A Decision-Making Framework for Groundwater Licensing Options in British Columbia

by

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ABSTRACT

British Columbia is one of the few jurisdictions in North America without regulatory mechanisms in place to monitor or license groundwater resources, leaving the resource vulnerable to depletion of quantity and quality. When BC's water plan – Living Water Smart – was released in 2009, it included a commitment to regulate "large groundwater withdrawals in priority areas." The BC Ministry of Environment has recently begun the process of integrating groundwater regulations into the province's existing surface water allocation policy.

This study investigates cases from other jurisdictions to identify operational definitions for "priority areas" and "large withdrawals" used to regulate and protect groundwater stocks. I identify key criteria and illustrate potential consequences of groundwater allocation policy decisions based on the case studies and use this information to create a decision-making framework for groundwater licensing in BC. The framework highlights lessons learned from other jurisdictions to help inform the decision-making process for groundwater policy in BC and suggests how these lessons can be applied to the BC context.

Keywords: groundwater; British Columbia; water licensing; well permitting; groundwater regulation; groundwater regulatory design; well exemptions; large groundwater withdrawals

EXECUTIVE SUMMARY

Canada is often presented as one of the most water-rich countries on Earth. It contains considerable proportion of the world's renewable freshwater, perhaps as much as 20 percent of the worlds fresh surface water, and British Columbia is the wettest province in Canada. Scientists indicate that climate change will affect the supply and regional distribution of BC's water resources in the future, while population growth and economic development increase water demand. In some regions of British Columbia – the Okanagan, Gulf Islands, and Fraser Valley – seasonal demand for water outweighs available water supply and puts pressure on water users who compete for water resources. Water management planning is particularly crucial for areas that are projected to see an increase in incongruence between water supply and demand.

BC is in a position to maintain invaluable water resources for an uncertain future by securing sufficient quantities of high-quality water for social, economic and cultural uses while maintaining, at the same time, adequate in-stream water resources to sustain and enhance necessary ecosystem services. However, the province does not regulate a significant portion of BC's water resources. BC's *Water Act* is the primary legislation that defines the provincial water allocation system and it applies only to surface water. BC's groundwater resources are not regulated or subject to water allocation laws. Unregulated groundwater may lead to overuse of water resources, create confusion about the value of water resources, and result in conflict among water users.

In the water cycle, there are continuous dynamic interactions between surface water stored above ground (in snowpack, streams, rivers and lakes) and groundwater stored in pores, cracks and crevices of the earth called aquifers. Many hydrologists and hydrogeologists suggest the two water sources should be considered a single resource. Scientists agree that extraction of groundwater that is in excess of its replenishment rate clearly results in overall water depletion over time as is evident in more arid climates such as Australia and the western United States. In extreme cases, over-withdrawal of

groundwater can cause surface water streams to disappear altogether during water shortages. The *Water Act* establishes a legal framework for regulators to determine which surface water licensees have priority rights to access available water when there is not enough water for all licensees in a region. As it stands, the province has no active legal mechanism of water licensing to claw-back groundwater consumption during periods of water scarcity.

Under current BC legislation, water users that rely on surface water pay the province for the right to use water as part of the water licensing process, whereas municipalities and industries that use groundwater do not pay for water. Without regulation, groundwater users have an inequitable advantage over similar surface water users because they access the same resource but do not consider water fees in their annual budget calculations. Groundwater extraction can have a direct, negative impact on surface water flows and the rights to water held by surface water licensees. Where water users extract unregulated groundwater to the extent that it negatively impacts the legal water-use rights of surface water licensees, there is clearly a source of conflict. Since groundwater and surface water are substitute goods, water users could extract unregulated groundwater as an alternative when the legal obligations in the *Water Act* restrict licensed surface water allocations. The absence of groundwater regulation creates a perverse incentive for water users to substitute groundwater use for surface water sources, particularly in areas that experience seasonal water scarcity.

Focus on Regulatory Design for BC's Groundwater

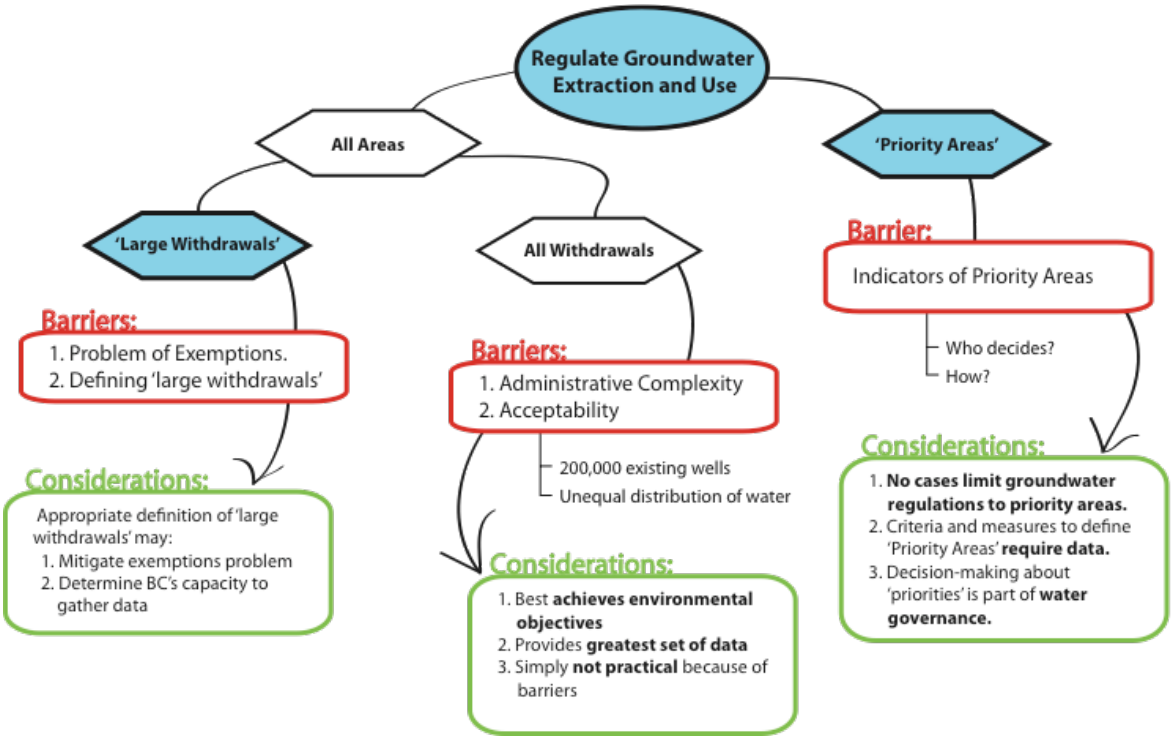
In this research, I analyze how British Columbia can change from the existing situation where groundwater extraction and use are unregulated to a different situation where groundwater extraction is regulated. This is an extremely complex process that, in its totality, is beyond the scope of my work. To reduce the complexity, I concentrate on BC's formal commitments regarding groundwater regulation. When BC's water plan – Living Water Smart – was released in June of 2008, it included a commitment to regulate "large groundwater withdrawals in priority areas." In my work, I explore what it means to regulate 'large withdrawals' and 'priority areas' as well as the barriers BC may face in

fulfilling its commitment and evaluate whether this is the most appropriate first step to regulate groundwater in the province.

The methodology for this research is a series of cases studies from other jurisdictions in the US and Canada that share key similarities with British Columbia. I study cases from Oregon, Colorado, Utah and Alberta to identify and compare operational definitions for 'priority areas' and 'large withdrawals' that these jurisdictions have used to regulate and protect groundwater stocks. To limit and navigate the complexity of groundwater regulation options, I provide a diagnostic chart that illustrates the most important factors and barriers that British Columbia should consider when designing groundwater regulations. Characteristics of groundwater regulation from the case studies inform the chart, specifically those that related directly to BC's commitment to regulate 'large withdrawals' in 'priority areas.' I identified in other jurisdictions and applied them to the BC status quo.

The diagnostic chart, depicted below, summarizes the consequences of groundwater allocation policy decisions from other jurisdictions along with the lessons learned, and applies them to the BC status quo regarding groundwater. The chart suggests barriers for consideration in groundwater regulations and options for how BC can avoid problems encountered in other jurisdictions. The chart helps evaluate BC's commitment to regulating 'large withdrawals' in 'priority areas' and informs the decision-making process for groundwater policy in BC.

'Diagnostic Chart' for Groundwater Regulation



BC's Living Water Smart commitment to regulate 'large withdrawals' in 'priority areas' implicitly acknowledges the substantial barriers of administrative complexity and public acceptability that arise if the province were to establish a groundwater regulation for all groundwater withdrawals in all areas. The province's commitment to large withdrawals and priority areas best mitigates the known problems of administrative complexity and public acceptability. However, the approach compounds potential problems of priority area indicators and exemption due to large withdrawals.

Case studies and the diagnostic chart suggest that the province would better achieve long-term water management objectives by focusing on policy options that regulate 'large withdrawals' of groundwater in all areas, rather than priority areas. The case study analysis suggests that BC's commitment to regulate groundwater only in priority areas is shortsighted. Cases suggest that more aggressive regulations for priority areas are best as a supplement to state- or province-wide groundwater extraction and use regulations. Although all of the cases studied regulate groundwater in 'priority areas,'

none of the jurisdictions limit groundwater regulation to priority areas. In all cases, jurisdictions employ basic groundwater regulations province- or state-wide.

Given this conclusion, my research focuses on groundwater regulation for 'large withdrawals' that are applied throughout BC. Most jurisdictions studied focus regulations on 'large withdrawals' and exempt small users from groundwater licensing. Jurisdictions can streamline administration and enforcement responsibilities and reduces expenses by reducing the number of wells that are subject to regulations. However, individual exempt users, left unregulated because they have a negligible impact on water supply, can have an aggregate impact that is greater than regulators initially expected. If BC targets only large withdrawals, it may face a *problem with exempt uses.* British Columbia's decisions about how to define 'large withdrawals' for groundwater licenses are essential to achieve its groundwater management objectives. The province's definition of 'large withdrawals' and the regulation's characteristics can mitigate the concerns about exempt uses, as well as problems of public acceptability and administrative complexity in implementation.

Underlying potential challenges with exemptions is a substantial *data problem* in BC. Data is a crucial component for monitoring changes in water supply or demand and play an important role in enabling adaptable regulations, and British Columbia has compiled very little data about groundwater extraction and use. Effective policy design can improve the province's capacity to extract groundwater-use data.

Evaluating Options for Licensing Large Withdrawals

The cases provide policy options for defining 'large withdrawals' and a system of groundwater license exemptions. Options are to apply one of the following systems for exempting small-scale water users from licensing:

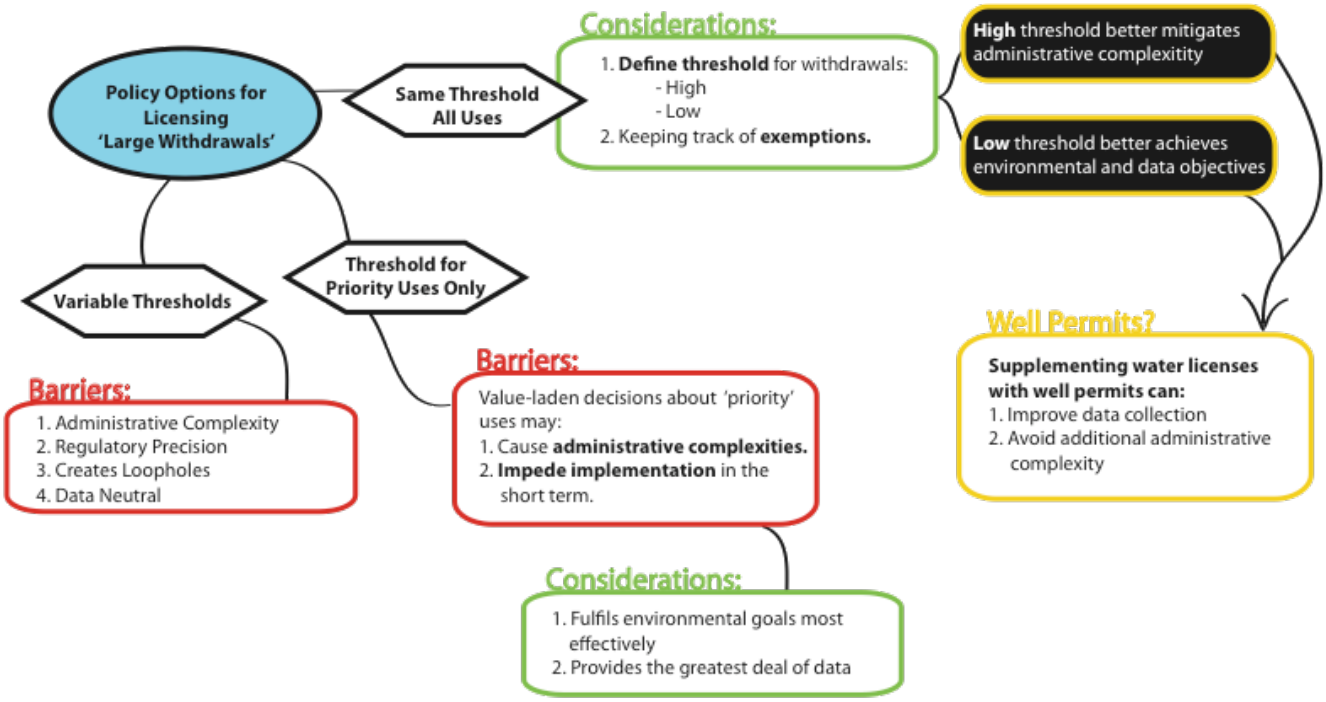
1. *Variable exemptions thresholds.*
   This is a system of exemptions tailored to specific water uses and is the least structured. Oregon law does not define a threshold for some exempt uses in the legislation, but requires beneficial use of water.
2. *Exemption thresholds for priority uses only.*
   This policy option licenses all non-priority uses equally, but leaves a number of exemptions for priority-use wells. Alberta is an example of this system.

3. *Consistent exemptions thresholds for all groundwater uses.*
   This policy option applies a consistent exemption for all wells that extract less than a prescribed quantity of water, regardless of what the water is used for. Colorado consistently applies regulations to all uses and allows exemptions from licensing for small users.

Each policy option has relative merits as well as complications when it comes to executing the water licensing policy.

To evaluate policy options from the cases, I create a set of criteria and measures which include (1) *political feasibility*; (2) *administrative complexity*; (3) *effectiveness*; and user-compliance through (4) *regulatory precision*. Using the criteria, I identify trade-offs between choices BC may make to regulate 'large withdrawals' and develop a decision-making framework to guide BC through options from other jurisdictions. The Large Withdrawals Decision-Making Framework, below, focuses attention on barriers inherent in BC's groundwater status quo that are important when BC decision-makers consider options for groundwater licensing and regulation in the province. By focusing on current barriers, the frameworks suggest next-steps that BC could consider to better manage limited groundwater stocks for the future.

Large Withdrawals Decision-Making Framework



Recommendations for Groundwater Licensing

The BC Ministry of Environment is undergoing a process to update its *Water Act* and a major pillar of the modernization effort is to integrate groundwater extraction and use into the province's water allocation framework. As part of the Ministry of Environment's Water Act modernization, provincial policy makers have also been developing options for groundwater regulation. The Ministry proposal included a two-tiered system that regulates withdrawals over 250 m3/day or 500 m3/day from unconsolidated aquifers and 100 m3/day for confined bedrock aquifers in all areas of the province. According to the Ministry's Water Sustainability Act Policy Direction paper, groundwater extraction at rates below these proposed thresholds would be exempt from regulation, regardless of intended use. As with focusing on regulations on 'priority areas,' a two-tiered approach treats users with different geographic and resource characteristics differently. The approach may be appropriate in the long-run. However, I argue that this approach is not the optimal starting point for groundwater licensing and regulation in BC. In the short-term the mechanism creates unnecessary burden on water users and results in complicated regulations that may decrease rates of compliance and increase administrative complexity for the province. Using a two-tiered approach requires each groundwater license applicant to determine whether the aquifer is unconsolidated or confined bedrock, a process likely to require more provincial intervention in the license application process. The table below summarizes BC's proposed approach to groundwater licensing and regulation, and my recommendations based on case studies and analysis.

Summary of BC Proposed and Recommended Groundwater Regulations

	BC's Proposed Groundwater Extraction	**Recommendations from Research**
Geographic Focus of Regulation	Licence large withdrawals in all areas.	Same – All areas of BC.
Exemptions threshold	Two-tiered system for large withdrawals, with thresholds at 250m3/day or 500 m3/day for unconsolidated aquifers and 100m3/day for confined bedrock aquifers.	Same withdrawal threshold for all uses, province wide. Exemption threshold is negotiable.
Well Permitting	Well permitting for non-exempt wells only.	Well permitting for all wells.

Because BC is moving from a state where there is no licensing or regulation of groundwater, I explored policy options for 'large withdrawals' that move toward the goal of regulating groundwater and avoid high costs for the province in the short- or long-term (assuming a broad definition of 'cost' that includes factors such as political and public support.) Given the context in British Columbia and practices in other jurisdictions, the easiest strategy to move from no regulations to some regulations is to create groundwater license requirements that allow a fairly large number of existing wells to remain exempt, but to include a well permitting system to register all wells and dramatically increase the amount of groundwater use data available to the province. The case studies indicated that most jurisdictions also supplement groundwater licenses with a well permitting system to mitigate some of the negative impacts of licensing only large withdrawals.

The absence of data is a significant gap in the Ministry of Environment's efforts to understand and management groundwater and data collection is a high priority that allows for more effective long-term solutions. My research suggests that the most practical step for BC at this point is to begin establishing a set of baseline data for the province. To focus on data collection in the short term, BC could limit additional

administrative complexity by limiting licensing to the largest groundwater users and allow most users to remain exempt from licenses in the short term.

If the province decides to implement a ‘same threshold for all uses’ licensing policy, the province must determine an appropriately high or low extraction threshold that determines how many groundwater users are exempt from licensing. An optimal definition of ‘large withdrawal’ thresholds for groundwater may not exist, as it depends on a number of scientific factors that are beyond the scope of this project. There is not likely a ‘right’ answer for an exemption threshold in BC. Most jurisdictions select an exemption threshold based on complex calculations about beneficial uses and ‘fairness’ for water users. The Ministry of Environment may adapt an initial exemption threshold from BC’s Water Act modernization proposal, but should acknowledge that the proposed 250 m3/day or 500 m3/day for unconfined aquifers are much higher than other jurisdictions have employed. In the long term, these high thresholds may limit the policy’s effectiveness at preventing conflict and securing water resources for the future.

Analysis suggests that water licensing alone is not sufficient to meet BC’s environmental and data collection needs. I suggest well permitting for all wells in BC as an alternative or supplementary strategy to collect well data for licence-exempt groundwater users and fulfil data collection objectives. Well permits provide a system for registering wells below the ‘large withdrawal’ threshold to reduce the impact of an exemptions problem and allow jurisdictions to improve their data collection.

