performance-based regulations, in varying levels of stringency. Most commonly, these kinds of regulations are larger subsections that impose specific commands on regulated parties, but also include a performance standard or outcome that must be achieved. As the coding data from Acts, Rules and regulations indicate, these hybrid regulations occur infrequently, but can provide valuable enabling authority

for activities or technologies that may be beyond the scope of a legislative or regulatory instrument but can meet a particular outcome or performance standard. Depending on the case and context, hybrid regulations can provide the necessary flexibility for AM to be implemented, while providing the regulatory backstop to prevent adverse or irreversible environmental or human impacts. This analysis found that the rules and regulations under investigation do not contain any optional or best practice guidance statements within the regulation.

Like the Acts, the rules infrequently involve economic instruments with the notable exception of the CRR. This regulation devotes just over 20% of its subsections to establishing a security regime for proponents and licensees. There are notable exemptions from this provision, including pipelines and oil production sites (see section 17.1); however, the Minister has discretion to designate activities as being subject to providing security. This provision for providing security largely pertains to the scope of the shale gas water and wastewater management cycle through wastewater storage and management facilities. Interestingly, the CRR is the only Rule/regulation that has an objective or statement of purpose, which stipulates that: “the objective of conservation and reclamation of specified land is to return the specified land to an equivalent land capability” (section 2, CRR). Given the extraordinary costs associated with conserving and reclaiming some lands used for energy development, the significant focus of this regulation on security is not surprising. It should be noted that “equivalent capability” in the CRR means: “that the ability of the land to support various land uses after conservation and reclamation is similar to the ability that existed prior to an activity being conducted on the land, but that the *individual land uses will not necessarily be identical”* (section 1[e]) (emphasis, mine).

Terms and conditions, as referenced by rules, provide additional cases where terms and conditions may be applied. Typically, terms and conditions are applied at the time of licensing, or relatively upfront in the lifecycle of development, but can also be applied to end-of-life activities such as closure plans. Terms and conditions were identified in the CRR, the Pipeline Rules and the OGCR, but not the WWSDR (Figure 5-4). The OGCR notes in section 3.1014(2) that “a closure plan must contain the information required by the Regulator and the plan must be approved by the Regulator subject to any terms and conditions imposed by the Regulator” and at subsection 4 of 3.1014: “A licensee shall comply with any terms and conditions of the licensee’s

approved closure plan." An application for a reclamation certificate issued under the CRR must contain a declaration that an operator has complied with all of the terms of conditions that have been issued throughout the lifecycle of the project (section 12(1)(b)(vi)(A)). There is a broader provision for terms and conditions in section 13 of the CRR which states: "An inspector may issue a reclamation certificate subject to any terms and conditions the inspector considers to be appropriate." It is essential to reiterate that AM is an iterative process in which practitioners are learning from management experiments, and subsequent actions and decisions are modified to integrate new information (Stankey et al., 2005; Walters, 1996; Williams, 2011).

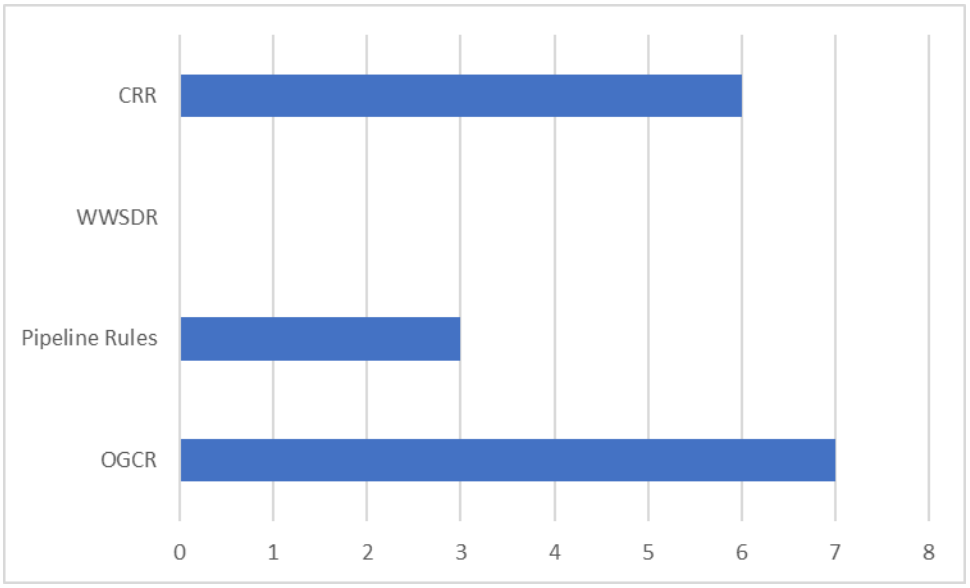

Figure 5-5 References to Terms and Conditions in Alberta Rules and Regulations

Without the provisions for terms and conditions to be applied at the authorization or initiate phase of a project authorized through the Acts discussed in the previous section, using terms and conditions to implement AM only at the reclamation phase would likely be too late to implement AM as intended by practitioners such as Holling (1978), Walters (1996) and Lee (1999); Moreover, as licensees progress towards the end of operations and the remaining resource is depleted, it becomes less likely that the licensee will have the necessary cashflow to be able to learn from AM and meaningfully integrate new information in operations. Rather, if unexpected adverse environmental effects present themselves, or if learning reveals that treatments have not performed as hoped, the licensee may not be able to respond at all.

5.2.3. Coding Results of Directives and Specified Enactment Directions and Implications for Adaptive Management

Directives and specified enactment directions (SED) provide contextual details and requirements to support Acts. This section contemplates a number of AER directives (all numbered directives), Government of Alberta directives (the Surface Water Allocation Directive [SWAD], and the directive for water licensing of MSHF projects – area of use approach [AUHFD]), and one SED (002)[36]. The instruments investigated in this subsection were drafted at different times in history and some have not been significantly amended since the original drafting date. For this reason, there have been challenges over time for some directives to accommodate new or unique technologies, such as hydraulic fracturing and directional drilling. The preambles of the Directive 55 Addendum and the AUHFD provide a more detailed explanation of this phenomenon, highlighting, for example, the increased backflow volumes of wastewater and the transient nature of drilling activities inherent with shale gas development.

General prescriptive requirements remain the most observed type of regulation in directives and SEDs, although the distribution across instruments is highly variable (Figure 5-5). Interestingly, there is considerable representation of hybrid regulations. I had expected that directives regulating highly technical activities (e.g., Directive 083: Hydraulic Fracturing – Subsurface Integrity) would have a higher-than-average composition of technical or design requirements. Interestingly, this directive appears to blend the most technical requirements together with outcome or performance-based regulatory requirements. There are other directives that rely heavily on highly technical prescriptive requirements. Unsurprisingly, the storage directives (D055 and D055 Addendum) contain highly prescriptive requirements for technologies and methodologies involved in waste management, as does Directive 077 pertaining to pipelines. The SWAD, for example, devotes more than half of the content to hydrological assessment

[36] Interestingly, SED 002 does not specifically reference AM, whereas 001 (Direction for Conservation and Reclamation Submissions Under an *Environmental Protection and Enhancement Act* Approval for Enhanced Recovery In Situ Oil Sands and Heavy Oil Processing Plants and Oil Production Sites) and 003 (Direction for Conservation and Reclamation Submissions Under an *Environmental Protection and Enhancement Act* Approval for Mineable Oil Sands Sites) do. Of note, SED 003 requires that: “The design process for post-mining landforms and landscapes requires an integrated and multidisciplinary approach with iterations that will typically last several decades, and it ***must*** adopt adaptive management principles” (page 53, emphasis, mine).

methods and screening criteria. Interestingly the SWAD applies where there is not already a water management plan or water conservation objective under the Water Act, or in the absence of a Land Use Framework regional plan or environmental management framework. Since only one of the six regional plans has been enacted (LARP, which was used as a proxy for others in Chapter 4 of this dissertation), the SWAD would apply in the rest of the province. This is particularly relevant to this study since three of those land use areas are known to have intense development of shale gas resources employing multi-stage hydraulic fracturing. Notwithstanding the level of prescription identified in the SWAD, there are numerous points throughout the methodologies that could serve as opportunities to implement AM. For example, depending on the level of risk and uncertainty inherent with water allocation, AM, if implemented properly, could potentially be utilized to close knowledge gaps within the context of watershed scale assessments.

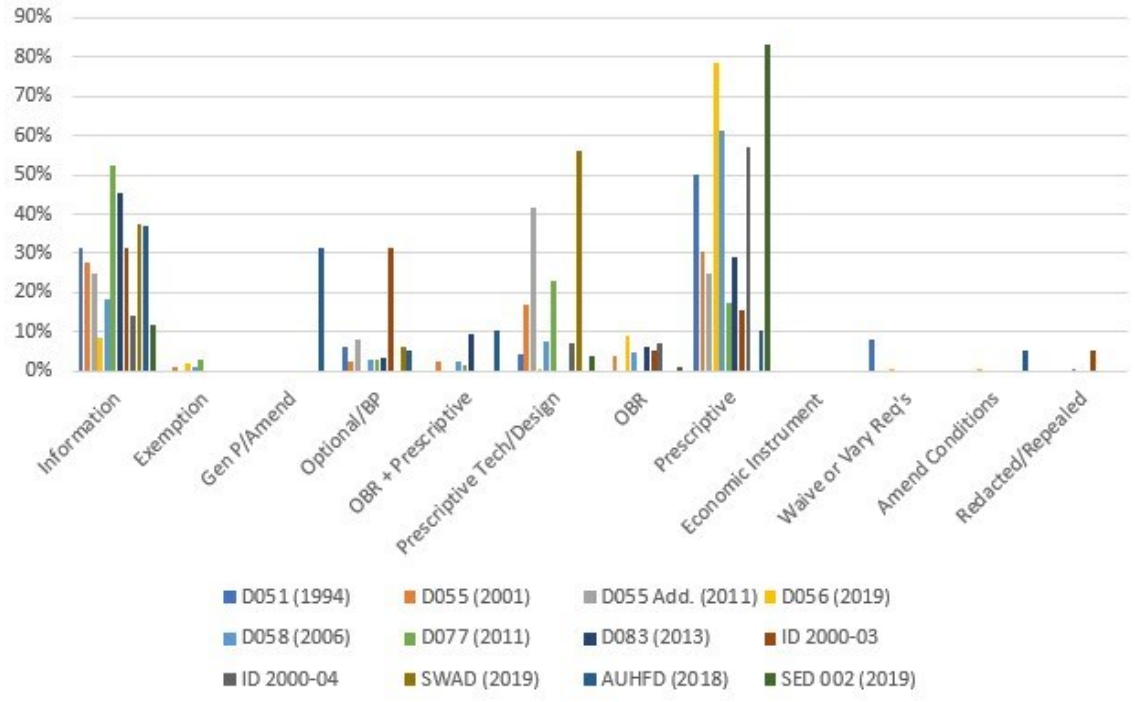

Figure 5-6 Regulatory Composition of Alberta Directives and Specified Enactment Directions

Refer to the Evaluation Rubric in Table 3-2 for a description of each code used on the X-Axis.

Directives and SEDs include a small proportion of optional or best practices subsections. It should be noted that there is a significant collection of manuals and other guidance documents relevant to the scope of this research. This sub-category of regulatory instrument was excluded from the content analysis to manage sample size and to focus the scope of analysis on regulatory instruments that are enforceable. That is, operators and licensees *must* follow the requirements rather than they *should* or *could*, where there might be a benefit or best practice to be realized. Conclusions drawn from Olszynski's 2016 work suggest that the voluntary or unregulated nature of how AM is implemented may be at least part of the problem. By focusing on what operators and licensees must or must not do, this study can make inferences about behaviors that would be expected in the field. This analysis highlights the relative absence of provisions to exempt, waive, or amend conditions in directives or SEDs as these authorities are already granted by higher order instruments and do not need to be restated at the operational level of regulation.

The Directives and SED investigated here have a much larger information component than higher order regulatory instruments (Figure 5-6). Information sections are non-regulatory (not subject to enforcement action) but may provide important context on the purpose of the instrument or parts thereof, background or history, references, or other pertinent information. Newer directives tend to have higher %ages of their composition dedicated to providing information and context. Although beyond the scope of this study, it would be interesting to investigate the extent to which this trend would hold across all directives under the AER's purview. The SED investigated in this study does not have a significant proportion of its composition dedicated to providing information when compared with other similar regulatory instruments; however, given the small sample size (i.e., 1 out of 3 SEDs), it cannot be known if this is representative of all SEDs without expanding the scope of this study to include the other two.

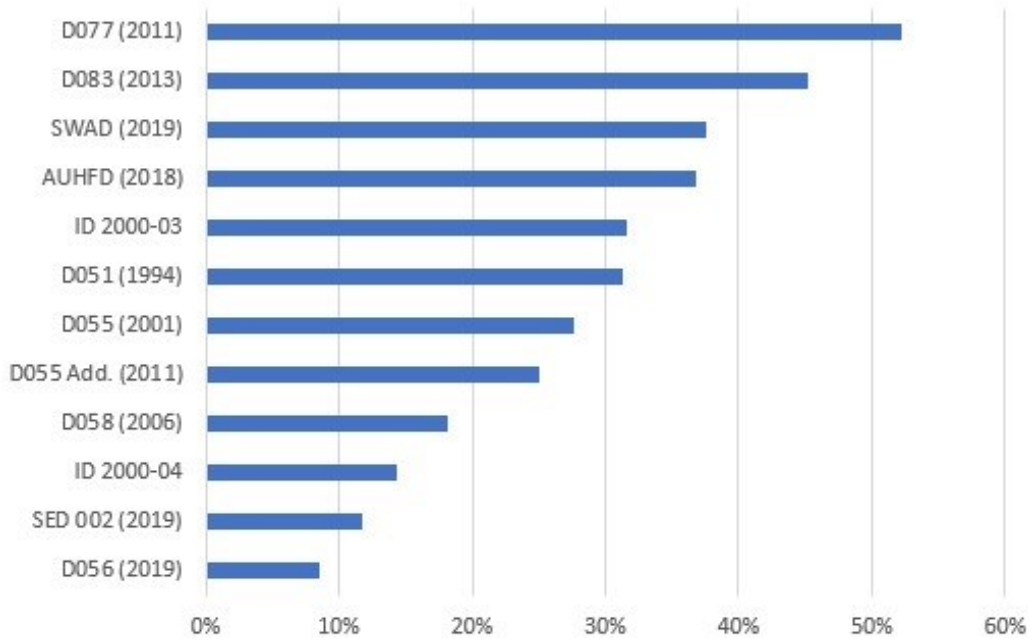

Figure 5-7 Proportion of Regulatory Composition that is Informational (non-regulatory)

5.2.4. Qualitative Analysis of Adaptive Management Implementation in the Regulatory Regime

The qualitative content analysis examined each subsection to assess the extent to which it supports or can support AM implementation. The coding began with general terms that could be construed as “AM-friendly” such as: enabling experiments/experimental schemes, provisions to amend or introduce flexibility; activities that would reduce uncertainty and/or foster learning, and iterative reviews. Coding a subsection as potentially enabling AM, should not be taken to indicate that it currently enables AM in the field. Many of these concepts were also captured in the coding that identified AM-related regulatory tools, such as terms and conditions and amending provisions for licences. The qualitative analysis also searched for terminology that pertained to the distinct phases of AM. Words and concepts that belonged to the AM phases shown in Figure 2-1 were separately coded and broken into subcategories in accordance with the coding methodology followed for Chapter 4, including: define; design; implement; monitor; evaluate; revise; communicate; stakeholder engagement; and indigenous consultation or traditional ecological knowledge (ITEK). Synonyms for AM-related concepts and activities were drawn from the table in Appendix A.

The content analysis identified subsections that could be construed as enabling AM, as well as those that could be construed as limiting or preventing implementation of AM. “AM-positive” coding captured concepts such as: flexibility; experimental approach(es); iterative review/iteration; addressing uncertainty; implementing a rigorous/scientific approach, and; citations of policies or policy documents that recommend or mention AM. Provisions to introduce flexibility were the most common and included references to: flexible terms and conditions; provisions to amend or revisit licences or decisions; discretionary decision-making and other kinds of flexibility.

For example, the Directive for water licensing of hydraulic fracturing (HF) projects – area of use approach (referenced as AUHFD in this chapter’s figures) introduces flexibility by making a water licence issued under the *Water Act* appurtenant to the point of diversion only. This is unlike other energy development cases where water licences issued under the *Water Act* might be appurtenant to both a point of diversion and a point of use. The point of use for MSHF may be more generally described at the time of application to accommodate the unique features of MSHF described in Chapters 1 and 2 of this dissertation and is typically regulated separately through licence terms and conditions. The coding exercise showed that flexibility was almost exclusively offered through terms and conditions, or amending licences or terms and conditions, rather than through other kinds of flexible approaches. The AUHFD also references the Water Conservation and Allocation Guideline for Oilfield Injection (2006) (WCAGOI) for guidance on conducting assessments for alternative water sources to fresh water. As discussed in Chapter 4, the WCAGOI recommends using an AM approach.[37]

Experimental approaches were less common, but five regulatory instruments made provisions for experimental schemes/technologies/approaches, alternative approaches, and/or equivalent approaches/technologies/methods: 1) the OGCA, 2) the OGCR, 3) Directive 055, 4), SED 002, and 5) the SWAD. SED 002 and the SWAD were the only instruments that referenced using a scientific approach, and only indirectly. SED 002 provides for scientific and experimental methodologies via section 7 which details requirements for reclamation information. It includes extensive detail on revegetation approaches, including hyperlinks to best practices documents which specify AM as a

[37] Note that the updated Water Conservation Policy for Upstream Oil and Gas Operations (2020) does not contain references to AM.

recovery strategy. The SWAD provides for scientific research and experimental methodologies via the screening criteria and assessment methodologies provided in the directive, which include provisions for addressing uncertainties and gaps in data, which could be positive for AM implementation. The energy enactments and associated directives refer to enabling experimental approaches and new or alternative treatments or technologies. Although beyond the scope of this investigation, EPLs used as a final repository for fluid tailings is one technology that has frequently invoked AM as a management strategy (CEMA/EUB, 2007; CEMA, 2012; Golder Associates, 2017). Iterative review can be overtly required (e.g., as in the case of ALSA), or implied, such as in the case of the OGCR or the *Pipeline Rules* which contain “expiry dates” by which they are to be reviewed and amended, if necessary. Similarly, authorizations issued under energy enactments or the specified enactments, including their terms and conditions, expire, but can be extended or renewed subject to revised terms and conditions, if appropriate (see sections 41-42 of the Water Act for an example).

There are few subsections, if any, across the legislative and regulatory framework investigated here that specifically prohibit or restrict AM. Rather the sample investigated in this research generally conforms to the two major observations made within the legal literature on AM: First, implementation of AM is situated within existing legislative and regulatory frameworks, protocols and government mandates, but that those frameworks do not necessarily support a robust implementation of AM (Benson & Schultz, 2015; Ruhl, 2008). This problem is investigated later in this section when individual phases within the AM cycle are coded in the content analysis. Some of the issues summarized in chapter 2 originate from the lack of definition, or specific mention, of AM in legal frameworks, or direction on how existing requirements might operationalize or provide a regulatory backstop for specific AM-related activities such as up-front design, rigorous monitoring, and feedback loops for emerging knowledge as uncertainty is reduced (Schultz & Nie, 2012). Second, the legal academic community has noted that legislative and regulatory frameworks typically do not support the iterative feedback loops that are fundamental to successful AM (Benson & Schultz, 2015). The legislative and regulatory instruments examined in this chapter largely conform to the patterns described in the literature.

The qualitative content analysis shows that the specified enactments (except for the *Public Lands Act*) are most likely to represent the different phases of AM. The *Water*

Act has the greatest number of subsections that are supportive of different phases of AM and have a relatively even distribution across phases, meaning that no one phase is overrepresented when compared with another. Most of the references are in the context of developing water management plans under the provincial planning framework. Notably, the Water Act specifically mentions “reviewing and revising water management plans” (section 7(2)), which is the most uncommon phase of AM represented (apart from stakeholder engagement or indigenous engagement/traditional ecological knowledge [ITEK]) across all legislative instruments. EPEA and the ALSA also have all phases of AM represented.

Interestingly, EPEA provides for AM to potentially be implemented through the role of the Chief Scientist whose roles and responsibilities regarding the environmental science program include:

> **(7)** *(a) to **plan, co-ordinate and conduct environmental monitoring**; (b) to collect, store, manage, **analyze, evaluate and assess environmental monitoring data** and to ensure the information is scientifically credible, including through prior peer review where the Chief Scientist considers it appropriate; (c) **to make environmental monitoring data and related scientific evaluations and assessments available to the public** and to the Science Advisory Panel established under section 15.2(1); (d) to **report to the public** on the condition of the environment in Alberta on the basis of the scientific evaluations and assessments of the data collected; (e) to establish and make public a schedule for the reporting under clause (d); (f) to consult with the Science Advisory Panel established under section 15.2(1) and the advisory panel established under section 15.3(1) and to **determine how to address any advice provided by those panels** (section 15.1(2), emphasis, mine).*

AM can also be provided for through the environmental assessment process. Notably, EPEA specifically mentions ITEK and creating an Indigenous Wisdom Advisory Panel:

> *The Minister shall establish an advisory panel to provide advice to the Chief Scientist and the Minister about how to **incorporate traditional ecological knowledge** into the environmental science program (section 15.3(1), emphasis, mine).*

ALSA makes similar provisions for all phases of AM through its requirements for review, implementation of, and elements of regional plans in sections 6, 8 and 9. Specifically, section 8, among other things, notes that a regional plan may contain several AM-related features, including:

- A regional plan *must* set a vision and objectives for a planning region (8(1)a) (emphasis, mine);
- Thresholds and indicators to determine whether an objective or policy in the regional plan is effective (sections 8(2) b & c);
- Monitoring criteria for thresholds (8(2)d);
- Evaluate if objectives and policies for the planning region are being met, and prescribe corrective course actions (8(2)e & f) (note that 64% of policies refer to AM within their text);
- Review regional plans and make changes where appropriate (section 6, to a lesser degree section 8(2)f, i).

There are numerous subsections in EPEA and the *Water Act* that refer to stakeholder engagement. This is not typically found in other Acts, or lower-level regulatory instruments possibly because Directive 056 contains a substantial chapter on ‘participant involvement. The analysis of Acts shows that “monitor” and “evaluate” are the most common phases of AM to be represented across all the Acts, and the only phases represented within the *Pipeline Act* and the *Public Lands Act* (which also have one reference to “revise”). The OGCA has references to “monitor” and “communicate;” however, no other phases of AM are represented. It is unlikely that the absence of stakeholder engagement or other AM phases in this analysis’ sample reflects low importance of the activity. Rather, as related to the comment about Directive 056, there are other policy and regulatory instruments that provide comprehensive requirements for stakeholder engagement, participant involvement and Indigenous consultation that were beyond the scope of this research. As such, the results suggest a compartmentalization of policy and legislative concepts rather than a complete omission. Further analysis of the regulatory instruments is

necessary to ascertain if AM phases are provided for in more detail elsewhere in the regulatory framework.

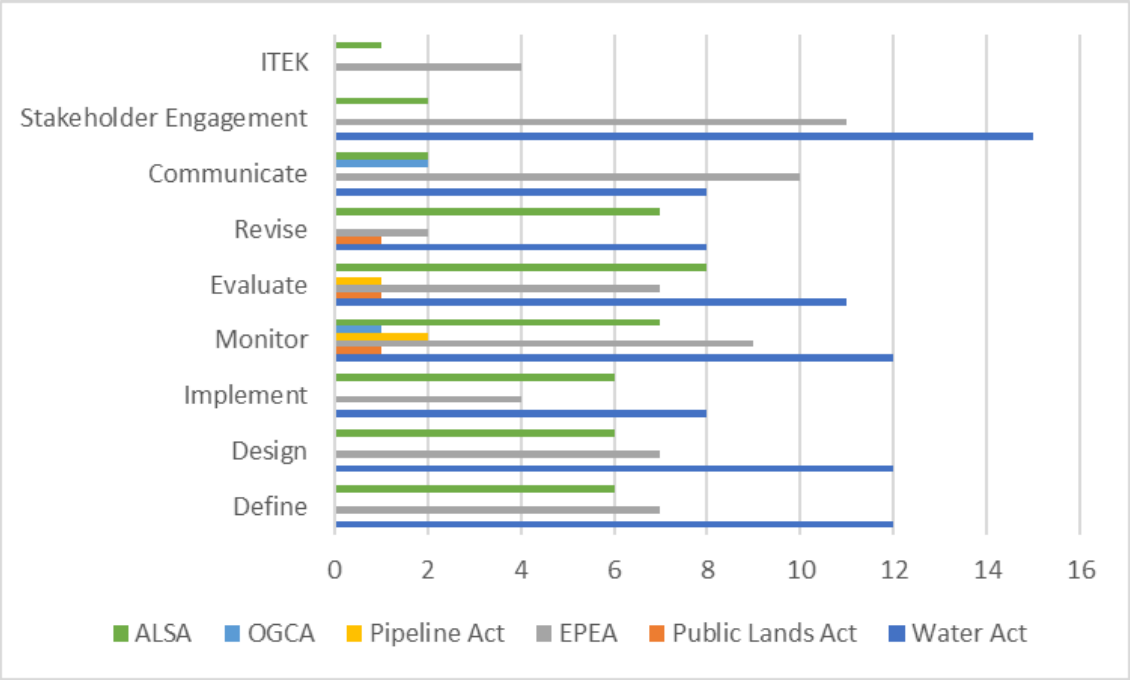

Figure 5-8 Adaptive Management Phases Supported in Acts

The analysis of the Rules and regulations in this sample illustrates a much stronger trend towards emphasizing “monitoring” and “evaluation” (Figure 5-8). “Monitoring” is almost three times more likely to be required than any other phase of AM within the OGCR and more than four times more common in the *Pipeline Rules*. The distribution for the *Conservation and Reclamation Regulation* (CRR) has no specific monitoring requirements, and a slightly higher emphasis on “evaluate,” when compared with other instruments, which is not surprising given the high level of scrutiny and assessment that is inherent with the end-of-life requirements for an activity and/or site. Monitoring should have largely concluded by the end of closure if the licensee has followed all applicable requirements and processes. The *Wastewater and Storm Drainage Regulation* (WWSDR), while potentially important for regulating aspects of MSHF (particularly operationalizing alternative water sources), was not found to contain any specific requirements to any phases of AM. Rather, it appears that the WWSDR is largely neutral with respect to AM, as the instrument does not contain requirements that would prevent or constrain AM from being rigorously implemented.