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GLOSSARY OF ACRONYMS

GWPR	Groundwater Protection Regulation
FITFIR	First-in-Time, First-in-Right
LWS	Living Water Smart, BC's Water Plan
MOE	BC Ministry of Environment
RSBC	Revised Statutes of BC
SSRB	South Saskatchewan River Basin
WRD	Water Resources Department
WAM	Water Act modernization
WAM DP	Water Act modernization Discussion Paper
WAM PP	Water Act modernization Policy Proposal
WAM ROE	Water Act modernization Report on Engagement
WAM TBR	Water Act modernization Technical Background Report
WMP	Water Management Plan – Alberta's local level water management planning process
WUP	Water Use Plan – BC's local level water management planning process

1: INTRODUCTION

Canada is one of the most water-rich countries on Earth. It contains a considerable proportion of the world's renewable freshwater, perhaps as much as 20 percent of the worlds fresh surface water (Statistics Canada, 2010), and British Columbia is the wettest province in Canada (Statistics Canada, 2010). Water has been crucial for BC's economy, and BC is in a position to maintain invaluable water resources for an uncertain future. However, BC does not regulate a significant portion of its water resources – only surface water and not groundwater is subject to water allocation laws in the *Water Act*. In the water cycle, there are continuous dynamic interactions between surface water stored above ground (in snowpack, streams, rivers and lakes) and groundwater stored in pores, cracks and crevices of the earth called aquifers. Although precise data is unavailable about groundwater supply and demand in BC, many hydrologists and hydrogeologists suggest the two water sources should be considered a single resource.

Provisions in BC's *Water Act* establish a legal framework for regulators to determine which surface water licensees have priority rights to access available water when there is not enough water for all licensees in a region. As it stands, there is no active legal mechanism for clawing-back groundwater consumption during periods of water scarcity. Scientists agree that extraction of groundwater that is in excess of its replenishment rate clearly results in overall water depletion over time as is evident in more arid climates such as Australia and the western United States. Groundwater extraction can have a direct, negative impact on surface water flows and the rights to

water held by surface water licensees. In extreme cases, over-withdrawal of groundwater can cause surface water streams to disappear altogether during water shortages (Nowlan, 2005). Where water users extract unregulated groundwater to the extent that it negatively impacts the legal water-use rights of surface water licensees, there is clearly a source of conflict (Bracken, 2010; Nowlan, 2005).

Under current BC legislation, water users that rely on surface water pay the province for the right to use water as part of the water licensing process, whereas municipalities and industries that use groundwater do not include water fees in their annual budget calculations. The absence of groundwater regulation creates a perverse incentive for water users to substitute groundwater use for surface water sources. Since groundwater and surface water are substitute goods, water users could extract unregulated groundwater as an alternative when the legal obligations in the *Water Act* restrict licensed surface water allocations. Without regulation, groundwater users also have a competitive advantage over similar surface water users due to reduced costs.

In British Columbia, seasonal demand for water outweighs available water supply and puts pressure on water users in some regions, such as the Okanagan, Gulf Islands, and Fraser Valley (WAM DP, 2009). Planning effective water allocation processes today is critical to ensure future social, economic and ecological sustainability. Currently, the BC Ministry of Environment is undergoing a process to update its *Water Act.* The primary motivation for modernizing water allocation law is to respond to the new information and water management challenges that have developed over the last hundred years and prepare for future growth and climate change projections for the province

(MOE, 2011a). A major pillar of the modernization effort is to integrate groundwater extraction and use into the province's water allocation framework.

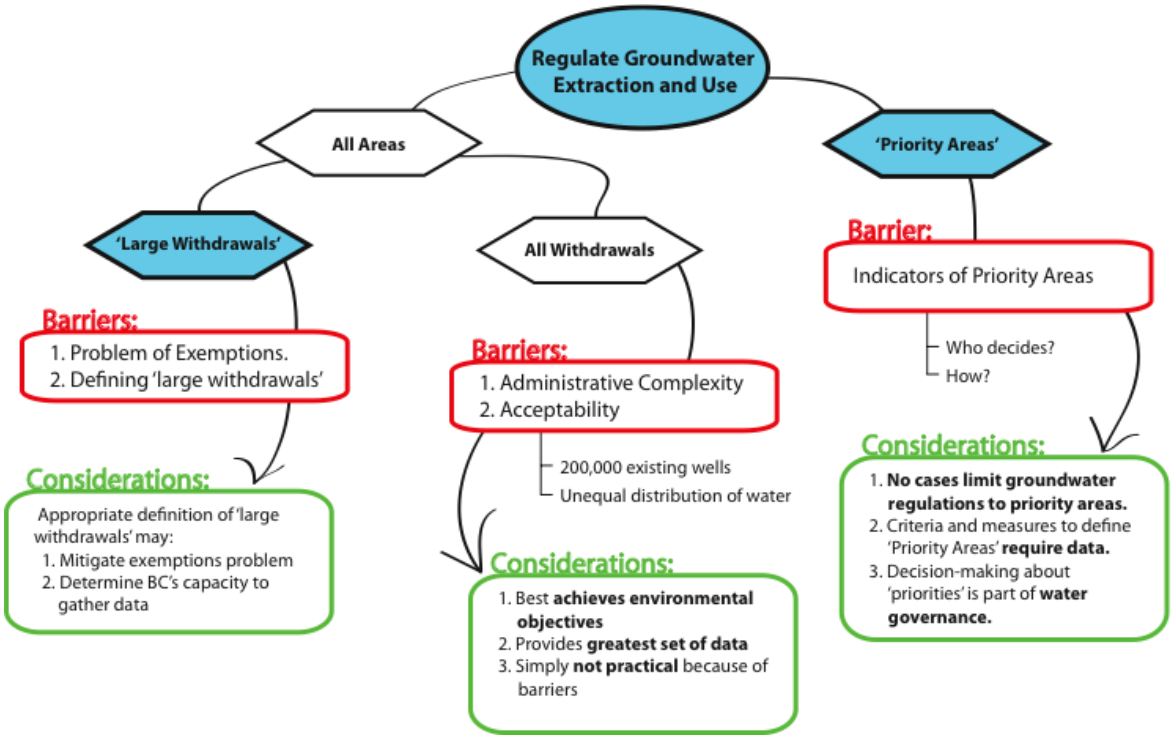
1.1 Focus on Regulatory Design for BC's Groundwater

In this research, I analyze how British Columbia can change from the existing situation where groundwater extraction and use are unregulated to a system that regulates groundwater extraction. My research examines the steps that creating regulations for groundwater entails. Groundwater regulation, in its totality, is an extremely complex process beyond the scope of my work. To reduce the complexity, I concentrate on BC's formal commitments regarding groundwater regulation. The release of BC's water plan – Living Water Smart (LWS) in June of 2008 included a commitment to regulate "large groundwater withdrawals in priority areas" (LWS, 2008). In my work, the specific focus is on what it means to regulate 'large withdrawals' and 'priority areas.' I explore the barriers BC may face in fulfilling its commitment as well as whether this is the most appropriate first step to regulate groundwater in the province.

The methodology for this study, explored in Chapter 3, is a series of cases studies from other jurisdictions in the US and Canada. I use case studies to identify and compare operational definitions for 'priority areas' and 'large withdrawals' that other jurisdictions have used to regulate and protect groundwater stocks. The case studies suggest that groundwater regulatory designs exist within a complex legal framework in other jurisdictions as well, and that water governance structure plays a role in policy options for groundwater regulations.

To limit and navigate the complexity of groundwater regulation options, I provide a diagnostic chart that illustrates the most important factors and barriers that British Columbia should consider when designing groundwater regulations. To inform the chart, I investigated characteristics of groundwater regulation from the cases, specifically those that related directly to BC's commitment to regulate 'large withdrawals' in 'priority areas' in Chapter 4. I identified consequences of groundwater allocation policy decisions in other jurisdictions and applied them to the BC status quo. The diagnostic chart, depicted in Figure 1 below, summarizes the lessons learned from other jurisdictions to help inform the decision-making process for groundwater policy in BC. The chart suggests barriers for consideration in groundwater regulations and options for how BC can avoid problems encountered in other jurisdictions.

Figure 1 – 'Diagnostic Chart' for Groundwater Regulation



The LWS commitment to regulate 'large withdrawals' in 'priority areas' implicitly acknowledges the substantial barriers of administrative complexity and public acceptability that arise if the province were to establish a groundwater regulation for all groundwater withdrawals in all areas. The province's commitment to large withdrawals and priority areas best mitigates the known problems of administrative complexity and public acceptability, but this approach compounds potential problems of priority area indicators and exemption due to large withdrawals. Analysis suggests that the province may face additional barriers such as problems with indicators of priority areas and exemptions. Underlying potential challenges with exemptions and indicators of priority areas is a substantial *data problem in BC.* Data is a crucial component for monitoring changes in water supply or demand and play an important role in enabling adaptable regulations, and British Columbia has compiled very little data about groundwater extraction and use.

The case study analysis suggests that BC's commitment to regulate groundwater only in priority areas is shortsighted. Although all of the cases studied regulate groundwater in 'priority areas,' none of the jurisdictions limit groundwater regulation to priority areas. Priority area regulations for groundwater do not stand alone. Cases suggest that more aggressive regulations for priority areas are best as a supplement to state- or province-wide groundwater extraction and use regulations. In all cases, jurisdictions employ basic groundwater regulations province- or state-wide. Given this conclusion, my research focuses on groundwater regulation for 'large withdrawals' that are applied throughout BC.

Case studies and the diagnostic chart suggest that the province would better achieve long-term water management objectives by focusing on policy options that regulate ‘large withdrawals’ of groundwater in all areas, rather than priority areas. Jurisdictions can streamline administration and enforcement responsibilities and reduces expenses by reducing the number of wells that are subject to regulations. Most jurisdictions studied focus regulations on ‘large withdrawals’ and exempt small users from groundwater licensing to reduce administrative complexity. However, individual exempt users, left unregulated because they have a negligible impact on water supply, have an aggregate impact that is greater than regulators initially expected. If BC targets only large withdrawals, it may face a *problem with exempt uses.*

1.2 Targeting ‘Large Withdrawals’

To achieve British Columbia’s groundwater management objectives requires decisions about how to define ‘large withdrawals’ for groundwater licenses. Effective policy design can improve the province’s capacity to extract groundwater-use data. The province’s definition of ‘large withdrawals’ and the regulation’s characteristics can also mitigate the problems of public acceptability and administrative complexity in implementation. The cases provide policy options for defining ‘large withdrawals’ and a system of groundwater license exemptions. The cases also suggest supplementing groundwater licensing with a system of well permitting. Well permits provide a system for registering wells below the ‘large withdrawal’ threshold to reduce the impact of an exemptions problem and allow jurisdictions to improve their data collection. In Chapter

5, I create a set of criteria and measures to evaluate policy options from the cases and identify trade-offs between choices BC may make to regulate 'large withdrawals.'

Chapter 6 explores policy options for licensing and permitting groundwater withdrawals based on groundwater regulations that are operational in other jurisdictions. Because BC is moving from a state where there is no licensing or regulation of groundwater, I explore policy options for 'large withdrawals' and well permitting that move toward the goal of regulating groundwater and avoid high costs for the province in the short- or long-term. I assume a broad definition of 'cost' that includes factors such as political and public support. I analyze the policy elements employed in other jurisdictions based on the criteria in Chapter 5 and evaluate the trade-offs to develop decision-making frameworks for 'Large Withdrawals' and 'Well Permits.' The decision-making frameworks focus attention on barriers inherent in BC's groundwater status quo that are important when BC decision-makers consider options for groundwater licensing and regulation in the province. By focusing on current barriers, the frameworks suggest next-steps that BC could consider to manage limited groundwater stocks for the future.

In the Large Withdrawals Decision-Making Framework, Section 6.2, I suggest that there are a number of consequences for BC, regardless of how the province defines 'large withdrawals.' If the province decides to implement a 'same threshold for all uses' licensing policy, the province must determine an appropriately high or low extraction threshold that determines how many groundwater users are exempt from licensing.

The analysis also suggests that water licensing alone is not sufficient to meet BC's environmental and data collection needs. The case studies indicated that most jurisdictions also supplement groundwater licenses with a well permitting system to

mitigate some of the negative impacts of licensing only large withdrawals. In the Large Withdrawals Decision Framework, I suggest well permitting as an alternative or supplementary strategy to collect well data for licence-exempt groundwater users and fulfil data collection objectives, while mitigating administrative complexity. I evaluate the effect of including well permits in the large withdrawal policy options and summarize the impact of supplemental well permits in Section 6.3 to create a Well Permits Decision-Making Framework.

Following analysis of the policy options presented in the case studies, I explore the policy proposals that the BC Ministry of Environment has released to-date regarding groundwater regulation for the province in Section 6.5. I describe and analyze the proposals for groundwater licensing according to the criteria from Chapter 5, and compare the outcomes to those from the Large Withdrawals and Well-permitting Decision-Making Frameworks. At the close of Chapter 6, I provide policy recommendations for BC to consider as the province moves ahead with groundwater regulations.

To analyze data from the cases and reach conclusions, I begin by exploring a number of factors from BC's groundwater status quo and the existing surface water allocation system that form boundaries for the policy options to regulate the province's groundwater. In Chapter 2, I provide background information about the interplay between groundwater and surface water, including BC's dependence on both for economic and environmental productivity. I explore the impact of unregulated groundwater use in BC and highlight the benefits that BC can achieve and harms that BC can avoid by regulating groundwater extraction and use. BC's current water allocation system for surface water

has laid a legal web of water rights in the province. Next, I investigate how BC's complex legal framework for water allocation shapes policy options for regulating groundwater. BC's existing water allocation policies include challenges and opportunities with regard to groundwater regulations.

2: WATER ALLOCATION IN BC

Water is essential for life on the planet and access to safe, clean drinking water is an important human rights issue recently discussed by high profile initiatives at the United Nations and the Canadian Council of the Federation.[1] This study skirts the human rights issue and focuses on 'water-use rights,' which are legal provisions that allow an individual or entity to use a specific volume of the water that British Columbia holds in the public trust.

In this study, I focus on "water-use rights." An administrative process of *water allocation* confers "water-use rights" and allows the diversion and use of water resources (Bird et al., 2009). Water-use rights are not an absolute right or ownership of the resource, but rather the ability of an individual or entity to use a specific volume of water. A water allocation system is the set of legal rules that specify how water resources are distributed or redistributed and the procedures that a regulator uses to grant, transfer, review, or remove water use rights. BC's water allocation system is also the primary vehicle for the province to regulate water use and make allocation adjustments during periods and in regions where water demand exceeds supply. It provides a legal framework of water-use rights and a set of procedures for regulators to determine which user rights have priority when there is not enough water for all licensees in a region.

[1] In July 2010, the United Nations General Assembly passed a resolution acknowledging rights to water clean drinking water as a "basic human right." Canada did not formally sign the resolution, but in August 2010, the Canadian Premiers adopted a Water Charter that stresses the importance of basic rights to access and use water, as well as the importance of conserving water and maintaining high quality standards for human consumption.

Social and cultural wellbeing, ecosystem conservation and protection, and provincial economic productivity depend on water. Therefore, water allocation policies have broad and important ramifications for a jurisdiction. The way a jurisdiction manages water resources affects public health, regional planning, and overall quality of life in Canada and BC. Methods of water allocation also affect the ability of a jurisdiction to protect ecosystem services and natural capital. Our natural environment, plants and animals rely on water as a valuable input and we rely on our natural environment. All sectors of BC's economy demand water for consumption, or use water as an input into the production of goods. Planning effective water allocation processes today is critical to ensure future social, economic and ecological sustainability for the future. Section 2.2 explores BC's ground and surface water supply and demand.

Canada does not have a national water strategy, and water management is lead by the provinces. British Columbia first introduced its existing water allocation system in the *Water Act* of 1909; the *Water Act* is the primary legislation that creates BC's water allocation system. BC's *Water Act* applies to both surface and groundwater but the province has not extended water licensing to groundwater and most aspects of groundwater remain largely unregulated in British Columbia (*Water Act*, RSBC 1996). Unregulated groundwater leaves BC vulnerable to the problems of overuse that I explore in Section 2.3. While the *Water Act* has undergone several revisions since its introduction, the system for allocating water remains largely the same. The legislation specifies an allocation model of prior appropriation, which prioritizes water licenses based on the original date of the water license. The system, frequently called "first-in-time, first-in-right" or FITFIR, assigns older water licenses higher priority water-use

rights than younger licenses. Alberta, Saskatchewan and much of the western United States employ FITFIR models for water allocation. I explore prior appropriation and other principle characteristics of BC's surface water allocation system further in Section 2.4, as the legislation provides context for thinking about groundwater regulation in the province. Other Acts such as the *Groundwater Protection Regulation*, *Drinking Water Protection Act* and the *Fisheries Act* affect some aspects of groundwater use. These Acts, explored in Section 2.4.3, establish regulations for well-drilling standards, drinking water quality expectations and protecting water for instream flow where water scarcity threatens fish populations.

That BC needs a system for regulating and monitoring groundwater withdrawal and use is evident in the literature. Living Water Smart, BC's water plan released in 2009, included a commitment to regulate "large groundwater withdrawals in priority areas" by 2012 (LWS, 2009). The BC Ministry of Environment has been engaged in an effort to update water legislation and fulfil Living Water Smart commitment since the plan's release. The goal of *Water Act* modernization is new water allocation legislation – a *Water Sustainability Act* – that includes introducing groundwater regulations. I discuss the *Water Act* modernization goals further in Section 2.5 and analyze policy directions for the province to consider in groundwater licensing later in Chapter 6.

2.1 Groundwater and Surface Water

Surface water and groundwater are sources of renewable fresh water replenished annually through precipitation. Surface water is stored above ground in snowpack,

streams, rivers and lakes. Groundwater is stored in pores, cracks and crevices of the earth called aquifers; it is the source water for wells and springs. The scientific community acknowledges a direct hydrologic connection between ground and surface water and the two water sources are highly interconnected in most areas of BC (Nowlan 2005). The relationship between groundwater and surface water may vary depending on geological characteristics, but in most locations there are continuous dynamic interactions between them within the natural water cycle. In BC, many of the most productive groundwater aquifers are small and shallow, occurring in direct connection with streams and rivers (WAM TBR, 2009[2]; Allen et al, 2009).

Policies for allocating ground and surface water have developed differently over time because surface water and groundwater have different characteristics. Some of these traits are physical, and frequently the physical characteristics also help to explain why regulators have a different attitude toward groundwater. I summarize the most prominent below (adapted from Nowlan, 2005):

- Regulators and users can observe the impacts of surface water use on multiple parcels directly because surface water moves visibly over the land, from parcel to parcel, whereas groundwater moves unseen beneath land.
- Movement of groundwater is much slower, occurring in decades or centuries, whereas surface water flows much more quickly. Recharge rates for aquifers are slow and difficult to measure, which makes the calculation of sustainable withdrawal rates more complex than for surface water.
- Groundwater aquifers may store more water than lakes and rivers of surface water, but we cannot readily see the storage and boundaries. Large aquifers cross provincial and international boundaries and pose cross-jurisdictional challenges.
- Measuring and monitoring groundwater levels takes more time and effort than monitoring surface water. Identification of trends from test wells takes years of observation.

[2] The Water Act Modernization Technical Background Report, cited with the acronym 'WAM TBR,' is an informational document that was published in February 2010 as part of the Ministry of Environment's Water Act Modernization public engagement process

- Developing the water sources for use takes different technology and approaches. Typically, projects to capture surface water require more substantial infrastructure development such as canals, dams or reservoirs. It is easier and cheaper to drill a well to tap water from an aquifer.
- Groundwater is less susceptible to seasonal variation and evaporation than surface water. Changes in precipitation may affect aquifer recharge rates, but not typically as substantially as precipitation changes affect surface water stores.

Some of the characteristics of groundwater sources may increase their appeal in the future. For example, it is beneficial that aquifers are less vulnerable to seasonal weather variations and contamination than surface water. They are harder to map and measure, but aquifers typically require smaller infrastructure investments to develop them for extraction and use than do surface water stocks or catchment reservoirs. [3] Although groundwater data is still underdeveloped, the scientific community considers surface water and groundwater as integrated resources that require joint management; many jurisdictions have begun to do so (Nowlan, 2005).

2.2 BC's Water Supply and Demand

Canada is one of the most water-rich countries on Earth, containing perhaps as much as 20 percent of the worlds fresh surface water (Statistics Canada, 2010). Canada's freshwater resources are not evenly distributed and BC is the wettest province in Canada (Statistics Canada, 2010), but within BC water resources are not uniformly distributed. The Pacific coastal region is the wettest area of the province, while the climate is noticeably drier east of the Coast Mountains. The Fraser-Lower Mainland region receives 36 percent of coastal water yield, while the Okanagan sees only 18 percent of that amount (Statistics Canada, 2010). The northern interior receives the lowest annual freshwater

[3] **Developing a groundwater resource** means drilling a well and, often, installing a pump to extract underground water.

supply in the province, but it is also home to a small fraction of the province's population and has lower demand. As with most of Canada, the southernmost parts of the province contain the majority of BC's population and economic activity (Statistics Canada, 2010).

Water is crucial for British Columbia's economic security. We use water consumptively and non-consumptively. A consumptive use – such as drinking, agriculture or manufacturing – removes a quantity of water from the water cycle and typically changes the form or quality of the water so it may not return to its original source. Non-consumptive uses, however, direct water for different uses but do not change the form or quality of water substantially so the water ultimately stays in the water cycle – as in the case of water stored for hydroelectric power generation. Consumptive uses include water that is the embedded and consumed as produce, lumber or goods as well as water used for mining or water that cannot be returned directly to the water cycle because of poor quality, such as water used for hydraulic-fracturing[4] in natural gas production. Non-consumptive uses include water preserved for recreational activities, diverted for power-generating reservoirs, and used to maintain instream flows that sustain ecosystems. Non-consumptive uses also infiltrate through the ground to recharge aquifers, where it can be stored or tapped with wells for human use.

BC's economy is composed of 'goods' and 'services' sectors that rely on water resources in diverse ways. BC's 'services' sector includes a variety of industries that provide services to individuals, businesses and governments. Industries in the goods sector are more heavily and directly dependent on water as an input. The 'goods' sector includes construction, manufacturing, agriculture and natural-resource-based industries

[4] A technique for releasing natural gas that employs high-pressure water to crack shale beds that is allowed and regulated under the BC Oil and Gas Activities Act (BC Oil and Gas Commission, 2010).

like forestry and mining. In some ways, services in British Columbia also rely on BC's water stores, but more indirectly for drinking or cleaning purposes. Some 'services' have direct ties to goods production, such as transportation and professional services like surveying, mapping, engineering and data analysis.

In 2008, the 'goods' sector made up 24 percent of BC's gross domestic product (GDP) and 22 percent of employment for the province (BC Stats, 2010). [5] Major 'goods' industries in BC include forestry, fishing, mining, manufacturing, agriculture and utilities. As with many 'goods' sector industries, forestry and forestry products are heavily dependent on water resources for success. Half of the Canadian softwood used to make lumber, newsprint and paper products comes from BC and paper production is the largest manufacturing use of surface water in the province (Statistics Canada, 2010). Commercial, recreational and aboriginal fishing depends on maintaining minimum stream flows to allow fish to spawn. Manufacturing uses water as an input for goods production, such as in food and beverage manufacturing, or as a part of processing like cleaning and cooling operations. Mining, oil and natural gas producers use water in their exploration and extraction operations. BC also relies on water for energy production. BC Hydro is the largest water-license holder in BC; 94 percent of BC's power is from hydroelectric sources and BC Hydro holds 98 percent of surface water licenses under the current water allocation system (MOE, 2006a). The largest consumptive surface water users in BC are agriculture, municipal waterworks and industry (MOE, 2006b).

[5] All calculations for BC's gross domestic product are 2008 data taken from http://www.guidetobceconomy.org/ and Statistics Canada.

Based on available information, a large number of British Columbian households and several major industries regularly turn to underground sources for water.[6] Groundwater users in BC include individual households and municipalities, as well as commercial enterprises and industry. Different users employ wells capable of extracting different volumes of water from aquifers. According to currently available well data, the significant majority of wells in BC are for domestic use. Domestic use wells extract water at a low rate and accounts for a relative small proportion of actual groundwater use. Estimates suggest that over one million people in BC, approximately 30 percent of the province's population, utilize groundwater for drinking (Nowlan, 2005). Most of BC's rural population and several large municipalities in BC rely on well-tapped aquifers for drinking water, including Langley, Abbotsford, Prince George and Chilliwack (WAM TBR, 2009). Many of the Gulf Island and areas of Vancouver Island, such as Duncan, also rely on groundwater stocks. Overall, 43 percent of BC's municipalities depend on groundwater or combined surface and groundwater for drinking water (Nowlan, 2005).

Industry is also a large user of groundwater in the province. Major commercial groundwater uses include irrigation, pulp and paper production, fish hatcheries, food processing, mining, chemical, petrochemical, parks, and airports (Foweraker , 2011). A significant percentage of agricultural operations use groundwater for irrigation (MOE, 2011a) and much of the water for mining, and oil and gas development in BC also comes

[6] Most of the recorded information role of water in BC's economy is based on data from surface water sources. The extent to which BC's goods sector relies on groundwater is unclear because BC does not have a comprehensive set of data about wells or groundwater extraction at this time; the availability of well data is explored further in Chapter 5.

from underground sources. [7] The extent to which these sectors rely on groundwater is difficult to confirm because a substantial proportion of groundwater use is unrecorded. The most recent comprehensive report on sectoral groundwater use in the province, a report from 1981, indicated that the largest groundwater users in the province were the industrial sector (55%) – including mining, oil and gas development – followed by agriculture (20%), municipal water works (18%) (MOE, 2011a).

2.3 Impacts of Unregulated Groundwater

In spite of our extensive use of groundwater, British Columbia is the only province in Canada that does not have legislation or regulatory mechanisms in place (WAM TBR, 2010). Under current legislation, water users that rely on surface water pay the province for the right to use water as part of the water licensing process, whereas municipalities and industries that use groundwater do not include water fees in their annual budget calculations. This creates financial inequity. Because BC's water allocation system fails to regulate groundwater extraction it has a lesser value than surface water, users may consider groundwater a 'free' resource. Without regulation, groundwater users have a competitive advantage over similar surface water users due to

[7] Numerous contaminants may affect water quality in different ways; some are natural and others are caused by human activity. There is a continuum of water quality based on the type and quantity of contaminants and a set of indicators that would make certain levels of contamination unacceptable for certain uses (MOE, 2011). Low quality groundwater contains contaminants such as salts and minerals that make it unusable for many consumptive purposes. Some industrial groundwater users, such as oil and gas industries, are able to tap lower quality water for some purposes. This research focuses on regulating groundwater quantity, without a specific focus on water quality concerns. The water quality of aquifers and that different sources of water are differently potable is a factor the province may consider with regard to groundwater regulations, and it is possible that aquifers that contain lower quality water could be licensed and regulated differently without a negative overall impact. However, water used by the oil and gas industries is unsuitable for drinking water or other purposes, it is still hydrologically connected to potable freshwater stores above and below ground and is susceptible to negative impacts of groundwater overuse explored in Section 2.3. Much more information is available about water quality standards and water testing through the BC Ministries of Environment and Health, or Environment Canada. See Water Quality Guidelines from the Ministry of Environment (http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#working) and drinking water quality guidelines from the Ministry of Health (http://www.health.gov.bc.ca/protect/water.html).

reduced costs. However, surface water licensing provides legal rights to access water and a structured mechanism for water management during periods of scarcity, which allows users greater security and a more comprehensive set of rights. Provisions in BC's *Water Act* establish a legal framework for regulators to determine which surface water licensees have priority rights to access available water when there is not enough water for all licensees in a region. As it stands, BC's legal framework for water allocation applies only to surface water so there is no active legal mechanism for clawing-back groundwater consumption or that protects groundwater users during periods of water scarcity.

Since groundwater and surface water are substitute goods, water users could extract unregulated groundwater as an alternative when the legal obligations in the *Water Act* restrict licensed surface water allocations. The absence of groundwater regulation creates a perverse incentive for water users to substitute groundwater use for surface water sources especially in areas where there is surface water shortage. Groundwater extraction can have a direct, negative impact on surface water flows and the rights to water held by surface water licensees. In extreme cases, over-withdrawal of groundwater can cause surface water streams to disappear altogether during water shortages (Nowlan, 2005). Where water users extract unregulated groundwater to the extent that it negatively impacts the legal water-use rights of surface water licensees, there is clearly a source of conflict (Bracken, 2010; Nowlan, 2005).[8]

[8] Over time aquifer depletion can also cause environmental impacts other than water shortage. Wetland deterioration, land subsistence, and saline intrusion are possible affects of groundwater over-use (Nowlan, 2005). Wetlands are low-lying areas where land is permanently or semi-permanently saturated with water. They provide habitat for a wealth of flora and fauna and play an important role in natural freshwater filtration, flood and drought control, and erosion prevention. Wetlands interact greatly with these shallow groundwater aquifers and they frequently occur where the water table is high and aquifers are close to the surface. Wetland ecosystems are particularly vulnerable to water shortage, and especially shortage due to groundwater overuse (Nowlan, 2005). Land subsistence occurs most often when aquifers occur in layers of porous, clay-rich soil materials. It is the gradual compaction of soil that occurs when groundwater extraction reduces underground water pressure and opens up empty space between soil particles that would otherwise be held by water. Land subsistence and soil compaction can reduce groundwater storage capacity, which cannot be regained. Subsistence

Projections suggest that British Columbia's renewable fresh water supply will change and may decrease in the future, and that some areas will fare worse than other areas. Long-term climate predictions indicate changes in the form and frequency of precipitation that impact available supply and regional distribution of water. Climate scientists expect precipitation to increase during the winter months, but may fall more frequently as rain than snow because of warmer atmospheric temperatures. Snowpack are natural water storage that supply water through the summer so reduced winter snowpack means that less water will be available in the late summer and early fall (Live Smart BC, 2010). According to a report by Statistics Canada, freshwater stores are already declining. From 1971 to 2004, water supply in Southern Canada decreased by an overall 8.5 percent (Statistics Canada, 2010). The average annual decrease in water supply is almost equal to the average demand for residential water each year (Statistics Canada, 2010), which means that annually Canadians chisel away one year's worth of drinking water from our water supply because of overuse in other sectors that will not be replenished by the water cycle. Within BC, some regions such as the Columbia River basin have a sustainable water supply in that consumption and renewal are balanced, while other areas such as the Fraser-Lower Mainland saw water volumes decline as much as 9 percent from 1971 to 2004 (Statistics Canada, 2010).

Meanwhile, expected population growth will increase demand for fresh water. Over the next 25 years, the population of BC is expected to grow from an estimated 4.45 million to a projected 6 million (WAM TBR, 2009). Population increases cause a

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has not yet been a problem for Canada, where bedrock supports most large aquifers (Nowlan, 2005), but it has been a significant problem in the western United States and Mexico. Saline intrusion is typically a problem on islands and in coastal areas, as it occurs when over-consumption from freshwater aquifers causes such low enough water levels to allow in-flow from ocean waters. Salinity from the ocean water contaminates freshwater stocks.

comparable increase in demand for water for consumptive purposes as residential, industrial, and agricultural use but also for non-consumptive uses such as the hydroelectric power generation. Projected growth will primarily occur in areas where water demand is already high, such as the Okanagan, Vancouver Island, and the Lower Mainland.

The result of decreasing supply and increasing demand is obvious: regional water shortage. Water shortage is a source of conflict between surface water licensees, groundwater users, and ecosystem needs. Other jurisdictions have included groundwater regulations in their allocation system, and many have done so out of necessity because of evidence of escalating water scarcity and conflict between water users in some regions. That groundwater is unregulated affects the government's ability to mitigate conflict among water users and protect water for ecosystems. Some areas of BC already experience seasonal water scarcity. There are cases in BC, such as in the Okanagan, where unregulated use of groundwater arguably has a great impact on the water table and increases stress on the water supply by a considerable amount. The BC Ministry of Environment has identified some of aquifers as 'critical' because there are known issues regarding groundwater quantity, water quality, and a substantial population depends on groundwater stocks for drinking water (WAM TBR, 2010).[9] According to predictions about water supply and demand this will only become more common.

[9] Ministry of Environment staff identified 'critical' aquifers through a two-step process. First, they assessed an inventory of more than 900 classified, mapped aquifers across the province. Of these, staff considered more than half (492) heavily or moderately developed for use. The Ministry then created a prioritization scheme using the following risk indicators:

- the level of groundwater use relative to the supply, with the level of development estimated from the British Columbia Aquifer Classification System;
- whether there are known quantity concerns indicated by the inventory of classified aquifers;
- whether the aquifer is shallow, unconsolidated (i.e. comprised of alluvial sediments) and is expected to be in direct hydrologic connection with surface water, based on its classification;
- the estimated population reliant on the aquifer for drinking water; and,
- whether the aquifer is trans-boundary.

2.4 Features of BC's Water Allocation System

British Columbia has not regulated groundwater, but the provincial government has built an elaborate system for regulating surface water extraction and use since 1909. The framework for surface water allocation in BC lays a complex legal canvas for developing groundwater use regulations. The *Water Act* is the primary legislation that regulates water allocation in British Columbia. When BC established the Act in 1909, urban and industrial expansion drove the culture of the time. The population of BC was very small and the land's resources appeared boundless. A century later, the province faces a modern set of water-related issues and needs that includes constraints due to much larger population, higher demand for water and other natural resources, and climate change projections. The most recent iteration of the *Water Act*, part of the 1996 Revised Statutes of British Columbia (RSBC), includes the same the fundamental characteristics of water allocation enacted over a century ago. As written, BC's *Water Act* applies to both surface and groundwater. However, the section of the *Act* relating to the licensing, diversion and use of water does not apply to groundwater.

The *Water Act* legally establishes that the **Crown owns all public waters** and the provincial government administers and allocates water in the public interest (*Water Act*, RSBC 1996). The province maintains ownership of water resources in the public trust and is ultimately accountable to the public for water allocation decision-making and implementation. The Ministry of Environment is the lead agency responsible for administering the *Water Act* and water allocation in BC. However, some responsibilities

Based on analysis, staff ranked known aquifers and created a list of the most at-risk. (WAM TBR, 2009)

for water are shared with other Ministries and local stakeholders. I explain some of these shared responsibilities further at the end of this section, after an overview of the *Water Act*.

Under BC's *Water Act*, the Ministry of Environment issues water-use rights only for beneficial use. **Mandatory Beneficial Use** means that the province will only issue water-use rights where license applications prove that diversion of water is for productive purposes (*Water Act*, RSBC 1996). The *Water Act* does not define mandatory beneficial explicitly; which leaves the definition to water managers. Beneficial uses approved for the province include domestic, agricultural, aqua-cultural, industrial and conservation uses.[10]

Like many jurisdictions in western Canada and the western United States, BC's *Water Act* employs an allocation system based on the **doctrine of prior appropriation**. Prior appropriation doctrine is also called FITFIR, (as described above), is an approach to water rights that where older licenses (senior rights) have higher priority over younger licenses (junior rights) (*Water Act*, RSBC 1996). For example, a license with a date of July 1, 1978 has greater priority than a license dated January 15, 1983. Under FITFIR allocation, older licenses were established first and therefore receive greater security. When water demand exceeds supply and water is scarce during the late summer or in low-precipitation years, the most junior licensees are the first to lose their right to withdraw water. Restricting junior licensee water access conserves available water for more senior licensees who have the better, more secure right. Prior appropriation

[10] Further information about surface water application fees, annual water rental fees and a chart of water-use purposes can be found online through the Ministry of Environment at http://www.env.gov.bc.ca/wsd/water_rights/licence_application/index.html

licensing is seen as a transparent, 'fair' system for restricting water uses during periods of scarcity that provides security to water license holders, although it may not be economically efficient in that rights allocation need not correlate with the water use value. Water security is important for all license holders, but is particularly important for risk-averse industrial water users and irrigators who are heavily dependent economically on water availability because they rely on water as a production input. The agricultural industry holds many of the most senior licenses for surface water in BC and uses the water for irrigation purposes.

Water rights in BC are **appurtenant to land.** This means that water licenses are legally and permanently connected to land parcels and cannot be used for purposes other than those approved in the original license application. Sale of the land cancels or transfers the water rights on that land to the new owner (*Water Act*, RSBC 1996). There are very few exceptions to this rule, although occasionally the province allows transfer of appurtenance for conservation initiatives (Barnett, 2011). Appurtenance improves security for water license holders because it ties the license for a certain quantity of water to a particular location where there are known impacts on other water users. Appurtenance prevents a license holder from transferring his allocation to another area where it could negatively impact other water license holders who have claim to water resources in that area. Permanent appurtenance helps the Ministry monitor the overall quantity of water allocated by region and also mitigates water conflict between licensees. However, appurtenance restrictions also limit flexibility for the regulator to adapt to changing circumstances and to employ modern water management tools. The issue of appurtenance is an interesting one. I explore appurtenance in other jurisdictions and

explore opportunities related to appurtenance in greater detail in the case studies available in Appendix A.

2.4.1 Tools for Water Allocation

The regulator's primary tool to manage water resources is the authority to adjust issuance of new licenses for water-use rights. Water licenses provide the legal right to use a specific quantity of water for a specific purpose. In BC, the *Water Act* creates water licensing for surface water rights. The *Water Act* establishes that application fees and annual rental fees apply to water use authorizations. The Water Regulation contains schedules for fees and annual rental rates that are based on the quantity of water allocated and the purpose for which it will be used (*Water Act*, RSBC 1996). The Ministry of Environment does not apply fees to applications from provincial or federal ministries or First Nations on Reserve land. The Ministry changes an additional percentage of rental fees as a penalty for overdue rent when a user does not pay the annual rent for a water license. The Ministry may cancel a water license if outstanding charges are not paid.

To apply for a surface water license under BC's current water allocation system, an individual submits a water license application to FrontCounter BC, which is the province's one-stop-shop for businesses and individuals to process authorizations, applications, licenses and permits for natural resources. FrontCounter staff helps clients complete application packages; interpret land information, maps, management plans; track application status and liaise between ministries, agencies, and governments (FrontCounter BC, 2011). Once the application is completed, Ministry of Environment

Water Stewardship Division Staff checks the application to identify potential impacts that may include: existing licence holders or earlier applicants, minimum instream flow requirements, landowners or crown land tenure holders, other agencies, and the interests of First Nations. FrontCounter and the Ministry notify potentially affected parties of the new license application and receive comment or objections before conducting a technical assessment of the application. Water Stewardship Division staff perform the assessment to determine if there is sufficient water available in the source to issue a new water license and advises the Regional Water Manager or Comptroller of Water Rights, who reviews the assessment and will either grant a water licence or refuse the application. All applicants have a right to appeal a decision of a Regional Water Manager or the Comptroller of Water Rights to the Environmental Appeal Board. (MOE, 2010)

Some water uses are eligible for 'Quick Licensing,' a fast-track process for adjudicating water new license applications or changes to licenses (*Water Act*, RSBC 1996). The use of quick licensing applies to applications for small quantities of water from sources where withdrawal would have no impact on other users, including the environment, First Nations or fisheries. Surface water extractions eligible for quick licensing are:

1. Domestic users with an allocation volume below 500 gallons/day (1.8 m3/day); and
2. Minor agricultural users with an allocation below 2,500 gallons/day (9.5 m3/day). (MOE, 2011b)

Approval for some water uses occurs outside the jurisdiction of the Ministry of Environment under BC's current legislation. The *Oil and Gas Commission Act* enabled the Oil and Gas Commission of British Columbia to authorize three types of approvals for the oil and gas industry under the *Water Act*. These are for the short-term use of

water, approvals for changes in and about a stream and permits across crown land. The *Oil and Gas Activities Act* (2010) expanded the Oil and Gas Commission's powers to manage water withdrawals, requiring increased metering, measuring and reporting for water accessed both through surface and subsurface methods. Oil and Gas approvals for the short-term use of water have been exempt from application and use fees since 2004 (MOE TBR, 2010).