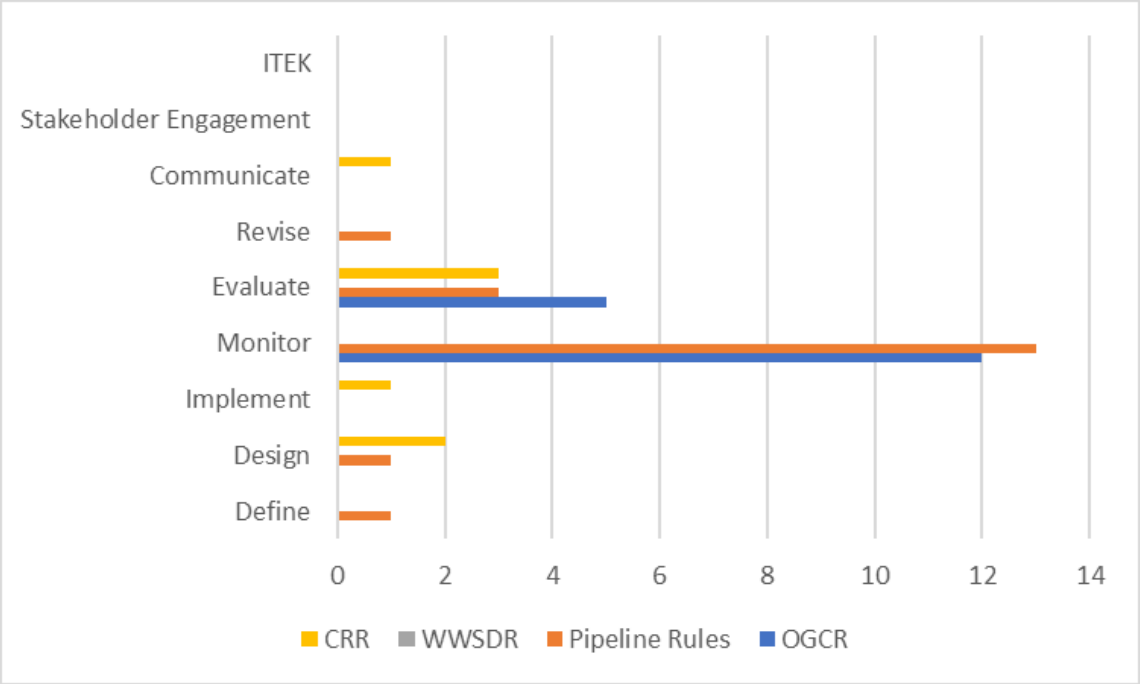

Figure 5-9 Adaptive Management Phases Supported in Rules and Regulations

The analysis of directives and the SED show that all phases of AM are at least minimally represented across the regulatory instruments (Figure 5-10). Directives and the SED investigated appear to have the most provisions or requirements that address monitoring. All of the instruments in this study have at least one mention of “design” in such a way that it could support that phase of AM as construed by Appendix A. Directive 58 has a number of references that could support “define” and “design” stages, particularly where there are requirements for operators and licensees to follow provisions in EPEA, especially where large facilities or waste management sites may need to undergo an Environmental Impact Assessment (EIA). The “evaluate” phase is also well represented and there are also references to “define,” particularly through the lens of applicants assessing application requirements for activities occurring within the boundary of a regional plan, or through siting criteria and project planning. Stakeholder engagement and the Indigenous/traditional ecological knowledge (ITEK) categories continue to be almost entirely unrepresented; however, as previously mentioned, there are other regulatory instruments that contain requirements for stakeholder engagement and indigenous consultation. Directive 083 is one of three instruments that specifically recommends revising: Section 9 recommends that “all licensees continually improve the planning and execution of its hydraulic fracturing operations by evaluating the effectiveness of its operations in meeting the regulatory objectives of this directive and

by revising the planning and execution of its subsequent hydraulic fracturing operations accordingly."

Most directives, with the notable exception of Directive 056, place higher emphasis on monitoring, but SED 002 places a higher emphasis on the evaluate phase. This is not unexpected, since evaluation of operation practices may be particularly emphasized at a project or development's end of life. Directive 056 predominantly contains requirements that would most closely align with the design phase of AM. This is not surprising since this directive provides details and requirements for proponents on how to submit applications and what the AER is expecting in terms of information, including any plans that are required. Also, Directive 056 contains large sections on participant involvement; however, it is not possible to tell from the requirements themselves whether stakeholders are satisfied with how these requirements are executed or what level of engagement applicants typically provide.

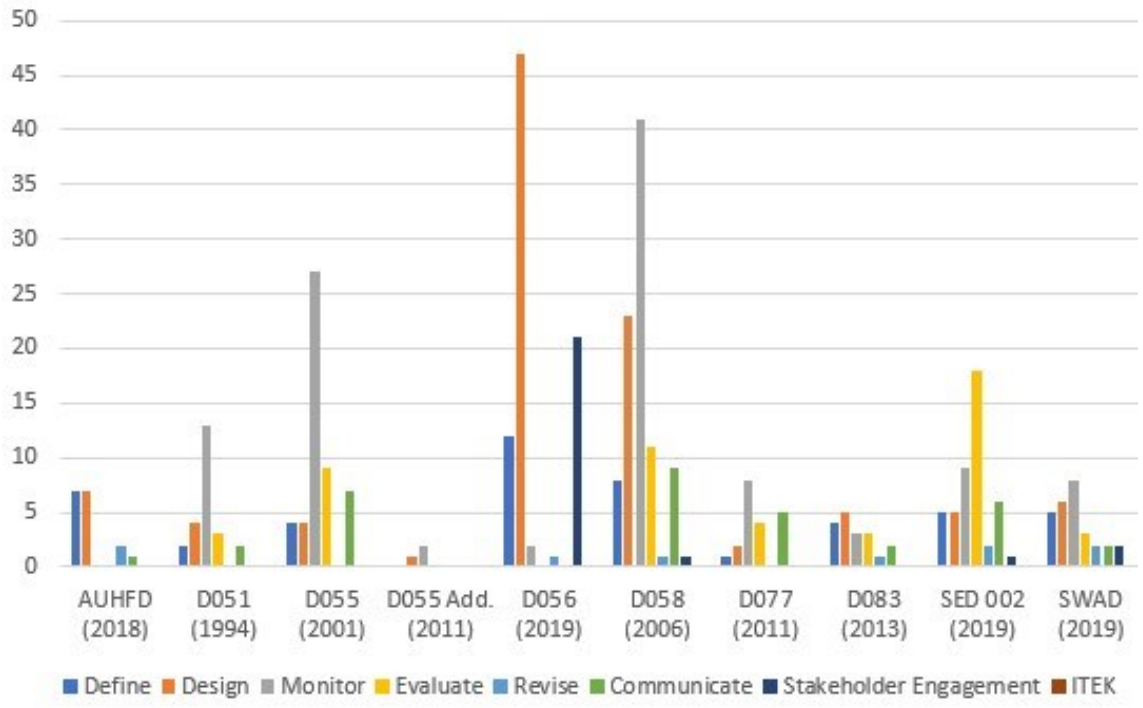

Figure 5-10 Adaptive Management Phases Supported in Directives and Specified Enactment Directions

Figure 5-11 illustrates the proportion a particular phase of AM represented in each directive, vis-à-vis all subsections that were coded as potentially operationalizing AM implementation. The figures show that for five of the ten directives shown,

monitoring comprises a high – as much as 50% or more – proportion of AM-related subsections discovered by the content analysis. This finding suggests that among the directives coded for this analysis, there is a disproportionately high emphasis on monitoring. In the absence of a parallel commitment to rigorous experimental design at the outset and evaluating results and data analysis, there is a significant likelihood that monitoring-focused AM (also referred to as Adaptive Monitoring) could be ineffective (Lindenmayer & Likens, 2009). Furthermore, this begs the question: what is the data collected during monitoring used for, and does it support AM? The lack of representation of all other phases of AM across the regulatory framework may produce an approach to AM that is monitoring for the sake of monitoring, or contingency planning since operators and licensees are not paying attention to controlled variables. As Gouin (2017) has noted, using AM in this way can lead to treatments or mitigation responses being implemented only when it is too late.

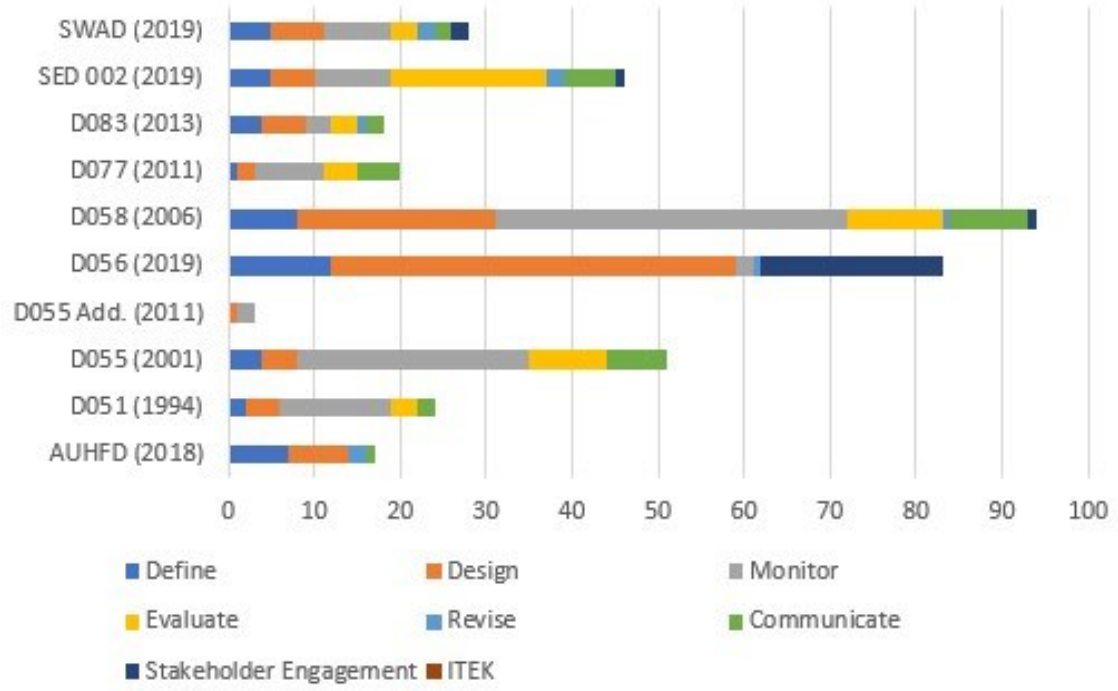

Figure 5-11 Adaptive Management Phases Present in Directives (Proportion)
Data are shown as a proportion in order of largest to smallest directive.

Interestingly, when considering directives as they are engaged across the lifecycle of operations, the distribution of AM references follows a logical sequence. Because Directive 056 is used at the time of application (i.e., before development and operations occur) it contains more requirements related to planning and design.

Directives that are relevant throughout the operational life of a project seem to focus on monitoring. Directive 058 requires consideration for siting and planning for waste management facilities and sites as well as operating them. As such, this directive contains a mix of planning and design requirements, as well as requirements for monitoring throughout the operational life. SED 002 contains reclamation requirements, so we see the distribution shifting towards evaluation, with limited references to revisiting or revising management actions. Given the limited subset, the results seem to indicate that stakeholder engagement may only happen at the time of application and is not revisited throughout the operational life of a project. This finding should be investigated further.

5.3. Conclusions

Based on the analysis of the data, this chapter concludes with the following summary of the major observations and takeaways:

- Legislation and regulations in Alberta are overwhelmingly prescriptive, which the academic literature has noted can constrain AM implementation.
- Terms and conditions and, to a lesser degree, clauses that enable amendments are the predominant mechanisms by which flexibility, oversight of AM, and the ability for iteration is introduced into the regulatory framework.
- AER directives and the SED show a greater distribution of regulatory categories. Prescriptive regulations remain the most common, but there is a significant increase in informational or non-regulatory material as well as an increasing proportion that is the most prescriptive regulatory type (that which specifies a technology or design);
- Specified enactments (e.g., water and environmental protection legislation) are significantly more likely than energy enactments (e.g., the OGCA) to contain provisions that could facilitate full-cycle AM implementation. Mandate sections and preambles of Acts could potentially align very well with the principles of AM;

- Where AM phases are provided for across the regulatory framework, there appears to be a disproportionate emphasis on monitoring, to the exclusion of other phases within the AM cycle.
- There is a significant gap between where AM is potentially provided for in Acts and operationalized by directives and regulations.

Chapter 6 applies the same coding and analysis methods to the legislative and regulatory framework in British Columbia. Chapter 7 provides an analysis of the findings of Chapters 4, 5 and 6, considered together.

Chapter 6.

Content Analysis of Adaptive Management Indicators in British Columbia's Water-Energy Legislative and Regulatory Regime

The research presented in Chapter 4 has identified that 47% of environmental policies in a 34-document sample in B.C. refer to or recommend adaptive management (AM) as an environmental management strategy. Chapter 5 noted that these findings are significant in that they suggest that proponents will ascertain through policy that AM is a viable and desirable option. This chapter employs the same methodology used for Chapter 5 (for Alberta) to conduct the legislative and regulatory analysis for B.C.; however, in this chapter, I begin a comparative analysis of the similarities and differences between provinces and use the findings from both samples to make inferences about the influence the legislative and regulatory regimes may have on AM.

6.1. Context and Approach

The legislative and regulatory content analysis described in this chapter analyzes 11 major legislative and regulatory instruments relevant to the shale gas water/wastewater lifecycle (Table 6-1). B.C.'s legislative framework is split between Acts, which provide overarching authority and underlying regulations which provide additional details and requirements for administration of the law. B.C.'s regulations appear to be a simpler model than Alberta's as the division between Acts and regulations is clear, whereas Alberta has multiple levels of Acts, Regulations, Rules, and Directives that may be administered by the government or the regulator. It is beyond the scope of this analysis to examine guidance documents and manuals that cannot be enforced under an Act since that would result in findings that are skewed 100% between information and optional or best practices recommendations. As such, a significant cross-section of B.C.'s regulatory framework was omitted from the analysis of types of requirements found in legislative and regulatory instruments. Therefore, this analysis finds that some of the detail provided in Alberta's directives is absent in B.C.'s enforceable regulation but exists as supplementary guidance to Acts and Regulations. However, B.C.'s guidance

documents were considered in the qualitative analysis of terms and concepts that could support AM.

Two thousand two hundred and seventy-five (2775)[38] individual subsections of text were analyzed and coded across two major categories:

1. The kind(s) of regulation(s) that the subsection is made up of, and

2. A qualitative analysis of indicators that would suggest the subsection is able or not able to enable implementation of Adaptive Management (AM), including specific steps in the AM cycle, if applicable.

As described in Chapter 3 outlining this study's methodology, different kinds of regulations and their associated level of prescription may be more or less aligned with the principles of AM and thus better suited to enable implementation. The legislative and regulatory instruments analyzed in this chapter are identified in Table 6-1.

Table 6-1 British Columbia Legislative and Regulatory Instruments Analyzed

Acts and Provincial Statutes	Regulations
Oil and Gas Activities Act (OGAA)	Drilling and Production Regulation (DPR) (OGAA)
	Environmental Protection and Management Regulation (EPMR) (OGAA)
	Oil and Gas Activities Act General Regulation (OGAA-GR) (OGAA)
	Pipeline Regulation
Environmental Management Act (EMA) (Referenced under OGAA)	Oil and Gas Waste Regulation (OGWR) (EMA)
Land Act (Referenced under OGAA)	
Water Sustainability Act (WSA) (Referenced under OGAA)	Groundwater Protection Regulation (GPR) (WSA)
	Water Sustainability Regulation (WSR) (WSA)

A discussion of the features that make a legislative or regulatory instrument compatible with AM is included in Chapter 2.

[38] The BC subset of Acts and regulations considered in this chapter is roughly 65% of the size of the Alberta sample that was analyzed in Chapter 5.

6.2. Results and Analysis

This section presents the results of the coded data collected for the 11 Acts and Regulations listed in Table 6-1 subdivided into three categories: 1. Results for Acts; 2. Results for Regulations; and 3. Results for the analysis of AM-related themes. B.C.'s legislative framework appears to be more straightforward than Alberta's since there is not an additional level of regulation between Acts and Regulations (e.g., Rules) and the Government of British Columbia enacts all enforceable laws and regulations. Whereas the Alberta Energy Regulator (AER) is given authority to release directives, specified enactment directions (SEDs), subsurface orders (out of scope for this analysis), and guidance documents (out of scope for this analysis) the B.C. Oil and Gas Commission (OGCR) publishes guidance documents to supplement only Acts and regulations with additional information and suggestions for how operators can comply with existing legislation (e.g., the Oil and Gas Operations Manual and the Management of Saline Fluids for Hydraulic Fracturing Guideline).

B.C.'s legislative framework has some notable differences from Alberta's. For example, the legislative framework is organized under only one energy enactment (the *Oil and Gas Activities Act* (OGAA) whereas Alberta also has a distinct *Pipeline Act* (whereas B.C.'s pipeline regulations fall under the OGAA). Also, B.C.'s specified enactments (e.g., *Water Sustainability Act* (WSA) and *Environmental Management Act* (EMA) have fewer associated regulations under their authority than Alberta's comparative *Water Act* and *Environmental Protection and Enhancement Act* (EPEA). B.C. does not seem to have codes of practice under the specified enactments, which further simplifies the regulatory framework. Other key similarities and differences will be discussed throughout this chapter.

6.2.1. Coding Results of Acts and Implications for Adaptive Management

Like Alberta, B.C.'s Acts – the *Environmental Management Act* (EMA), the *Land Act*, the *Oil and Gas Activities Act* (OGAA) and the *Water Sustainability Act* (WSA) – are predominantly comprised of prescriptive requirements (~56%-81%) but show a growing proportion of outcome-based requirements (OBR) for the EMA (~20%) and WSA (~30%) (Figure 6-1). The OGAA and *Land Act* continue to be highly prescriptive, albeit less so

than Alberta. The level of flexibility demonstrated by the WSA may also be a feature of its age (first enacted in 2014) since many jurisdictions across Canada have recently begun to focus on using OBR to reduce administrative and regulatory burden, and to foster innovation, particularly for dynamic technical industries such as oil and gas (Treasury Board of Canada Secretariat, 2018). Interestingly, the WSA in B.C. has the highest proportion of OBR when compared with the other Acts (30%) whereas the *Water Act* in Alberta has the lowest proportion of OBR when compared with other Alberta Acts (>1%). It should also be noted that B.C.'s WSA was enacted in 2016 to replace its badly out-of-date predecessor the *Water Act*. Although the new Act preserves the system of seniority for water licenses (first-in-time, first-in-right), it also introduces a "no compensation" provision whereby, unlike Alberta, the government is not required to compensate a permit holder if there is any "change in precedence of water rights, a restriction or prohibition on the exercise of rights, or a change or the imposition of new terms and conditions on an approval" (WSA, section 121). This inclusion is potentially groundbreaking and could enable B.C. governments and regulators to recognize, respond, and adapt to emerging hydrological and environmental changes over time without penalty or the risk of litigation (Curran, 2014). Figure 6-3 further illustrates the great extent to which the WSA provides flexibility through terms and conditions (including changes to terms and conditions) which appears 77 times in the text. If regulators choose to use these new powers, they could possibly be used effectively for the administration and implementation of AM.

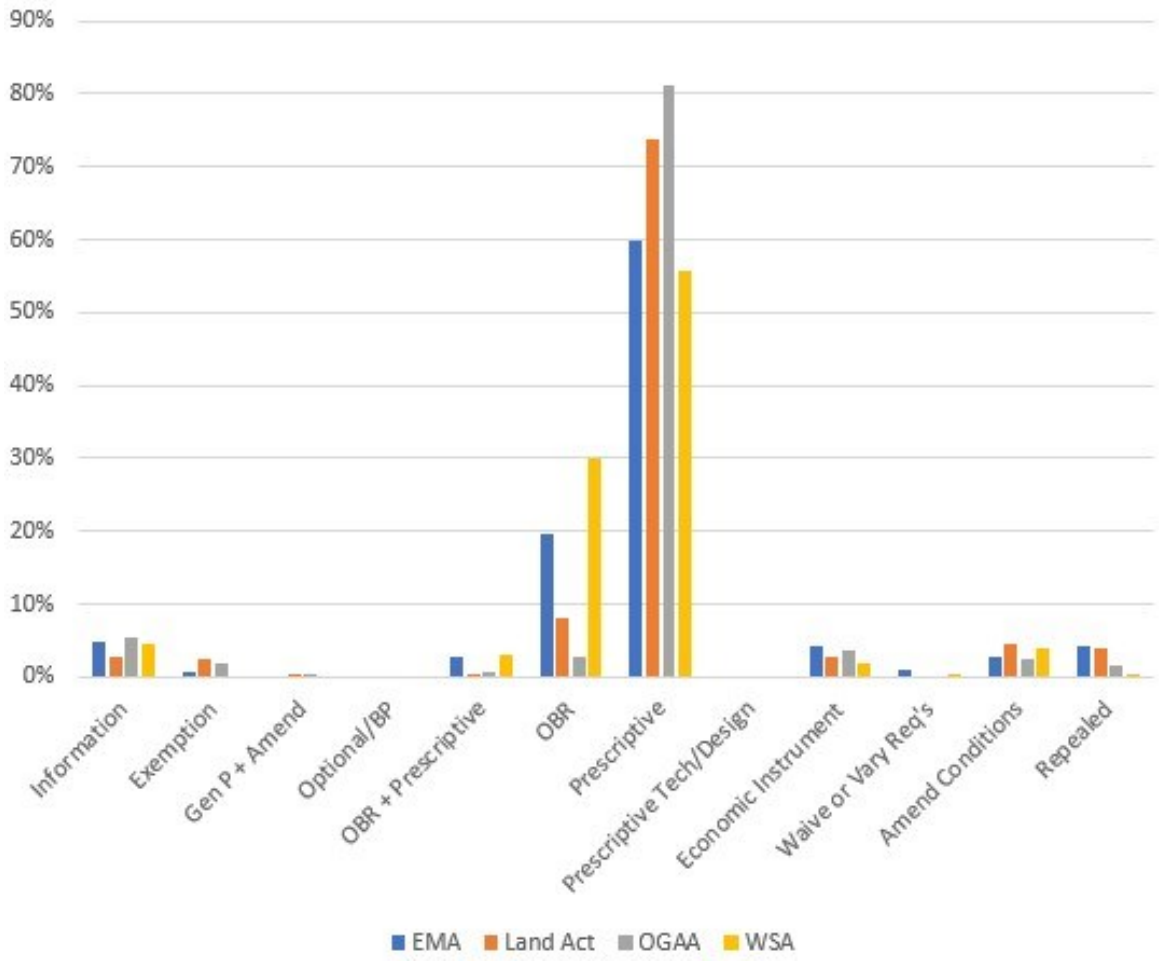

Figure 6-1 Regulatory Composition of British Columbia Acts
Refer to the Evaluation Rubric in Table 3-2 for a description of each code used on the X-Axis.

Figure 6-2 presents the y-axis on a logarithmic scale to enable a more detailed representation of the less represented regulatory categories. The data in Figure 6-2 compared to the data for Alberta (Figure 5-2), show that regulations, other than prescriptive or OBR, are less common in B.C. and range anywhere from less than 1% to just over 5%.

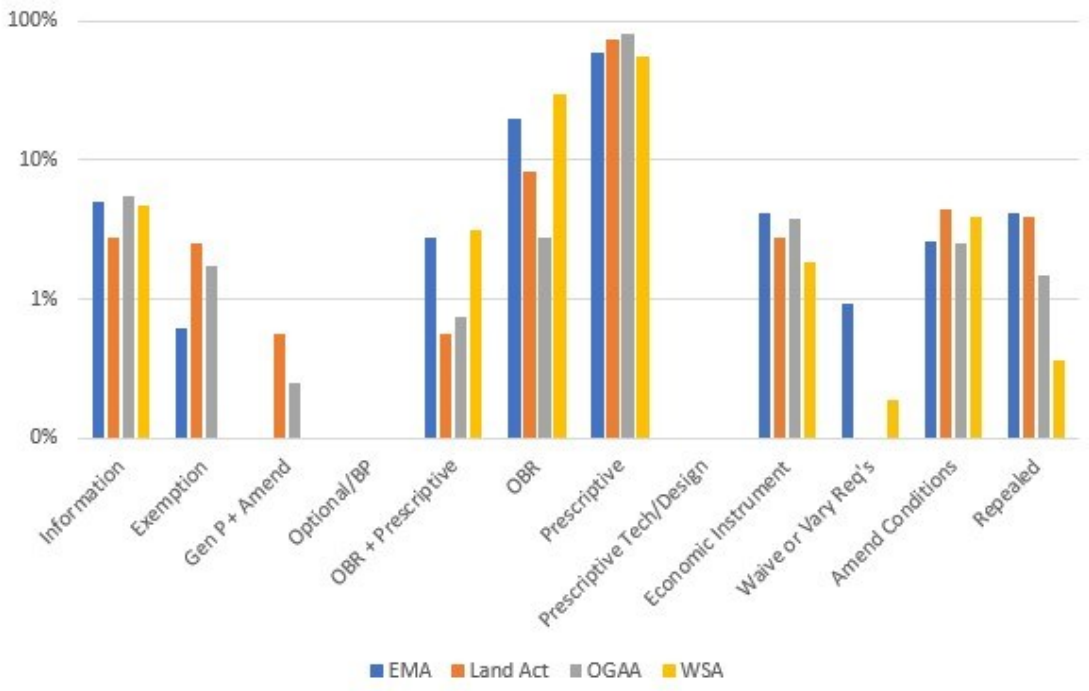

Figure 6-2 Regulatory Composition of British Columbia Acts (Log Scale)
Y-axis is presented on a logarithmic scale. Refer to the Evaluation Rubric in Table 3-2 for a description of each code used on the X-Axis.

The ability to use flexible regulatory types such as amendment clauses is meaningful, albeit uncommon (<%5 of any Act), offering valuable opportunities to review licences and integrate new information, when possible. At least theoretically, amendment provisions could support the iterative requirements of AM implementation. It should be noted that the EMA and WSA make numerous references to amending terms and conditions, permits, licences and authorizations. The EMA gives broad authority to a director to amend the requirements of a permit or approval on their own initiative, or if they consider it necessary, for the protection of the environment (section 16). It was beyond the scope of this analysis to determine how often such provisions are used; however, they are certainly not unheard of for cases that warrant intervention, and there has been at least one precedent set for rescission of a water licence that relied on a flawed scientific model as part of its AM strategy as discussed below. Figure 6-2 shows that the WSA has very low representation of economic instruments. It should be noted that B.C. Reg.37/2016, the *Water Sustainability Fees, Rentals and Charges Tariff Regulation*, which was developed under the WSA, contains fees for water use which largely act as a subsidy.

In 2015, the B.C. Environmental Appeal Board (EAO) rescinded Nexen's (a hydraulic fracturing company) licence issued in 2012 under section 8 of the *Water Act* (predecessor to WSA). Nexen's licence was supported by a Water Development Management Plan and relied heavily on AM to address major uncertainties inherent in making water withdrawals in the Tsea watershed in northeastern B.C. In response to Nexen's insufficient response to numerous Environmental Management Orders, the EAO cancelled their water licence on the basis that; Nexen had fundamentally misused and skewed hydrometric models (para 337); that the results of the environmental assessments provided by Nexen were incorrect and would not adequately address adverse environmental impacts (para 338); and that the consultation process with the Fort Nelson First Nation had not been adequate or conducted in good faith from the beginning (Chief Gale v Assistant Regional Water Manager & Nexen [(3 September 2013), Decision No 2012-WAT-013(c) (BC Environmental Appeal Board)]. Another major complaint of the Fort Nelson First Nation, which was not accepted by the EAO, was that the precautionary principle was incorrectly applied to the water licence and water management plan, in general (Para 179).