In general, 'beneficial use' is an important factor used to allocate water. Regulators estimate the need for water for different beneficial uses by measuring and averaging water allocation and use data over time. They define exemption thresholds based on estimated average water demand for different uses. Jurisdictions frequently produce guidelines of water quantities for different purposes to meet beneficial use requirements, which are useful for water license applicants when they estimate their water demand in a license application. For example, the guidelines include information about the quantity of water one should expect to need to irrigate one hectare of a specific crop or to raise each head of cattle.

2.4.2 Local Level Water Management Planning

Part Four of the *Water Act* authorizes regional water users to organize into water user communities to manage collectively some aspects of the local water use (*Water Act*, RSBC 1996). The Act provides a framework for regional Water Management Planning. The minister may, by order, designate an area for the purpose of developing a water management plan if the minister considers that a plan will assist in addressing or

preventing conflicts between water users, conflicts between water users and in-stream flow requirements, or risks to water quality. A Water Use Plan (WUP) is a technical document that "defines the detailed operating parameters to be used by [water] managers in their day-to-day decisions" (British Columbia, 1998). A growing number of local communities around BC have crafted Water Use Plans in preparation for increased scarcity. The plans clarify how to exercise rights to water resources and how to account for multiple uses of the resources on the local or regional level.

Stakeholders in critical areas of BC such as the Okanagan Basin, the Lower Mainland (Langley and Abbotsford), the east coast of Vancouver Island and the Gulf Islands have developed Water Use Plans on the watershed level in reaction to more frequent experiences of water scarcity (MOE, 2011a). WUPs recognize existing legal and constitutional rights and responsibilities as set out in legislation and court decisions. However, many WUPs suggest that creating groundwater regulations aligned with surface water regulations would help better manage regional water resources.

The Ministry of Environment is increasingly relying on partnerships with municipalities and non-government actors to aid in developing and executing provincial water policy. Under the *Local Government Act (RSBC 1996)* and the *Community Charter* (2003), municipalities and regional districts often have the authority or at least planning capacity to manage land-use, zoning and bylaws in their jurisdiction and this decision-making potentially has significant impact on water quality and quantity (WAM TBR, 2009). Functions of local governments include conducting local elections, taxation, by-law formation and enforcement. Local governments are also responsible for maintaining public assets that impact the development of local communities and economy – such as

land and water – through zoning, planning and land-use management. By extension, local governments manage urban and rural infrastructure, such as transportation, waste management and the responsibility for both drinking water and wastewater.

In 2007, the Wetland Stewardship Partnership – a multi-agency group dedicated to wetland conservation[11] – developed the Green Bylaws Toolkit to provide local governments (municipal and regional) and the public with practical tools that help protect natural capital and preserve ecosystem services. It includes bylaw language that local governments in BC have used to protect sensitive ecosystems and explains the various legal approaches to protection, including their benefits and drawbacks. The Green Bylaws Toolkit includes a Groundwater Bylaws Toolkit, as a supplementary appendix. Developed by the Okanagan Basin Water Board and partners in 2009, the Groundwater Bylaws Toolkit contains information to help local governments protect groundwater quality and quantity within their geographic and legislative jurisdictions. The Toolkit provides practical land use management tools for local government to protect groundwater including strategies for monitoring groundwater quality and quantity, protecting aquifers, and maximizing water recharge instead of surface runoff (OBWB, 2009).

2.4.3 Other Legislation in BC that affects groundwater

Over the last century, BC has developed the plethora of legislation that in some way influences water in the province. Much of the legislation affects surface water but

[11] The Wetland Stewardship Partnership (WSP) is a multi-agency group dedicated to the conservation of wetlands and other sensitive ecosystems. WSP Partners include BC Hydro, Ducks Unlimited Canada, Environment Canada, BC Nature (Federation of BC Naturalists), Fisheries and Oceans Canada, Grasslands Conservation Council of BC, Ministry of Environment, Nature Conservancy of Canada, Union of BC Municipalities, BC Wildlife Federation, Pacific Salmon Foundation, and Ministry of Forests and Range.

does not directly influence groundwater and no legislation in the province establishes procedures related to groundwater allocation. Legislation that directly affects groundwater in BC includes the following:

- *Environmental Management Act* (regulates the discharge of waste to the environment, including to groundwater);
- *Environmental Assessment Act* (requires a review an assessment of very large groundwater withdrawals, specifically those designed to operate at a rate of 75 litres per second or more);
- *Water Protection Act* (prohibits bulk water removals and interbasin transfers);
- *Utility Regulation Act* (approves private water utility water supplies);
- *Drinking Water Protection Act* (regulates potability of drinking water, including drinking water from wells) (MOE, 2011a); and the,
- *Groundwater Protection Regulation*, described below.

The *Ground Water Protection Regulation* (GWPR) was enacted in 2004 to establish a set of basic standards and safeguards for well installation, altering and deactivation. The GWPR applies to groundwater monitoring wells, drainage wells, and water supply wells including domestic and non-domestic wells for irrigation. The GWPR does not apply to geothermal wells, oil and gas wells, or wells used for coalbed methane extraction that are regulated under other acts, like the *Geothermal Resources Act*, *Mines Act*, and *Petroleum and Natural Gas Act* (MOE, 2011a).

The GWPR does not restrict a landowner's ability to drill new wells. Rather, that it requires that landowners employ qualified drillers to develop wells and requires qualified well drillers and pump installers to register with the province. Registration provides a provincial database of qualified well drillers, but the drillers are not required to report on their work after registering. The Regulation also specifies that drillers execute a consistent set of practices when developing a well, which includes

requirements for well identification, sealing and flood-proofing (WAM TBR, 2010). The GWPR is the only piece of legislation in BC that specifically applies to groundwater development and no legislation directly addresses on-going extraction and use of groundwater.

Requirements under the *Groundwater Protection Regulation*, the *Drinking Water Protection Regulation* and the *Environmental Management Act* focus on groundwater quality concerns, not water quantity or allocation. Wells regulated under the GWPR are not licensed and the province does not charge any fees or rentals for extraction of groundwater (MOE, 2011a). In other jurisdictions, regulators use water licenses as the primary tool to manage water resources and well drilling permits as a second tool used specifically for groundwater allocation. Drilling permits assess and ensure well construction standards are in the interest of protecting the quality of drinking water, but also help to record data about well extraction rates and location. Processing well permits is less intensive than water-use license applications, and well permits do not allocate water-use rights to well owners so they do not require enforcement after wells are registered.

2.5 *Water Act* Modernization

The literature supports the argument that BC needs a system for regulating and monitoring groundwater withdrawal and use and the BC Ministry of Environment recognizes that the lack of groundwater regulations is a problem. The Ministry of Environment's Water Stewardship Division produced a strategic plan in 2008 (MOE

Water Stewardship Division, 2008), which highlighted three primary goals:

(1) 'Water is Safe,' pertains to water quality concerns such as community drinking water protection, which are not the direct focus of this study.
(2) 'Water Use is Sustainable,' highlights the need to readdress BC's water governance structure as well as expand a collection of integrated and accessible information on British Columbia's water resources. Objectives included:
    - Monitor and characterize provincial water resources based on relevant and authoritative data
    - Validate, manage and provide water resource information
    - Leading science informs decision-making
(3) 'Water is Valued by All,' promotes British Columbians recognize the many values of water and share responsibility for stewardship. Objectives included:
    - Improve understanding of the value of water to British Columbia
    - Develop and implement a provincial water demand management strategy

The later two of these goals are the foundation for introducing groundwater regulations to the province, but do not directly target groundwater regulation. First, groundwater regulations bring groundwater resources, which are currently 'free' for users, to parity with surface water in terms of value. Second, groundwater regulation provides a vehicle for which BC may expand its ability to monitor and characterize provincial groundwater resources and collect data to inform future decision-making.

In Living Water Smart, BC's water plan, the province committed to regulate "large groundwater withdrawals in priority areas" by 2012 (LWS, 2008). Other Living Water Smart recommendations included:

- requiring all large water users to measure and report their water use;
- legislative changes for protection of ecological values;
- incentives to be water efficient; and

- establishing water flow requirements for ecosystems and species. (LWS, 2008)

Since the release of Living Water Smart, the BC Ministry of Environment has initiated *Water Act* modernization (WAM) as a vehicle to initiate the changes in legislation outlined in Living Water Smart. The goal of *Water Act* modernization is to update water allocation legislation and create a new '*Water Sustainability Act*.'

WAM targets four major areas of water management practices for reform in BC:

(1) Protecting Stream health and Aquatic Environments: Objectives that protect water for in-stream flow target provincial environmental protection goals. For streams to function naturally, they require a certain base level that varies by stream to protect the environment and the water cycle. The water that stays in a stream, sometimes referred to as 'in-stream flows,' maintains British Columbia's natural riparian ecosystems and protects fish populations, which are dependent on a supply of water. Water allocations can alter water flow to an extent that degrades stream health, reducing the natural ecosystem services provided by the stream and affecting the survival of plants and animals (MOE, 2011a). Some of the effects include: increasing water temperatures in a stream; reducing the streams' ability to flush out pollutants and excess sediments; loss of connectivity, and decreasing available habitat for fish and other species. A review of Canadian, North American, and other world leading jurisdictions shows allocation systems are evolving to recognize ecosystems as legitimate users of water (MOE, 2011a). Hydrologists and water experts in BC have made advances in understanding how much water is needed to protect stream health and how that influences our economy and well being.

(2) Improving Water Governance Arrangements. Water governance refers how British Columbia's organizes and executes the decision-making, management and enforcement of provincial water regulations. Governance is typically about decision-making authority and process. It relates to networks that influence water policy, including formal and informal exercises of authority, and recognizes the role of state and non-state actors. Improving water governance includes unifying the legislation that affects water allocation in BC and streamlining water laws with other natural resource statutes (MOE, 2011a). Unified, streamlined regulations are easier to understand, use and enforce. It could also include delegating greater responsibility or decision-making authority to local, watershed-level authorities in some areas (MOE, 2011a). Governance plays a substantial role in the effectiveness of water allocation regulations at achieving provincial water objectives.

> **(3) Introducing More Flexibility and Efficiency in the Water Allocation System.** To respond to new circumstances, the province needs a water allocation system that provides the regulator greater flexibility and the capacity to adapt regulations to changing conditions while providing on-going security for water licensees. Flexibility enables the government to respond proactively in areas where there are conflicts over water resources or where water scientists predict there will be risk to ecosystems. This goal includes objectives that may enable government to encourage efficient water use by metering water use or employing economic instruments, such as water pricing schemes or creating opportunities for licensees to trade water rights (MOE, 2011a).
>
> **(4) Regulate Groundwater Extraction and Use in Priority Areas for Large Withdrawals.** BC's current water allocation regulations apply to surface water but not groundwater stores, although the two are intrinsically connected. The *Water Act* modernization project is an opportunity to better integrate surface and groundwater in policy, planning, allocation, and decision-making for water resources in the province.

In Water Act modernization, the Ministry derives the single objective for groundwater, highlighted in the *Water Act* modernization discussion paper, from Living Water Smart's commitment to regulate "large groundwater withdrawals in priority areas" by 2012 (WAM DP, 2009; LWS, 2008).

The unanswered questions in groundwater regulation that I approach in this study are (1) who to regulate and (2) how. Water resources are distributed unequally across the province. BC must determine whether to regulate users in all areas of the province, or only in areas where groundwater supply is low relative to demand. Once that is determined, the next step is to explore what form of regulation to introduce in the new legislation.

3: METHODOLOGY: GROUNDWATER REGULATION CASE STUDIES

The ultimate goal of this research is to provide guidelines for the province to define what groundwater users the province should target with regulations; determine what regulations the province should apply to these users; and recommend a course of action. As mentioned above, the current provincial goal is to regulate large groundwater withdrawals in priority areas. In this study, I deconstruct this policy objective and determine the factors that affect provincial decision-making to move forward with its application.

The methodology for this study is an examination of groundwater regulations from other jurisdictions in the US and Canada. I explore cases through literature review and key informant interviews to identify and compare operational definitions for 'priority areas' and 'large withdrawals.' Finally, I highlight policy trade-offs and analyze options applied in other jurisdictions as well as current proposals from the BC Ministry of Environment to recommend a course of action for the province.

3.1 Review of Case Study Literature

I conducted detailed case studies of four water allocation frameworks in jurisdictions that share similarities with British Columbia to provide examples of groundwater allocation policy options for BC. In the case studies, I examined strategies

and challenges from other jurisdictions that can provide guidelines for groundwater allocation approaches in BC.

My review of groundwater policy in other jurisdictions revealed that many cases feature similar macro-level approaches such as collaborative governance, consistent license application procedures for surface and groundwater, exemptions for small groundwater extractions and a special set of control mechanisms for priority areas. Jurisdictions varied in their approaches to legislating policy, defining detailed practices for groundwater management and implementing groundwater regulations. In general, case studies provide a plethora of policy options for managing groundwater resources. A detailed description of the case studies is available in Appendix A.

For the purpose of this report, I focus on identifying how other jurisdictions have approached ‘priority areas’ and ‘large withdrawals’ in their groundwater regulations. In the case studies, I identify operational definitions for ‘priority areas’ and ‘large withdrawals’ that other jurisdictions have used to regulate and protect groundwater stocks. I explore these findings in Chapter 4. The cases suggest that groundwater regulatory design exists within a complex legal framework in other jurisdictions as well as in BC. To limit and navigate the complexity of groundwater regulation options, I synthesize case study findings into a diagnostic chart that illustrates the most important factors and barriers that British Columbia should consider when designing groundwater regulations for ‘large withdrawals’ in ‘priority areas.’ The diagnostic chart summarizes the lessons learned from other jurisdictions to help inform the decision-making process in BC.

3.2 Key Informant Interviews

Groundwater allocation frameworks include a large number of variables; local geology, hydrology, water users and governance structures influence water allocation decision-making. The impact of these factors can vary greatly between jurisdictions. Additionally, there is nuance in how different jurisdictions implement and enforce groundwater regulations, as well as variations in the local impacts of regulations. Therefore, I interviewed expert practitioners and academics from other jurisdictions to supplement the information collected from the literature review of case studies. In my interviews, I specifically targeted experts from Oregon and Alberta because the cases are the most applicable to the BC context.

Informants included:

Oregon

Todd Jarvis, Associate Director, Institute for Water and Watersheds, Oregon State University

Doug Woodcock, Manager, Groundwater Division, Oregon Water Resources Department

Ann Reece, Water Rights Division - Adjudications, Oregon Water Resources Department

Alberta

Guy Bayegnak, Groundwater Policy Specialist, Alberta Environment

Doug Ohrn, Planner, South Saskatchewan River Basin Approved Management Plan, Alberta Environment Southern Region

I also consulted periodically with Mike Wei, a groundwater specialist and key policy-maker at the BC Ministry of Environment, to keep abreast of provincial leanings with regard to groundwater policy that were continuously evolving throughout development process of the *Water Act* modernization. Finally, I interviewed Andrea Barnett, the Head

of Industry and Government Relations at Ducks Unlimited Canada and coordinator of the BC Wetland Stewardship Partnership, regarding groundwater conservation ethics and opportunities.

3.3 Rationale for Case Selection

I first explored the literature on what were best practices for the allocation of surface and groundwater. Australia is the jurisdiction cited by many studies as an example of very progressive regulations for surface and groundwater. Each state operates under the guidance of a national water policy to govern water allocation responsibilities within their jurisdiction, but they delegate water allocation authority to regional governing bodies. Victoria is the largest and most populous state in Australia and employs the most aggressive water management policies.

Victoria has never employed the prior appropriation system for water-use rights that forms the foundation of BC's surface water allocation. Instead, Victoria uses an administrative process of water entitlements and licenses for annual water allocation based on 'riparian rights' (Bjornlund, 2003).[12] Victoria calls long-term rights to access to a volume or proportion of water from a given resource 'water entitlements' and are distributed proportionally based on riparian land ownership. In Victoria, 'water licenses' allow the holder of an entitlement the right to access to their water annually. The allocation of 'water licenses' is announced every year and the quantity of the licenses varies depending on this year's expected annual water availability and last year's water

[12] A system that allocates water among those who own the land about its source.

use (Bjornlund, 2003). For example, in a dry year, the regulator may only allow licensees to access 75 percent of their entitlement. 'Proportional reduction' is the name for this process and it requires careful monitoring and nearly constant analysis of groundwater availability.

Australian examples are different from Canada and British Columbia in several meaningful ways. Canada is one of the wettest countries in the world, while Australia is one of the driest. In Australia, surface water is vulnerable to high rates of evaporation, which limits the state's ability to rely on surface water stored naturally in lakes or artificially in reservoirs so underground water storage in aquifers plays a crucial role in Australia (Victoria DSE, 2009.) Many regions throughout Victoria are 'fully allocated,' meaning that no new entitlements or licenses can be granted and the right to use water must be acquired through water license trading (Victoria DSE, 2009). Finally, Australia's current approach to water allocation was spurred by record droughts in 2005 when national and state governments responded with a national water policy that included aggressive allocation practices out of necessity (Victoria DSE, 2009).

In some areas of BC, seasonal water scarcity is already a growing concern and local stakeholders are feeling the severity of the situation; however, projections suggest that it is unlikely BC will experience dramatic, Australian-style water scarcity in the future. Proportional reductions and water markets used to regulate groundwater in Victoria may be among the most effective, but they are not practical to pursue in BC at this time. Introducing the aggressive mechanisms currently used in Australia would require significant changes in BC's legislation that are not realistic given BC's current situation and do not appear necessary given the future outlook of BC. The focus of this

report is on steps that the province can realistically begin to take toward sustainable water allocation and management practices.

After a preliminary scan of BC's existing water allocation structures, I developed a set of characteristics to identify relevant cases for consideration. I wanted to look at jurisdictions with established groundwater regulations that share traits with BC's current surface water allocation system. Namely, that the jurisdiction features:

- Governance where authority for groundwater regulation occurs at the provincial-level;
- Water allocation with a foundation of prior appropriation doctrine;
- History of appurtenance;
- Unequal regional distribution of water resources; and that
- A notable portion of the jurisdiction's economy is dependent on natural capital and goods production that is driven by demand for water.

3.4 Cases Selected

I chose to explore cases from western Canada and the western United States for further analysis because they have political, historical and geographic background that are most similar to the British Columbia. After a review of possible cases that met the characteristics, I focused my research on Alberta, Oregon, Utah and Colorado.

1. Utah, United States. Water management is centralized and coordinated by a Water Resources Department. Utah is distinct among western states in that it has the most comprehensive approach to regulating groundwater resources. Utah allocates groundwater use rights by the exact same process as surface water and does not exempt any uses of groundwater from regulation. However, Utah has a much drier climate than BC and regulates groundwater with a more aggressive approach out of necessity.

2. Colorado, United States. Colorado has a natural resources base to its economy, a similar distribution of water users, and is characterized

geology that results in a high rate of surface and groundwater interaction similar to BC. The state's water allocation system is based on prior appropriation and water management is centralized and coordinated by a Water Resources Department. Colorado's state-wide approach to groundwater regulation could be highly applicable to the BC context. However, in Colorado, water allocation is administered and adjudicated regionally by a system of water courts that is not likely to be employed in BC.

3. Oregon, United States. Oregon has managed groundwater resources for many years, so its approach to management has developed through several iterations that can guide BC's process for introducing a regulatory framework**.** In Oregon, the distribution of water resources, water users is most similar to BC and regional scarcity concerns are most similar to the BC context. However, like Colorado and Utah, Oregon's water management is coordinated by a centralized Water Resources Department. The central agency authorizes regional bodies to conduct some groundwater management because of basin-level planning.

4. Alberta, Canada. Alberta shares a similar geography, governance structures and distribution of water users with BC and is perhaps the most directly pertinent case study given BC's context. Alberta manages its water is by it ministry, Alberta Environment, which also manages other natural resources in the province. In Alberta, Municipalities and local stakeholders have a similar relationship with the provincial jurisdiction and therefore the similar ability to affect water management on the local level. Alberta shares a border and some aquifers with BC.

Case studies from Alberta and Oregon correlate more directly with British Columbia's circumstances and are, therefore, examined in the greatest detail. Table 1, below, provides an overview of the selected cases, given the selection criteria.

Table 1 – Cases Selected for Examination

	Utah	***Colorado***	***Oregon***	***Alberta***
Regulates groundwater	Yes, in conjunction with surface water	Yes, in conjunction with surface water	Yes, in conjunction with surface water	Yes, in conjunction with surface water
Authority for groundwater regulation is at the provincial-level	State jurisdiction	Regional Water Courts, groundwater monitored by the state	State jurisdiction	Provincial jurisdiction with input from regional stakeholders and municipalities
Employs prior appropriation doctrine	Yes with priority use levers enabled in priority areas	Yes	Yes with residual riparian rights structure for licenses before 1909	Yes
History of Appurtenance	Yes	No, water rights are real property that can be bought or sold	Yes	Yes
Subject to variation in regional distribution of water resources	Most of the state is much drier than BC, with wetter areas in the mountainous central regions and the northeast	Wetter mountainous west with drier areas in the east and desert conditions in the south	Wet, mountainous coastal regions with drier areas in the northern and interior regions	Wetter mountainous regions in the west and north, with very dry agricultural areas in the south and east

3.5 Criteria and Decision-Making Frameworks to Analyze Options

I use information collected from cases studies, summarized by the diagnostic chart, as well as principles of effective regulation to create a set of criteria by which to analyze the trade-offs between options for groundwater regulations. Using the criteria, I analyze the policy elements employed in other jurisdictions and assess policy options for groundwater regulations. I evaluate the trade-offs to develop decision-making frameworks for 'Large Withdrawals' and 'Well Permits.' The framework highlights

lessons learned from other jurisdictions to help inform the decision-making process for groundwater allocation strategy in BC and suggests how to avoid problems from other jurisdictions. By focusing on current barriers, the frameworks suggest next-steps that BC could consider to manage limited groundwater stocks for the future.

4: FACTORS THAT AFFECT GROUNDWATER ALLOCATION IN BC

In this section, I outline factors of the current state of groundwater use in BC that effect the province's options for regulating groundwater regulation. Then, I explore the barriers and challenges that other jurisdictions have encountered in groundwater regulation, particularly with regard to targeted regulation for 'priority areas' and 'large withdrawals.' The case studies suggest that BC should ultimately be working toward a water allocation system for both surface and groundwater that includes well permitting and licensing for all groundwater extraction in all areas.

4.1 Groundwater Data Limitations in British Columbia

The Auditor General of BC recently released a report concluding that (1) the BC government does not effectively sustain the province's groundwater resources; (2) the Ministry of Environment's data about groundwater is insufficient to ensure sustainable management of the resource; and (3) groundwater is not being protected from depletion or contamination to sufficiently protect the ecosystems it supports (BC Auditor General, 2010). Groundwater monitoring and data collection is particularly limited in British Columbia. Where data is available, its quality is not consistent.

The Ministry of Environment maintains a voluntary electronic database of wells throughout the province (WELLS database). The WELLS database is a collection of voluntary data submitted by well users since the 1960s, but there are frequently holes

about water quantity or quality that users voluntarily submit in the data (WAM TBR, 2010). Participation in the database and the amount of data entered is at the discretion of the wells owners. Owners of existing wells are not required to register wells or report use. The WELLS database contains information about 100,000 wells throughout the province. Based on site visits and surveys, the Ministry estimates that only half the wells in the province have been entered in WELLS. Of those, the MOE is uncertain how many wells are still in operation, and data about the quantity and quality of groundwater extracted is often incomplete. There is not a consistent process for confirming or updating data entered into the database. BC has better groundwater data for some areas than others, typically richer data is available in regions where water quantity and quality are of local concern and stakeholders have developed a monitoring process for water resources, such as in the Okanagan Basin (WAM TBR, 2010).

BC's *problem with data collection* currently impedes effective water resource management in the province. Data collection is a critical objective of Living Water Smart and is housed in *Water Act* modernization's goals to improve water use efficiency and conservation. The province and major water stakeholders also recently conducted a Water Science initiative to develop a better strategy to address BC's data problem (LWS, 2008; WAM DP, 2009). Improving data collection and water use monitoring is a goal of *Water Act* modernization, as the Ministry of Environment hopes to introduce policy levers that will help the province increase efficient use of water resources.

As mentioned in Chapter 2, the regulator's primary tool to manage water resources is the authority to adjust issuance of new licenses. Water-use licenses and drilling permits both contribute data about well extraction rates and location to the

province, and the latter also provides a mechanism to protect drinking water quality by improving compliance with well construction standards. In all cases, well permits and water-use licenses were the government's primary instruments for collecting groundwater-use data and are a vehicle for monitoring water supply and demand.

Of the cases, Utah and Colorado keep the most precise usage records because mandatory registration and water metering is part of their application processes. Both require a well permit for all wells, regardless of size, and meters groundwater extraction, although Colorado meters wells only in priority areas. Utah also relies heavily on a state-wide groundwater monitoring program cooperatively operated with the United States Geological Survey to monitor small domestic and groundwater wells and collect pertinent groundwater data, including water levels and estimated well withdrawals (Bracken, 2010).

Alberta also requires new wells be registered with the province. Alberta Environment requires well drillers to submit a record of completion of a well separate from standard water license applications. Registration allows the Alberta to map wells and model groundwater use. However, Alberta does not have a centralized information system that combines the list of allocated resources with estimated available resources, or that can map the effect of individual wells on the water table (Bayegnak, 2011). Oregon has recently begun to require mandatory well drilling reports as already exist in Utah, Colorado and Alberta.

4.2 BC's Groundwater Context

First, it is important to reiterate that British Columbians have been developing wells and using groundwater without regulations for over a hundred years. The BC Ministry of Environment estimates that there are around 200,000 existing wells in the province are not subject to provincial regulation (WAM DP, 2009). Based on WELLS data, the province estimates that domestic use comprises 95 percent of the wells in the province. Well for domestic use extract water at a low rate of approximately 2-3 m3/day. An additional 2-4 percent of wells withdraw between 4 and 100m3/day – these include small supply systems such as mobile home parks, campgrounds and small to mid-sized farms or ranches (WAM DP, 2009). This means that 97 percent of wells in BC withdraw water at a level that, individually, has a very small impact on overall groundwater supply. Table 2, below, outlines the approximate breakdown well by sizes in BC.

Table 2 – Wells in BC, by Extraction Rate in Daily Volume (Approximated)

Well Size (Extraction Rate)	2 to 3 m3/day	3 to 25 m3/day	25 to 100 m3/day	100 to 500 m3/day	500 to 1000 m3/day	1000 to 2500 m3/day	> 2500 m3/day
Approximate proportion of BC wells	95%	0.6%	1.1%	1.7%	0.5%	0.5%	0.5%
Type of Use	Primarily domestic water supply for single-family homes.	Small water supply systems such as mobile home parks, camps and small farms or ranches.	Small to medium-sized water supply systems, farms and ranches.	Mid-sized water supply systems such as large mobile home parks, motels, communities with hundreds of residents, schools, parks, and farms, ranches or golf courses.	Medium to large-sized waters supply systems such as small towns, schools, parks, farms, ranches, golf courses and ski resorts.	Large water supply systems such as towns with thousands of residents, fish hatcheries, farms and ranches, nurseries, ski resorts and industries like gravel pits.	Large water supply systems such as cities with thousands to tens of thousands of residents, pulp mills, fish hatcheries, large farms and ranches.

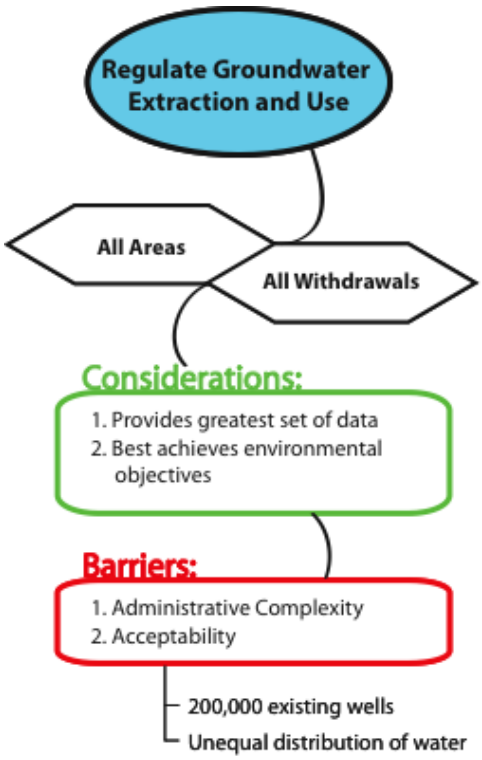
Source: MOE, 2011a

The large number of existing wells in BC causes a considerable *administrative complexity* for the province if it were to license and regulate all wells equally. To do so, BC must first collect an accurate inventory of wells throughout the province. This requires site visits to all known wells from the WELLS database to confirm whether wells are still in operation. Staff would also need to conduct a campaign to identify and record approximately 100,000 unrecorded wells throughout the province, many of which belong to single-family homes in rural areas. After inventorying existing wells, the Ministry of Environment would collect license applications from well owners and process applications. The Ministry would also need to develop a strategy for applying the

priority dates that establish legal priority rights and water security for groundwater licensees because water allocation in BC is based on prior appropriation doctrine. The administrative process of introducing regulations to existing well owners is a short-term consideration, even though completing the enumeration may require a number of years. In the longer term, the province could expect to experience additional administrative complications when it comes to enforcing the terms of groundwater licenses, particularly for small, rural water users and in areas where water shortage is not a serious problem.

British Columbia's geography and climate are highly variable regionally. Public and stakeholder demand for groundwater regulation differs across the province depending on the availability of water supplies relative to demand, creating a problem of *public acceptability*. In areas where seasonal water shortages are common, local water users and stakeholders are concerned about conflict over limited water resources; they express a pressing need for groundwater regulation and licensing, often through local-level water management planning. In BC, there are several regions that might currently be classified as priority areas based on available data and measures employed in other jurisdictions, such as annual precipitation and indications of water-related conflict during periods of seasonal scarcity. Possible priority areas in BC include the Okanagan River Basin in the

Figure 2 'All Withdrawals, All Areas' Considerations



south-central interior, the east coast of Vancouver Island, and areas on the lower mainland including Abbotsford.[13] In many of these regions, local stakeholders and water licensees have already undergone basin-level water use management planning (WAM TBR, 2010). Figure 3 depicts possible priority areas in BC.

Figure 3 – Distribution of Water Resources in BC

Areas in dark grey indicate serious concerns for water supply or water quality issues. Blue areas are at risk for these concerns, while green areas are not currently viewed as at-risk. (WAM PP, 2011)

[13] The BC Ministry of Environment identified these areas based largely on surface water data, since the province has severely limited information about groundwater supply and demand, but it can be inferred that these regions are areas of concern for groundwater because the resources are intrinsically connected.

Demand for groundwater regulation provides an incentive for the province to target groundwater regulations in priority areas. However, water scarcity is not a high-priority issue for well owners in most areas throughout the province. Figure 3 depicts in green color the locations where water is plentiful. In these areas, local stakeholders enjoy the benefits of unrestricted access to groundwater stocks and do not experience negative consequences due to unregulated groundwater resources. As a result, these local stakeholders and water users are not presently concerned about water conflict and may not prioritize the introduction of groundwater licensing. The Ministry of Environment is likely to encounter public and stakeholder opposition to groundwater licensing in areas that do not currently demand regulation. Local communities and some water users would find it more difficult to acknowledge the need for groundwater regulation and accept mandatory application processes and licensing fees.

The province's Living Water Smart commitment to focus on 'large withdrawals' in 'priority areas' clearly seeks to mitigate the barriers present in the current status of groundwater use in BC and the province's susceptibility to problems with (1) administrative complexity and (2) public acceptability. However, limiting groundwater regulation to 'large withdrawals' or priority areas causes additional challenges which are explored in greater detail below, such as problems with creating indicators and transitioning to priority areas, data collection problems and problems with exemptions.

4.3 Priority Areas

Demand for groundwater regulation in BC provides an incentive for the province to target groundwater regulations in priority areas. The cases showed that employing a priority area strategy to protect groundwater stores is a common strategy to address natural variations in geographic distribution of water resources and to improve the effectiveness of regulations in regions where water demand exceeds available water supply. Colorado has identified eight at-risk 'Designated Basins' and established 13 'Groundwater Management Districts' within these areas of the state. Similarly, Oregon has classified six regions as 'Critical Groundwater Areas' and Alberta's South Saskatchewan Basin operates under an 'Approved Water Management Plan.' Utah experiences state-wide water scarcity and classifies most areas as critical.

4.3.1 Defining 'Priority'

To activate regulations in priority areas, the regulator must clearly define characteristics of a 'priority area,' designate boundaries for priority areas and establish a transparent process for identifying them. Other jurisdictions typically base boundaries on basin or watershed level hydrogeology. Definitions for 'priority areas' are based on data and typically depend on water demand, water availability, and risk factors due to hydrogeology such as groundwater/surface water interaction. I call this the problem of *indicators of priority areas*. A crucial aspect of identifying priority areas is developing criteria and measures that provide clear definitions for 'priority areas' that provide a legal basis for the government to enable and implement new water regulations that may affect legally held water-use rights.

Table 3 – Definitions for Groundwater Priority Areas from Cases

	Utah	Colorado	Oregon	Alberta
Definition for Priority Areas	Utah's state engineer issues groundwater management plans for geographic regions where he suspects the safe yield of the aquifer may soon be reached. The state engineer: 1. studies each area to find the annual precipitation, recharge and discharge rate; then 2. estimates future needs and demands. 3. Decisions rest upon the Engineers belief of whether or not there is unappropriated water in the area. Plans are specific to the area and may include promoting efficient use, maximizing the benefits, and protecting existing rights. The Engineer uses the plans to develop area specific guidelines for use when reviewing license applications and managing groundwater.	In Colorado, any party can petition the Water Resources Department to create a new Designated Basin. Petitioners must submit specific information supporting the designation including: 1. Names of aquifers and proposed boundaries of the new basin (including a map and legal description of the proposed basin); the 2. Estimated quantity of water stored in the basin; the 3. Annual rate of recharge and groundwater usage; and 4. A list of water users. The Colorado Groundwater Commission holds a hearing to determine if groundwater in the proposed basin meets the definition of a Designated Basin.	Oregon's Water Resources Department institutes a Critical Groundwater Area designation in areas where: 1. Groundwater levels in the area are declining or have declined excessively; 2. The WRD finds substantial interference between wells or appropriators; 3. The available groundwater supply in the area in question is being or is about to be overdrawn; 4. The purity of groundwater in the area in question has been or reasonably may be expected to become polluted to an extent contrary to the public welfare, health and safety; or 5. Groundwater temperatures in the area in question are expected to be, are being, or have been substantially altered.	Regional stakeholders and staff from Alberta Environment initiate Water Management Plans on the local or regional level when well-level monitoring suggest water supply shortages or stakeholder conflicts begin to escalate due to limited resources.
Source	Bryner, 2003	Colorado Water Resources Dept, 2011	Bryner, 2003	Ohrn, 2008

In all cases, indicators of priority areas demand data and that the regulator has a system to monitor water supply and use to determine when the criteria for 'priority areas' are met. All jurisdictions relied on criteria and measurements for priority areas that require a substantial amount of groundwater supply and demand data, as well as information about the hydrogeological interaction between ground and surface water resources. In Utah, the Department of Natural Resources, in conjunction with the United States Geological Survey, collects water usage data annually through mandatory water metering and annual reports from water licensees. Utah's access to comprehensive and accurate data allows the regulator to monitor regional water use and determine when an area should be classified as a priority groundwater area. Other jurisdictions have less complete information about groundwater-surface water interaction and actual water use than Utah, and collecting accurate data is a significant and on-going barrier for groundwater management in all jurisdictions.[14]

The regulator must establish processes by which a region would transition from non-priority area into a priority area. Water governance and processes for decision-making are also factors in determining priority areas. Regulators in Colorado, Oregon and Alberta rely more heavily on local stakeholders than Utah to identify priority areas and initiate in the process of designating them. This is also a strategy to reduce the administrative burden on the state or provincial water allocation authority. Local or

[14] Governance is also an important aspect of determining priority areas, particularly where data is less readily available (Bryner, 2010). Evidence from the case studies suggests that local stakeholders frequently initiate priority area designation based on regional knowledge and local observation of water supply and demand, playing a significant role in identifying priority areas. In many of the cases, the regulator confirms data and introduces designation under statutory authority. All of the cases have developed governance structures that include local and provincial-level players in decision-making procedures to determine priority areas. The extent to which local government and stakeholders participate in provincial decisions about regional water management is beyond the scope of this research.

regional participation in priority area designation capitalizes on local knowledge about water resource supply and demand promotes local involvement in policy-making and implementation to better achieve provincial goals for water management.

In Oregon and Colorado, local groundwater organizations or license holders petition the Groundwater Commission to evaluate the region for 'designated basin' status through a legal process and evidence available through data collection. Stakeholders submit a petition when conflicts over water rights begin to arise in the area (Woodcock, 2011). When evidence suggests that groundwater use exceeds the aquifer recharge rate, the regulator declares the region a priority area and enables additional groundwater regulations, such as restricting new groundwater allocation in that area. In Oregon and Utah's priority areas, some beneficial uses of water take priority over other uses regardless of priority dates, meaning that a priority-of-use system overrides FITFIR. The priority-of-use system fundamentally favours high-priority water needs (such as drinking water and agricultural use) over lower-priority uses in the region (such as water for recreation) (Hecox, 2001).