Unlike Alberta's Acts, the B.C. Acts considered in this study do not contain preambles and mandate statements[39]. However, there are important provisions that could potentially be used to implement AM. For example, Part 3 of the WSA (Protecting Water Resources) provides for water objectives:

> ***43*** *(1)For the purposes of sustaining water quantity, water quality and aquatic ecosystems in and for British Columbia, the Lieutenant Governor in Council may make regulations*
>
> *(a)* ***establishing water objectives*** *for a watershed, stream, aquifer or other specified area or environmental feature or matter in order to sustain*
>
> *(i)water quality required for specified uses of water,*
>
> *(ii)water quantity required for specified uses of water, and*

[39] B.C. does not have purpose statements in its legislation which reflects the legislative drafting culture of this jurisdiction. While purpose statements can inform the interpretation of the law, they do not specifically enable any particular action.

(iii)water quality and water quantity required to sustain aquatic ecosystems in relation to the watershed, stream, aquifer or other area, feature or matter,

*(b)**specifying factors and criteria to apply for evaluating the impacts of a land use or resource use proposal on objectives established under paragraph** (a), and*

(c)respecting measures to address impacts of such proposals on the objectives.

(2)A regulation under this section may

(a)require that a water objective be considered by a public officer making a specified decision under a specified enactment, if the decision is in relation to the watershed, stream, aquifer or other area or environmental feature or matter for which the water objective was prescribed, and

*(b)authorize or require a person referred to in paragraph (a), **in order to promote achievement of the water objective, to impose requirements, as terms and conditions**, on any instrument the person issues.*

A 'water objective' is loosely defined by the WSA but could theoretically allow for defining management goals and objectives, identifying uncertainties, building models, and stating hypotheses and assumptions to fully implement step 1 (assess and define the problem) of AM (see Appendix A). Note that the water quantity and quality, and aquatic ecosystem objectives could practically conflict if the needs of the aquatic ecosystem were threatened by a consumptive user.

As noted by Curran and Mascher (2016), B.C.'s WSA has made several important changes to the water legislative regime that can serve to better implement AM. Division 4, under Part 3 of the Water Sustainability Act (sections 64-84) enables the creation of Water Sustainability Plans, which offer powerful authorities to governments and regulators to amend approvals, and/or the terms and conditions thereof. Similarly, section 23 of the WSA allows for a 30-year license review which requires licensees and

persons who divert water to make “beneficial use” of the diversion which may also result in an audit of the licensee. This “use it or lose it” provision, where a license might be suspended or cancelled should the licensee fail make “beneficial use of the quantity of water authorized” within 3 years could provide an essential mechanism by which to enable flexible decision making and AM (Curran & Mascher, 2016: 212; B.C. WSA at subsection 30).

Similarly, under the EMA, a minister can order that an ‘area-based management plan’ be developed and require the participation of specific licensees, permit holders or other individuals designated by the minister (section 89). Notwithstanding the lack of clarity on *when* an area-based management plan might be prepared or at what stage of development the area may already be subject to, the plan seems to request a number of elements that could facilitate any of the steps of AM, including a process for public and stakeholder consultation and ongoing monitoring and reporting. Subsection 4(c) notes that the plan may include “environmental management objectives and outcomes for the area.” The devil, of course, is in the details of implementation. Comparing the contents and timing of the area-based management plans with the steps required for AM would be an interesting follow-up to this study.

It should be noted that, although a legislative provision is broad enough to enable AM, this dissertation makes no comment on whether it is ever used in that way. Moreover, if the legislation is used in this way, it would not be possible to determine the quality of implementation without conducting further analysis on the programs and plans that are drafted in response. On the one hand, it is positive to note that AM could theoretically be implemented without major legislative amendments. It appears that a minister or decision maker has the necessary tools to enable the implementation of AM; however, it seems likely that additional guidance and requirements would be necessary to ensure that obligations are clear, and performance is managed.

Like Alberta, B.C.’s legislative regime contains numerous references to terms and conditions (Figure 6-3), although B.C.’s legislative framework applies terms and conditions far more frequently than Alberta. For example, EPEA (Alberta) refers to terms and conditions in 25 cases, whereas B.C.’s EMA refers to terms and conditions 70 times. Alberta’s *Water Act* refers to terms and conditions 11 times, whereas the WSA provides for terms and conditions 77 times across a similarly sized document.

Comparatively, the energy enactments in both jurisdictions are less likely to enable a decision maker to use terms and conditions, however, the authority is more present in B.C.'s legislative sample than in the Alberta sample.

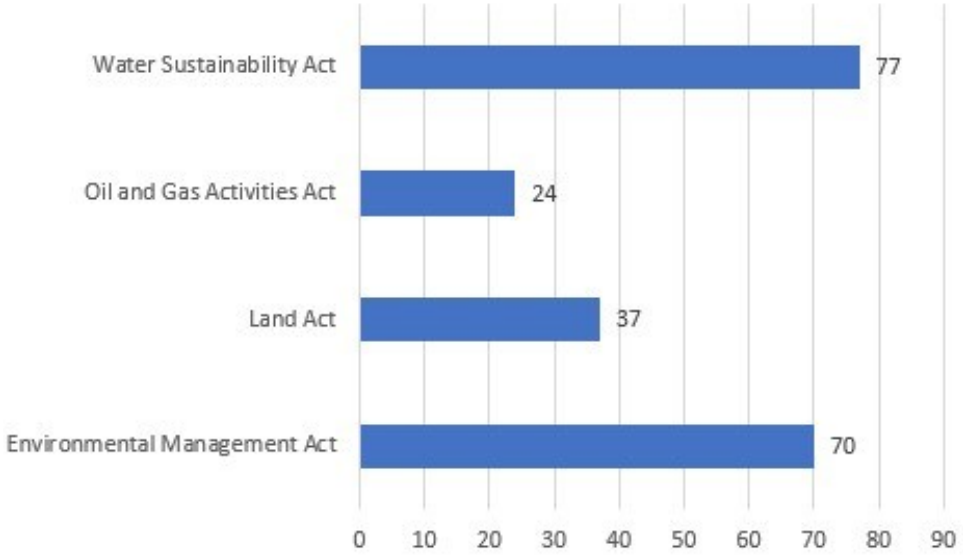

Figure 6-3 Number of References to Terms and Conditions in British Columbia Acts

In B.C. terms and conditions can be applied to permits, authorizations or approvals. As was highlighted in Chapter 5, understanding the extent to which terms and conditions ever explicitly include AM was beyond the scope of this research.

6.2.2. Coding Results of Regulations and Implications for Adaptive Management

Seven regulations were analyzed in this dissertation: The Drilling and Production Regulation (DPR), the Environmental Protection and Management Regulation (EPMR), the Groundwater Protection Regulation (GPR), the OGAA – General Regulation (OGAA-GR), the Oil and Gas Waste Regulation (OGWR), the Pipeline Regulation and the Water Sustainability Regulation (WSR). Unlike Alberta, while these regulations are typically predominantly prescriptive (Gen P), outcome-based regulation (OBR) is very much present in the sample (Figure 6-4). In particular, the OGWR is over 40% OBR. It should be noted that the OGWR is very short (only ten subsections) and the OBR components primarily establish thresholds or limits on discharge of air contaminants or fluids discharged during activities carried out under the OGAA (e.g., produced water, drilling

muds, etc.). For all of the regulatory instruments investigated in this section, the general prescriptive category covers requirements for what should be included in applications, general operational criteria (e.g., storage of waste, minimum standards for well construction, who may carry out activities under the Acts, etc.). This aligns with Baldwin et al.'s (2012) description of general command-and-control regulation under a typical administrative law regime in a western democracy.

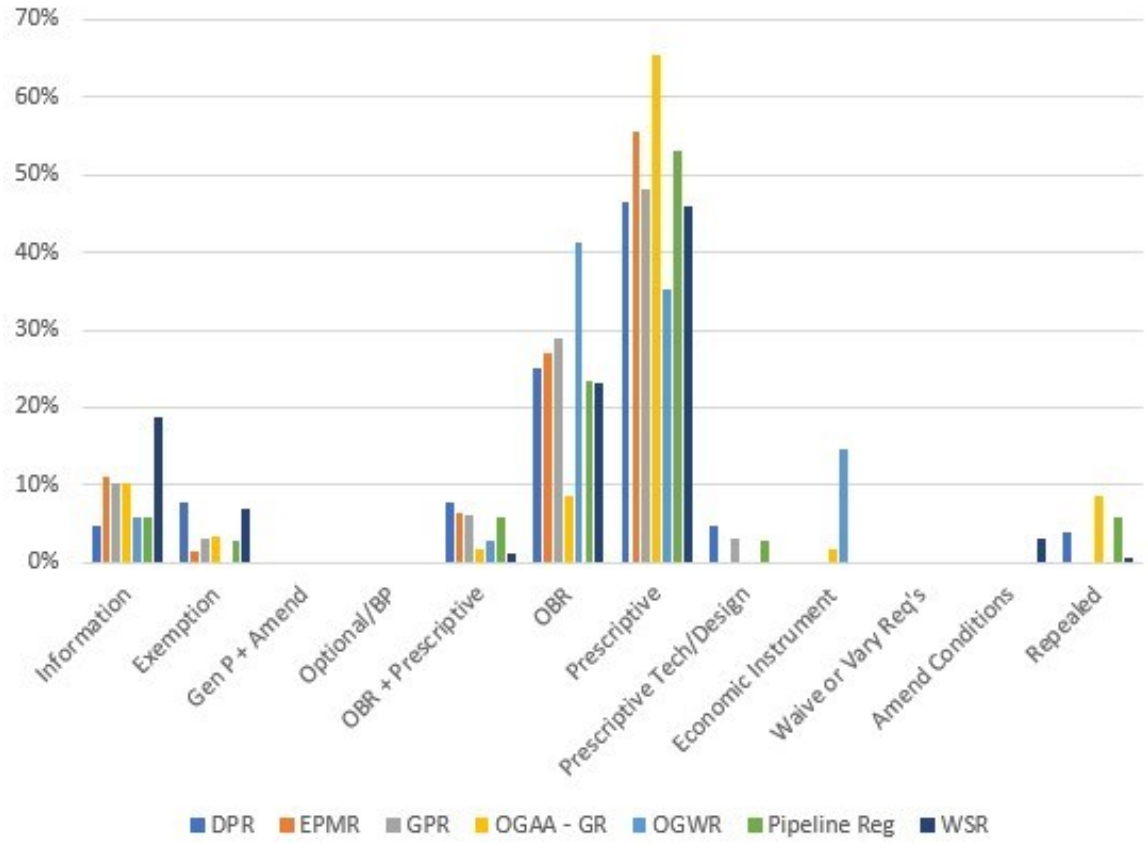

Figure 6-4 Regulatory Composition of British Columbia Regulations
Refer to the Evaluation Rubric in Table 3-2 for a description of each code used on the X-Axis.

Note that very few of the regulatory instruments give the authority to amend terms and conditions or approvals, impose economic or financial instruments (except for fines in the OGWR), or contain highly prescriptive technical or design requirements. Interestingly, none of the regulations reviewed for B.C. included best practices or optional recommendations for industry, which was more commonly observed in Alberta. However, like Alberta, B.C.'s regulatory framework includes numerous operational guidance manuals which contain processes and recommended practices to improve

compliance with the regulations or describe OGC's expectations for submissions from applicants.

The Water Sustainability Regulation and the Groundwater Protection Regulation contain more references to terms and conditions than regulations under energy enactments, although, somewhat surprisingly, the EPMR does not provide for terms and conditions (Figure 6-5). In the case of the GPR, terms and conditions seem to be used predominantly for establishing special requirements in the case of siting, constructing, operating, or decommissioning wells. In that sense, it can be presumed that the terms and conditions would be protective of groundwater sources. As such, it is likely that AM would not be considered a suitable management strategy and the precautionary principle could apply. However, there may be cases where a decision-maker determines that this is not the case. Similarly, the WSR imposes a number of standalone conditions that are primarily protective in nature as well as terms and conditions attached to a licence approval. Applications or applications to change approvals or activities carried out in and about a stream may be subject to terms and conditions where the applicant is required to comply.

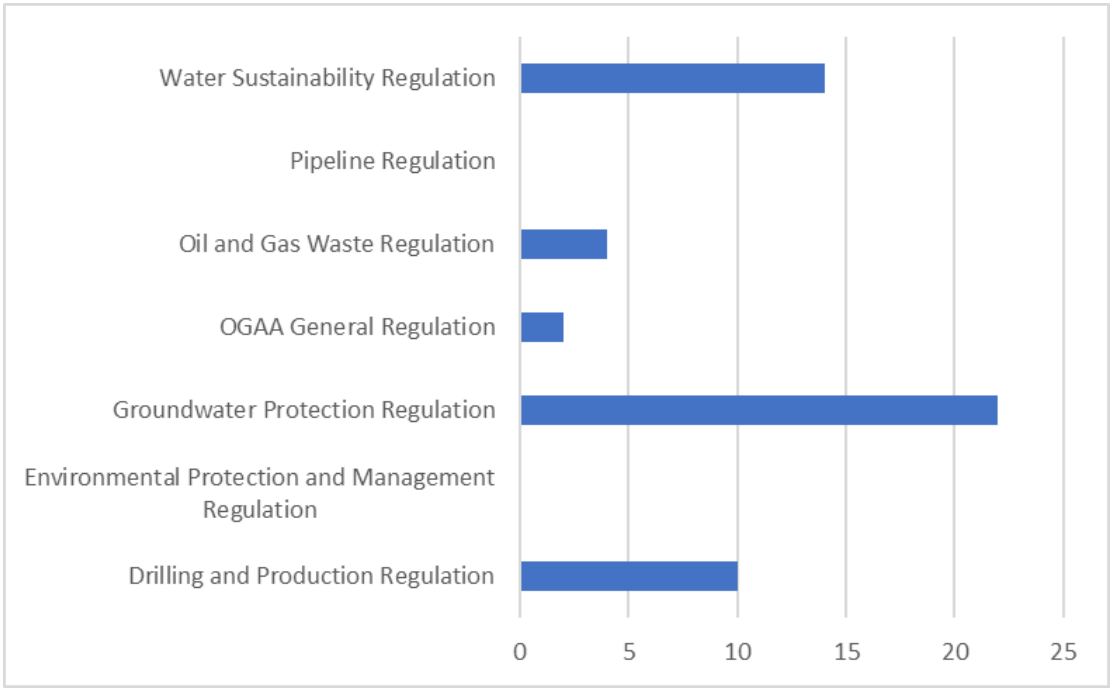

Figure 6-5 Number of References to Terms and Conditions in British Columbia Regulations

6.2.3. Qualitative Analysis of Adaptive Management Implementation in the Regulatory Regime

Some of the Acts considered in this dissertation contain some provisions that could enable implementation of AM. The specified enactments, with the notable exception of the Land Act, contain the highest numbers of subsections that could be used to implement one or more phases of AM (Figure 6-6). References that could be construed as supporting the AM steps outlined in Appendix A were virtually non-existent in the Land Act and the OGAA. Particularly with respect to the OGAA, this may be due to its narrow focus on the permitting and application process and the operational phase of the lifecycle. Interestingly, the OGAA also does not contain references to monitoring which is far more present in the regulations under the authority of the OGAA. Additionally, the OGAA establishes that in the case of conflict or inconsistency between OGAA and the Muskwa-Kechika Management Area[40] Act (M-KMAA), M-KMAA prevails. This is an important distinction as AM serves as a component of the resource management plans in the M-KMA. Although beyond the scope of this study, it would be interesting to investigate the AM implemented in M-KMA and the extent to which the overarching legislative and regulatory framework enables a robust implementation.

[40] The Muskwa-Kechika Management Area (M-KMA) is a protected area in northeastern B.C. known for its pristine wilderness, biodiversity, and First Nation's culture, including the practice of traditional ecological knowledge (TEK). The M-KMA includes parks and other areas that are protected from resource extraction and several "management zones" where development is subject to more stringent requirements than anywhere else in B.C. Refer to the M-KMA website for further information.

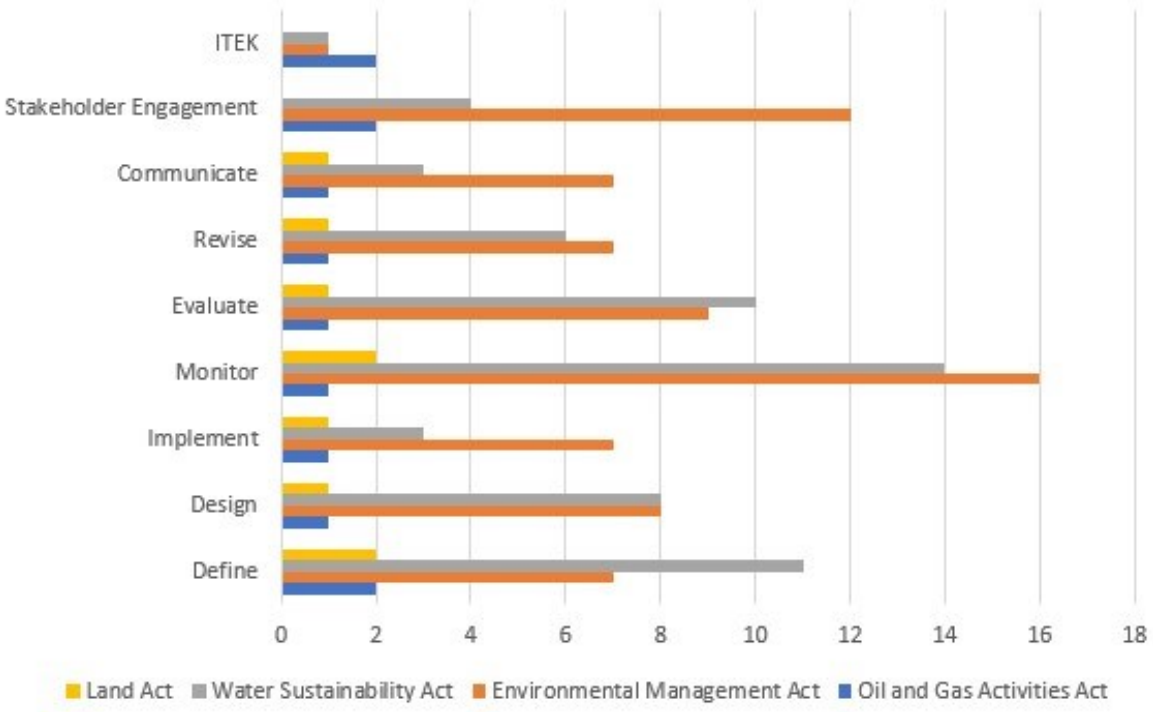

Figure 6-6 Adaptive Management Phases Supported in Acts

The EMA and the WSA contain the most requirements that align with the phases of AM. As was observed in Alberta, references to monitoring are the most common. Interestingly, the EMA contains 12 references to stakeholder engagement or consultation, whereas references that explicitly include consultation with Indigenous peoples or consideration of TEK are infrequent. This seems to further point to the inherently colonial nature of resource development and environmental management that is practiced in resource-rich jurisdictions. The legislation seems to follow the pattern observed in the policies reviewed for Chapter 4 which indicate that Indigenous peoples and TEK are not explicitly situated in AM. When considering the four Acts reviewed in this chapter, it is interesting that none of them, particularly the specified enactments, mention Indigenous rights or practices. While this is likely due to provisions being found for Indigenous peoples, TEK and consultation in other Acts and regulations, it is interesting that B.C.'s environmental and water management legislation is essentially silent on the matter. The WSA, in particular, is an interesting case for consideration given that it was enacted in 2016 and should, at least theoretically, be a more contemporary reflection of the priorities of the B.C. government with respect to Indigenous consultation and reconciliation.

It is important to note that the WSA makes 21 references to “mitigation measures,” and in some cases “compensatory mitigation measures” if there is a risk that what is proposed in an application are likely to have “a significant adverse impact on water quality, water quantity or aquatic ecosystem” (section 16). The WSA also contains provisions for mitigation measures for sensitive streams (section 17 and 128), protected fish populations (section 17), remediation activities (section 47 and 93) and compliance agreements for mitigating adverse impacts (section 102). This is important, because Chapter 2 presented evidence that, at least occasionally, AM is linked to mitigation measures in contexts where it should not have been. The CEAA Operational Policy Statement notes “commitment to adaptive management is not a substitute for committing to specific mitigation measures in the EA prior to the course of action decision. Adaptive management is an approach involving flexibility to modify mitigation measures or develop and implement additional measures in light of real-world experience” (IAA, OPS, 2009: web). Kwasniak (2009 & 2010) has noted that the court’s problematic conflation of AM’s use has resulted in AM being used improperly to cover situations where the success of mitigation measures is not technically or economically feasible.

The WSA does not specifically define ‘mitigation measures,’ although the federal *Impact Assessment Act* (IAA) defines them as: “measures to eliminate, reduce, control or offset the adverse effects of a project or designated project, and includes restitution for any damage caused by those effects through replacement, restoration, compensation or any other means” (section 2). A related concept, follow up programs, is defined in the IAA as “a program for verifying the accuracy of the impact assessment of a designated project and determining the effectiveness of any mitigation measures” (section 2). The IAA does not specifically mention AM, but it’s predecessor, the CEAA linked AM to follow up programs. The CEAA Operational Policy Statement for the *Canadian Environmental Assessment Act*, 2012. CEAA notes several cases where AM might be appropriate, particularly in cases where a mitigation measure “may not function as intended,” where “some aspects of the proposed mitigation may not actually be needed, or they are no longer required,” or “the likelihood that advances in scientific knowledge or technology over the life of the project may enable improved mitigation measures” (CEAA, 2016: web). Also, as required by the 2012 Act and as Chalifour (2009) has noted, mitigation measures must be technically and economically feasible. This is further highlighted in the 2016 OPS which states “it is insufficient to assert that implementation of an

unidentified future measure, developed as a result of adaptive management, constitutes mitigation of a predicted adverse environmental effect" (CEAA, 2016: web). The clarity provided in the Act, combined with the criticisms raised by experts such as Chalifour (2009) and Kwasniak (2009 & 2010), highlight that special care should be taken when designing mitigation measures to ensure that a context is appropriate for AM and that AM is designed in a way that conforms to the best practices identified in the literature.

Observations of the performance of the seven regulations under review indicate that they do not contain requirements that would indicate a high level of support for AM (Figure 6-7). The findings are similar to those in Chapter 5 and are supported by the academic literature discussed in Chapter 2. Notably, there are no references to either stakeholder engagement or Indigenous consultation or ITEK or cross-references that indicate requirements may be found somewhere else. Neither the Pipeline Regulation nor the OGAA-GR contained any provisions that could be construed as supporting any of the phases of AM. Monitoring was more likely to be represented in the regulations. The EPMR put equal emphasis on the evaluate phase as well as monitoring. However, B.C.'s sample regulations do not appear to support the phases of the AM cycle directly.

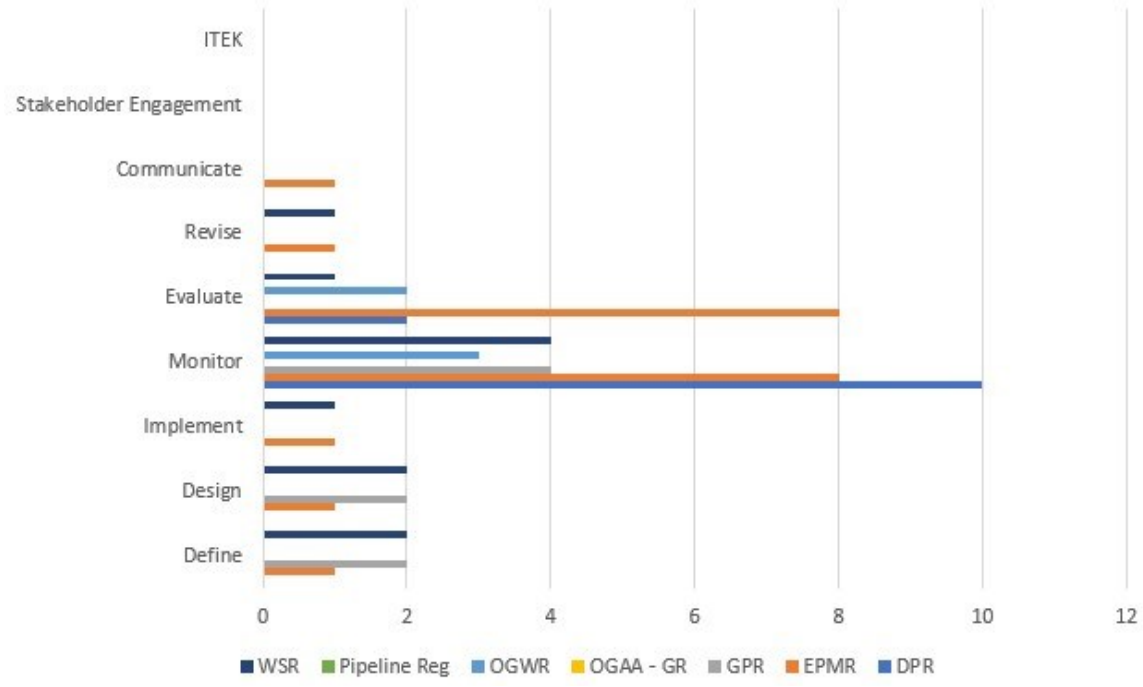

Figure 6-7 Adaptive Management Phases Supported in Regulations

Figure 6-8 illustrates the AM phases as a proportion of references found in the individual regulations. Monitoring continues to be the most referenced phase of AM, although the EPMR contains requirements that could support the evaluation phase. Stakeholder engagement is virtually non-existent, suggesting that these requirements and processes are available elsewhere.

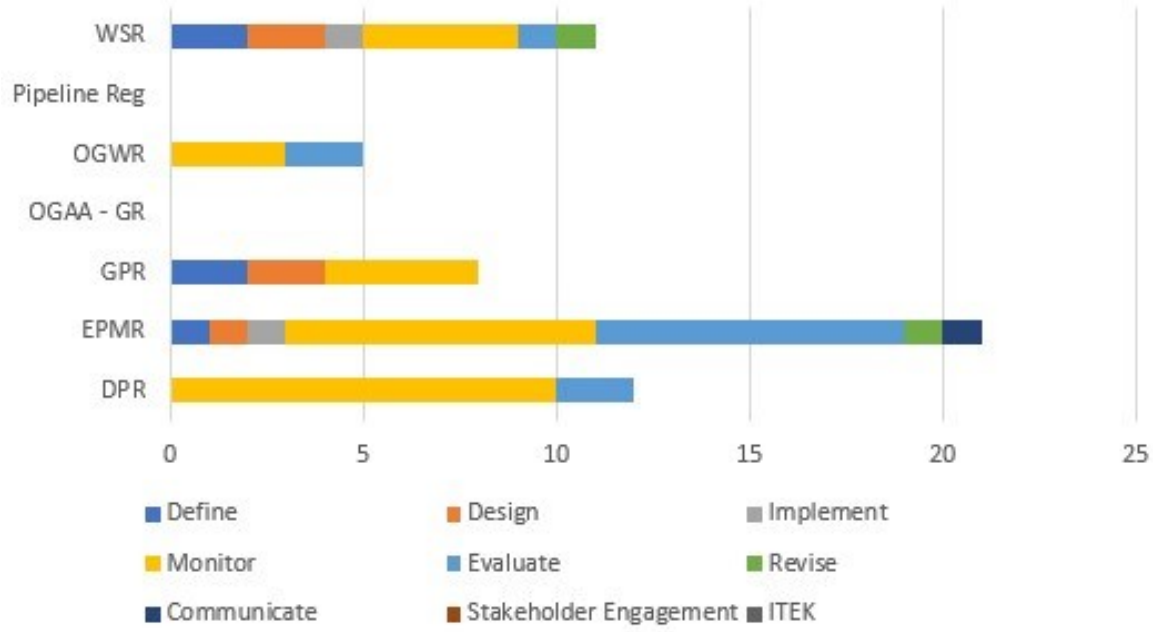

Figure 6-8 Adaptive Management Phases Present in Regulations (Proportion)

The EMPR contains two key sections that could possibly enable AM implementation: sections 27 (Fisheries sensitive watersheds established) and 35 (Designated watersheds established). Section 27 states:

> ***27*** *The minister responsible for administering the Wildlife Act, by order, may establish a fisheries sensitive watershed in a watershed that has significant downstream fisheries values, significant fisheries values and significant watershed sensitivity if satisfied that the area requires special management to protect fish by*
>
> *(a)conserving*
>
> *(i)the natural hydrological conditions, natural stream bed dynamics and stream channel integrity, and*

(ii)the quality, quantity and timing of water flow, or

(b)preventing cumulative hydrological effects that would have a material adverse effect on fish.