Alberta designates its priority areas through Water Management Plans (WMP) and a planning process legislated in Alberta's *Water Act*, similar to BC's Water Use Planning highlighted in Chapter 2.4.1. Regional stakeholders and staff from Alberta Environment initiate WMPs on the local or regional level when well-level monitoring suggest water supply shortages or stakeholder conflicts begin to escalate due to limited resources. The local stakeholders and regional staff at Alberta Environment determine the severity of concern for the region when conducting local planning and select the appropriate mechanism. The majority of WMPs provide guidelines for local water

management that regulators must consider, but adhering to WMP objectives is not mandatory. Only WMPs in highest priority, at-risk areas are submitted for 'approval' from the Lieutenant Governor. It is compulsory that local decision-makers adherence to objectives and regulations in Approved Water Management Plans. In the case of the South Saskatchewan River Basin Approved WMP, the designation was driven by an agreement between Alberta, Saskatchewan, Manitoba and the federal government regarding water flow in the South Saskatchewan Basin – the 1969 Master Agreement on Appropriations. In that case, the total volume of allocated and diverted water in Alberta's SSRB exceeded the province's allocation in the Master agreement during drier years (Ohrn, 2008). Alberta bases its allocation in the agreement on measurements of annual natural water flow.

4.3.2 The Problem with 'Priority Areas'

None of the jurisdictions studied limit groundwater regulation to priority areas; some groundwater regulations apply outside of the priority groundwater areas as well. Province-wide regulation is a common characteristic from the case studies. Cases suggest that more aggressive regulations for priority areas are best as a supplement to state- or province-wide groundwater extraction and use regulations; in no case do priority area regulations for groundwater stand alone. Within the boundaries of priority areas, jurisdictions enable special provisions to protect groundwater stores in addition to standard water licensing procedures.[15] This suggests that focusing on groundwater

[15] Special provisions include closing the area to any further appropriation of groundwater; enabling transfer of appurtenance; determining the permissible total withdrawal of groundwater in the critical area each day, month or year; and making additional requirements as are necessary to protect the public welfare, health and safety (Bryner, 2003).

regulations for priority areas is a more advanced approach to groundwater regulation, rather than a basic strategy to manage the resource.

The future quantity, quality and regional distribution of BC's water resources is uncertain but projections suggest an increase in demand and decrease in overall supply of water, as was outlined in Chapter 2. Since some areas of BC already experience greater incongruence between water supply and demand than other areas, groundwater regulations should acknowledge and accommodate variations in the regional distribution of water resources and acknowledge that aggressive regulation is more necessary in some areas than others. Enabling priority areas creates a legal provision that allows the regulator the flexibility to respond to problem areas and to new information. However, because BC is currently without any regulatory framework for groundwater resources, it requires basic approaches to resource management.

Although WAM respondents expressed concern for critical areas and aquifers under stress as a key reason for groundwater regulation (WAM ROE, 2010), comments from several stakeholder groups supported groundwater regulation throughout the province instead of limiting regulations to priority areas. After a series of public consultations and technical analysis as part of *Water Act* modernization, the British Columbia Ministry of Environment released a policy direction paper that suggests the Ministry will regulate groundwater in all areas of the province, but only apply regulations to large groundwater users (WAM PP, 2011). In known problem areas ('priority areas'), groundwater licensing requirements may also apply to smaller users and to private domestic wells in some circumstances.

BC's limited information about groundwater use, actual surface water use and the interaction between ground and surface water resources may impede how the province defines 'priority areas' and executes special provisions for water management in those areas. Therefore, BC needs a systemic approach to collect groundwater use data, and learn more about how ground and surface water interact in basins to identify priority areas and select the best tools for appropriately adjusting allocation of water-use rights. What is measured is managed, and accurate water use data plays a crucial role in sustainable water allocation practices. The province should focus on building a system of groundwater regulations for the whole province that better collects data about groundwater supply and demand such that scientific measures from Oregon or Colorado become options for identifying priority areas.

4.4 'Large' Withdrawals and Water License Exemptions

As in BC, most wells in other jurisdictions extract groundwater at low rates and individually have an insubstantial impact on surrounding groundwater supply and interconnected surface water. To reduce administrative burden, jurisdictions often include license exemptions for small groundwater uses. Where a jurisdiction allows exempt uses, the law only requires licensing and regulation for groundwater extraction at rates and quantities above or equal to the minimum rates established in water allocation legislation. By exempting small users, jurisdictions may dramatically reduce the number of wells that are subject to regulations, which streamlines administration and enforcement responsibilities and reduces cost to the regulator.

Establishing a system of exempt uses for small water users benefits BC by reducing administrative complexity; fewer wells require licensing and, therefore, enforcement. The majority of wells drilled in BC are for domestic use and extract water at rates that have limited impact on overall water supply. If BC regulates 'large withdrawals' instead of all withdrawals, the province can avoid undue burden on small water users, and sidestep problems with public acceptability.

4.4.1 Defining 'Large' and establishing exempt groundwater uses

Policy makers legislate exemptions for particular groundwater uses by defining minimum extraction rates, often based on beneficial use calculations for different purposes. Table 4, below, presents groundwater uses and minimum thresholds for groundwater extraction that are legislated in the case studies for Utah, Colorado, Oregon and Alberta.

Table 4 – Groundwater License Exemptions from the Cases

	Utah	Colorado	Oregon	Alberta
Groundwater uses that do not require a water-use license with a priority date	All wells must be licensed for groundwater extraction and beneficial uses defined by Utah's legislation, which include agriculture, domestic, industrial, irrigation, manufacturing, municipal and in-stream flow.	• Wells not exceeding 15 gallons a minute used for household purposes, fire protection, the watering of poultry or livestock, and for the irrigation of not over one acre of home gardens and lawns; • Wells not exceeding 15 gallons a minute and used for drinking and sanitary facilities in individual commercial business; • Wells not exceeding 50 gallons/minute in production as of May 22, 1971 and used for ordinary household purposes; and • Wells used for firefighting only; • Wells used exclusively for monitoring purposes. • Wells in designated groundwater basins (these are regulated elsewhere as part of priority area regulation).	• Single or group domestic uses not exceeding 15,000 gallons • Single industrial or commercial uses not exceeding 5,000 gallons per day • Stockwatering • Lawn watering or noncommercial gardening of less than one-half acre • Limited schoolground uses • Oregon's definition of 'wells' also exempts exploratory wells for oil, gas or geothermal development.	• Household purposes at a rate less than 1250 m3/year; • Traditional agriculture use less than 6,250 m3/year;
Exemption thresholds in cubic meters per day (m3/day)	Utah's legislation does not exempt groundwater allocations from licensing for any use.	Wells for any purpose that extract less than 15 gal/minute (81.76 m3/day) Domestic wells less than 50 gal/minute (272.5 m3/day)	Domestic wells less than 15000 gal/day = 56.78 m3/day. Industrial or commercial wells less than 5,000 gal/day = 18.927 m3/day.	Domestic wells less than 1250 m3/year (3.5 m3/day) Traditional use wells less than 6,250 m3/year (17 m3/day)
Data Source	Hecox, 2001; Bryner, 2003	Bryner, 2003	Bryner, 2003; Woodcock, 2011	Alberta Environment, 2011; Baynegak, 2011

Of the cases, Utah is unique in that it does not exempt any groundwater uses from licensing and it is the only western state to do this (Jarvis, 2011). Colorado consistently applies regulations to all uses, like Utah, but allows exempt uses for small users. Colorado applies a lower extraction threshold and fewer exemptions for groundwater extraction than Oregon and many other Canadian provinces (WAM TBR, 2010). Colorado allows exemptions for wells that extract less than 82 m3/day for most purposes, and allows a higher threshold for domestic well users as well as an exemption for emergency groundwater extraction used for firefighting. Colorado and Utah apply the **same threshold for all uses**, but vary in that Colorado allows exempt uses under a defined extraction rate while Utah has no exemptions.

Legislation in most jurisdictions includes a provision that grants domestic groundwater use highest priority during extreme scarcity. In Alberta, wells used for domestic purposes and for traditional small-scale agricultural use, such as stockwatering and irrigation, are exempt from licensing. Alberta Environment's policy and legislation considers these uses higher priority uses for water than other purposes, regardless of priority dates on water licenses (Bayegnak, 2011). Alberta's exemptions do not apply consistent thresholds to all uses. The province allows **exemptions for only highest priority uses** for groundwater. Beneficial use data guides the maximum exemption thresholds that Alberta employs for the priority uses. In Alberta, all groundwater for other purposes is non-exempt and subject to groundwater licenses.

Oregon provides a third approach to groundwater license exemptions. Oregon has the least structure to its exemptions and features neither consistent quantities of intended

use. Oregon's Water Resources Department authorizes a system of **exemptions tailored to specific water uses.** Oregon law requires beneficial use, but does not define a threshold for some exempt uses in the legislation. Exemptions in Oregon are not consistent. Domestic users are exempt below a different threshold than industrial uses. Where Oregon has defined thresholds, they are somewhat higher than those in Colorado and Alberta. Oregon's legislation also leaves a loophole for some wells, as the legal definition of 'well' excludes some wells, such as those drilled for oil, gas or geothermal exploration (Oregon Water Resources Department, 2001). In Oregon, exemptions are *stackable*, which means that a single entity may own multiple exempt wells attached to a single piece of property (Woodcock, 2011). Oregon is also unique from the other cases in that its law contains legal definitions create irregularities in groundwater management. For example, the definition of 'well' does not include a hole drilled for the purpose of either prospecting, exploration or production of oil or gas, prospecting or exploration for geothermal resources, production of geothermal resources derived from a depth of greater than 2,000 feet or exploration for minerals (Bryner, 2003). Other Departments and legislation regulate drilling and reporting procedures of wells drilled for these purposes in Oregon, an exception similar to BC's exception for oil and gas water use.

4.4.2 The Problem with 'Large Withdrawals'

To achieve water management and environmental protection objectives, it may be most effective to license all groundwater extraction in the province as in Utah although this is the most administratively complex approach. Limiting groundwater regulation to large withdrawals can help British Columbia mitigate the problems of administrative

complexity and public acceptability that come with regulating all groundwater in all areas. However, the unquantified and unregulated nature of exempt wells poses potential challenges with water allocation, administration, and water quality (Bracken, 2010). A groundwater allocation system that allows exempt wells may not fully mitigate the negative impacts of unregulated groundwater stocks outlined in Chapter 2. Where there are a large number of exempt wells, jurisdictions have found that exempt groundwater users may have an impact in aggregate. When the number of exempt users reaches a critical mass, it creates a ***problem of exemptions***. Some North American jurisdictions have experienced significant fall-out from the problem of exemptions, including several of the cases studied in this report.[16]

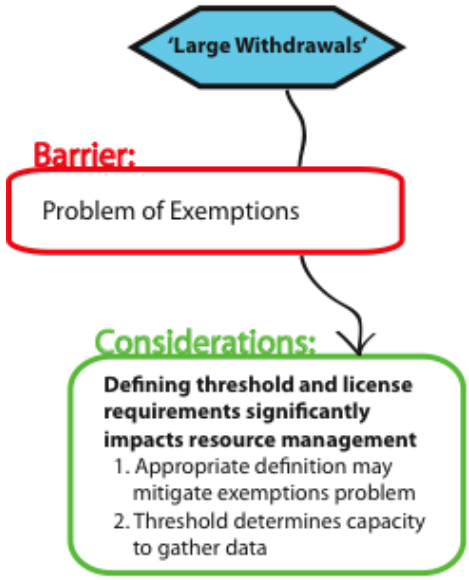
Exempt users individually have a negligible impact on the water table. However, a large group of exempt wells may have a collective impact on groundwater stores. The problem of exemptions occurs when the cumulative effect of many exempt wells may equal the impact of a single large withdrawal. The problem of exemptions may occur intentionally in the course of typical water resource development, or may be the result of strategic decisions by commercial groundwater users. Establishing a threshold for large withdrawals can create a loophole allowing groundwater users to drill multiple wells with unregulated pumping rates rather than a single large, regulated well to avoid groundwater licensing and annual water rental fees. For example, in Oregon subdivision developments that depend on groundwater supplies for domestic use have caused a problem of exemptions (Jarvis, 2011). A subdivision may include a hundred homes, each with a domestic well extracting 2-3 m3/day. This type of exempt groundwater development has

[16] Nathan Bracken of the Western States Water Council explores the specific challenges posed by exemptions in different American jurisdictions in much greater detail in his work Exempt Wells in the West (Bracken, 2010).

had a significant effect on licensed water users in some areas of Oregon and the western United States (Bracken, 2010).

The problem of exemptions has been observed in some but not all jurisdictions with groundwater withdrawal exemptions (Bracken, 2010). There are a number of strategies BC can employ when defining the provincial approach to groundwater license exemptions. Selecting the appropriate strategy can help mitigate the effect of an exemptions problem for the province. How BC defines its exemption threshold also affects the amount of data available to the Ministry of Environment for future groundwater resources management. Figure 4 illustrates the considerations for defining 'large withdrawals.'

Figure 4 Considerations for 'Large Withdrawals'



Most jurisdictions include license exemptions for small groundwater uses. Because of challenges with exempt uses, regulators in all of the cases studied used well permits as supplement to licensing for groundwater.

4.5 Well Permits and Application Processes for Groundwater

In the cases, as in BC, acquiring a water-use license requires an application process with the regulatory body. Applicants provide information about how much water

they intend to use, for what purpose and in what location. With the application, they submit a plan for developing the groundwater resource that acknowledges regulated construction requirements. The standard process for applications may include a period of public comment, regulator review of the facts presented in the application, and an investigation into to water supply in the proposed location before the regulator approves or rejects applications. There are typically administrative fees associated with applications. In addition to typical water license application protocol, regulators also require well drilling permits or notification for groundwater developers, regardless of whether use is ultimately licensed. By the process of well permitting, registration and record of all wells in the province occurs

Utah, Colorado, and Alberta require anyone seeking to develop groundwater for any use by drilling a well must first apply for a drilling permit from a regulatory body. After the regulator approves the permit, the applicant must complete well construction within a prescribed time frame. Upon completion, well drillers file a well report to the regulator indicating that they have fulfilled construction requirements specified by the permit and tested water quantity and quality from the well. After the well report is completed, the well developer of non-exempt wells submits a water-use license application through the same channels as a surface water license.

In Colorado, the State Engineer, head of the Water Resources Department, **requires well permits for all new wells but allows exempt groundwater uses** within the state's prior appropriation system at the basin-level water courts. After construction, non-exempt well developers procure water-use licenses through the same water court procedures as surface water applicants (Hecox, 2001). Under Alberta's *Water Act*,

groundwater and surface water are subject to a similar application process. As in other jurisdictions, Alberta's Ministry of Environment (Alberta Environment) **allows exemptions for groundwater use but requires well drilling permit for all groundwater development prior to drilling**. Alberta Environment requires well drillers to submit a record of completion of a well separate from standard water license applications. Alberta does not require unlicensed users to have metered wells that record how much water is withdrawn and when – thus, exempt groundwater uses affect the accuracy of Alberta's projects for water supply and demand (Bayegnak, 2011).

In Utah, **all groundwater use is both permitted and licensed**. Anyone seeking to drill a well must apply to the State Engineer for a new water-use right or buy an existing right and apply to the State Engineer to transfer appurtenance; there are no exceptions to this rule and Utah has no exempt water uses so there is no separate permitting process for 'exempt use' wells (Bryner, 2003). This approach increases administrative complexity for the state. According to Boyd Clayton, the Deputy Engineer for Utah's Division of Water Rights as cited by Alan Bracken, Utah is able to bear the administrative burden of a system without exemptions for small groundwater users because "[t]he burden has always been there so we just consider it part of the necessary workload" (Bracken, 2010). However, Clayton indicated that "[d]elays have been an issue for all water right applications and a backlog of 5,000 applications has accumulated over a period of 25–30 years" and that "there has been a significant push" during the past five years "to provide adequate funding to get the work done and focus on eliminating the backlog" (Bracken, 2010). Of the cases, Utah has the most rigorous process for groundwater drill permits and water-use license application. Metered water use is a

requirement under Utah's water-use licenses, and the US Geological Survey collects the data and shares it with the Natural Resources Department.

Recall from Section 4.4.1 that Oregon employs a system of variable thresholds. Unlike other jurisdictions, Oregon **does not require a drilling permit, but does require drillers to notify the Water Resources Department** before beginning work and to submit a well report following project completion that includes water quantity and quality data (Woodcock, 2011). In Oregon, after a well is developed, users with the intention to extract water for a non-exempt purpose and quantity must apply for water-use license through processes similar to surface water licenses. Oregon does not meter or measure groundwater use as part of their license requirements outside of 'priority areas' where water scarcity is a significant concern (Bryner, 2003).

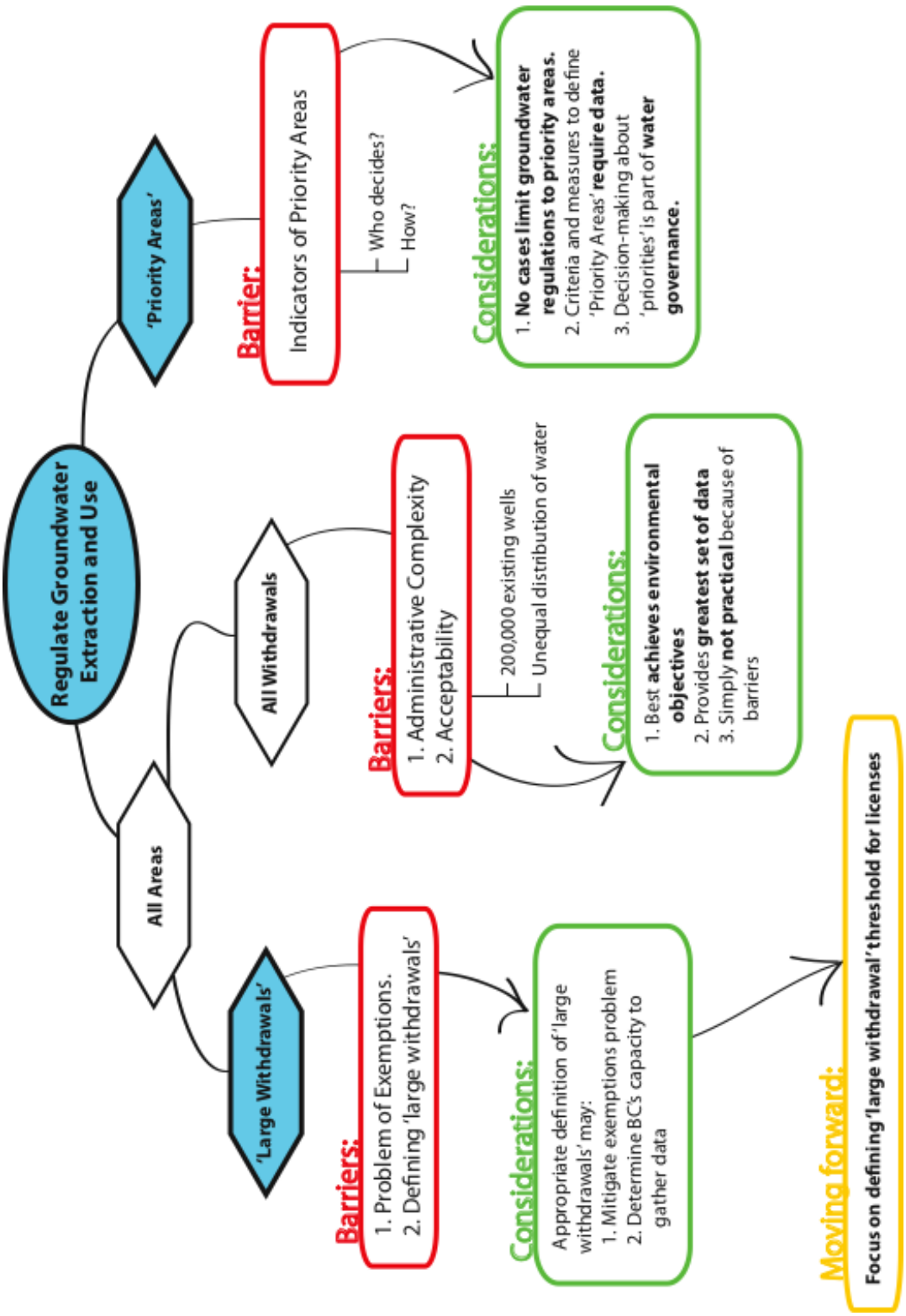
4.6 Conclusions from the Case Studies

Aggressive groundwater regulations for all groundwater withdrawals in all areas, such as those approaches assumed by Utah and Australia, would likely have a positive impact on BC's future environmental and economic productivity. Thorough regulation also provides the most comprehensive set of data that would allow BC to monitor groundwater stores and opportunity to adapt to changing information. On the other hand, the province faces serious limitations to implementing aggressive groundwater management at this time so regulating all groundwater withdrawals in all regions of the province is not a realistic policy option for the province to consider. To reduce administrative complexity, many jurisdictions include license exemptions for small

groundwater uses and policy makers create exemptions for particular groundwater uses in legislation by defining minimum extraction rates.