Section 35 states:

35 *The minister responsible for administering the Water Sustainability Act, by order, may establish a watershed or a portion of a watershed, including a community watershed or a portion of a community watershed, as a designated watershed, if the minister is satisfied that the watershed or portion of the watershed requires special management to protect*

(a)the quality or quantity of water, or

(b)the timing of flow of water.

These sections could broadly enable AM implementation for areas that require special management or areas where preventing cumulative effects may be necessary.

6.3. Conclusions

Based on the analysis and the data, this chapter concludes with the following summary of the major observations and takeaways:

- Like Alberta, legislation and regulations in B.C., with a few notable exceptions, are overwhelmingly prescriptive. As discussed at length in this dissertation, the academic literature has noted that this can constrain AM implementation.
- Like Alberta, terms and conditions and, to a lesser degree, amendment clauses are the predominant mechanisms by which flexibility, oversight of AM, and the ability for iteration is introduced into the regulatory framework. Clauses that enable terms and conditions are represented at significantly higher frequencies in B.C.'s legislative framework; however, it is not possible to determine from the regulatory instruments how often terms and conditions are applied to approvals, or for what.

- There is low variability across regulatory categories. Prescriptive regulations are the most common, but there is a significant proportion of OBR that is seen in Acts and regulations. Technology or design requirements are not common in B.C.
- B.C.'s specified enactments (the WSA and EMA) seem to provide the most alignment and opportunity to incorporate all AM phases.
- Some of B.C.'s Acts and regulations place a disproportionately high emphasis on monitoring, but most legislative and regulatory instruments do not incorporate the phases of AM. This, combined with the prescriptiveness of the regulatory regime, seems to suggest that the opportunity to effectively implement AM may be low unless special effort is made to use the flexibility provided through terms and conditions, and amendment clauses.

Chapter 7 considers the combined results of the policy and regulatory analysis from Alberta and B.C.

Chapter 7.

Discussion

Since the methodology and underlying principles of Adaptive Management (AM) were articulated in Holling's (1978) book *Adaptive Environmental Management,* AM has become pervasive across North American natural resource management contexts (Harm-Benson & Schultz, 2015; Olszynski, 2016 & 2020). In recent years, AM has been invoked for oil and gas development contexts at both the licensing level (see Chief Gale v Assistant Regional Water Manager & Nexen [(3 September 2013), Decision No 2012-WAT-013(c) (BC Environmental Appeal Board)] up to the major project level where multiple approvals across both energy and specified enactments are required (e.g., Benga Grassy Mountain Coal Project, described in Chapter 1). The literature illustrates that while AM is "important, possibly essential, in the search for a durable and sustainable relationship between humans and the natural world" (Lee, 1999: 12) it is rarely implemented fully (i.e., active AM) or successfully in the field for reasons that are well-documented in the literature and discussed in Chapter 2 (Allen & Gunderson, 2011; Gregory et al, 2006; Lee, 1999; National Academies of Science, Engineering, Medicine, 2011; Susskind et al., 2010; Walters, 2007; Williams & Brown, 2015). Nevertheless, AM is a fixture in the environmental resource management landscape, and it is important and timely to discuss mechanisms to improve its outcomes.

This chapter summarizes and explores the key findings of my research and discusses their relevance with observations and conclusions about the policy, legislative, and regulatory regimes that I have reviewed. Secondly, I compare the *Model Adaptive Management Procedures Act* (MAMPA) model with the Acts reviewed in Chapters 5 and 6, discuss their similarities and differences, and what this means for the way that AM can be applied to energy development in Alberta and B.C. Additionally, this chapter identifies the key opportunities, challenges, and gaps from my research for these provinces.

7.1. Key Findings of this Research

I examined two of the major academic findings with respect to AM in this dissertation for my specific cases in B.C. and Alberta. 1) I investigated the extent to

which policies rely on AM as an environmental management strategy and I confirmed that AM is present in at least half of the policies in this sample. 2) The literature argued that AM implementation is heavily constrained in administrative law regimes. My in-depth analysis of Alberta and B.C. largely confirms that these two jurisdictions do not exhibit any characteristics indicating they would be any more successful than other jurisdictions where AM serves as a pillar of the environmental management strategy. Rather, I found indicators to suggest that the patterns observed in the literature also apply to Alberta and B.C. (see table 7-1 for highlights and Chapters 5 and 6 for analysis). This leads me to conclude that Professor Ruhl's (2008) assessment is correct. First, he notes that there is a "disconnect between [AM] in practice and [AM] in law"; notwithstanding the great extent to which AM appears at the policy and agency practice level, "it appears almost nowhere as codified statutory and regulatory text, and it is dealt with significantly in only a handful of judicial opinions" (Ruhl, 2008: 11-3). In Alberta and B.C., AM does not appear in any Acts and did not appear in any of the regulations examined in my analysis.[41] This indicates that, like other jurisdictions, Alberta and B.C. are recommending AM at the policy level with no additional regulatory requirements or parameters that would transparently communicate what is expected in a way that can also be enforced. This is a major problem given that, although evidence seems to indicate widespread use of AM in Canada, its performance is largely under-delivered or, at the very least, there is not enough transparency to identify where it is successful (Olszynski, 2017).

Table 7-1 summarizes the key findings of Chapters 4, 5 and 6 and enables comparisons between Alberta and B.C. It should be noted that I included comparative statistics on the size of the industries. B.C.'s oil and gas industry and associated infrastructure is a fraction of the size of Alberta's. Alberta also consolidates its legislative and regulatory framework across more documents and distinct instruments than B.C. This raises questions about the underlying differences and complexities of regulation in

[41] Note that Directive 085: Fluid Tailings Management for Oil Sands Mining Projects contains one general reference to AM, stating that "The AER will include conditions in approvals that are outcomes based, manage risk and uncertainties, support flexibility and adaptive management, and are enforceable" (section 4.1). Although this directive was out of scope for this research, the reference to AM as a condition of approval seems to further reinforce the importance of term and conditions and the role they could potentially play in AM implementation.

the provinces and likely indicates that a one-size-fits-all approach to solving problems or responding to opportunities could not be equally applied to both provinces.

Table 7-1 Comparison of Alberta and British Columbia Findings

	Alberta	British Columbia
Size of energy industry	>156 000 operating wells >442 000 kilometers of pipeline >19 000 gas facilities >28 000 oil facilities[42]	>10 000 operating wells >50 000 kilometers of pipeline ~1200 gas facilities ~1000 oil facilities[43]
Number of policies reviewed	28	34
Percent of policies that reference adaptive management	64%	47%
Type of AM present in foundational policies	Active	Passive
Number of subsections of legislation/ regulations reviewed	4275	2775
Number of Energy Enactments Reviewed	2	1
Number of Specified Enactments Reviewed	4	3
Number of Rules/Regulations Reviewed	16	7
Percent of subsections in Acts that can be categorized as prescriptive	84%-91%	56%-81%
Percent of subsections in Acts that can be categorized as OBR	0%-5%	3%-30%
Percent of subsections in Rules/ Regulations/ Directives that can be categorized as prescriptive	~50%-80%	35%-41%[44]

[42] From OAG Report (2023). Note that these numbers do not include infrastructure associated with oil sands or coal development.

[43] From BC Energy Regulator's website (2023).

[44] It should be noted that, except for the *Oil and Gas Activities Act – General Regulation*, the lowest representation of OBR was 23% or more of the makeup of the instrument.

	Alberta	British Columbia
Percent of subsections in Rules/ Regulations/ Directives that can be categorized as OBR	0%-10%	8%-41%
Percent of subsections in Acts that are hybrid (e.g., two+ of regulatory types)	>2%	0%-3%
Percent of subsections in Rules/ Regulations/ Directives that are hybrid (e.g., two+ of regulatory types)	0%-12%	1%-8%
Purpose of Act Section	Yes	No
Summary of qualitative findings in Acts	• Aspirational mandate and purpose sections introduce broad alignment with AM principles. • Specified enactments are more aligned with AM principles than energy enactments. • Terms and conditions and amendment clauses are important mechanisms where AM could be introduced, and decisions can be revisited.	• Specified enactments are more aligned with AM principles than energy enactments. • Terms and conditions and amendment clauses are important mechanisms where AM could be introduced, and decisions can be revisited.
Summary of qualitative findings in Rules/Regulations/Directives	• Monitoring is the most frequently invoked phase of AM. • Stakeholder and Indigenous involvement were not explicitly mentioned; however, Directive 056 contains extensive participant involvement requirements for licensees as a pre-application requirement.	• Except for the EPMR and the DPR (monitoring), AM phases were not commonly found in B.C.'s regulatory framework. • Stakeholder and Indigenous involvement were not explicitly mentioned.

In the literature, a number of challenges were identified and contexts where AM may not be an appropriate mechanism to mitigate adverse environmental effects. I discuss these issues in Chapter 2. Rather, the literature suggests that AM is best suited for situations where there is high uncertainty, the ability for the researcher to control the situation or "experiment," and the context is low risk (e.g., not involving critically endangered species or some other high-consequence or irreversible situation). Watershed management where there are multiple users and priorities is a common context where AM has been applied and many of the case studies involving watersheds seem to be held as the better examples of where AM has had the most satisfactory outcomes (e.g., Columbia River, Glen Canyon Dam, etc.). For these reasons, I conclude that AM could be effectively leveraged in the shale gas context to identify and manage cumulative effects (CE). The iterative approach required by AM could be effectively leveraged to learn about, and adjust, the effects of multiple licenced and un-licenced (e.g., recreation) activities (industrial and non-industrial) in a defined region over time. I am less convinced that AM is appropriate for major projects without major changes to how AM is regulated. It seems that these are the cases where AM is "sprinkled like pixie dust" to obtain the necessary approvals and the decision to undertake major, irreversible development on the landscape is made. In these cases, we may find that AM is used to manage the adverse environmental effects of significant disturbances (e.g., end pit lakes (EPLs) and likely to become a fixture of the post-mining landscape in Northeastern Alberta).

7.2. Comparison of Alberta and British Columbia Acts with the Model Adaptive Management Procedure Act (MAMPA)

Thus far, my dissertation has focused on the rather dismal view that administrative law regimes have not led to successful implementation of AM. Additionally, my research supports the conclusion that Alberta and B.C.'s legislative and regulatory regimes largely conform to these patterns. However, given that there are several features I have identified that could be used to implement AM, it seems prudent to investigate what other options exist that could potentially also be implemented in Alberta and B.C. Also, it should be noted that, while there are very few laws that specifically deal with AM, many agencies have produced detailed guidance documents

on AM (e.g., B.C. Ministry of Forests, Department of the Interior, United States Army Corps of Engineers, United States Geological Survey, etc.). If any AM-related legislative or regulatory amendments are pursued by either Alberta or B.C., it could be helpful for these jurisdictions to also produce oil and gas, or regional-specific, AM guidance documents to clarify the details of the requirements, expectations, important definitions, and processes that are expected to accompany them.

In this section, I apply the same methodology described in Chapter 3 to Craig and Ruhl's (2014) MAMPA. Figure 7-1 presents the breakdown of the regulatory analysis in MAMPA (right of graph) compared to Acts in Alberta (far left) and B.C. (center of the graph). For this analysis, regulatory types other than prescriptive requirements, information and outcomes-based regulation (OBR) (e.g., hybrid sections, economic instruments, amendment clauses, etc.) were grouped together in an "other" category. In general, the MAMPA is comprised of a higher proportion of OBR (35%) than other Acts, thus indicating that it may be inherently more flexible than the legislation in my sample, even though it conforms to administrative law drafting principles. As I have discussed in Chapter 2, there are disadvantages with OBR and the context in which AM is applied is complex and comprised of many variables, not just the regulatory regime – in short, OBR is not a silver bullet and should not be considered as such. That said, OBR could be inherently more able to accommodate AM through its own design. This means that, in an environment that incorporated the right kinds of OBR, the government or the regulator could set thresholds or performance criteria, and the agency or proponent would have to use their Adaptive Management Plan (AMP), and ongoing monitoring plan, to demonstrate how they are meeting these expectations. The combination of some AM-related OBR coupled with the flexibility offered by terms and conditions, and amending terms and conditions as more is known about that management context, could enable a version of AM that is better equipped to successfully engage in each phase of the six-step cycle.

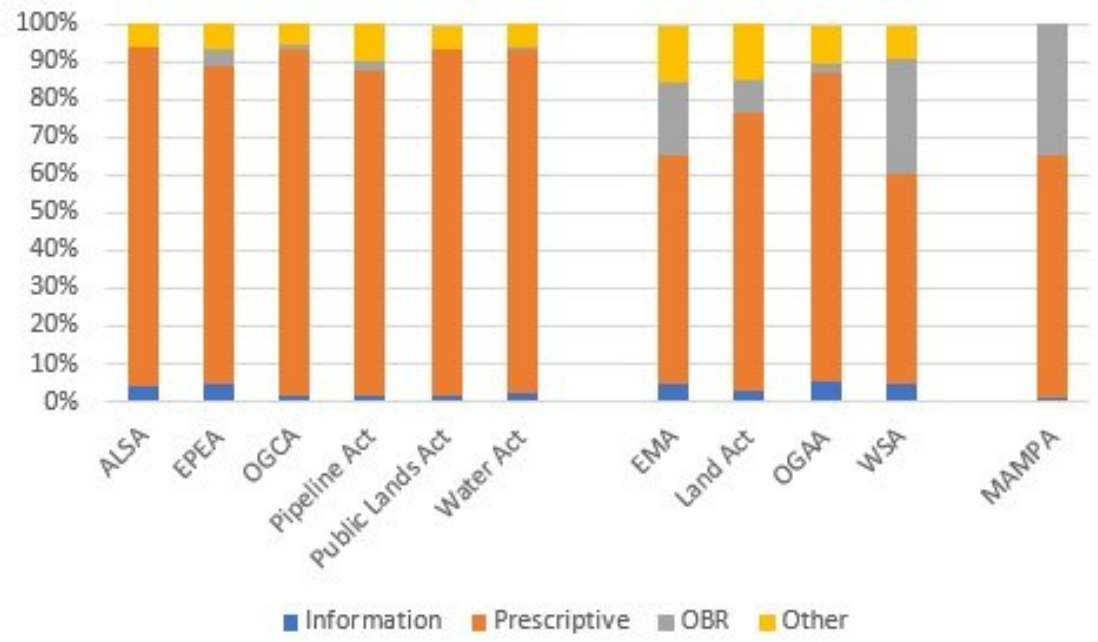

Figure 7-1 Comparison of MAMPA to Alberta (far left) and B.C. (center) Acts

The MAMPA was drafted keeping in mind that, if it were real, it would have to function within the constraints of an administrative law regime and would have to function alongside other predominantly prescriptive laws. As such, it is important to note that 64% of the MAMPA is made up of prescriptive subsections. It would likely not improve the current situation to pass an AM-related Act that was entirely made of general duty clauses or OBR. If that were the case, it is highly likely that proponents would not know what to do and regulators could struggle to determine compliance. Even so, because the focus of OBR is on the result, significant failures can occur along the way without regulatory agencies initiating action until a major tipping point is reached. Indeed, the lack of clarity has seemed to be one of the problems all along. For example, in Chapter 2, I discussed the proposed Whites Point Quarry and Marine Terminal Project in Nova Scotia (rejected in 2007), the Joint Review Panel found that there was considerable confusion about AM and recommended that the federal government develop a guidance document to provide clarity. Governments should keep in mind that reducing some of the discretion in how AM is practiced or what it is to look like would be a good thing. Moreover, it seems clear that the unenforceable OPS that was created out of the JRP's request has not seemed to have much effect either. It may well be that, if

AM is to continue to be allowed as an environmental management option, it is time to beef up the regulatory framework with some clear command-and-control requirements.

In addition to it being drafted in a more flexible style, the MAMPA also places significant emphasis on the details of the AM phases, with particular reference to the first two phases (define and design). No other Act in the sample puts such a high emphasis on up-front, comprehensive project planning and design. It should also be noted that this level of detail is not found in the underlying regulations and rules either. Figure 7-2 compares the presence of the AM phases in MAMPA with the Acts studied from Alberta and B.C. (B.C.'s Acts are grouped in the middle (directly under the MAMPA), Alberta's Acts are the bottom group). As shown in Table 7-1, Alberta, and B.C.'s Acts are accompanied by underlying regulations and guidance documents. Focusing only on the Acts allows me to discuss the features of the sample legislation at a high level, while also acknowledging that incorporating a law like the MAMPA would likely have to be accompanied by other instruments to be successful.

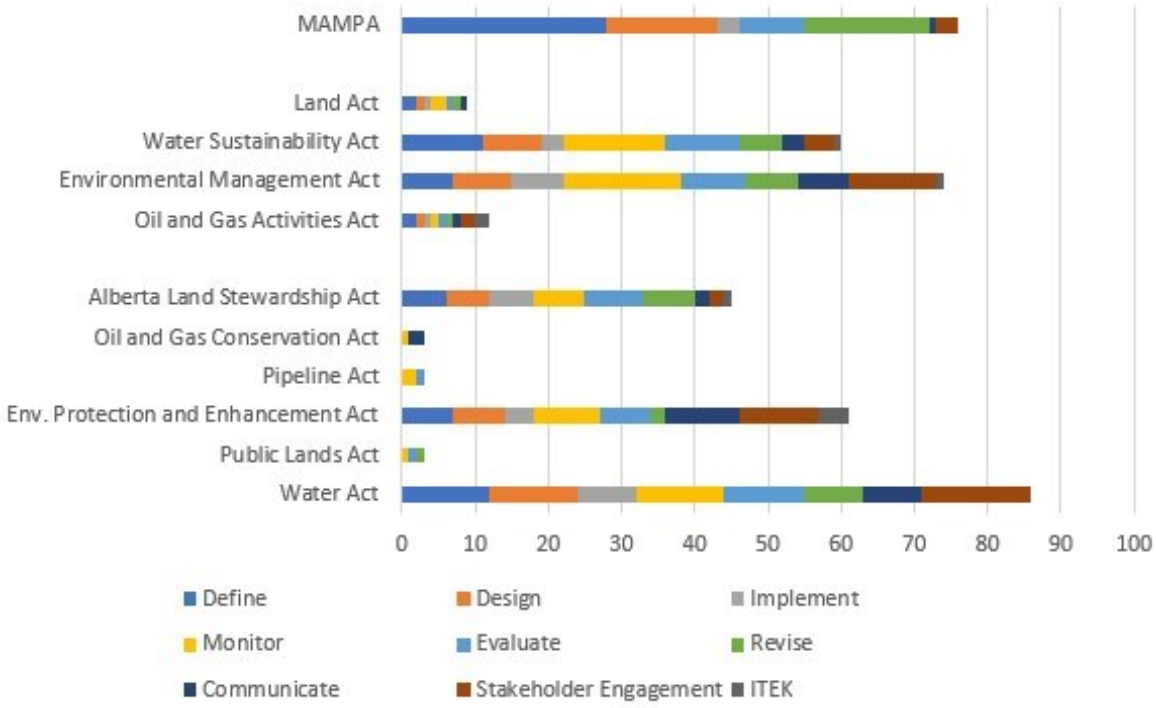

Figure 7-2 Comparison of AM Phases in Acts: Alberta (bottom set), B.C. (middle set) and MAMPA (top)

Interestingly, the provisions in the MAMPA are almost exclusively dedicated to three phases of AM: define, design and revise. More than half of the AM-related requirements relate to how the agency (or proponent) is to prepare the AMP and what its contents should include (define and design phases). Equally importantly, the MAMPA describes how evaluation of the monitoring results should be used in the feedback loop for improving the overall management approach. My findings suggest that legislation and their associated regulations require proponents to engage in up-front planning and design as part of the application process; however, it is debatable as to whether those processes could produce the level of planning, design, and detail that is required by an AMP. This leads me to believe that, although it appears the regulatory environment is broad enough to enable AM, it does not, because the requirements are not specific enough with respect to the rigour demanded by AM. Furthermore, as I have illustrated in Chapter 2, if expectations are not specifically stated and required, regulated parties are not motivated to respond and nor can they be made to.

The MAMPA also includes an important provision for regular releases of monitoring data and reports to the public and for peer review. It states that the reports must be in plain language so that a layperson could understand them, and that data should be released every six months, and a report on the implementation of the AMP at least yearly. Additionally, the Act provides for a well-defined public participation process which would include both notice and opportunity to review, and provide comments on, AMPs, as well as opportunities for direct involvement. These provisions speak to the need for transparency.

7.3. Responses to Policy Research Questions

I posed two major research questions in this dissertation pertaining to the policy frameworks in Alberta and B.C.: In Chapter 4 (policy analysis) I investigated:

1) To what extent is AM referenced in water and energy policies in Alberta and B.C.?
    a) How many policies out of a sample of environmental-water-energy policies reference AM?
2) Where is AM referenced in the policy, what is the nature of the reference?
    a) What kinds of details, requirements or parameters are included in the reference?

b) How closely do the references conform to descriptions of AM and its phases provided in the academic and technical literature?

My research confirms that AM is pervasive across environmental-energy-water nexus policies in the study. Sixty-four percent of policies in the Alberta subset and almost half of policies in the B.C. subset reference or recommend AM as an appropriate environmental management strategy. This is a critical finding for energy development contexts; moreover, I would suggest that the findings of Chapter 4 become even more important if they can be reasonably extrapolated to be representative of environmental policy in general. This hypothesis could be tested further given that government mandates and priorities should theoretically be consistent across departments. Given the problems with how AM implementation is constrained by administrative law discussed in Chapter 2, it becomes particularly critical to examine the extent to which the underlying legislative and regulatory frameworks can operationalize the policy intent.

The samples investigated indicate that 97% of the sample of policies that refer to AM suggest it as a general strategy without additional clarifying or guidance information. My research suggests that Alberta's policies may be more supportive of an active-AM approach while B.C.'s policies support a more passive-AM approach. With respect to Alberta, some of the supplementary policies under Lower Athabasca Regional Plan (LARP) include thresholds, parameters, and AM triggers, which is a positive observation. The way it is invoked in the Surface Water Quality Management Framework (SWQMF) further suggests that it could be appropriate for watershed or river basin management. Further analysis could be done to evaluate the performance of the triggers and the reasons for any challenges or successes.

7.4. Responses to Legislative and Regulatory Research Questions

In Chapters 5 and 6 (legislative and regulatory analysis), I investigated three questions based on the results of my analysis in Chapter 4:

1) If policy appears to be suggesting that proponents use AM, are the underlying legislative and regulatory frameworks built in such a way that would support the kind

of flexibility and iteration that AM requires (i.e., can AM be implemented in the administrative law regimes found in Alberta and B.C.)?

2) Do legislative and regulatory instruments contain provisions that either require AM or its component parts to be followed, or are compatible with AM principles in general?

3) Do legislative and regulatory instruments contain provisions that would prevent AM or its component parts from being followed or that are incompatible with AM principles in general?

My findings confirm that while policy seems to recommend AM, the underlying regulatory frameworks, particularly Acts, have provisions and features that could enable AM. Second, my findings suggest that there are some features that could even require AM. In that sense, the legislative and regulatory frameworks could be compatible with AM, with additional requirements and guidance from legislators and regulatory agencies. Currently, it appears that regulatory frameworks are primarily focused on monitoring. References to AM phases, or activities that would fall within the AM phases, would require a parallel commitment from regulatory agencies to specifically use those sections with the AM-cycle in mind. For example, requirements for “plans” would require additional clarification within the regulatory instruments if a decisionmaker were going to specifically use that requirement to require an AMP. I also found that Alberta’s policies seem to suggest an active AM approach, whereas B.C.’s policies were more aligned with passive AM. Particularly with respect to Alberta, it seems that requirements to support the early phases of AM (assessing and defining the problem and AM actions and designing the AM treatments) are largely missing. In response to question 3, I did not find provisions that would prohibit AM, but there are numerous concepts (contingency planning, mitigation of adverse effects, mitigation measures, etc.) that are associated with less-than-ideal AM outcomes. Generally, my research found that the underlying legislative and regulatory regimes are, as could be expected from the literature review, overwhelmingly prescriptive; moreover, the findings largely confirm that Alberta and B.C. are not unique from jurisdictions studied in the literature in their prescriptiveness. As such, I conclude that it is not surprising that my findings seem to confirm that Alberta and B.C. also seem to experience the same types of challenges observed in other jurisdictions with administrative law regimes that use AM.

Notwithstanding the challenges, there are two major features observed in the legislative regimes that suggest AM could be implemented successfully, provided additional support and oversight were also applied. First, in Alberta, Acts contain

purpose statements that confer broad mandates onto legislators and regulatory agencies. The specified enactments provide for sustainable development, conservation, environmental protection and mitigating environmental impacts. The *Alberta Land Stewardship Act* (ALSA) specifically mentions responding to cumulative effects (CE) management (CEM). Although it should be noted that there can be internal conflict in how the mandate is exercised to support values such as economic growth and prosperity with other values such as water conservation, these broad mandate and purpose statements could provide for the clarification of AM approaches in the instruments under their legislative authority. These broad mandates further suggest that enabling an AM approach could be possible without a major legislative overhaul because the mandate largely conforms to authorities already held by the governments and regulatory agencies that administer these Acts. If appropriate AM-related requirements were added to the legislative framework, they would not be introducing new authorities or mandates that do not already exist.

Second, the legislative frameworks in both Alberta and B.C. make it possible to approve something subject to terms and conditions, and to amend the approval or its terms and conditions after it has been issued. These provisions could be important mechanisms by which AM is integrated into decision making and regulated through the lifecycle of a project or development. However, it is unclear how often these amendment clauses are used, or if their widespread use would create a lack of certainty for proponents, thus creating a chilling effect on investment. It seems, within the context of AM, that there would be an opportunity to provide transparency and clarity on the process by which, and when, approval conditions might be reviewed and potentially changed for licensees on an AM track.