Recall that the Living Water Smart commitment for groundwater was to regulate groundwater extraction and use for large withdrawals in priority areas. The LWS commitment implicitly acknowledges the substantial barriers of administrative complexity and public acceptability that arise if the province were to establish a groundwater regulation for all groundwater withdrawals in all areas. Based on lessons learned from other jurisdictions, I developed the chart of problems, Figure 5, to weigh barriers and considerations for moving forward with groundwater regulations for British Columbia. Although demand for groundwater regulation in BC provides an incentive for the province to target groundwater regulations in priority areas, the cases suggest that no jurisdiction uses groundwater management in priority areas as a stand-alone strategy. More aggressive regulations for priority areas are best viewed as a supplement to state- or province-wide groundwater extraction and use regulations. The framework suggests that the province faces greater barriers to targeting groundwater regulation in ‘priority areas’ than to meet its commitment to regulate ‘large withdrawals.’

Figure 5 – 'Diagnostic Chart' for Groundwater Regulation Updated



Since the cases suggest that priority areas are not an optimal starting point for groundwater regulations, I focus on aspects of groundwater licenses related to operationalizing the definition for 'large withdrawals.' I explore the options for approaching 'large withdrawals' and using well permitting as a supplement to licensing further in Chapter 6, and analyze their applicability to the BC context.

How British Columbia defines 'large withdrawals' for groundwater licenses is pivotal for the province in achieving its other groundwater management objectives. Effective policy design can also improve the province's capacity to extract groundwater-use data. The province's definition of 'large withdrawals' and the regulation's characteristics may also mitigate the problems of public acceptability and administrative complexity. Finally, there is a question about whether the province employs well permitting as a supplement to groundwater licensing and how. Well permits can affect the province's ability to achieve its other objectives of adaptability, water use efficiency and environmental protection.

In Chapter 5, I build a set of criteria and measures by which to analyze policy options for exemptions thresholds and permitting for wells. The problems outlined by the decision-making framework in this section, and by theories in regulatory compliance help inform the criteria.

5: CRITERIA FOR DETERMINING REGULATIONS

This chapter defines criteria that I use to evaluate policy options for groundwater licensing. In this section, I first explore optimal precision in regulation based on regulatory theory. By combining theory with the problems associated with 'large withdrawals' and 'priority areas' explored in Chapter 4, I select and define a number of criteria that I will use to analyze and evaluate options for regulating groundwater allocation in BC in Chapter 6.

5.1 Criteria definitions and measures

I considered the characteristics of optimally precise regulations and the inherent efficiency trade-offs within them to inform a set of criteria used to evaluate possible groundwater regulatory frameworks for BC. The following criteria are used to measure trade-offs between options:

- Political Feasibility
- Administrative Complexity
- Effectiveness
- Regulatory precision

The criteria and their measures are defined in greater detail below and compiled into a matrix in Section 5.2. They target short-run feasibility of policy options as well as their relative success in addressing the long-run problems identified in the case studies.

5.1.1 Political feasibility

The political feasibility criterion focuses on the practicality of applying a new groundwater regulation to the BC context. All policy options consider existing elements in BC's surface water allocation system, such as currently surface water application processes and legal priority rights based in FITFIR. Policy options represent an *incremental* step forward for the province to achieve groundwater allocation goals. This is the first step to achieve political feasibility.

Regulations for groundwater must also consider the demands of major stakeholders and satisfy stakeholder needs to be politically feasible. This is a major strategy to mitigate problems of public acceptability for groundwater regulations. Stakeholders in this case are groundwater users who know they are groundwater users. I identified major groundwater stakeholders and their key issues from the Ministry of Environment's Report on Engagement from the *Water Act* modernization, released in September 2010. The groups with a primary stake in how to the province determines 'large withdrawal' thresholds are as follows:

1. **Agriculture –** In BC, agriculture is a major user of groundwater for irrigation. Ranchers also use groundwater for stockwatering. According to the engagement report, the Agriculture sector, particularly small farms, are concerned that groundwater licensing, metering and water-efficient irrigation may add costs to their business to the extent that they will no longer be able to compete. However, agricultural stakeholders also prefer regulations that provide greater water security and support regulations that encourage "smart," proactive water-use planning, rather than a reactive approach to drought management (WAM ROE, 2010).
2. **Environmental Advocates –** These include non-governmental organizations, like Ducks Unlimited and West Coast Environmental Law, whose mandates feature environmental protection goals. They also include academics from the fields of resource management, hydrology or hydrogeology. According to the *Water Act* modernization Report on Engagement, feedback from stakeholders in these groups indicated

support for regulating all groundwater extraction, rather targeting only large groundwater withdrawals and priority areas. These stakeholders stressed that, because groundwater and surface water are linked, groundwater thresholds are arbitrary and will likely be abused without firm enforcement (WAM ROE, 2010).

3. **Domestic Well Owners and Municipalities dependent on groundwater –** Owners of domestic wells and municipalities that provide water works for domestic and commercial purposes are major stakeholders because they may be affected by new groundwater regulations and are aware of their impact. However, members of the general public who rely on municipal water from wells are not major stakeholders. They are frequently unaware of their dependence on groundwater and the impact of regulations is indirect.
4. **First Nations –** Many First Nations communities rely on groundwater sources and will be affected by groundwater regulation (WAM ROE, 2010). First Nations are a major stakeholder group and potentially have the greatest political impact on the *Water Sustainability Act*. It is difficult to gauge where First Nations stand with regard to definitions of 'large withdrawals' in groundwater regulations because First Nations dispute the legitimacy of provincial authority to make decisions about water management. The political relationship between First Nations groups and the province are based on a long and often confrontational legal history, which are beyond the scope of this research. First Nations maintain that conservation and preservation measures are important policy shifts. For the purposes of this analysis, I infer that groundwater policy options that increase the province's capacity to promote sustainable groundwater use are at least moderately acceptable to First Nations groups. This measure will not fully capture the nuance of the relationship between First Nations and the provincial government with regard to resource management.

There are other stakeholders affected by groundwater regulations, such as the oil, gas and mining sectors. The feedback from these groups focused more on water quality than water quantity when it came to groundwater regulations.

The measure for this criterion is the degree to which a policy option satisfies the demands of the stakeholder groups. It will be measured on a scale of 'highly support,' 'somewhat support,' 'somewhat oppose' or 'highly oppose.' Support of each policy option will vary by stakeholder group. Where the clear majority of stakeholders fully support the policy option, it receives a 'highly support' designation. If more stakeholders

would support the option than oppose it, it receives a ‘somewhat support’ designation, and so on.

5.1.2 Administrative Complexity

The administrative complexity criterion acknowledges that any new groundwater regulation must consider the administrative burden on the Ministry of Environment for the short term, outlined in Chapter 6. The measure for this criterion is the approximate number of wells that the Ministry would have to retroactively process under the new regulation, calculated based on WELLS database estimates.

5.1.3 Effectiveness

The effectiveness of a regulatory policy is the congruency aspect of regulatory precision, or the extent to which a policy fulfils the provincial goals for groundwater management. BC has committed to specific groundwater policy goals outlined in Living Water Smart and in the *Water Act* modernization process to date. The commitment is to regulate large groundwater withdrawals in priority areas. This is a reasonable short-term goal for the province and was developed given administrative complexity and public acceptability constraints. Since there are not clear long-term goals specific to groundwater in BC, I infer long-term goals from the province’s long-term water management goals. Science suggests that groundwater and surface water are intrinsically connected and are arguably a unified resource.

The effectiveness criterion focuses on congruency with two of the provinces water objectives introduced in Section 2.5, namely (1) that water is valued by all and (2) the extent to which the policy option improves provincial groundwater data and, therefore capacity to achieve environmental objectives (WSD Strategic Plan, 2008). I define the first as the relative ability of policy options to introduce a groundwater regulation that promotes groundwater value to users in BC and congruence with other WAM goals. I use a normative scale of effective, somewhat effective, and not effective as shown in Table 5.

Table 5 – Goal Congruency Criterion

Groundwater regulations align with water conservation goals by promoting the value of groundwater to users and congruence with WAM objectives.	1. Effective: Allows the province to meet water valuation goals and promotes other WAM objectives. 2. Somewhat Effective: Achieves some water valuation goals without negative affects on others. 3. Not Effective: Does not achieve water valuation goals, impedes other WAM objectives.

I measure the second effectiveness attribute by how much groundwater-use data the policy option allows the province to collect and record. The measurement is on a normative scale where policy is 'data heavy' if it substantially improves groundwater data collection throughout the province; policy is 'data supportive' if it enables some data collection or are 'data neutral' if it does not contribute greatly to BC's capacity to collect groundwater data. Table 6 outlines this criterion and its measure.

Table 6 – Data Collection Criterion

The degree to which the policy provides BC with the ability to gather information, monitor water use and, therefore, respond when circumstances change.	The policy is: 1. Data Heavy: Provides a comprehensive source of groundwater data for the province. 2. Data Supportive: Improves BC's groundwater data collection for some uses and in some areas. 3. Data Neutral: Does not substantially improve BC groundwater data collection.

5.1.4 Regulatory precision

Regulatory precision focuses on the water users ability to understand and comply with proposed groundwater regulations, which reduces the administrative burden on the province for the long-term. These criteria come into play with procedural approaches to water licensing, such as application processes and well permitting requirements. According to *theories of regulatory compliance* (Morgan and Yeung, 2007), *optimally precise regulations* are congruent, accessible and transparent.

- Regulation is transparent if it uses language that is well defined and universally accepted so that the rule is clearly understood. Transparency includes simple, consistent rules, such as Colorado's 15 gallon/day threshold regardless of use or Utah's rules that exclude any exemptions to water licensing.
- Regulation is accessible if the rule is applicable to concrete situations and can be implemented without excessive difficulty or effort. Simple application processes and consistent regulations for all types of water license applications achieve horizontal equity – where all equal users are affected equally by the regulation.
- Regulation is congruent with policy objectives if the message communicated in the rule produces behaviour that matches the underlying policy objectives (Morgan, 2007). Congruent regulations are effective at achieving province's desired outcomes of monitoring groundwater stocks, maintaining sustainable water use and mitigating conflict for limited water rights.

Within choice of regulatory precision there are inherent trade-offs, efficiency considerations and associated costs. The choices a regulator makes about how to weigh the three traits of regulator precision and apply the elements can impact both the primary

behaviour of the rule's audience and transaction costs of administering the regulations. For example, a perfectly transparent and congruent rule is likely to be complex, which makes it inaccessible and cumbersome in implementation. Administrative and enforcement costs will increase if opacity and inaccessibility are high. Unclear rules have higher transaction costs because they increase the regulator's responsibility to deliberate the applicability of rules with different individual actors. On the other hand, a perfectly transparent and accessible rule may not be effective at achieving the desired policy objectives. Developing a detailed and explicit legal definitions or a fine-tuned system that includes exceptions in the rules for different actors risks shifting the focus from the law's intent to the letter of the law. Regulations that are complicated or that have exceptions may allow loopholes and are likely to decrease a regulation's congruence with provincial policy objectives. Striking a balance of transparency, accessibility and congruency plays an important role in developing effective and cost-effective regulations.

For this criterion, I focus on the two user-focused aspects regulatory precision: transparency and complexity (Morgan and Yeung, 2007).

- *Transparency* - A transparent regulation is one that is clearly defined and easily understood by groundwater users. Simpler regulations with fewer variations are less complex for users to understand. This encourages voluntary compliance and improves the regulator's ability to implement the rule effectively. The measures for transparency are: (1) does the regulation employ consistent exemption thresholds and (2) are the license processes similar for both ground and surface water? The measure for this criterion will be dichotomous yes or no answers to these two questions.
- *Complexity* - This other aspect captures procedural complexity for the groundwater user. It is measured by how many steps an applicant must fulfil in addition to typical surface water applications to acquire a license for groundwater use where water rights are available.

5.2 Criteria Matrix

Table 7 summarizes the criteria with their measures. Some criteria apply differently in the evaluation of policy options for groundwater exemptions thresholds and well permits, indicated in the far right column. For example, under most policy options for groundwater licensing, I assume that BC employs the same water-use license application process as for surface water license holders. Therefore, the last criterion regarding regulatory precision – 'complexity' – comes into play in a discussion about well permitting, but not in the initial exploration of licensing option.

Table 7 – Criteria, Definitions and Measures

Criterion	Definition	Measure	Stage at which Criterion Applies
Political Feasibility	Degree to which the policy option satisfies major stakeholders.	Highly support, somewhat support, somewhat oppose or highly oppose.	Licensing and Permitting
Administrative Complexity	Administrative burden on the province.	Number of existing wells eligible for licensing. #	Licensing and Permitting
Effectiveness	Groundwater regulations align with water conservation goals by promoting the value of groundwater to users and congruence with WAM objectives.	1. Effective: Allows the province to meet water valuation goals and promotes other WAM objectives. 2. Somewhat Effective: Achieves some water valuation goals without negative affects on others. 3. Not Effective: Does not achieve water valuation goals, impedes other WAM objectives.	Licensing and Permitting
	The degree to which the policy provides BC with the ability to gather information, monitor water use and, therefore, respond when circumstances change.	1. Data Heavy: Provides a comprehensive source of groundwater data for the province. 2. Data Supportive: Improves BC's groundwater data collection for some uses and in some areas. 3. Data Neutral: Does not substantially improve BC groundwater data collection.	Licensing and Permitting
Regulatory precision	Transparency for water users	Clear exemption thresholds for users. Y/N (1) Does the regulation employ consistent exemption thresholds for all uses? Y/N (2) Are the license processes similar for both ground and surface water? Y/N	Licensing and Permitting
	Appropriate complexity for water users	Steps in the license application process in addition to typical surface water applications. #	Permitting

5.3 Fees and Costs

Water license application fees and annual water rental rates for surface water licensees are designed to consider and attenuate the administrative, enforcement and research costs incurred by the Ministry of Environment and FrontCounter BC (MOE, 2011a). According to the policy direction paper, licenses for groundwater will feature a similar application procedures and annual rental fees for groundwater to those for surface water. Surface water fees vary according to the purpose of the water-use and volume allocated. Groundwater licenses will likely specify the maximum quantity of groundwater that can be extracted and set out terms for pumping and use, including annual rental fees (WAM PP, 2011). Other jurisdictions also include one-time fees with well permit applications to cover administrative and processing costs. Oregon allocates a portion of well permit fee to groundwater data analysis and additional groundwater research.

Licensing requirements for groundwater with a use-pay system alleviates the financial impact for the government, but may have negative impacts on the private sector. Industries that are dependent on groundwater have built a business model based on unregulated access to a water source, whereas other industries are surface water users and have integrated water license requirements in their planning. Commercial groundwater users who extract a great deal of groundwater and have historically not paid for that water but who operate at narrow margins, such as farmers and ranchers, may be affected by groundwater rental and application fees. The political feasibility criterion somewhat considers financial impact on commercial sectors, as financial impacts affect stakeholder

support for regulations and were an undercurrent in many submissions to the *Water Act* modernization engagement process.[17]

There are also potential negative impacts to the overall BC economy in the short term due to additional operating costs for industry and agriculture. Long-term economic benefits of protecting groundwater resources in perpetuity likely outweigh short-term costs and the method of implementation alleviates much of the short-term financial stress on commercial water users.

5.4 Implementation

The most significant and immediate barriers the province faces are with administrative complexity and public acceptability for new groundwater regulation. Implementation strategy can play a substantial role in overcoming these obstacles, regardless of which of the policy options the province chooses to implement. Implementation complexity is a substantial consideration for groundwater regulations regardless of BC's final decisions about groundwater exemptions and well permitting.

There are two aspects of implementing new groundwater licensing or permitting. First, there is the approach that the Ministry of Environment uses to inform well drillers and groundwater users that seek to develop new wells to access groundwater. Enacting regulations for future groundwater development is much simpler than applying new regulations to existing users. Integration of groundwater licensing and permitting

[17] BC's *Water Act* modernization suggests that the province may increasingly look to economic instruments to encourage water-use efficiency for surface water, such as water pricing structures that vary based on water availability or the quantity of water used (WAM PP, 2011). Including these pricing levers in groundwater regulations could impact the political feasibility, administrative complexity, effectiveness, and transparency of groundwater licensing requirements for the long-term.

requirements into the guidelines for well drillers and developers of new groundwater resources encourages them to comply with regulations from the beginning of their application process. For new wells, permitting can be combined with the drilling procedures legislated by the *Groundwater Protection Regulation*. Existing well owners would have to register wells with the province, and provide basic information about well location and groundwater extraction information. Non-exempt well owners would submit license applications in accordance with existing regulations for surface water licenses.

Applying new regulations to existing wells, however, is trickier because of the large number of existing groundwater users and gaps in provincial well data (explained in Chapter 5). The province could take a blanket approach to implementing new groundwater licensing regulations. The BC Ministry of Environment applied this strategy for retroactively introduce regulations for existing well users in the mid-1990s when the province ushered in the *Water Protection Act* (RSBC 1996). As mentioned in Chapter 2.4.2, the *Water Protection Act* limits bulk water removals from the province and interbasin transfers within the province. When the Act was introduced, a number of water licensees were already engaged in bulk water transfers. To bring existing users under compliance with the new regulation, the province developed a comprehensive registration system that maintains existing bulk water removal rights within clearly defined limits (MOE, 2011a). The legislation permitted surface water licensees and groundwater users who have removed water in bulk prior to June 1, 1995 to continue, provided they registered with the province (MOE, 2011a). Registered surface water licensees were permitted to continue removing water to the extent of their existing water-use rights, where as groundwater users – exempt from water-use licensing requirements under the

Water Act – were permitted to remove water up to the maximum volume they have removed in any 12 consecutive months over the three years preceding June 1, 1995 (MOE, 2011a). The province notified those engaged in bulk water removal of intent to regulate and gave them one year to voluntarily register their use with the province to maintain their rights to export or transfer water under the new legislation.