My analysis suggests that while legislative and regulatory frameworks contain mechanisms that can support AM implementation and iterative review, there is very little in the way of specific requirements that would ensure the component phases of the AM cycle are included in the lifespan of a project or development. Moreover, as Figure 7-2 shows, which compares the prevalence of AM concepts in MAMPA with other Acts in this study, the MAMPA contains a significantly higher proportion of the first two phases of AM. This leads me to conclude that, among other things, legislation and regulations could be changed to include more emphasis on up-front planning, including preparation of an AMP (Appendix C). Monitoring is the AM phase most typically found in regulatory

frameworks. It should also be noted that the presence of terms that could be construed as being aligned with AM principles (e.g., planning, producing a model, monitoring), should not be taken to mean that the outcome would meet the requirement for rigour that is demanded by active-AM. Rather, many of the references I found in Alberta and B.C.'s legislative and regulatory frameworks seem to weakly enable an AM approach should the proponent be motivated enough to implement one.

My findings lead me to conclude that despite the high prevalence of AM in the policy frameworks, the underlying legislative and regulatory frameworks may be too prescriptive in a general sense, but neither do they include the right level of prescription to operationalize AM-specific activities or make it clear to licensees and permit holders what performance is expected. To that end, it seems that there is something missing from the legal and regulatory framework that would be necessary to facilitate AM implementation. My findings indicate that the major gaps are: 1) lack of flexibility in the legislative and regulatory regimes, which could be solved by introducing greater levels of performance-based and OBR, where appropriate; 2) gaps in requirements for rigorous planning and documentation of the plan (e.g., the AMP); 3) evidence that decisions are revisited frequently enough, or in the right way, to enable AM learning to be applied, and 4) a focus on single-applicant, single-activity approvals. Regional management and CEM could require a different approach that may not be easily legislated under the current regime, particularly with respect to the FITFIR regime for water licensing. However, there have been successful regional initiatives and collaborative efforts between oil and gas industry operators in the past (see Alberta's Area Based Closure Program as an example). Governments could certainly reimagine specialized regulations and requirements that could apply under regional plans to implement AM approaches to CEM.

Drafting a law like the MAMPA is one of many regulatory options. Interestingly, since the *Impact Assessment Act* (IAA) replaced the *Canadian Environmental Assessment Act* (CEAA), and contains two significant references to AM, there is room for such a discussion. In addition to the creation of a standalone piece of legislation, Olszynski (2017) has proposed adapting the Canadian legislative framework to accommodate AM, noting that Alberta's *Water Act*, the *Environmental Protection and Enhancement Act* (EPEA), and the federal *Fisheries Act* could incorporate amendments to include AM. Given the findings of my research, I would broadly extend AM-

applicability to B.C.'s *Water Sustainability Act* (WSA) and *Environmental Management Act* (EMA) as well, with particular emphasis on the WSA. Olszynski notes that "If adaptive management is going to be available in such contexts, the surrounding legislation should be amended to set out the relationship between it and other legislative imperatives. For example, under the *CEAA, 2012* (or any successor) [now the IAA], Parliament could clarify that adaptive management cannot be relied upon for the determination of environmental effects where uncertainty with respect to mitigation effectiveness is moderate to high; it might also require adaptive management for such measures, should the project ultimately be approved" (Olszynski, 2017: 792).

Legislative and regulatory reform, particularly where Acts are concerned, is a massive undertaking. With the notable exception of the WSA, the ages of the instruments considered in my study indicates that fully overhauling a legislative framework seems to be done infrequently. Even in the case of the WSA, it took over one hundred years for the original Act to be replaced. Similarly, given that AM is invoked in the federal *Impact Assessment Act* (IAA), it does not seem necessary for a stand-alone MAMPA-type Act to be passed by the Canadian government. However, the notable absence of legislative provisions for AM at provincial levels is a significant gap. Given that this dissertation considers AM for the shale gas context, it is unlikely that the projects associated with MSHF would trigger thresholds for federal review under IAA, notwithstanding their potential to impose enormous CE over time. For this reason, it seems prudent for the provinces to develop AM regulatory requirements and processes using, and aligning themselves with, the existing federal guidance. There is a considerably broad spectrum of possible interventions – ranging from leaving things as they are, which I do not recommend, to drafting and implementing a standalone statute – that could be explored to solve the problems identified by the literature and my research. An analysis of the options, including the resourcing required and costs of implementing a corresponding audit and compliance program to ensure success, would be beneficial. To this end, I make a number of recommendations in Chapter 8, most of which have to do with amending and enhancing the regulatory regimes.

7.5. Regional and Cumulative Effects Management

The literature reviewed in Chapter 2 indicates that the regional and cumulative effects caused by shale gas development are not well understood (Becklumb et al, 2015; Buono et al., 2020; Council of Canadian Academies, 2014; Canadian Water Network, 2015; Scientific Review of Hydraulic Fracturing in British Columbia, 2019); moreover, the layers of requirements and legislation administered by multiple government and regulatory agencies further complicate the matter. The Council of Canadian Academies (2014), however, notes that these problems may warrant an AM approach for CE management. Specifically, they note that there is a risk that the complexity of regulating shale gas, and the way in which it is currently done, may completely fail to estimate the long-term impacts of development. They state that "methodologies for studying cumulative effects are not well developed and will require more effective implementation of strategic impact assessment processes. Moreover, the need for post-operational cumulative effects monitoring should not be underestimated. Even with full compliance, unforeseen cumulative consequences of development may only be detected and addressed through post-operational monitoring and adaptive management" (Council of Canadian Academies, 2014: 128- 129).

Administrative law regimes are not designed to respond well to wicked problems, in general. Complex problems are common in policy making; however, wicked problems, such as climate change, regional cumulative effects management, or the response to a global pandemic, are made significantly more complicated by the interconnectedness of a multitude of underlying problems, as well as the diversity in values, economic priorities, and cultural perspectives and norms held by those who are impacted (Head, 2022). Climate change effects are expected to intensify, and with them, many regions will experience loss of stationarity. At the same time, if global demand for natural gas continues to climb, as forecasted, the resulting mechanisms and policy options for managing regional water use and energy development and production are unlikely to be straightforward or uncontroversial. To manage wicked problems, such as the intersection of energy demand with CEM and climate impacts, Professor Head notes that "it is important for government leaders and departmental units responsible for policy development to understand the dynamic causes of the problems, map their inter-relationships, and **design appropriate policy frameworks that allow for adaptive**

management and effective implementation" (Head, 2022: 47-48, emphasis, mine). I believe my research shows that the policy framework is not enough, and that effective implementation will also include the appropriate and complementary regulatory tools and compliance regimes.

Chapter 8.

Conclusions

8.1. Contributions to the Adaptive Management Literature

This dissertation makes two major contributions to the body of literature on AM. First, my study is situated in Western Canada and provides an in-depth review of the relationship between policy regimes and their underlying legislative and regulatory regimes. I am not aware of any other study that considers a sample size of documents this large or applies the rigorous content analysis methodology in the way that I have. Nor, to my knowledge, have Alberta and B.C. been subject to a content analysis of this kind before with respect to water-energy policy and regulation. Shale gas activities in Alberta and B.C. have been highly scrutinized by academia and other interested parties. As such, my contribution to the discussion provides both critique and solutions for common problems observed in Western democratic administrative law regimes. It is possible that my findings could be considered and applied to other similar contexts.

Second, my research contributes to important discussions on how provinces and states regulate and how problems can be effectively explored (and solved) under different regulatory models. Quantitatively highlighting the disconnect between environmental policies and the regulatory regimes that would operationalize them further enables policymakers and decisionmakers to have conversations about their effectiveness. There are many positions on what kind(s) of regulation are “best” for a particular context (see Baldwin, 2012; Black, 2007; Carrigan, 2015; Frieberg, 2010; Sparrow, 2008 & 2020). By “best,” I mean most effective at solving a given problem. My hope is that my research provides a thought-provoking addition to the discourse on the evolution of theoretical and practical conceptions of regulation by showing the gaps in my case studies. It is only by having a clear articulation of the dimensions of the problem, as well as its context, that we might be able to solve it.

8.2. Recommendations for Policy Makers and Regulatory Agencies

Given the apparent disconnect between the overarching policies that may propose or reference AM as a resource management strategy and the underlying administrative law regimes that development and AM activities must be situated in, I have identified four categories of recommendations for policy makers, law makers and regulatory agencies to consider. It is important to note that many of my recommendations are similar, or build on, recommendations that have already been made about shale gas and water regulation. In particular, the Council of Canadian Academies (2014) identified five component parts of a fulsome approach to managing the risks of MSHF, three of which I find are directly related to the findings of my research. In short, they note that an appropriate framework for risk management for shale gas would include (CCA, 2014: 2019):

> *(1) The technologies to develop and produce shale gas. Materials, equipment, and products must be adequately designed, installed in compliance with specifications, and reliably maintained.*
>
> *(2) The management systems to control the risks to the environment and public health. The comprehensive and rigorous management of materials, equipment, and processes associated with the development and operation of shale gas sites will ensure public safety and reduce environmental risks.*
>
> *(3) **An effective regulatory system.** Rules to govern the development of shale gas must be based on sound science, and compliance with these rules must be monitored and enforced.*[45]
>
> *(4) **Regional planning**.*[46] *To protect the environment, drilling and development plans must reflect local and regional environmental conditions, including existing land uses and*

[45] Note that an effective regulatory system is also made up of the right kind of rules. My Recommendation #2 provides a detailed response to this point.

[46] My research suggests that the AM approaches currently described in Alberta and B.C.'s policies and enabled through the associated regulatory frameworks, are likely to be inadequate on large geographic or long temporal scales. Because policies typically have not considered cumulative impacts regulation at the watershed level scale (i.e., regulation is done through individual licenses) they cannot consider the impacts of a range of projects and activities or effectively consider cumulative impacts over time. Recommendations #1 and #2 respond to this issue.

environmental risks. Some areas may not be suitable for development whereas others may require specific management measures.

(5) ***The engagement of local citizens and stakeholders.***[47] *Public engagement is necessary not only to inform local residents of development but also to identify what aspects of quality of life and well-being residents value most, in order to develop a process that wins their trust and protects their values.*

My recommendations fall into four broad categories: ensuring that the risk context is appropriate for AM; recommendations to improve the policy, legislative and regulatory frameworks where AM is proposed and implemented; improved transparency and stakeholder involvement; and aligning the Indigenous involvement in AM processes with the principles of the TRC and UNDRIP.

8.2.1. Recommendation #1: The Risk Context Must be Appropriate for an Adaptive Management Approach.

Like other applications, Benga Mining Ltd.'s EIA proposed AM for numerous environmental problems and mitigations, one of which was to use AM for its Reclamation Plan. Benga proposes that "Reclamation will begin as soon as practical after mining activities are completed in areas where no additional mining, dumping, or stockpiling is required. Progressive reclamation will be optimized though the mine planning process to take advantage of all opportunities for progressive reclamation. Benga's *adaptive management approach will involve establishing end land use; monitoring reclamation, soils, revegetation, and wildlife to allow objectives and end point to be reviewed, and, if necessary, develop modified mitigations and site expectations according to changing conditions*" (Riversdale Resources, 2016: A-149, emphasis, mine). Decision makers should consider that using AM for end-of-life reclamation poses significant risk and should be allowed only under specific conditions and with viable alternatives. By the time major projects are winding up, the asset value of the resources extracted has likely

[47] Recommendations #3 and #4 address stakeholders, and Indigenous peoples and TEK, respectively. The literature highlights the centrality of local knowledge and participation to good decision making, and the many adaptive co-management governance models that are emerging. I will also note that Indigenous peoples are not stakeholders. Rather, they constitute nations and have significant unextinguished rights. Whereas the CCA references only "stakeholders" in their 2014 Report, I would further recommend that the CCA expand their references to reflect this.

already gone to the shareholders. There may not be enough extractable resource left to cover the cost of closure, let alone enable the iterative, experimental process that AM requires. If mitigation measures under AM are not performing effectively, the licensee or approval holder may lack the funds to safely close the site, causing it to become an orphan.

When AM is proposed as a mitigation strategy, particularly if it is used to override the precautionary principle, proponents should be required to pay a security deposit to cover the risk of worst-case-scenario, at least until the uncertainty and the risk is reduced. A discussion of the adequacy of financial security programs for energy development is beyond the scope of this dissertation; however, audit reports have found that there is unfunded liability in both Alberta and British Columbia. While appropriately securitizing risk is another matter entirely, I suggest that decision makers should consider demanding security (or potentially more security) where AM is used to address uncertainty about the effectiveness of mitigations to ensure that the "polluter pays principle" is upheld, even if the licensee is not financially capable at the end of life. The mechanisms for such an approach already exist in Alberta's *Oil and Gas Conservation Rules*[48] and B.C.'s. *Fee, Levy and Security Regulation* under the *Oil and Gas Activities Act.*[49] Refer to B.C. Ministry of Energy and Mines (2017 report) and Auditor General of Alberta (2015 & 2023 reports) for a more fulsome discussion of the shortcomings of the security frameworks.

8.2.2. Recommendation #2: Adaptation of Legal and Regulatory Frameworks to Enable Adaptive Management

One option for regulatory agencies to consider is a shift to a more outcomes-focused, flexible regulatory model. The Council of Canadian Academies recommends

---

[48] The OGCR broadly enables the AER to collect security on wells or facilities under a number of scenarios, but in particular "[d] at any time where the Regulator considers it appropriate to do so to offset the estimated costs of providing care and custody for a well, facility, well site or facility site, and [e] at any time where the Regulator considers it appropriate to do so to offset the estimated costs of carrying out any other activities necessary to ensure the protection of the public and the environment" (OGCR 1.100(2)).

[49] The FLSR imposes several thresholds on the amounts of security that can be collected, although the OGAA makes broad provisions for security collection in general. It is unclear if B.C.'s legislative framework would need amendments to enable such an approach, although it appears that the OGAA would allow for this.

that “given the current knowledge gaps, a science-based, adaptive, and outcomes-based regulatory approach is more likely to be effective than a prescriptive approach and is more likely to result in an increase in public trust” (CCA, 2014: 219). It should be noted that outcomes-based regulation requires careful design and would be a significant paradigm shift, particularly for Alberta. B.C. has shown a shift towards OBR, particularly with the promulgation of the WSA in 2016, but it could be helpful for other specified enactments to follow suit. Prescriptive requirements provide clear compliance signals. OBR, on the other hand, defers compliance assessment to when a level of performance can be reviewed and determined. Because compliance can only be assessed at the end (i.e., the licensee or permit holder has either achieved the performance standard or not), 1) the deterrence for noncompliance must be sufficiently compelling to drive desired behaviour (i.e., the stick must be sufficiently large), and/or 2) the risks imposed by the noncompliance must be sufficiently low (i.e., the licensee can either be brought back on track, or the effects of the noncompliance must not be disastrous). Nevertheless, OBR is still a potentially viable mechanism by which to introduce the flexibility required for iterative decision-making and could allow for major reviews and adjustments to be set up according to established performance thresholds or triggers.

Shifting from a prescriptive regulatory regime to OBR would be a massive undertaking. Indeed, there are extensive bureaucratic and political processes required to amend or replace legislation, including requirements for public consultation. However, it should be noted that some of the legislation and regulations considered in my study are of great antiquity and pre-date the commercial viability of shale gas development, including the incredible technological innovations made to enable it. This becomes evident in regulatory instruments such as the OGCR, which was first enacted in 1971, in which my study identified that 21% of the subsections had been repealed. B.C. has taken another approach entirely when the government opted to fully replace the 100-year-old *Water Act* with the *Water Sustainability Act* in 2016. The benefits highlighted by B.C.’s new WSA cannot be ignored – the Act is overwhelmingly more flexible, contains a higher proportion of OBR (30%) than any other Act reviewed, and makes 77 references to terms and conditions, including the power to revisit decisions and amend license approvals and/or their terms and conditions. Nevertheless, Alberta should consider following suit and amend or draft new legislation that is better able to regulate for contemporary challenges such as regulating under uncertainty, emerging industries, and

resource types (e.g., geothermal, commercially viable renewables projects, minerals, etc.), cumulative effects management and AM.

In any case, a greater level of detail on what AM is and what is expected (including material on what an acceptable AMP would include) would be helpful. Olszynski (2017) recommended that a definition of AM be enshrined in law. I concur. I would recommend that, rather than implementing a standalone Act such as the MAMPA, that carefully considered amendments to the existing environmental law regime be made at the provincial level.[50] Introducing requirements for critical steps in AM such as the 'define' and 'design' phases, like MAMPA, could ensure that appropriate adaptive management plans (AMPs) are drafted and considered during approval phases for projects. Situating AM provisions within specified enactments (rather than energy enactments) would ensure that they can be equally relevant for other activities that contribute to cumulative effects. Moreover, as CEM becomes increasingly more relevant, legislators and regulatory agencies should review the extent to which administrative law frameworks that primarily regulate through one-off decisions (e.g., licenses, approvals, permits) with single entities (e.g., one licensee at a time) could be reconsidered to accommodate multiple operators in a region where the combined effects of their approvals could have implications over certain time horizons. Reimagining regulation to better accommodate multi-operator water plans (MOWPs) situated within land use frameworks (LUFs), regional consultation, flexible review, and potential reconsideration of activities, and early identification of issues would be a positive development. For example, licensees and permit holders with approved AMPs should expect their approvals to be subject to regular, iterative reviews, and amendments but perhaps could also benefit from other appropriate incentives. While governments would have to lead

[50] As noted in this dissertation, AM is already enshrined in the federal *Impact Assessment Act* and was in its predecessor *Canadian Environmental Assessment Act*. It is important to note that this legislation only pertains to major projects that meet certain criteria for federal review. As such, it necessarily does not apply to multiple smaller projects in a defined region or area that might pose concerns from a cumulative effects perspective, including shale gas. Also, given the division of powers between federal and provincial governments under sections 91 and 92 of the Canadian Constitution, most, if not all, of the regional activities that would form the basis of a cumulative effect would likely be solely regulated at the provincial level, thus making provincial governments the best avenue to manage CE and AM as discussed in this dissertation. Additionally, it is also important to note that provincial oil and gas regulators have broad powers to regulate under provincial and energy enactments, but only for oil and gas activities. There are numerous other activities contributing to CE on the landscape that are not under their purview. These challenges make provincial governments, together with Indigenous nations, the primary governance regimes that need to have meaningful oversight in CE matters.

any strategies and legislative changes focused on CE due to the significance of other activities that are not under the purview of single window oil and gas regulators (e.g., consumptive water use by the agricultural sector and other users), regulators would do well to consider how to situate oil and gas activities within the broader CE context. Positive steps have been made in technology solutions such as the Northeast Water Tool (NEWT) and the Hydrologic Unit Code (HUC) Watersheds approach in Alberta, which enable regulators to make more informed decisions about water allocation. Over time, and as variables are added to the analytic capabilities of such tools, they will become increasingly important and could serve AM approaches well.

Finally, it should be noted that AM may be conceptually at odds with provisions in other environmental laws. Legal scholars and academics in both Canada and the U.S. have noted that there are challenges in reconciling AM with endangered species, fisheries, and wildlife legislation; moreover, there may be ethical implications were one to even try (Allan & Gunderson, 2011; Olszynski 2017). As others have recommended, I would also recommend that the steps of AM be clarified legally and that there be clear requirements associated with it that can be enforced. There is an opportunity to spell out when AM can be used, timing for reviews and decisions (to help address the finality of the front-loaded approval), the obligations of the agency or proponent (including the preparation of a comprehensive AMP that is updated to reflect new information), and, as Craig and Ruhl (2014) have argued, a termination clause that enables a reviewer to conclude that AM is not working, and the experiment should be stopped (i.e., “abort indicators”). Additionally, ideally, the robustness and reasonableness of the upfront AMP would allow for decisionmakers to determine which cases are suitable for AM.

8.2.3. Recommendation #3: Improve Transparency and Stakeholder Engagement

Successful examples of adaptive co-management models are becoming more common, and the literature and case studies demonstrate that stakeholders want increased opportunities for participation as well as transparency (Armitage et al., 2007; Scholz & Stiftel, 2005). There are three key opportunities to improve transparency and stakeholder participation in the AM process. First, there are several land use frameworks (LUFs) and regional plans that are either under development or are up for renegotiation in shale gas producing areas and as required by the policies, must include consultation.

For example, in B.C. the Fort St. John Land and Resource Management Plan is currently being updated and has included public comment on the scoping period, identifying avenues for engagement and proposes to align the process with UNDRIP. Similarly, four out of seven regions do not have an approved regional plan. There is a significant opportunity for meaningful stakeholder engagement, particularly on the AM approaches recommended, as I have suggested there is a high likelihood that the new regional plans will model LARP to at least some degree and contain provisions for AM.

Second, legislation is beginning to include requirements for publicly reporting on progress. It would be helpful if AM laws and regulations included requirements for proponents and actors engaged in AM activities to report on their progress. For example, B.C.'s *Climate Change Accountability Act* has created baselines for emissions reduction by industrial sectors, including requiring a 33-38% reduction from the oil and gas industry. Under the *Greenhouse Gas Industrial Reporting and Control Act,* operators meeting certain criteria must verify and report their emissions. In addition to transparency, reporting can add a second layer of value by imposing a nudge or "name-and-shame" strategy on regulated parties to drive desirable behaviour, as discussed in Chapter 2.

Finally, and related to reporting, there is significant value in making AMPs publicly available for peer review. While governments and regulators have web-access to project submissions, environmental impact assessments, and documents related to review processes, these sites are notoriously hard to use. Grouping documents or submissions associated with active licenses and specific projects (or regional plans) could be helpful for consumers to understand the progression of an AMP, as well as the regional context it is situated in. The process of peer review could also add valuable layers of accountability and credibility of the process.

8.2.4. Recommendation #4 Align Indigenous Involvement in Adaptive Management with the Recommendations of the Truth and Reconciliation Commission

In addition to recommending that Indigenous groups be offered increased opportunities for participation and greater transparency, I would also recommend that ongoing applications of AM under land use frameworks and action plans in Alberta and

B.C. be reviewed to determine the general alignment of the plans with section 35 of the Constitution, the principles of UNDRIP and calls to action from the TRC. Additionally, it would be helpful to assess if practices on the ground are meeting the intent and if Indigenous peoples would propose changes. There may be additional opportunities to meaningfully incorporate the feedback from Indigenous groups, where appropriate, into decision making related to AM and CEM. It will be interesting to see how B.C. navigates the path forward now that the courts have found in the Yahey decision that the Province failed in their fiduciary responsibility to honourably and diligently implement the Treaty. The good news is that the pressure applied by a judicial decision can bring about change in the way that Indigenous peoples are involved in decision making and CEM; moreover, given that Treaty 8 encompasses both sides of the Alberta-B.C. border, there may be interesting implications for Alberta as well, particularly given that Alberta has its own case concerning Indigenous rights and cumulative effects winding its way through the court system.[51]

Further I note that while Indigenous *consultation* is frequently discussed in the context of energy development, *consent* is largely missing from the discourse. This will become increasingly important in regions that have been heavily impacted by industrial development where full remediation of the landscape may take generations or and where new industrial activities may seek to take place, particularly if the local nations had not been consulted with or given consent in the first place. Systemic change is needed is needed to foster more meaningful reconciliation.

8.3. Limitations of the Study

There are three key limitations of this study. First, this dissertation has focused almost exclusively on the challenges and limitations inherent with implementing AM in administrative law regimes. Despite the singular focus, the reader should not forget that there are numerous other variables at play in resource management contexts that are often quite complex. Creating a legal context where AM can be successfully implemented is only one small part of the picture. This dissertation in no way claims that

[51] In 2008 Beaver Lake Cree Nation filed a lawsuit against the Canadian and Alberta governments arguing that the cumulative effects and density of industrial development on traditional lands has now rendered it impossible to exercise treaty rights. The case (Lameman v. Alberta) is similar to Yahey v. B.C. and proceedings are currently scheduled to begin in 2024.

solving the legal and regulatory barriers would always produce successful AM experiments. Rather, removing such challenges could produce *more* examples of failed AM if licensees became predisposed to using AM more frequently and for different problems, and if the necessary approvals followed suit. However, my research findings identify some key gaps and opportunities that, if addressed, could potentially overcome some of the barriers inherent with administrative law. Given the importance of regulatory oversight, improvements could possibly have a spill-over effect of improving challenges experienced with other variables.

Second, as noted in Chapter 3, this study could be triangulated with other research methods (e.g., interviews and/or surveys) to increase its validity and identify AM approaches or practices that are not in the public domain. This would enable a rich analysis of what agencies and practitioners do for implementation. Moreover, if the study were appropriately expanded to include stakeholders and Indigenous peoples who live in the development zones, their perspectives could significantly enhance and confirm the extent to which the perspectives taken by this dissertation on their relative exclusion from participation in the regulatory process is justified.

Finally, regulation encompasses a much larger scope than just the legislation. Broadening the scope of this research to include the terms and conditions of approvals that involve AM, amendments to approvals and plans, using each Province's *Freedom of Information and Protection of Privacy Act* (FOIPP)[52] to request documents and communications involving AM, and monitoring data that is both publicly available and can be accessed through FOIP would give a clearer picture of how AM is actually being regulated. For example, in the terms and conditions to approval for Syncrude's Mildred Lake extension (MLX) project and Mildred Lake Tailings Management Plan, the AER included a condition that the plan must "include a proposal on a course of action for any mitigation and/or adaptive management approaches that would be required as a result of project related effects…" (ABAER 006, 2019: 18, 4.2.331 c). It would be interesting to investigate what the proponents submit, consolidate the results, and to submit the resulting plans to a public peer review.

[52] Such studies undertaken in other jurisdictions could invoke the comparable legislation to FOIPP in Alberta and B.C.

8.4. Opportunities for Future Research

This study represents a snapshot in time. It is to be expected that policies, legislation, and regulations change and are amended over time to respond to changes in government, changes in priorities and values, emerging risks (e.g., climate change, losses of stationarity, etc.), shifts and improvements in technology (e.g., unconventional oil and gas extraction via multi-stage hydraulic fracturing (MSHF)) and myriad other influences. Indeed, there have been several regulatory and legislative amendments since this research process began. The findings of this dissertation provide an important baseline which can be used in the future to measure the extent to which policies and their associated legislative and regulatory frameworks evolve and become more-or-less amenable to AM over time.

There is an opportunity to conduct an extensive review of adaptive management plans (AMPs) created pursuant to approvals where AM is proposed as a mitigation strategy under provincial legislation or a component of a follow-up program under the *Impact Assessment Act*. My research has confirmed that, notwithstanding the presence of AM in policy, Alberta, and B.C.'s legislative and regulatory frameworks generally adhere to the common criticisms of implementing AM in administrative law regimes. However, I cannot comment about the quality of the plans and reports, nor the progress made under them, that are routinely submitted to governments and regulatory agencies. For example, many large operators in Alberta and B.C. submit extensive reports pursuant to their project approvals (see, for example oil sands mine projects submitted under the LARP or Teck Coal Ltd.'s "Area Based Management Plan (ABMP) – The Elk Valley Water Quality Plan [2014] submitted to the B.C. Ministry of Environment pursuant to Ministerial Order No. M113 (Order)). While Olszynski (2013 & 2017) began this work with an investigation of the project approvals under EPEA (i.e., the front-loaded AM approval process), a deeper dive into the required reports that are routinely submitted by licensees and approval holders to determine alignment with AM principles, progress made under the experimental process and the extent to which findings are fed back into the management approach over the lifecycle of operations would be an interesting contribution to the field.

I began this dissertation with a quote from C.S. Holling where he noted that "Efforts to reduce uncertainty are admirable… But if not accompanied by an equal effort

to design for uncertainty and to obtain benefits from the unexpected, the best of predictive methods will only lead to larger problems arising more quickly and more often. This view is the heart of adaptive environmental management – an interactive process using techniques that not only reduce uncertainty but also benefit from it. The goal is to develop more resilient policies" (Holling et al., 1978:8-9). I looked at a small subset of contemporary policies in Western Canada. By assessing the relationship between the policies and their underlying regulatory frameworks, my work invites further discussion on what resilient environmental policies look like, how closely aligned to that definition current environmental policies are, and where AM can fit into improving performance. I have noted that the policies that were considered are only a part of a larger environmental management and governance structure. A holistic review of AM across all policy and regulatory instruments would enable consideration of the connections between a larger set of instruments that interact with each other and would certainly enable a gap analysis for important findings that I may have missed.

8.5. Final Thoughts

> *Sustainable development is not a policy objective so much as it is a vision of appropriate human endeavor on the planet we inhabit. Although in principle the pursuit of sustainability could be developed into a portfolio of policies, given the uncertainty of human action no such grand plan is practicable. Policies such as adaptive management must meet a test of feasibility: they must seem likely enough to work to be adopted, and they must be workable in practice if they are to make a difference.*
>
> *Kai N. Lee, 1993: 198.*

Despite the many implementation challenges, it is argued that AM is a necessary component of regulatory oversight and management of natural resource development that contributes to a sustainable environment. Factors such as the growing global demand for energy and mineral resources, a growing gulf between the haves and the have-nots, loss of stationarity, and cumulative effects caused by competing land base users and the intensifying impacts of climate change increase the urgency of having regulatory systems that effectively and meaningfully incorporate AM. Many academics

and policymakers have taken these factors to argue that policies must become more resilient to cope with the unpredictability of so many variables and their impacts on humans and the environment. To that end, AM seems to be one of our best shots at sustainability and resilience, provided it is applied to the right problems and is rigorously implemented. My research confirms that AM is highly prevalent in environmental policies. However, I would suggest that the poor performance observed by scholars is, in large part, related to the lack of a clear, consistent, and transparent regulatory regime, with necessary flexibility built in, in which to implement it. However, this need not be the case. While, as Lee (1993) states that sustainability is unlikely to be translated into a grand plan, I think the evidence indicates that numerous smaller plans (or AMPs) could be useful to articulate the path, meaningfully learn, and use what we learn to make better policies. Moreover, the recommendations I have made are likely to have a positive effect on making AM more workable, and accessible, in practice.

The WSA in BC shows a promising example where an AM approach could be successfully operationalized within the existing structure, provided there was necessary clarity, and particularly using terms and conditions and amendment clauses. Moreover, the comparative analysis with MAMPA seems to indicate that a small, but significant shift to a more OBR approach could have real value, particularly if it were accompanied by stronger requirements to plan and design projects upfront and according to the steps of AM. My findings and the literature suggest that if designed and executed properly, AM can be used to serve sustainable development. This should also include appropriate opportunities for stakeholders to be involved, as well as local and Indigenous peoples, and for their expertise to be integrated into decision making. The approach should be viewed as an opportunity to pursue reconciliation and decolonization of the environmental management space. The gap between where we are today and where we need to be is, of course, enormous. Nevertheless, technological innovation, changing societal norms, different approaches to environmental management and regulation, and emerging crises are all likely to influence how quickly and effectively we can solve wicked problems, as well as the nature of what those problems are and how we choose to prioritize them. AM has emerged as a popular policy option. It’s time it became a legitimate and credible regulatory solution too.

References

Works Cited

Adaptive Management for Water Resources Project Planning. (2004). Committee to Assess the U.S. Army Corps of Engineers Methods of Analysis and Peer Review for Water Resources Project Planning. National Academies Press: Washington DC.

Adaptive Management Measures under the Canadian Environmental Assessment Act. (2009). Government of Canada. Retrieved from: https://www.canada.ca/en/impact-assessment-agency/services/policy-guidance/adaptive-management-measures-under-canadian-environmental-assessment-act.html

Ahmadun, Fakhru'l-Razi, Alireza Pendashteh, Luqman Chuah Abdullah, Dayang Radiah Awang Biak, Sayed Siavash Madaeni, Zurina Zainal Abidin. (2009). Review of technologies for oil and gas produced water treatment. *Journal of Hazardous Materials* 170: 530-551

Alberta Energy Regulator. Decision 2019 ABAER 006: Syncrude Canada Ltd. Mildred Lake Extension Project and Mildred Lake Tailings Management Plan. Retrieved from: https://static.aer.ca/prd/documents/decisions/2019/2019ABAER006.pdf

Alberta Energy Regulator (AER). (2019). ST98: Low Permeability and Shale Area Assessment. AER: Calgary, AB. Retrieved from: https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st98/statistics-and-data.html#reserves

Alberta Energy Regulator (AER). (2019). Water Use Performance Report: Hydraulic Fracturing. AER: Calgary, AB.

Alberta Energy Regulator (AER). (2017a). 2017 AER Survey of Albertans and Stakeholders. AER: Calgary, AB.

Alberta Energy Regulatory. (2017b). Enabling the Use of Alternatives to High-quality Non-saline Water by the Oil and Gas Sector in the MD of Greenview: Recommendations to the Alberta Energy Regulator and Alberta Environment and Parks from the Multi-Stakeholder Panel for the Area-Based Regulation Pilot Project. Calgary, AB.

Alessi D.S., A. Zolfaghari, S. Kletke, J. Gehman, D.M. Allen, G.G. Goss. (2017). Comparative analysis of hydraulic fracturing wastewater practices in unconventional shale development: water sourcing, treatment, and disposal practices. *Canadian Water Resources Journal* (2017).

Allan, C and G.H. Stankey (Eds.). 2009. *Adaptive Environmental Management : A Practitioner's Guide.* Springer Science + Business Media B.V.

Allan, & Curtis, A. (2005). Nipped in the Bud: Why Regional Scale Adaptive Management Is Not Blooming. *Environmental Management (New York)*, *36*(3), 414–425.

Allen, Craig R, & Garmestani, Ahjond S. (2015). Adaptive Management. In *Adaptive Management of Social-Ecological Systems* (pp. 1–10). Springer Netherlands. https://doi.org/10.1007/978-94-017-9682-8_1

Allen, Fontaine, J. J., Pope, K. L., & Garmestani, A. S. (2011). Adaptive management for a turbulent future. *Journal of Environmental Management*, *92*(5), 1339–1345.

Allen, C., & Gunderson, L. (2011). Pathology and failure in the design and implementation of adaptive management. *Journal of Environmental Management, 92*: 5), 1379-1384.

Altheide, D. L. (1987). "Ethnographic Content Analysis." *Qualitative Sociology* 10 (1) 65-77.

American Petroleum Institute RP 54, Recommended Practice for Occupational Safety for Oil and Gas Well Drilling and Servicing Operations, Third Edition, August 1999 (2007).

Argent, Robert M. 2009. Components of Adaptive Management. In: Catherine Allan and George H. Stankey (Eds.). 2009. *Adaptive Environmental Management: A Practitioner's Guide.* Springer Science + Business Media: Collingwood, Australia. Pages 11-38.

Armitage, Derek, Fikret Berkes, and Nancy Doubleday (Eds.). (2007). *Adaptive Co-Management: Collaboration, Learning, and Multi-Level Governance.* UBC Press: Vancouver, BC.

Aronson, J. (1995). "A Pragmatic View of Thematic Analysis*." The Qualitative Report* **2**(1): 1-3. Retrieved from: https://nsuworks.nova.edu/cgi/viewcontent.cgi?article=2069&context=tqr

Ayres, Robert U. (1999). The second law, the fourth law, recycling and limits to growth. *Ecological Economics* 29(1999): 473-483.

Baldwin, Robert, Martin Cave, Martin Lodge. (2012). *Understanding Regulation: Theory, Strategy, and Practice.* Oxford University Press Inc.: NY, NY.

BC Hydraulic Fracturing Scientific Review Panel (Allen, D.M., Eberhardt, E., and Bustin, A.) (2019). Scientific Review of Hydraulic Fracturing in British Columbia. Final Report to BC Minister of Energy, Mines and Petroleum Resources, February 2019, 236 pp. Retrieved from: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-gas-oil/responsible-oil-gas-development/scientific_hydraulic_fracturing_review_panel_final_report.pdf

BC Ministry of Energy and Mines. (2017). EY report & recommendations for BC's mine reclamation financial security policy. Ernst & Young LLP: Vancouver, BC. Retrieved from: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/mineral-exploration-mining/documents/reclamation-and-closure/bc_mem_ey_report_on_mine_reclamation_security_final.pdf

BC Oil and Gas Commission (BCOGC). (2020). Water Used in Natural Gas Activities. BC Oil and Gas Commission: Victoria, BC. Retrieved from: https://www.bcogc.ca/node/11474/download

BC Oil and Gas Commission (BCOGC). (2018). British Columbia's Oil and Gas Reserves and Production Report. BC Oil and Gas Commission: Victoria, BC. Retrieved from: https://www.bcogc.ca/node/15819/download

Beazley, Doug. (November 15, 2018). Canada's proposed new Impact assessment: Putting science first? *National Magazine*. The Canadian Bar Association.

Beese, W.J., Deal, J., Dunsworth, B.G. et al. Two decades of variable retention in British Columbia: a review of its implementation and effectiveness for biodiversity conservation. Ecol Process 8, 33 (2019). https://doi.org/10.1186/s13717-019-0181-9

Bell, Baker, J. A., Bruemme, G., Pineau, J., & Stinson, A. (2008). The Canadian Ecology Centre – Forestry Research Partnership: Implementing a research strategy based on an active adaptive management approach. *Forestry Chronicle*, *84*(5), 666–677.

Bennear, Lori. (2011). "Beyond Belts and Suspenders: Promoting Private Risk Management in Offshore Drilling". Duke University: Nicholas Institute. Working Paper EE 11-11

Bennett, Nelson. (2019). B.C. fracking report recommends improvements to Montney regulatory regime. *JWN Energy.* Retrieved from: https://www.jwnenergy.com/article/2019/3/bc-fracking-report-makes-97-recommendations-improve-montney-regulatory-regime/

Benson. (2009). Integrating adaptive management and oil and gas development: existing obstacles and opportunities for reform. *Environmental Law Reporter*, 39(10), 10962.

Benson, M.H., Garmestani, A.S., (2011). Embracing panarchy, building resilience and integrating adaptive management through a rebirth of the National Environmental Policy Act. *Journal of Environmental Management* 92 (5), 1410e1417.

Benson, Melinda Harm, and Asako Stone. (2013). Practitioner Perceptions of Adaptive Management Implementation in the United States. *Ecology and Society* 18(3): 32.

Benson, Melinda Harm and Courtney Schultz. (2015). Adaptive Management and Law. In Craig Allen and Ahjond Garmestani (Eds.). *Adaptive Management of Social-Ecological Systems.* Dordrecht: Springer: 39-59.

Black, Julia. 2007. “Principles Based Regulation: Risks, Challenges and Opportunities”. LSE Research Online.

Blake, B. J. (2003). Private property, public rights, and environmental protection: A perspective on takings, compensation, and regulatory takings. *Environmental Law Reporter*, 33(9), 10577-10587.

Bormann, B.T., P.G. Cunningham, and J.C. Gordon. (1996). Best management practices, adaptive management, or both? Proceedings National Society of American Foresters convention held at Portland, Maine, October 28 to November 1, 1995: 6 p.

Braun, V. and V. Clarke (2006).""Using thematic analysis in psychology." *Qualitative Research in Psychology* 3 (2): 77-101.

Buchannan J., Stubblebine, C., (1962), “Externality” Economica

Bunnell, Fred L., and Glen B. Dunsworth. 2009. *Forestry and biodiversity: Learning how to sustain biodiversity in managed forests*. Vancouver, BC: UBC Press.

Buono, Regina M.; López Gunn, Elena; McKay, Jennifer; Staddon, Chad. (2020). *Regulating Water Security in Unconventional Oil and Gas* (Water Security in a New World). Cham: Springer International Publishing.

Canada West Foundation. (no date). The Evolution of Water Policy in Alberta: Water Information Sheet #7. *Canada West Foundation*: Calgary, AB. Retrieved from: https://static1.squarespace.com/static/557961b3e4b084c9759bd919/t/5586cc04e4b04f6516e2abe2/1434897412283/the-evolution-of-water-policy-in-alberta.pdf

Canadian Association of Petroleum Producers (CAPP. (2019). Water Use for Hydraulic Fracturing in British Columbia. CAPP: Calgary, AB. Retrieved from: https://www.capp.ca/wp-content/uploads/2019/12/Water-use-for-hydraulic-fracturing-in-BC-351500.pdf

Canadian Energy Regulator (CER). (2019). *Canada's Energy Future*. Government of Canada: Ottawa, ON. Retrieved from: https://www.cer-rec.gc.ca/nrg/ntgrtd/ftr/2019/index-eng.html

Carrigan, Christopher. 2015 "Choices in Regulatory Program Design and Enforcement". Penn Program on Regulation.

CEMA/EUB. (2007). "EUB Recommendations for the "End Pit Lakes Technical Guidance Document" Retrieved from: https://www.ceaa.gc.ca/050/documents_staticpost/cearref_37519/44851/t.pdf

Chalifour, Nathalie, The Significance of Pembina Institute for Appropriate Development et al. v. Canada (Attorney-General) for the Future of Environmental Assessment (2009). McGill International Journal of Sustainable Development Law & Policy, Vol. 5, No. 2, 2009, Available at SSRN: https://ssrn.com/abstract=2619382

Chenail, R. J. (1997). "Keeping Things Plumb in Qualitative Research." *The Qualitative Report* **3**(3): 1-8. Retrieved from: https://nsuworks.nova.edu/cgi/viewcontent.cgi?article=2020&context=tqr

Coad, Len, Daniel Munro, Prince Owusu, Allison Robins. (2016). A Changing Tide: British Columbia's Emerging Liquefied Natural Gas Industry. Conference Board of Canada: Ottawa, ON.

Coglianese, Cary. 2017. "The Limits of Performance-Based Regulation". University of Pennsylvania Law School. 525 – 563.

Commission of the European Communities (EU). (2000). Communication from the Commission on the Precautionary Principle. Brussels, Belgium.

Coon, Lyon, N. J., Raynor, E. J., Debinski, D. M., Miller, J. R., & Schacht, W. H. (2021). Using Adaptive Management to Restore Grasslands Invaded by Tall Fescue (Schedonorus arundinaceus). *Rangeland Ecology & Management*, *76*(1), 84–94.

Cosens, Ruhl, J., Soininen, N., & Lance, G. (2020). Designing Law to Enable Adaptive Governance of Modern Wicked Problems. *Vanderbilt Law Review*, *73*(6), 1687–1732.

Council of Canadian Academies, (2014). Environmental Impacts of Shale Gas Extraction in Canada. Ottawa (ON): The Expert Panel on Harnessing Science and Technology to Understand the Environmental Impacts of Shale Gas Extraction, Council of Canadian Academies. Retrieved from: https://cca-reports.ca/wp-content/uploads/2018/10/shalegas_fullreporten.pdf

Craig, R. K., & Ruhl, J. (2014). Designing administrative law for adaptive management. *Vanderbilt Law Review*, 67(1), 1.

Cullen, Alison and Mitchell Small. “Uncertain Risk: The Role and Limits of Quantitative Assessment.” In: McDaniels & Small. (2004). *Risk Analysis and Society: An Interdisciplinary Characterization of the Field.* Cambridge University Press. Pp 163-212.

Curran, Deborah. (2020). “Hydraulic Fracturing in Canada: Regulation by Moratorium or Specialized Agencies in Landscapes of Aboriginal or Treaty Rights.” In: Buono, Regina M. ; López Gunn, Elena ; McKay, Jennifer ; Staddon, Chad. (2020). *Regulating Water Security in Unconventional Oil and Gas* (Water Security in a New World). Cham: Springer International Publishing.

Curran, D., & Mascher, S. (2016). Adaptive management in water law: evaluating Australian (New South Wales) and Canadian (British Columbia) law reform initiatives. *McGill International Journal of Sustainable Development Law and Policy*, 12(2), 177-230

Curran, Deborah. (2014). British Columbia’s Water Sustainability Act – A New Approach to Adaptive Management and No Compensation Regulation. ABlawg: University of Calgary. Retrieved from: https://ablawg.ca/2014/05/28/british-columbias-water-sustainability-act-a-new-approach-to-adaptive-management-and-no-compensation-regulation/

Daly, Herman E. (1995). Commentary: On Nicholas Georgescu-Roegen’s contributions to Economics: An obituary essay. *Ecological Economics* 13 (1995): 149-154.

Douglas, Neil, and Terry Wykowski. (2011). *From belief to knowledge: Achieving and sustaining an adaptive culture in organizations*. Boca Raton, FL: CRC Press.

Doremus, H. (2002). Adaptive management, the Endangered Species Act, and the institutional challenges of “new age” environmental protection. *Washburn Law Journal* 41(1): 50-89.

Downe-Wamboldt, B. (1992). "Content analysis: Method, applications, and issues." *Health Care for Women International* **13**(3): 313-321.

Doyle, M., & Drew, C. A., & Society for Ecological Restoration International. (2008). *Large-scale ecosystem restoration five case studies from the United States / edited by Mary Doyle and Cynthia A. Drew.* Island Press.

Dubé, M., Duinker, P., Greig, L., Carver, M., Servos, M., McMaster, M., Noble, B., Schreier, H., Jackson, L., & Munkittrick, K. R. (2013). A framework for assessing cumulative effects in watersheds: An introduction to Canadian case studies. *Integrated Environmental Assessment and Management*, *9*(3), 363–369.

Dudgeon R.C., Berkes F. (2003). Local Understandings of the Land: Traditional Ecological Knowledge and Indigenous Knowledge. In: Selin H. (eds) *Nature Across Cultures. Science Across Cultures: The History of Non-Western Science*, vol 4. Springer, Dordrecht

Duriau, Vincent J., Rhonda K. Reger and Michael D. Pfarrer. (2007). A Content Analysis of the Content Analysis Literature in Organizational Studies: Research Themes, Data Sources and Methodological Refinements. *Organizational Research Methods* 10(1): 5-34. Sage. Retrieved from: http://media.terry.uga.edu/socrates/publications/2011/07/A20Content20Analysis20of20the20Content20Analysis20Literature2028ORM20200729_1.pdf

Dusseault, Maurice. (2017). The Shale Oil Revolution in the USA – Can it Continue? Waterloo Institute for Sustainable Energy. Retrieved from: https://wise.uwaterloo.ca/news1/newsupdates/the_shale_oil_revolution_in_the_usa__can_it_continue_maurice_dusseau

Elliott, V. (2018). "Thinking about the Coding Process in Qualitative Data Analysis." *The Qualitative Report* 23 (11): 2850-2861.

Environmental Assessment of the Whites Point Quarry and Marine Terminal Project: Joint Review Panel Report. (2007). Government of Nova Scotia. Retrieved from: https://novascotia.ca/nse/ea/whitespointquarry/WhitesPointQuarryFinalReport.pdf

Ernst, Jessica. (2013). Brief Review of Threats to Canada's Groundwater from the Oil and Gas Industry's Methane Migration and Hydraulic Fracturing. Rosebud, Alberta: Ernst Environmental Services.

Fischman, R., & Ruhl, J. (2016). Judging adaptive management practices of U.S. agencies. *Conservation Biology: The Journal of the Society for Conservation Biology, 30*(2), 268-275.

Fort McKay First Nation. (2015). Position Paper on the Lower Athabasca Regional Plan Frameworks. Retrieved from: https://fmsd.knowledgekeeper.ca/sites/default/files/fortmckay_home/documents/2015%2006%2001%20FMFN%20LARP%20Position%20Paper_FINAL.pdf

Freiberg, Arie. 2010. *The Tools of Regulation*. Sydney. The Federation Press.

Freyman, Monika. (2014). Hydraulic Fracturing and Water Stress: Water Demand by the Numbers. 49-50.

Frohlich, Miguel F., Timothy F. Smith, Chris Jacobson, Pedro Fidelman, R.W. (Bill) Carter, Claudia Baldwin. (2019). Towards adaptive coastal management: Lessons from a "legal storm" in Byron Shire, Australia. *Ocean & Coastal Management* 179 (2019) 104909.

Georgescu-Roegen, Nicholas. (1971). *The Entropy Law and the Economic Process*. Harvard University Press: Cambridge, MA.

Gibson, R. (2002). From Wreck Cove to Voisey's Bay: The evolution of federal environmental assessment in Canada. Impact Assessment and Project Appraisal, 20(3), 151-159.

Golafshani, N. (2003). "Understanding Reliability and Validity in Qualitative Research." *The Qualitative Report* **8**(4): 597-607. Retrieved from: http://www.brown.uk.com/teaching/HEST5001/golafshani.pdf

Golder and Associates Ltd. (2017). Literature Review of Global Pit Lakes: Pit Lake – Case Studies. Retrieved from: https://cosia.ca/sites/default/files/attachments/Literature%20Review%20of%20Global%20Pit%20Lakes_0.pdf

Gomm, Leslie and Bill Slater. (2021). Guidelines for developing adaptive management plans in Yukon: Water related components of quartz mining projects. Government of Yukon. Retrieved from: https://yukon.ca/sites/yukon.ca/files/env/env-amp-guidelines.pdf

Goss, Greg, Daniel Alessi, Diana Allen, Joel Gehman, Jason Brisbois, Stefanie Kletke, Ashkan Zolfaghari Sharak, Chelsea Notte, D. Yvette Thompson, Kailun Hong, Victor Renan Covalski Junes, Wladimir Barroso Guedes de Araujo Neto, Chloe Prosser. (2015). *Unconventional Wastewater Management: A Comparative Review and Analysis of Hydraulic Fracturing Wastewater Management Practices Across Four North American Basins.* The Canadian Water Network: Ontario, CA. Retrieved from: http://www.cwn-rce.ca/assets/resources/pdf/Hydraulic-Fracturing-Research-Reports/Goss-et-al.-2015-CWN-Report-Unconventional-Wastewater-Management.pdf?u=keyword%3Dgoss

Greig, L, D. Marmorek and C. Murray. **(**2008). Guideline for Preparation of Adaptive Management Plans. Prepared by ESSA Technologies Ltd., Richmond Hill, ON for Fisheries and Oceans Canada, Western Arctic Area, Central and Arctic Region, Yellowknife [NT] 8 pp.

Greig, L. A., D. R. Marmorek, C. Murray, and D. C. E. Robinson. (2013). Insight into enabling adaptive management. *Ecology and Society* **18**(3): 24. http://dx.doi.org/10.5751/ES-05686-180324

Gregory, R., L. Failing, M. Hartstone, G. Long, T. McDaniels, D. Ohlson. (2012). *Structured Decision Making: A Practical Guide to Environmental Management Choices.* Wiley-Blackwell: West Sussex, UK.

Guillemin, M. and L. Gillam (2004). "Ethics, Reflexivity, and “Ethically Important Moments” in Research." *Qualitative Inquiry* **10**(2): 261-280.

Gunderson, L.H., Holling, C.S., Light, S. (1995). *Barriers and Bridges to Renewal of Ecosystems and Institutions.* Columbia University Press: New York, NY.

Gunningham, Neil. 1998. “Designing Smart Regulation”. Oxford University Press.

Hardin, Garrett. (1968). The Tragedy of the Commons. *Science* Vol. 162 (3859): 1243-1248. Retrieved from: http://science.sciencemag.org/content/162/3859/1243.full

Harvie, A. & Mercier, T. (2010). The Alberta Land Stewardship Act and its Impact on Alberta's Oil and Gas Industry. *Alberta Law Review*, *48*(2), 295.

Hasselman, L., 2017. Adaptive management intentions with a reality of evaluation: getting the science back into policy. *Environ. Sci. Policy* 78, 9–17.

He, Yuhe ; Flynn, Shannon L ; Folkerts, Erik J ; Zhang, Yifeng ; Ruan, Dongliang ; Alessi, Daniel S ; Martin, Jonathan W ; Goss, Greg G. (2017). Chemical and toxicological characterizations of hydraulic fracturing flowback and produced water. *Water Research, 114*, 78-87.

Head, Brian. (2022). Wicked Problems in Public Policy: Understanding and Responding to Complex Challenges. Palgrave Macmillan. University of Queensland, Australia.

Hobbs, N. Thompson, and Ray Hilborn. (2006). Alternatives to Statistical Hypodissertation Testing in Ecology: A Guide to Self Teaching. *Ecological Applications* 16, no. 1 (2006): 5-19. http://www.jstor.org.proxy.lib.sfu.ca/stable/40061776.

Holling, C.S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, Vol. 4 (1973), pp. 1-23. Retrieved from: http://www.zoology.ubc.ca/bdg/pdfs_bdg/2013/Holling%201973.pdf

Holling, C.S. (Ed.). (1978). *Adaptive Environmental Assessment and Management.* International Institute for Applied Systems Analysis: The Pitman Press, Bath.

Holling, C.S. (1995). What barriers? What bridges? In Gunderson, L.H., Holling, C.S., Light, S.S. (Eds.). *Barriers and Bridges to the renewal of Ecosystems and Institutions.* New York: Columbia University Press: 3-34.

Houck, OA. (2009). Nature or nurture: what's wrong and what's right with adaptive management. *Environmental Law Reporter* 39 (10): 10923-10924.

International Energy Agency (IEA). (2019a), The Role of Gas in Today's Energy Transitions: World Energy Outlook Special Report. IEA, Paris: https://www.iea.org/reports/the-role-of-gas-in-todays-energy-transitions

International Energy Agency (IEA). (2019b), World Energy Outlook 2019, IEA, Paris https://www.iea.org/reports/world-energy-outlook-2019

International Energy Agency (IEA). (2011), Are we entering a golden age?, IEA, Paris https://www.iea.org/reports/are-we-entering-a-golden-age

International Institute for Applied Systems Analysis (IIASA). (1979). *Expect the Unexpected: An Adaptive Approach to Environmental Management: Executive Report 1.* Laxenburg, Austria.

International Risk Governance Council (IRGC). (2016). Planning Adaptive Risk Regulation, Conference Report. Lausanne: EPFL International Risk Governance Center.

International Risk Governance Council (IRGC). (2015). A short introduction to 'planned adaptive regulation.' Retrieved from: https://www.irgc.org/wp-content/uploads/2015/12/A_short_introdution_to_Planned_Adaptive_Risk_Regulation-19Nov15.pdf

Jansen, Kolden, C., Schmalz, H., Karl, J., & Taylor, R. (2021). Using Satellite-Based Vegetation Data for Short-Term Grazing Monitoring to Inform Adaptive Management. *Rangeland Ecology & Management*, *76*(1), 30–42.

Johnson, B. L. (1999). The role of adaptive management as an operational approach for resource management agencies. Conservation Ecology **3**(2): 8. Ebsco*host*. Retrieved from: http://web.a.ebscohost.com.proxy.lib.sfu.ca/ehost/pdfviewer/pdfviewer?sid=206bdd75-ebc8-4634-855d-03add9070aee%40sessionmgr4006&vid=3&hid=4212

Kato, Sadahisa & Jack Ahern (2008) 'Learning by doing: adaptive planning as a strategy to address uncertainty in planning, *Journal of Environmental Planning and Management*, 51:4, 543-559, DOI: 10.1080/09640560802117028

Kingsford, R.T. and Biggs, H.C. (2012). Strategic adaptive management guidelines for effective conservation of freshwater ecosystems in and around protected areas of the world. IUCN WCPA Freshwater Taskforce, Australian Wetlands and Rivers Centre, Sydney

Kirkman, R., Arson, C.F., Stewart, L., Harris, R. and Francis, A., (2017). The risks of hydraulic fracturing and the responsibilities of engineers. Elem Sci Anth, 5, p.17. DOI: http://doi.org/10.1525/elementa.218

Klimchuk, Amanda, Richard MacDonald, and Wesley Ferris (Higher Ground Consulting). (February 18, 2016). *Performance Analysis of Engineered Liner Systems Used to Store Saline Fluids in the Canadian Oil and Gas Industry: Physical and Environmental Influences.* Petroleum Technology Alliance Canada (PTAC): Alberta Upstream Research Petroleum Fund.

Kondash, A., Lauer, N., & Vengosh, A. (2018). The intensification of the water footprint of hydraulic fracturing. *Science Advances, 4*(8), Eaar5982.

Kwasniak, Arlene. (2009). *Adaptive Management in Environmental Assessment and Environmental Management: A Legal and Policy Analysis.* Canadian Environmental Network. Retrieved from: http://deslibris.ca.proxy.lib.sfu.ca/ID/224703

Kwasniak, Arlene. (2010). Use and Abuse of Adaptive Management in Environmental Assessment Law and Practice: A Canadian Example and General Lessons. *Journal of Environmental Assessment Policy and Management* Vol. 12, No. 14: 425-468

Labuschagne, A. (2003). "Qualitative Research - Airy Fairy or Fundamental?" The *Qualitative Report* **8**(1): 100-103. Retrieved from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.471.3616&rep=rep1&type=pdf

Lee, K. N. (1999). Appraising Adaptive Management. *Conservation Ecology*, *3*(2), 3. https://doi.org/10.5751/es-00131-030203

Lee, Kai N. (1993). *Compass and Gyroscope: Integrating Science and Politics for the Environment.* Island Press: Washington DC, USA.

Lindenmayer, D.B. and E.G., Likens. 2009. Adaptive monitoring: a new paradigm for long-term research and monitoring, *Trends in Ecology and Evolution* Vol.24 No.9.

Linkov, I, F.K. Satterstrom, G. Kiker, C. Batchelor, T. Bridges, E. Ferguson. (2006). From comparative risk assessment to multi-criteria decision analysis and adaptive management: recent developments and applications. Env Int, 32 (2006): 1072–1093.

MacDonald, G. Blake, John Z. Fraser, and Paul Gray. 1999. Adaptive management forum: Linking management and science to achieve ecological sustainability. In Ann Arbor: ProQuest Micromedia.

McDermott. Constance L., Benjamin Cashore & Peter Kanowski (2009) Setting the bar: an international comparison of public and private forest policy specifications and implications for explaining policy trends, *Environmental Sciences*, 6:3, 217-237,

McDonald, Stephen. (1971). *Petroleum Conservation in the United States: An Economic Analysis.* Resources for the Future, Inc., John Hopkins Press: Baltimore and London.

McFadden, Jamie E., Tim L. Hiller, and Andrew J. Tyre. (2011). Evaluating the efficacy of adaptive management approaches: Is there a formula for success? *Journal of Environmental Management* 92(5): 1354-1359. Retrieved from: http://www.sciencedirect.com.proxy.lib.sfu.ca/science/article/pii/S0301479710003701

Meidinger, E. E. (1995). Adaptive ecosystem management and regulatory taking. *Environmental Law*, 25(3), 827-854

Melis, T.S., Hamill, J.F., Bennett, G.E., Coggins, L.G., Jr., Grams, P.E., Kennedy, T.A., Kubly, D.M., and Ralston, B.E., eds. (2010). Proceedings of the Colorado River Basin Science and Resource Management Symposium, November 18–20, 2008, Scottsdale, Arizona: U.S. Geological Survey Scientific Investigations Report 2010–5135, 372 p.

Miller, Erica C. (2015). [:En]BC's Environmental Appeal Board Overturns Nexen Water Licence on Appeal by Fort Nelson First Nation[:fr]L'Environmental Appeal Board de la C.-B. invalide le permis d'utilisation des eaux de Nexen dans l'appel déposé par la première nation de Fort Nelson[:]. *Energy Regulation Quarterly*. https://energyregulationquarterly.ca/fr/case-comments/bcs-environmental-appeal-board-overturns-nexen-water-licence-on-appeal-by-fort-nelson-first-nation

Moir, W. H. and Block W. M. (2001) Adaptive management on public lands in the United States: Commitment or rhetoric? *Environmental Management* **28**, 141–148

Murphy, Blakely M. (ed.). (1949). *Conservation of Oil and Gas: A Legal History, 1948.* Section of Mineral Law, American Bar Association: Chicago, Illinois.

Murray, Carol, and David R. Marmorek. (2004). Adaptive Management: A Spoonful of Rigour Helps the Uncertainty Go Down. Submitted to the 16th International Annual Meeting of the Society for Ecological Restoration, Victoria, British Columbia, Canada – August 23rd to 27th, 2004. Retrieved from: https://www.ethz.ch/content/dam/ethz/special-interest/usys/ites/ecosystem-management-dam/documents/EducationDOC/EM_DOC/Recommended%20readingDOC/Murray_Marmorek_adaptive_management_SER_conference.pdf

Murray, C. and M. Nelitz. (2008). Review of Diavik and EKATI Adaptive Management Plans. Prepared by ESSA Technologies Ltd.: Vancouver BC, for Fisheries and Oceans Canada, Western Arctic Area, Central and Arctic Region, Yellowknife, NT. 23 pp.

Natural Resources Canada (NRCAN). (2020). *Natural Gas Facts.* Government of Canada. Retrieved from: https://www.nrcan.gc.ca/science-data/data-analysis/energy-data-analysis/energy-facts/natural-gas-facts/20067

Nie, Martin. (2008). The underappreciated role of regulatory enforcement in natural resource conservation. *Policy Sciences* 41(2): 139-164. Retrieved from: http://www.jstor.org.proxy.lib.sfu.ca/stable/pdf/40270960.pdf

Nie, M. A., & Schultz, C. A. (2012). Decision-making triggers in adaptive management. *Conservation Biology*, 26(6), 1137–1144

Nikiforuk, Andrew. (March 27, 2019). 'Insufficient,' 'Unknown,' 'Concerns': BC's Fracking Report Full of Apprehension: Scientific panel ran into 'lack of info' many, many times. *The Tyee.* Retrieved from: https://thetyee.ca/Analysis/2019/03/27/BC-Fracking-Report-Apprehension-Insufficient-Unknown-Concerns/

Noble. (2010). *Cumulative Environmental Effects and the Tyranny of Small Decisions: Towards Meaningful Cumulative Effects Assessment and Management*. Natural Resources and Environmental Studies Institute, University of Northern British Columbia.

Norton, Bryan G. 2005. *Sustainability: A Philosophy of Adaptive Ecosystem Management.* The University of Chicago Press: Chicago, USA.

Office of the Auditor General of Alberta. (2023). Liability Management of (Non-OilSands) Oil and Gas Infrastructure. Retrieved from: https://www.oag.ab.ca/wp-content/uploads/2023/03/oag-report-of-the-auditor-general-mar-2023.pdf#page=23

Office of the Auditor General of Alberta. (2015). Systems to Ensure Sufficient Financial Security for Land Disturbance from Mining. Retrieved from: https://www.oag.ab.ca/reports/oag-aep-and-aer-sufficient-financial-security-land-disturbances-mining-july-2015/

Olszynski, Martin. (2013). Shell Jackpine JRP Report: Would the Real "Adaptive Management" Please Stand Up? *The University of Calgary Faculty of Law Blog on Developments in Alberta Law.* University of Calgary Faculty of Law: Calgary, AB. Retrieved from: http://ablawg.ca/wp-content/uploads/2013/07/Blog_MO_Shell_Jackpine_July2013.pdf

Olszynski, Martin Z.P., Failed Experiments: An Empirical Assessment of Adaptive Management in Alberta's Energy Resources Sector (2017). *University of British Columbia Law Review,* 50(3): 697.

Olszynski, Martin. (November 14, 2020). Day 15 – Joint Review Panel Hearing for Benga Mining Limited Grassy Mountain Coal Project. Alberta Energy Regulator: Calgary, AB. Livestreamed on November 14, 2020. Presentation accessed on December 14, 2020 at: 136737E.pdf (iaac-aeic.gc.ca)

Olszynski, Martin and Nigel Bankes, "Setting the Record Straight on Federal and Provincial Jurisdiction Over the Environmental Assessment of Resource Projects in the Provinces" (May 24, 2019), online: ABlawg, http://ablawg.ca/wp-content/uploads/2019/05/Blog_MO_NB_BillC69.pdf

Owens, Philip N. (2009). Adaptive management frameworks for natural resource management at the landscape scale: Implications and applications for sediment resources. *Journal of Soils Sediments* 9: 578- 593. Retrieved from: http://www.unbc.ca/assets/owens/jss.pdf

Peterson, G.D., G.S. Cumming, and S.R. Carpenter. (2003). Scenario planning: a tool for conservation in an uncertain world. *Conservation Biology* 17: 358-366.

Raadgever, G.T., Erik Mostert, Nicole Kranz, Eduard Interwies, & Jos G. Timmerman. (2008). Assessing Management Regimes in Transboundary River Basins. *Ecology and Society*, *13*(1), 14. Retrieved from: https://doi.org/10.5751/ES-02385-130114

Raiffa, Howard. (1968). *Decision Analysis: Introductory Lectures on Choices under Uncertainty.* Addison-Wesley: Reading, Massachusetts.

Report of the Joint Review Panel Established by the Federal Minister of Environment and Climate Change and the Alberta Energy Regulator. Decision 2021 ABAER 010: Benga Mining Limited, Grassy Mountain Coal Project, Crowsnest Pass. (June 17, 2021)

Ridlington, E. and Rumpler, J. (October 2013). Fracking by the Numbers. Retrieved from: http://www.environmentamerica.org/sites/environment/files/reports/EA_Fracking Numbers_scrn.pdf http://www.environmentamerica.org/home

Rist, L., A. Felton, L. Samuelsson, C. Sandstrom, and O. Rosvall. (2013). A new paradigm for adaptive management. *Ecology and Society* 18(4): 63. Retrieved from: http://www.ecologyandsociety.org/vol18/iss4/art63/

Rivard, C., Lavoie, D., Lefebvre, R., Séjourné, S., Lamontagne, C., & Duchesne, M. (2014). An overview of Canadian shale gas production and environmental concerns. *International Journal of Coal Geology*, *126*, 64–76. https://doi.org/10.1016/j.coal.2013.12.004

Riversdale Resources. (2016). Benga Mining Limited, Grassy Mountain Coal Project, Section A: Project Introduction. Retrieved from: https://iaac-aeic.gc.ca/050/documents/p80101/115588E.pdf

Ruhl, J.B. (2005-2006). Regulation by adaptive management - is it possible? *Minnesota Journal of Law, Science & Technology*, *7*(1), 21-58.

Ruhl, J. B., Adaptive Management for Natural Resources - Inevitable, Impossible, or Both? (February 4, 2009). *Rocky Mountain Mineral Law Institute Proceedings*, Vol. 54, Chapter 11, (2008), FSU College of Law, Public Law Research Paper No. 343, Available at SSRN: https://ssrn.com/abstract=1337749

Ruhl JB, Fischman RL. (2010). Adaptive management in the courts. *Minnesota Law Review* 95: 424–484.

Ruhl, J.B., and Robin Craig, Designing Administrative Law for Adaptive Management, 67 *Vanderbilt Law Review*. 1 (2014) Available at: https://scholarship.law.vanderbilt.edu/faculty-publications/463

Runge M. (2011). An Introduction to Adaptive Management for Threatened and Endangered Species. *Journal Of Fish & Wildlife Management* [serial online]. November 2011; 2(2):220-233. Available from: Environment Complete, Ipswich, MA. Accessed October 19, 2016.

Salafsky, N., R. Margoluis, K. Redford. (2001). *Adaptive Management: a Tool for Conservation Practitioners.* Available on Biodiversity Support Program, Washington, DC. Retrieved from: http://www.fosonline.org/wordpress/wp-content/uploads/2010/06/AdaptiveManagementTool.pdf

Saldaña, J. (2016). *The Coding Manual for Qualitative Researchers* (3rd ed.). London: Sage.

Schramm, E. (2011). What is flowback, and how does it differ from produced water? Institute for Energy and Environmental Research of Northeastern Pennsylvania Clearinghouse website.

Schreier, M. (2014). Qualitative content analysis. In Flick, U. *The SAGE handbook of qualitative data analysis* (pp. 170-183). London: SAGE Publications Ltd

Schultz, Courtney & Martin Nie. (2012). Decision-making Triggers, Adaptive Management, and Natural Resources Law and Planning. *Natural Resources Journal*, *52*(2), 443–521.

Shapiro, G., & Markoff, G. (1997). In C. W. Roberts (Ed.), *Text analysis for the social sciences: Methods for drawing statistical inferences from text and transcripts* (pp. 9–31). Mahwah, NJ: Lawrence Erlbaum Associates.

Sirota, L. (2018). Canadian Administrative Law and Good Governance. *Canadian Journal of Administrative Law & Practice*, *31*(3), 285–305.

Sparrow, Malcolm K. (1994). *Imposing Duties: Government's Changing Approach to Compliance.* Praeger Publishers: Westport, CT.

Sparrow, Malcolm K. (2000). *The Regulatory Craft: Controlling Risks, Solving Problems, and Managing Compliance.* The Brookings Institution: Washington DC.

Sparrow, Malcolm K. (2008). *The Character of Harms.* Cambridge University Press, New York.

Sparrow, Malcolm K. (2020). *Fundamentals of Regulatory Design.* Malcolm K. Sparrow.

Spellman, Frank. (2013). Environmental Impacts of Hydraulic Fracturing. FL, USA: CRC Press, Taylor & Francis Group.

Stankey, George H.; Clark, Roger N.; Bormann, Bernard T. (2005). Adaptive management of natural resources: theory, concepts, and management institutions. Gen. Tech. Rep. PNW-GTR-654. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Retrieved from: https://www.fs.fed.us/pnw/pubs/pnw_gtr654.pdf

Susskind, L., Camacho, A.E., Schenk, T. (2010). Collaborative planning and adaptive management in Glen Canyon: a cautionary tale. *Columbia Journal of Environmental Law* 35, 1-54.

Susskind, & Secunda, J. (1999). "Improving" Project XL: Helping Adaptive Management to Work within EPA. *UCLA Journal of Environmental Law & Policy*, *17*(2), 155.

Swanson, Darren, et al. (2010). Seven tools for creating adaptive policies. *Technological Forecasting & Social Change* Volume 77, Issue 6, July 2010, 924–939. Retrieved from: http://www.sciencedirect.com/science/article/pii/S0040162510000727

Taylor, Brenda, Laurie Kremsater, and Rick Ellis. (1997). Adaptive Management of Forests in British Columbia. BC Ministry of Forests (BCMF) – Forest Practices Branch: Victoria, BC. Retrieved from: https://www.for.gov.bc.ca/hfd/pubs/docs/sil/sil426-1.pdf

Taylor, C.M.. 2012. “Better by Design: Rethinking interventions for better environmental regulation”. Elsevier. 488 – 499.

Timoney, Kevin, and Peter Lee. (2001). Environmental management in resource-rich Alberta, Canada: first world jurisdiction, third world analogue? *Journal of Environmental Management* 63: 387-405. Retrieved from: http://ac.els-cdn.com/S0301479701904876/1-s2.0-S0301479701904876-main.pdf?_tid=ac8cc78c-85c3-11e6-9373-00000aacb362&acdnat=1475098794_e5da0e6db40572e4dcef7f8cc5946e1f

Thompson, Dixon (Ed.). (2002). *Tools for Environmental Management.* New Society Publishers: Gabriola Island, BC.

Treasury Board of Canada Secretariat. (2018). Policy on Regulatory Development. Retrieved from: https://www.canada.ca/en/government/system/laws/developing-improving-federal-regulations/requirements-developing-managing-reviewing-regulations/guidelines-tools/policy-regulatory-development.html

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2005). *The Precautionary Principle.* World Commission on the Ethics of Scientific Knowledge and Technology: UNESCO: Paris.

U.S. EPA. Hydraulic Fracturing For Oil And Gas: Impacts From The Hydraulic Fracturing Water Cycle On Drinking Water Resources In The United States (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-16/236F, 2016.

United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). (2007). United Nations. Retrieved from: https://www.un.org/development/desa/indigenouspeoples/wp-content/uploads/sites/19/2018/11/UNDRIP_E_web.pdf

United States Geological Survey (USGS). (no date). Glen Canyon Dam Adaptive Management Program (GCDAMP). Retrieved from: https://www.usgs.gov/centers/southwest-biological-science-center/science/glen-canyon-dam-adaptive-management-program

University of Calgary School of Public Policiy. (2015). *The Importance of Certainty and Stability in Regulatory Processes.* Retrieved from: https://www.policyschool.ca/importance-certainty-and-stability-regulatory-processes/

Walsworth, & Schindler, D. E. (2016). Long time horizon for adaptive management to reveal predation effects in a salmon fishery. *Ecological Applications*, *26*(8), 2695–2707.

Walters, Carl. (1986). *Adaptive Management of Renewable Resources.* International Institute for Applied Systems Analysis. Macmillan Publishing Company: New York, NY.

Walters, Carl. (December, 1997). Challenges in adaptive management of riparian and coastal ecosystems." *Conservation Ecology (11955449)* 1, no. 2 (December 1997): 1. *Environment Complete*, EBSCO*host* (accessed October 13, 2016).

Walters, C.J., Jeremy S. Collie, Timothy Webb. (1988). Experimental designs for estimating transient responses to management disturbances. *Canadian Journal of Fisheries and Aquatic Sciences* 45(3): 530-538.

Walters, C.J., J. S. Collie, and T. Webb. (1989). Experimental designs for estimating transient responses to habitat alterations: is it practical to control for environmental changes? *Canadian Special Publication of Fisheries and Aquatic Sciences, Habitat Symposium.* 13-20. Retrieved from: http://www.dfo-mpo.gc.ca/Library/111493.pdf

Walters, C.J. and C.S. Holling. (1990). Large-scale management experiments and learning by doing. *Ecology* 71(6): 2060-2068. Retrieved from: http://www.jstor.org.proxy.lib.sfu.ca/stable/pdf/1938620.pdf

Weber, Bob. (March 19, 2014). Alberta's plan for Athabasca Riverr 'pathetic,' not science-based: critics. *The Canadian Press.* Retrieved from: https://www.ctvnews.ca/sci-tech/alberta-s-plan-for-athabasca-river-pathetic-not-science-based-critics-1.1735778

Whyte, K.P. (2013). On the role of traditional ecological knowledge as a collaborative concept: a philosophical study. *Ecol Process* **2,** 7 (2013). https://doi.org/10.1186/2192-1709-2-7

Williams, Byron K. (2011a). Adaptive management of natural resources – framework and issues. *Journal of Environmental Management* 92 (2011): 1346-1353. Retrieved from: http://www.webpages.uidaho.edu/fish510/PDF/Williams%202011%20adaptive%20mgt.pdf

Williams, Byron K. (2011b). Passive and active adaptive management: Approaches and an example. *Journal of Environmental Management* 92 (2011): 1371-1378. Retrieved from: http://www.sciencedirect.com.proxy.lib.sfu.ca/science/article/pii/S0301479710003713

Williams, B.K., and E.D. Brown. (2016). Technical challenges in the application of adaptive management. *Biological Conservation* 195 (2016): 255-263.

Williams, B.K., and E.D. Brown. Adaptive Management: From More Talk to Real Action. *Environmental Management* (2014) 53: 465-479.

Williams, B. K., R. C. Szaro, and C. D. Shapiro. (2009). *Adaptive Management: The U.S. Department of the Interior Technical Guide*. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC. Retrieved from: https://www2.usgs.gov/sdc/doc/DOI-%20Adaptive%20ManagementTechGuide.pdf

Wilson, George, and Margaret Woodrow. (2009). Kuka Kanyini, Australian Indigenous Adaptive Management. In: Allan and G.H. Stankey (Eds.). 2009. *Adaptive Environmental Management: A Practitioner's Guide.* Springer Science + Business Media B.V.: 117-141.

Winter, Jennifer & Dobson, Sarah & Lorefice, Sophie. (2016). Hydraulic Fracturing and Public Policy. Final Report to the Social Sciences and Humanities Research Counsel of Canada: Knowledge Syndissertation Grant. School of Public Policy, University of Calgary. Retrieved from: https://www.researchgate.net/publication/326547902_Hydraulic_Fracturing_and_Public_Policy

Winter, J., Fellows, G. K., & Goodday, V. (2019). Enabling partial upgrading in Alberta: A review of the regulatory framework and opportunities for improvement. *The School of Public Policy Publications (SPPP), 12* doi:https://doi.org/10.11575/sppp.v12i0.68199

Wintle. B.A., and Lindenmayer, D.B. (2008). Adaptive risk management for certifiably sustainable forestry. *Forestry Ecology and Management* Vol: 256 (6): 1311-1319. Retrieved from: http://www.sciencedirect.com.proxy.lib.sfu.ca/science/article/pii/S0378112708005306

Wondolleck, Julia Marie, and Steven Lewis Yaffee. (2000). *Making collaboration work: lessons from innovation in natural resource management*. Island Press: Washington DC.

Wurtzebach. (2015). Adaptive Management for Oil and Gas Development on Public Lands: An Innovative Approach to Resource Protection, or Symbolic Placation of Public Interests? *The Review of Policy Research,* 32(2), 246–268

Zimmermann, Erich W. (1957). Conservation in the Production of Petroleum: A Study in Industrial Control. Yale University Press: New Haven.

Policies Laws and Regulations

Alberta

Alberta Land Stewardship Act, Statutes of Alberta, 2009, Chapter A-26.8. Accessed on December 4, 2020 at: https://www.qp.alberta.ca/1266.cfm?page=A26P8.cfm&leg_type=Acts&isbncln=9780779777259

Alberta Wetland Policy. (2013). Environment and Sustainable Resource Development, Government of Alberta: Edmonton, Alberta. Retrieved from: https://open.alberta.ca/dataset/5250f98b-2e1e-43e7-947f-62c14747e3b3/resource/43677a60-3503-4509-acfd-6918e8b8ec0a/download/6249018-2013-alberta-wetland-policy-2013-09.pdf

Bulletin 2014-38: Temporary Surface Water Pipelines for the Energy Resource Industry. (December 5, 2014). Alberta Energy Regulator: Calgary, AB. Accessed on November 24, 2020 at: https://www.aer.ca/regulating-development/rules-and-directives/bulletins/aer-bulletin-2014-38

Cumulative Effects Assessment in Environmental Impact Assessment Reports Required Under the Alberta *Environmental Protection and Enhancement Act*. (2000). Alberta Environment, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/ffb3a8b8-8eab-421f-98aa-56f21dc98dbe/resource/a87805b5-96c4-45a8-8899-92fafa3b0503/download/cumulativeeffectseiareportsunderepea-a.pdf

Directive 51: Injection and Disposal Wells – Well Classifications, Completions, Logging, and Testing Requirements. (1994). Energy Resources Conservation Board (ERCB) (Alberta Energy Regulator): Calgary, Alberta. Accessed on November 6, 2020 at: https://www.aer.ca/regulating-development/rules-and-directives/directives/directive-051

Directive 55: Storage Requirements for the Upstream Petroleum Industry (2001). Energy Resources Conservation Board (Alberta Energy Regulator): Calgary, AB. Accessed on October 20, 2020: http://www.aer.ca/documents/directives/Directive055.pdf

Directive 55 (Addendum): Interim Requirements for Aboveground Synthetically- Lined Wall Storage Systems, Updates to Liner Requirements, and Optional Diking Requirements for Single-Walled aboveground Storage Tanks. (2011). Energy Resources Conservation Board (Alberta Energy Regulator): Calgary, AB. Accessed on October 22, 2020: http://www.aer.ca/documents/directives/Directive055_addendum.pdf

Directive 056:

Directive 58: Oilfield Waste Management Requirements for the Upstream Petroleum Industry. (November, 1996, incorporating change of 2006). Energy Resources Conservation Board (Alberta Energy Regulator): Calgary, AB. Accessed on January 4, 2021 at: https://static.aer.ca/prd/2020-07/Directive058_0.pdf

Directive 77: Pipelines – Requirements and Reference Tools. (2011). Energy Resources Conservation Board (Alberta Energy Regulator): Calgary, AB. Accessed on January 2, 2021 at: https://static.aer.ca/prd/2020-07/Directive077_0.pdf

Directive 83: Hydraulic Fracturing – Subsurface Integrity. (2013). Energy Resources Conservation Board (Alberta Energy Regulator): Calgary, AB. Accessed on November 13, 2020 at: https://static.aer.ca/prd/documents/directives/Directive083.pdf

Directive for Water Licensing of Hydraulic Fracturing Projects – Area of Use Approach. (February 22, 2018). Alberta Environment and Parks, Water Quantity, 2018, No. 1. Accessed on October 23, 2020 at: https://open.alberta.ca/dataset/ef2df211-1091-4470-9b42-defe6529a862/resource/abce01b3-2011-494c-bc50-a42774d49995/download/directivehydraulicfracturing-feb16-2018.pdf

Environmental Protection and Enhancement Act (EPEA). Revised Statutes of Alberta 2000, Chapter E-12. Alberta Queen's Printer. Accessed on October 23, 2020 at: https://www.qp.alberta.ca/documents/Acts/E12.pdf

Guidelines for Alberta Brine Storage Reservoirs. (1978). Alberta Environment (Alberta Energy Regulator). Retrieved from: https://open.alberta.ca/dataset/24d3c269-0f39-4c6c-8a77-77eca18aa22b/resource/39ddaa6f-2deb-46e3-b969-9d3afa88cb72/download/guidelinesbrinestorage.pdf

Interim Directive ID 2000-3: Memorandum of Understanding between the Alberta Energy and Utilities Board and Alberta Environment on Harmonization of Waste Management. (May 31, 2000). Energy and Utilities Board (EUB) (Alberta Energy Regulator): Calgary, AB. Accessed on November 17, 2020 at: https://static.aer.ca/prd/2020-07/id2000-03_0.pdf

Interim Directive ID 2000-4: An Update to the Requirements for the Appropriate Management of Oilfield Wastes. (June 19, 2000). Alberta Energy and Utilities Board (EUB) (Alberta Energy Regulator): Calgary, AB. Accessed on November 17, 2020 at: https://static.aer.ca/prd/2020-07/id2000-04_0.pdf

Land Use Framework. (2008). Land use Secretariat, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/30091176-f980-4f36-8f5a-87bc47890aa8/resource/bc4b3fac-5e59-473b-9a99-1a83970c28e7/download/4321768-2008-land-use-framework-2008-12.pdf

Lower Athabasca Region Groundwater Management Framework. (2012). Alberta Environment and Sustainable Resource Development, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/90a86c75-60a3-46aa-9893-cef9a040bc99/resource/bde418ba-c70e-4bc4-ab77-0e72d4770b6a/download/6248198-2012-08-larp-framework-groundwatermgt-finalv2.pdf

Lower Athabasca Region Groundwater Management Framework Supporting Document for the Cold Lake – Beaver (CLBR) Area. (2012). Environment and Sustainable Resource Development, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/94fbc1cc-99ac-4b8c-8e9a-edafdd1aa3ce/resource/1bcb2bff-45a3-43a6-9d94-87902417283e/download/8872.pdf

Lower Athabasca Region Groundwater Management Framework Supporting Document for the North Athabasca Oil Sands (NAOS) Area. (2013). Environment and Sustainable Resource Development, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/2ae24dcf-3906-40d1-b344-b8e4c322f111/resource/abd24184-9a55-498b-9363-773012ea0075/download/8873.pdf

Lower Athabasca Region Groundwater Management Framework Supporting Document for the South Athabasca Oil Sands (SAOS) Area. (2013). Environment and Sustainable Resource Development, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/3fda404f-312c-4d44-9e1a-e3295dcf39a1/resource/7c082450-8e89-4225-8eaf-eb38e1ebd761/download/8874.pdf

Lower Athabasca Regional Plan. (2012). Land Use Secretariat, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/37eab675-19fe-43fd-afff-001e2c0be67f/resource/a063e2df-f5a6-4bbd-978c-165cc25148a2/download/5866779-2012-08-lower-athabasca-regional-plan-2012-2022.pdf

Muskeg River Interim Management Framework for Water Quantity and Quality: management guidance for aquatic components of the Muskeg River watershed. (2008). Alberta Environment, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/ba3a7d26-edfe-4e6a-8b3f-57600d1ac04c/resource/a876fb44-9310-48c2-a4ae-9cca9bd40d33/download/2008-muskegriverinterimwaterreport-jun2008.pdf

Oil and Gas Conservation Act, Revised Statutes of Alberta 2000, Chapter O-6. Accessed on November 8, 2020 at: https://www.qp.alberta.ca/documents/Acts/O06.pdf

Oil and Gas Conservation Rules, Alberta Regulation 151/1971. Accessed on October 19, 2020 at: https://www.qp.alberta.ca/documents/Regs/1971_151.pdf

Our Water Our Future: A Plan for Action. (2014). Environment and Sustainable Resource Development, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/d1d7962a-d926-4e89-866f-1f6cb71e4d1f/resource/721910e6-6cd4-423c-975c-130f806d67dd/download/zz-2014-our-water-our-future-plan-action-2014-11.pdf

Pipeline Act, Revised Statutes of Alberta 2000, Chapter P-15. Accessed on November 12, 2020 at: https://www.qp.alberta.ca/documents/Acts/p15.pdf

Pipeline Rules, Alberta Regulation 91/2005. Accessed on November 18, 2020 at: https://www.qp.alberta.ca/documents/Regs/2005_091.pdf

Provincial Energy Strategy, The. (2009 – Archived). Alberta Energy, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/6f220382-b4ae-43f8-b3f9-7c1230e6700e/resource/e7c2f3d2-7e0d-4774-a463-c54c5450a04e/download/4256197-2009-launching-albertas-energy-future-provincial-enregy-strategy-2009-08-27.pdf

Public Lands Act, Revised Statutes of Alberta 2000, Chapter P-40. Accessed on November 13, 2020 at: https://www.qp.alberta.ca/documents/Acts/P40.pdf

Responsible Energy Development Act (REDA). Statutes of Alberta, 2012, Chapter R-17.3.

Regional Sustainable Development Strategy for the Athabasca Oil Sands Area. (1999 – Archived). Alberta Environment, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/7693d291-fef9-4784-9e7f-15a51aec66f3/resource/113fbad5-bf54-43e8-8ac9-a7b28353c773/download/1999-regional-sustainable-development-strategy-for-athabasca-oil-sands-area-july-1999.pdf

South Saskatchewan Regional Plan. (2014). Alberta Environment and Parks, Government of Alberta: Edmonton, AB. Retrieved from: https://landuse.alberta.ca/LandUse%20Documents/South%20Saskatchewan%20Regional%20Plan%202014-2024%20-%20May%202018.pdf

South Saskatchewan Region Surface Water Quality Management Framework. (2014).

Surface Water Allocation Directive. (February, 2019). Alberta Environment and Parks, Government of Alberta: Edmonton, Alberta. Accessed on November 17, 2020 at: https://open.alberta.ca/dataset/ba87f44e-9bea-4430-84d8-d2ab41b5a4fb/resource/8e0258e7-ae43-41e3-b864-7867f5f7b38c/download/surfacewaterallocationdirective-2019.pdf

Surface Water Quality Management Framework for the Lower Athabasca River. (2012). Environment and Sustainable Resource Development, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/publications/9781460104514#summary

Surface Water Quantity Management Framework for the Lower Athabasca River (2015). Environment and Sustainable Resource Development, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/publications/9781460121733#summary

Tailings Management Framework for the Mineable Athabasca Oil Sands. (2015). Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/publications/9781460121740

Too Good to Waste: Making Waste A Priority. (2007).

Waste Control Regulation (*Environmental Protection and Enhancement* Act) Alberta Regulation 192/1996. Accessed on December 11, 2020 at: https://www.qp.alberta.ca/documents/Regs/1996_192.pdf

Wastewater and Storm Drainage Regulation

Water Act, Revised Statutes of Alberta 2000, Chapter W-3. Accessed on November 23, 2020 at: https://www.qp.alberta.ca/documents/Acts/W03.pdf

Water Conservation and Allocation Guideline for Oilfield Injection. (2006). Alberta Environment, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/f4f40c00-5e52-4ea0-a1cf-3ecdafd61b95/resource/db3ccf86-5b54-4cc5-bfce-a5b42f9282bf/download/water-oilfieldinjectionguideline-2006.pdf

Water Conservation and Allocation Policy for Oilfield Injection. (2006). Alberta Environment, Government of Alberta: Edmonton, AB. Retrieved from: https://open.alberta.ca/dataset/fc3d3079-9291-4648-8669-762098f76721/resource/ee976dcd-d87e-41f9-920c-fff027a235e9/download/waterconservationoilfieldinjectionpolicy.pdf

Water Management Framework for the Industrial Heartland and Capital Region. (2007).

Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River. (2007).

Water for Life: A Renewal. (2008).

Water for Life: Action Plan. (2009).

Water for Life: Alberta's Strategy for Sustainability. (2003).

British Columbia

A New Direction for Strategic Land Use Planning in British Columbia: A Synopsis. (2006).

A Water Conservation Strategy for British Columbia. (1998).

Cumulative Effects Framework. (2016).

Cumulative Effects Framework and Environmental Assessment. (2017).

Cumulative Effects in EAO-Led Environmental Assessments. (2017).

Development of Major Projects Within the Natural Resource Sector: An Overview of British Columbia's Regulatory Processes. (2015).

Drilling and Production Regulation (2010).

Environmental Assessment Office User Guide. (March 2020).

Environmental Management Act

Environmental Mitigation Policy (Working Document). (2013).

Guidance for the Derivation and Application of Water Quality Objectives in British Columbia. (2013).

Guidelines for Socio-Economic and Environmental Assessment. (2007).

Indigenous participation in an Environmental Assessment. (2018). Environmental Assessment Office, Government of British Columbia: Victoria, B.C.

Interim Guidelines for Wetland Protection and Conservation in British Columbia. (2007). *Chapter 7: Oil and Gas Extraction.*

Interim Guidelines for Wetland Protection and Conservation in British Columbia. (2007). *Chapter 12: Monitoring and Reporting.*

Land Use Objectives Regulation: Policy and Procedures. (2008).

Land Use Policy: Oil and Gas Facilities and Well Sites. (2020).

Living Water Smart: British Columbia's Water Plan. (2008).

Management of Saline Fluids for Hydraulic Fracturing Guideline. (February, 2016).

New Direction for Strategic Land Use Planning in British Columbia: Initiating Planning Projects and Developing a Business Case: Policies and Procedures. (2007).

Northeast Water Strategy. (2015).

Policy Bulletin for Groundwater Users. (2019).

Procedures for Mitigating Impacts on Environmental Values. (2014).

Resource Analysis Guide to Sustainable Resource Management Planning (SRMP Policy). (2004 – Archived).

Sustainable Resource Management Planning Standards Guide (SRMP Policy). (2004 – Archived).

Water Conservation Guide for British Columbia. (2003).

Water Quality Guidelines Policy. (2019).

Water Sustainability Act

Water Use Plan Guidelines. (1998).

Canada

An Act to Amend the Canadian Environmental Assessment Act, S.C. 2003, Bill C-9, 2nd Session, 37th Legislature. (Assented to 2003-06-11) CanLII. Retrieved from: http://www.canlii.org/en/ca/laws/astat/sc-2003-c-9/latest/sc-2003-c-9.html?autocompleteStr=canadian%20environmental%20assessment%20&autocompletePos=3

Canadian Environmental Assessment Act, 2012 (S.C. 2012, c. 19, s. 52). (Repealed 2019, c. 28, s. 9) Retrieved from: https://laws-lois.justice.gc.ca/eng/acts/C-15.21/page-1.html

Canadian Environmental Assessment Agency [CEAA]. 2009. *Operational policy statement: adaptive management measures under the Canadian environmental assessment act*. Canadian Environmental Assessment Agency, Ottawa, Ontario

Impact Assessment Act (S.C. 2019, c. 28, s. 1). Retrieved from: https://laws.justice.gc.ca/eng/acts/I-2.75/

Court Cases

Canadian Parks and Wilderness Society (CPAWS) v. Canada (Minister of Canadian Heritage), 2003 FCA 197, [2003] F.C.J. No. 703

Haida Nation v. British Columbia (Minister of Forests), 2004 SCC 73 (CanLII), [2004] 3 SCR 511

Morton v. Canada (Fisheries and Oceans), 2015 FC 575 (CanLII). Retrieved from: https://www.canlii.org/en/ca/fct/doc/2015/2015fc575/2015fc575.html?resultIndex=1#_The_precautionary_principle

Pembina Institute for Appropriate Development v. Canada (Attorney General) [2008] FC 302, CanLII. Retrieved from: http://www.canlii.org/en/ca/fct/doc/2008/2008fc302/2008fc302.html

Yahey v. British Columbia, 2021 BCSC 1287. Retrieved from: https://www.bccourts.ca/jdb-txt/sc/21/12/2021BCSC1287.htm#_Toc75942743

Appendix A.

Elements within each step in the Adaptive Management cycle

Table A-1 Elements within each step of the Adaptive Management cycle adapted from Murray & Nelitz (2008)

AM Steps	Ideal Elements within each Step
Step 1: Assess and define the problem	Clearly state management goals and objectives Identify key uncertainties (what are the management questions?) Explore alternative management actions and options (experimental treatments) Identify measurable indicators Identify spatial and temporal boundaries of the study Build conceptual models Articulate hypotheses to be tested Explicitly state assumptions Articulate how findings and what is learned will be used Involve stakeholders Involve scientists Involve resource managers/decision-makers
Step 2: Design	Use active AM Include contrasts, replications, controls Get statistical advice Predict outcomes Consider next steps under alternative scenarios and outcomes Develop a data management plan Develop a monitoring plan Develop a formal AM plan (AMP) Get the design peer-reviewed Obtain multi-year budget commitments Involve stakeholders
Step 3: Implementation	Implement contrasting treatments Implement as designed (document any changes) Monitor and document the implementation
Step 4: Monitoring and data collection	Implement the monitoring plan, as designed Undertake baseline (before) monitoring Undertake effectiveness monitoring
Step 5: Evaluation of results	Compare monitoring results against objectives Compare monitoring results against assumptions, uncertainties and hypotheses Compare actual results against model predictions Receive statistical or analysis advice (check validity)

	Have data analysis keep up with data generation from monitoring activities
Step 6: Revise and/or adjust hypotheses and management actions	Meaningful learning occurred Meaningful learning was documented Communicate with decision-makers Communicate with others (stakeholders and the public, where appropriate) Actions or instruments changed based on what was learned

Source: Murray & Nelitz, 2008

Appendix B.

Shale Gas Water and Wastewater Management Policies Reviewed for Chapter 4

Alberta

1. Alberta Wetland Policy (2013) – Foundational
2. Athabasca River Water Management Framework (2014 – Archived) - Foundational
3. Cumulative effects assessment in environmental impact assessment reports required under the Alberta EPEA (2000) - Supplementary
4. Enabling Partnerships: A Framework in Support of Water For Life (2005) - Supplementary
5. Framework for Water Management Planning (2001) - Foundational
6. Groundwater Management Framework (LARP) (2012) - Supplementary
7. Land Use Framework (2008) – Foundational
8. Lower Athabasca Region Groundwater Management Framework Supporting Document for the Cold Lake – Beaver (CLBR) Area (2012) - Supplementary
9. Lower Athabasca Region Groundwater Management Framework Supporting Document for the North Athabasca Oil Sands (NAOS) Area (2013) - Supplementary
10. Lower Athabasca Region Groundwater Management Framework Supporting Document for the South Athabasca Oil Sands (SAOS) Area (2013) - Supplementary
11. Lower Athabasca Regional Plan (LARP) (2012) – Foundational (Regional)
12. Muskeg River Interim Management Framework for Water Quantity and Quality (2008) - Supplementary
13. Our Water Our Future: A Plan for Action (2014) – Foundational
14. Regional Sustainable Development Strategy for the Athabasca Oil Sands Area (1999 – Archived) – Foundational (Regional)
15. South Saskatchewan Region Surface Water Quality Management Framework (2014) - Supplementary
16. South Saskatchewan Regional Plan (2018) - Foundational

17. Surface Water Quality Management Framework for the Lower Athabasca River (2012) - Supplementary
18. Surface Water Quantity Management Framework for the Lower Athabasca River (2015) - Supplementary
19. Tailings Management Framework for the Mineable Athabasca Oil Sands (2015) - Supplementary
20. The Provincial Energy Strategy (2009 – Archived) – Foundational
21. The Water Management Framework for the Industrial Heartland and Capital Region (2007) - Foundational
22. Too Good to Waste: Making Waste A Priority (2007) – Supplementary
23. Water Conservation and Allocation Guideline for Oilfield Injection (2006) - Supplementary
24. Water Conservation and Allocation Policy for Oilfield Injection (2006) – Foundational
25. Water for Life: A Renewal (2008) - Foundational
26. Water for Life: Action Plan (2009) – Foundational
27. Water for Life: Alberta's Strategy for Sustainability (2003) - Foundational
28. Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River (2007) – Supplementary

British Columbia

1. A New Direction for Strategic Land Use Planning in B.C.: Synopsis (2006) - Foundational
2. A Water Conservation Strategy for British Columbia (1998) – Foundational
3. Cumulative Effects Framework (2016) - Foundational
4. Cumulative Effects Framework and Environmental Assessment (2017) - Supplementary
5. Cumulative Effects in EAO-led Environmental Assessments (2017) - Supplementary
6. Dawson Creek Land and Resource Management Plan (1999) - Foundational
7. Development of Major Projects Within the Natural Resource Sector: An Overview of B.C.'s Regulatory Processes (Guidance Document) (2015) - Supplementary
8. Environmental Assessment Office User Guide (2020) - Supplementary

9. Environmental Mitigation Policy (Working Document) (2013) – Foundational
10. Fort Nelson Land and Resource Management Plan (1997) - Foundational
11. Fort St. John Land and Resource Management Plan (1997) – Foundational (currently under review and being updated)
12. Guidance for Technical Assessment Requirements in Support of an Application for Groundwater Use in British Columbia (2016) - Supplementary
13. Guidance for the Derivation and Application of Water Quality Objectives in British Columbia (2013) - Supplementary
14. Guidelines for Socio-Economic and Environmental Assessment (2007) - Supplementary
15. Indigenous participation in an Environmental Assessments. (2018) – Supplementary
16. Interim Guidelines for Wetland Protection and Conservation in British Columbia: Chapter 7: Oil and Gas Extraction; Chapter 12: Monitoring and Reporting (2007) – Supplementary
17. Land and Resource Management Planning: A Statement of Principles and Process (1993) – Foundational
18. Land Use Objectives Regulation: Policy and Procedures (2008) - Supplementary
19. Land Use Policy: Oil and Gas Facilities and Well Sites (2020) – Foundational
20. Living Water Smart: B.C.'s Water Plan (2008) – Foundational
21. New Direction for Strategic Land Use Planning in B.C.: Amending Strategic Land and Resource Plans: Policy and Procedures (2007) – Supplementary
22. New Direction for Strategic Land Use Planning in B.C.: Initiating Planning Projects and Developing a Business Case: Policies and Procedures (2007) - Supplementary
23. Northeast Water Strategy (2015) - Foundational
24. Policy Bulletin for Groundwater Users (2019) – Foundational
25. Procedures for Mitigating Impacts on Environmental Values (2014) - Supplementary
26. Resource Analysis Guide to Sustainable Resource Management Planning (SRMP Policy) (2004 – Archived) - Supplementary
27. Sustainable Resource Management Planning Standards Guide (SRMP Policy) (2004 – Archived) - Supplementary

28. Technical Guidance 1: Environmental Impact Assessment and Technical Assessment Terms of Reference (2014) - Supplementary
29. Technical Guidance 6: Water and Air Baseline Monitoring Guidance for Mine Proponents and Operators (2016) - Supplementary
30. Technical Guidance 8: Framework for Development and Use of Freshwater Science-Based Environmental Benchmarks for Mines (2016) - Supplementary
31. Water Conservation Guide for British Columbia (2003) – Supplementary
32. Water Quality Guidelines Policy (2019) - Foundational
33. Water Quality Guidelines Policy (2019) – Supplementary
34. Water Use Plan Guidelines (1998) – Supplementary

Appendix C.

Adaptive Management Plans

Developing an adaptive management plan (AMP) is one of the most important parts of up-front planning for AM initiatives. As described by Grieg et al. (2008), a comprehensive AMP must include sufficient details about steps 1 and 2 of the AM to enable a fulsome peer review and evaluation of the AMP.

Table C-1 Components of Adaptive Management Plans

	Phase of AM where activity is considered	Phase of AM where activity occurs	AMP should include/describe:
1.	Assess and define the problem (1)	Assess and define the problem (1); Design (2)	A clear statement of the management goals and objectives for the adaptive management initiative (AMI), in measurable terms.
2.	Assess and define the problem (1)	Assess and define the problem (1); Design (2)	A list of the key uncertainties (management questions) to be addressed by the AMI.
3.	Assess and define the problem (1)	Assess and define the problem (1); Design (2) Assess and define the problem (1); Design (2); Monitoring (4)	A description of the alternative management actions (experimental "treatments") to be employed in the AMI, and how they relate to the uncertainties (row 2). Management actions considered during the assessment stage, but which are not included in the AMI, if any, should also be identified and the reasons for their elimination from the AMI should be documented. If the AMI will employ a Passive AM approach, the plan should indicate the initial management action to be explored, the duration of monitoring required to evaluate that action, and the likely sequence of alternative management actions thereafter depending on the outcome of the monitoring and evaluation steps (i.e., a series of if…then statements). If the sequence of alternatives is not specified, then the criteria for selecting alternatives for subsequent investigation should be described.
4.	Assess and define the problem (1)	Assess and define the problem (1)	A graphic (map based) and textual description of the spatial / temporal bounds of the AMI.

	Phase of AM where activity is considered	Phase of AM where activity occurs	AMP should include/describe:
5.	Assess and define the problem (1)	Assess and define the problem (1); Design (2)	Conceptual models which describe the hypotheses to be tested, and which thus underlie the design, should be clearly documented. Such models are best presented in terms of diagrams that illustrate the pathways through which the effects of alternative management actions are thought to occur, accompanied by descriptive text to explain the meaning of the linkages in the pathway diagrams. As appropriate to the context of the AMI such models should clearly illustrate the specific spatial / temporal boundaries, and spatial / temporal dynamics of the pathways. The discussion / presentation of the models should clearly state the assumptions made in developing the AMI design.
6.	Assess and define the problem (1)	Assess and define the problem (1); Design (2)	A description of the indicators that will be measured to assess the effects of management treatment(s) (effectiveness indicators).
7.	Assess and define the problem (1)	Monitoring (4)	A description of the sampling design (locations, timing / frequency of sampling for each indicator) employed in collecting any baseline data used to develop or inform the AMI, and a presentation of the results of the baseline monitoring (this may be incorporated in the presentation of the conceptual models which describe the hypotheses to be tested).
8.	Assess and define the problem (1)	Adjustment/ revision of hypothesis and management (6)	A description of how what is learned from the AMI will be used to change management policy or practice (a commitment to revise).
9.	Assess and define the problem (1); Design (2)	Throughout all phases	A description of the involvement of Indigenous Peoples, stakeholders, scientists, and managers in the development of the design of the AMI (who was involved, the methods of involvement, and their contributions). The AMI should include a description of when and how Indigenous Peoples, stakeholders, scientists, and managers will be involved in the future.
10.	Design (2)	Implementation (3); Monitoring (4); Evaluation of results (5)	If the AMI will employ an active AM approach (preferred) then the AM plan should include a description of the contrasts, replications, controls to be employed in the AMI.

	Phase of AM where activity is considered	Phase of AM where activity occurs	AMP should include/describe:
11.	Design (2)	Monitoring (4); Evaluation of results (5)	Predicted outcomes of the management treatments. This should include not just the most likely expectation, but the possible range of expected outcomes. The next steps to be taken in response to each of the alternative outcomes should also be described. This is especially important for any designs that may employ a tiered approach (e.g., one in which the initial level of monitoring is designed to detect a problem which if detected would necessitate a subsequent management response – either the implementation of corrective management actions, or increased monitoring to further identify the cause of the problem.
12.	Design (2)	Monitoring (4); Evaluation of results (5); Adjustment (6b: communicate)	Develop a data management plan: • data formats, locations, backup security, • planned design of the statistical / data analysis of the AMI results, • planned timing of analysis and reporting • planned reporting formats, • planned methods for data sharing and review
13.	Design (2)	Implementation (3); Monitoring (4)	Develop a monitoring plan, that should include: • A description of implementation monitoring to be done (where, how, by who, how often, for how long) including and reporting formats, to track and document the implementation of the prescribed management treatment(s), and any deviations from the intended implementation. • A description of the effectiveness monitoring to be done (sampling locations, timing / frequency / duration by indicator, methods of data collection, methods for securing, transporting, and analyzing samples, etc.).
14.	Design (2)	Implementation (3); Monitoring (4)	A description of the plan for implementation of the treatment(s) to be explored in the AMI. This description should be provided in sufficient detail that persons responsible for implementation of the management action(s) can successfully implement it/them as intended by the architects of the design. This would for example include a sufficiently detailed description of the management methods to be employed, their location and timing (and clear instructions to document any deviations that might be unavoidable; although implementation monitoring as described in the monitoring plan should also be sufficient to catch this).

	Phase of AM where activity is considered	Phase of AM where activity occurs	AMP should include/describe:
15.	Design (2)	Evaluation of results (5); Adjustment/ revision of hypotheses & management (6)	A description of the plan for data analysis, evaluation, and reporting (i.e., how will you go from data to decisions?)

Source: Adapted from Grieg et al., 2008

Figure C-1 shows a more detailed perspective on how an AMP could be operationalized across multiple adaptive management initiatives (AMIs).

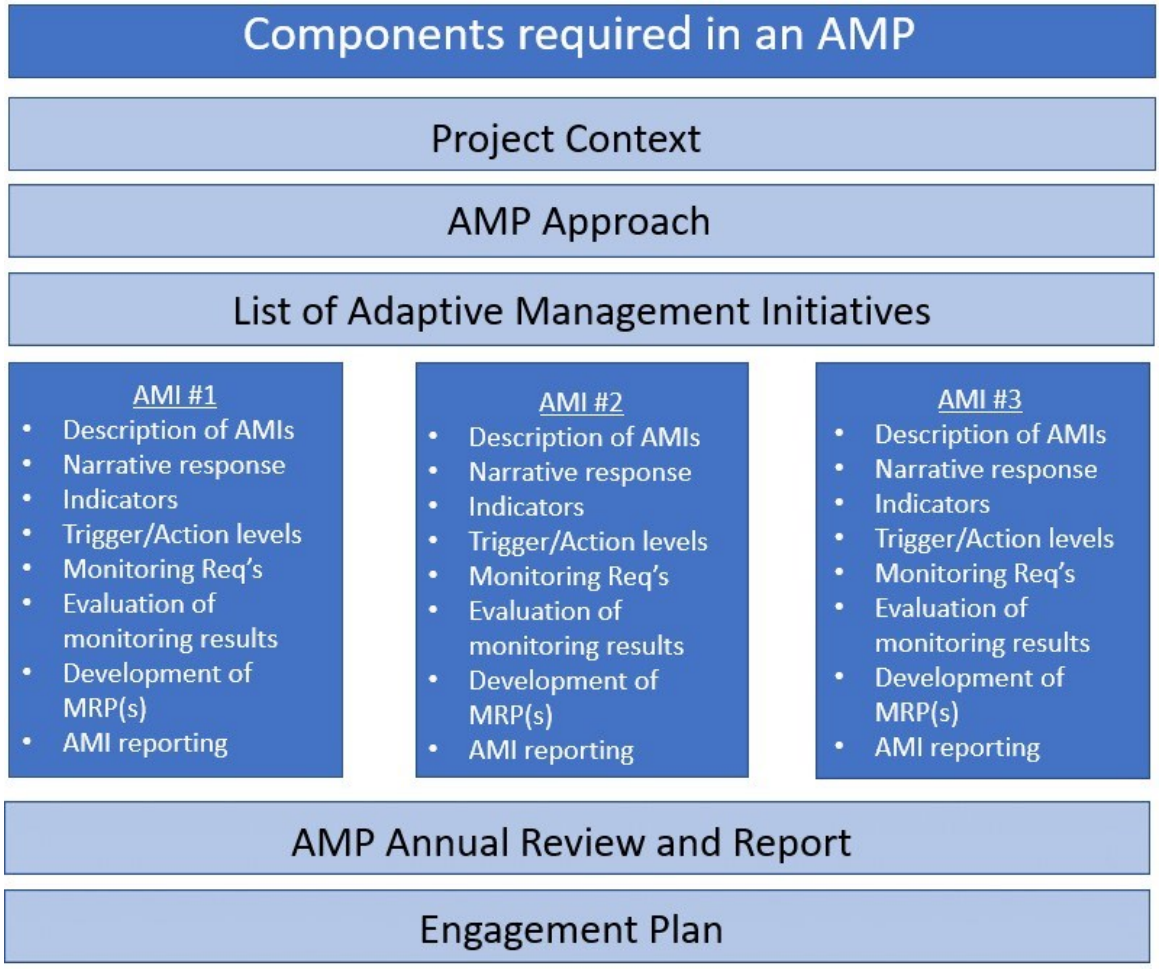

Figure C-1 Components of an Adaptive Management Plan (Appendix C)
Adapted from: Gomm & Slater (2021).