This process for registering large users would also be consistent with Oregon's approach to introducing groundwater regulations in 1955. Oregon gave licensable well users notice of intent to regulate and were required to register wells by a certain date to maintain their claim to water rights. The registrants received a water-use license based on their current and historical rate of water use, and could continue their present water use under this license (Woodcock, 2011). Voluntary registrants received license 'priority dates' set several years prior to the start of the regulation period, to allow them a degree of seniority over new users in the FITFIR system.

However, 'priority dates' established by the blanket approach are not typically founded in reality so they do not reflect the date a well was actually developed for use. During periods of scarcity the province restricts groundwater use, this could substantially increase administrative complexity. When determining legal priority rights for users during water shortage, these dates will not correctly reflect seniority. Evidence from Oregon suggests that adjudicating actual priority dates can be a resource intensive and politically charged process. According to Ann Reece at the Oregon Water Resources Department, Oregon has systemically adjudicated surface water licenses basin by basin since in 1910, shortly after it first introduced water allocation legislation for surface water (Reece, 2011). Presently, "about [a third] of the state's surface water rights are yet to be

adjudicated" (Reece, 2011). To date, none of the state's groundwater licenses have been adjudicated to establish actual priority dates.

Oregon's experience illuminates the future administrative considerations that may arise if BC selects a similar implementation strategy for groundwater regulations in BC. Clearly, implementation approach is a significant consideration when moving forward with groundwater regulations, but is somewhat beyond the scope of this research.

6: OPTIONS AND ANALYSIS FOR GROUNDWATER REGULATION POLICY

The policy options in this paper focus on defining optimally precise thresholds for 'large withdrawals' in BC and the processes by which groundwater users register wells and apply for groundwater licenses. The jurisdictions in the case studies have already defined groundwater extraction thresholds and implemented groundwater regulations, providing a template for British Columbia that informs the following policy options. British Columbia's definition of 'large withdrawals' and the procedures it employs to register and license wells provide a foundation for the province to achieve its long-term water management objectives.

I explore policy options for defining groundwater license extraction thresholds in Section 6.1; then I use the analysis to develop a 'Large Withdrawals' Decision Making Framework to inform provincial groundwater policy-making in Section 6.2. In Sections 6.3 and 6.4, I introduce and analyze options for including well permitting into BC's groundwater regulatory framework. Finally, in Section 6.5, I analyze the policy options and the BC Ministry of Environment has proposal for defining large withdrawal thresholds based on criteria from Chapter 5 and make recommendations based on my research at the close of this chapter.

6.1 Defining 'Large Withdrawals' for Water Licenses

In Section 4.4, I provided a number of policy approaches to defining 'large withdrawals' based on case studies. Alberta employed a system of 'thresholds for priority uses only'; Oregon's exemptions featured 'variable thresholds'; Utah and Colorado applied 'consistent thresholds for all uses.' I explain briefly the options for thresholds below. I analyze them based on the criteria proposed in the previous chapter and create a decision-making framework to balance the trade-offs and considerations of the policy options.

6.1.1 Option: Threshold for Priority Uses

The majority of cases studied rank domestic and agricultural uses more highly than other uses in groundwater allocation policy. In British Columbia, surface water allocation policy also gives a small degree of precedence for water used directly for human consumption (drinking water or domestic water) and water used by agriculture, which is an important consideration for food security. Decisions about 'priority uses' are value-laden and should include stakeholder input and these strategic discussions should be considered in measuring administrative complexity. Value-laden decision-making processes are time consuming and add cost to rule making therefore the process for identifying 'priority' uses adds substantial administrative complexity to this option. On the other hand, value-based discussions about groundwater for different uses encourage stakeholders to think about the value of groundwater and ultimately promote the effectiveness of the regulation.

Alberta applies only exemptions for priority uses – namely domestic and agricultural wells – at a low threshold that corresponds with beneficial use calculations

from Alberta Environment. BC could adopt Alberta's system for priority uses rather than involve stakeholders in a process to determine BC-specific standards 'priority' uses and thresholds. This policy option licenses all non-priority uses equally, but leaves a number of exemptions for priority uses. License processes are similar for ground and surface water, but the groundwater licensing procedures are not the same for all users since the legislation treats priority uses differently. This option also provides the greatest deal of data to the province, but allows exemptions for the smallest priority users like domestic well owners. Under Alberta's system, the province would license fewer than 8,800 wells and eliminate a substantial number of wells from licensing requirements according to WELLS data.

6.1.2 Option: Variable Thresholds

Oregon has the least structure to its exemptions and features neither consistent quantities of intended use, nor does it target only priority groundwater uses. Oregon's system employs "variable thresholds." The effectiveness of variable thresholds depends heavily on how the province determines which groundwater uses will be licensed, and where particular uses will have exemption thresholds. This strategy may satisfy some stakeholders, particularly those likely to engage in creative compliance practices and capitalize on loopholes in the regulation, reducing the effectiveness of groundwater licensing at achieving provincial policy goals. Industries like oil and gas benefit from a system of groundwater regulations where their groundwater use is regulated by the Oil and Gas Commission rather than the Ministry of Environment. However, stakeholders who prioritize environmental objectives such as First Nations, environmental

organizations and other industries may not support variable thresholds, which create loopholes and increase risk for ecosystems and some groundwater uses like irrigation.

It is not clear how many wells would be exempt if BC were to adopt Oregon's policy for groundwater exemptions, due to the variable nature of the state's thresholds. How the province defines variable exemptions may decrease administrative complexity by reducing the overall number of wells that must be retroactively licensed. However, vague or variable rules are more difficult for water users to understand and the Ministry of FrontCounter BC can expect to spend more time and resources translating complex exemption rules to well owners than under the other options. Finally, this option does provide additional groundwater data for the province, but it is not likely that the Ministry captures data consistently and efficiently under this strategy.

6.1.3 Option: Same Threshold All Uses

Utah and Colorado base their exemptions on quantity of groundwater extraction. Utah's approach is a blanket 'no exemptions approach,' where all groundwater uses require mandatory permitting and licensing. Because of the barriers to licensing all withdrawals in all areas, explored in Chapter 5, I assume that Utah's no-exemptions approach is not an option for BC.

How this option ranks against the measures for the criteria established in Chapter 6 depends almost entirely on what thresholds BC determines to set for groundwater license exemption. Agriculture stakeholders would be split in their support. Higher exemption thresholds apply to license requirements for the fewest irrigators on the largest

farms, which may receive support from the sector. However, stakeholders from agriculture also preferred "'smart' water-use plans" that employ "proactive measures to mitigate damage caused by water shortage" because "they noted close links between drought management, food security and their ability to thrive and survive" (WAM ROE, 2010). Agriculture supports secure water rights through FITFIR licensing, but is also hesitant about water pricing structures that will add costs to their businesses. Provincial groundwater regulations should consider the economic ramifications of groundwater licensing that have an equitable impact on commercial irrigators.

I acknowledged in my definition for this criterion that it is difficult to approximate First Nations support for any threshold. First Nations groups could argue that provincial monitoring and management does not guarantee improved protection of groundwater stores and that there is a legal conflict with Aboriginal rights and title (WAM ROE, 2010). As in the agricultural sector, there are substantial equity considerations among First Nations groups who rely on groundwater and provincial groundwater regulations should consider the economic ramifications of groundwater licensing have an equitable impact. In Chapter 6, I indicated I would infer First Nations support from the perspective of environmental protection and environmental advocates. From that perspective, lower thresholds are better to protect and monitor groundwater stores from over-allocation because of the exemptions problem.

This option provides the greatest regulatory precision for groundwater users in that the same standard regulates all uses. The province's choice of a high or low exemption threshold determines the extent to which this policy option is administratively complex, and effective at collecting data or promoting the value of groundwater for all

users in accordance with provincial environmental objectives. High thresholds reduce administrative complexity, but reduce policy effectiveness at achieving data and resource management objectives. Consistently, this option requires greater attention to determine how it stands against the criteria.

6.1.4 Analysis by Criteria

Table 8 summarizes the policy options for groundwater license exemptions from the case studies and organizes them into a matrix to compare how their measures based on the criteria from Chapter 5.

Table 8 – Analysis of Policy Options for Large Withdrawals

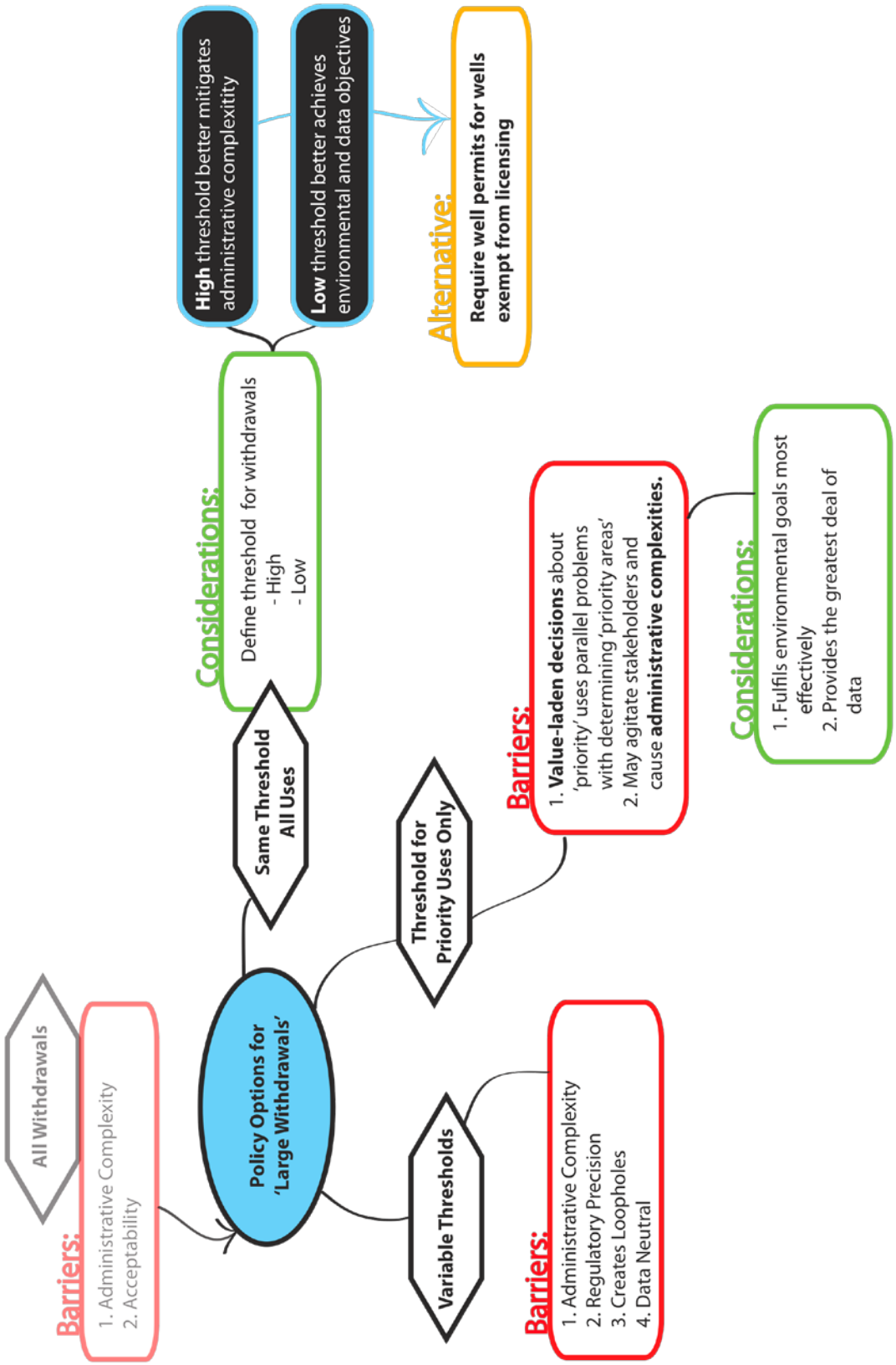
Criterion	Definition	Threshold for Priority Uses	Variable Thresholds	Same Threshold All Uses
Political Feasibility	*Degree to which the policy option satisfies major stakeholders.*	**Indeterminate:** Support from stakeholder groups depends on how the province determines priority uses.	**Highly oppose:** This approach does not provide consistent regulation or security for some groundwater users. It is most likely to miss resource protection targets because of loopholes.	**Somewhat support:** Support from stakeholder groups depends on thresholds.
Administrative Complexity	*Administrative burden on the province.*	**Moderate-High:** Under Alberta's exemption structure, BC would regulate fewer than 8,800 wells. Requires value-laden decisions about priority uses.	**Variable:** Exemptions system may exclude a large number of wells from administrative processing. Communicating the rules to well owners may be complex.	**Variable:** Depends on thresholds.
Effectiveness	*Groundwater regulations align with water conservation goals by promoting the value of groundwater to users and congruence with WAM objectives.*	**Somewhat effective**	**Not effective:** Applies value to some groundwater, but not consistently. May impede other WAM objectives.	**Somewhat effective:** Depends on thresholds.
	The degree to which the policy provides BC with the ability to gather information, monitor water use and, therefore, respond when circumstances change.	**Data Heavy:** Of the options, provides the most comprehensive data set for the province, as this policy applies to the greatest number of wells.	**Data Neutral:** Provides groundwater data, but data will reflect inconsistencies in the regulation.	**Data Neutral or Supportive:** Extent of data depends on threshold.
Regulatory precision	*Transparency for water users:* *(1) Does the regulation employ clear exemption thresholds for all users?* *(2) Are the license processes similar for both ground and surface water?*	**Depends on how province designates priority uses.** **No**	**No** **No**	**Yes** **Yes**
	Appropriate licensing complexity for water users	Application same as surface water and only applies to non-exempt users.	Application only applies to non-exempt users.	Application only applies to non-exempt users.

As evident in the above chart, the **'variable thresholds'** option based on the Oregon groundwater allocation model does not consistently fulfil criteria for groundwater licensing regulations. The '**thresholds for priority uses**' policy option introduces a value-laden discussion about 'priority' uses. Although this policy option reduces the number of wells to retroactively regulate somewhat, by excluding wells for 'priority uses,' all wells for other uses are subject to licensing and must therefore be processed. This policy option is the most effective at achieving provincial water management goals, and provides the most comprehensive set of data. Clearly the '**same threshold all uses'** policy option depends on where the province draws the threshold for groundwater mandatory licensing. The thresholds for exemptions have a significant effect on the ranking of this policy option according to criteria.

6.2 'Large withdrawals' Decision-Making Framework

The 'large withdrawals' decision chart (Figure 6) is an extension of the diagnostic chart I developed in Chapter 4, which suggested that BC focus on regulating large withdrawals. It highlights some of the barriers and considerations affiliated with the proposed policy options for defining groundwater regulation exemptions.

Figure 6 – Large Withdrawals Decision-Making Framework



Based on analysis, the ‘variable threshold’ option does not hold up well in the analysis and the two policy options for further consideration are ‘same threshold for all uses’ and ‘threshold for priority uses only’ and each have their relative merits. Because of the barriers associated with ‘variable thresholds’ and ‘thresholds for priority uses only,’ the additional considerations regarding well permitting are best applied to the licensing option that applies the ‘same threshold to all uses.’

Determination of ‘priority uses’ requires an administrative process for making value-laden decisions with stakeholders. Priority uses may vary by basin, depending on local or regional stakeholders. Once the province determines high level criteria for ‘priority uses,’ the devil is certainly in the details. For example, many jurisdictions consider agricultural users to be higher priority than other water uses such as industry. The regulator may decide to let priority date licenses provide legal guidance within the agricultural sector. However, water users in priority areas may eventually ask: ‘Within the agricultural sector, which users get higher priority?’ and value decision-making could spiral into a legal quagmire. British Columbia is not prepared to pay deliberate attention to clearly defining ‘priority’ and creating a neutral, equitable process for identifying ‘priority uses’ at this stage because of data gaps and provincial water governance structure is in flux. The province’s process for identifying water ‘priorities’ depends heavily on the decisions the province makes about water governance.

The most practical approach given BC’s current status is to develop groundwater licensing regulations that apply the same threshold for exemptions to all groundwater uses. To implement a ‘same threshold for all uses’ licensing policy, the province must determine an appropriately high or low extraction threshold. Additionally, analysis

suggests that water licensing alone is not sufficient to meet BC's environmental and data collection needs. The next section addresses well permits and how they can be applied to improve the 'same thresholds for all uses' policy option and mitigate some of the barriers presented by the options.

6.3 Utilizing Well Permits

In the decision tree, I suggest well permitting as an alternative or supplementary strategy to groundwater licensing. Well permits can collect well data for licence-exempt groundwater users and fulfil data collection objectives, while mitigating administrative complexity and monitoring for exemptions problems. Well permits improve the policy's effectiveness by increases the amount of data available to the province, enabling BC to improve groundwater allocation policy by providing more thorough information. Permits can be integrated into the licensing process as a part of the license application procedure that already exists for surface water users in BC, or developed as a separate step required only for groundwater users. Well permits can apply to all wells, or only wells that will be licensed under provincial regulations. Whether the province decides to employ permits for all wells or only non-exempt wells drives the approach the province will likely take to integrating permits into licensing procedures. Data gaps or inconsistencies may arise for a jurisdiction if it processes well permit data from exempt and non-exempt wells differently.

6.3.1 Option: Well drilling permits for non-exempt wells only.

Where permits only apply for wells that require licenses – non-exempt wells – the permitting process can be part of water license application to reduce the number of steps applicants must complete to acquire a water-use right for groundwater. This is a current proposal for BC (Mike Wei, 2011). Requiring well drilling permits only for wells eligible for water-use license can reduce administrative complexity for the province because it reduces the overall number of permit applications that the government must process. However, this approach can be problematic because it does not substantially increase the amount of information the government collects about wells in the province.

Until very recently, Oregon did not require owners of new wells to notify the Water Resources Development prior to drilling and the oversight contributed to an exemptions problem in that jurisdiction, where legislation allows a number of exempt well uses (Jarvis, 2011). The state did not have sufficient information to anticipate the impact of exempt users on the water table in some urbanizing areas in post-agricultural regions. When exempt uses reached a critical mass in some areas, due to an influx of subdivisions, the Water Resources Department had a limited capacity to respond rapidly to increasing water shortage.

6.3.2 Option: Register all wells through well drilling permits.

Water-use license applications for groundwater use in Utah, Colorado, and Alberta included well drilling permits. Well permits are a uniform requirement for all wells – exempt and non-exempt. In these jurisdictions, entities interested in developing a groundwater resource by drilling any well must first apply for a drilling permit from the

regulatory body. After the regulator approves the permit, the applicant must complete well construction within a prescribed time frame. Upon completion, well drillers file a well report to the regulator indicating that they have fulfilled construction requirements specified by the permit and tested water quantity and quality from the well. In these jurisdictions, the well permitting process is separate from the water-use license application because drill permits are required regardless of whether the well will operate at a level exempt from licensing.

Where well permits apply to all wells, the permitting process is separate from the water-use license application and drill permits are required regardless of whether the well will operate at a level exempt from licensing. Well permits for all uses adds another step to the water license application process for non-exempt users. However, employing single, consistent system for all well owners reduces the administrative complexities of communicating different requirements to exempt and non-exempt users.

Mandatory well permitting increases the amount of data that BC collects about water use and the province's ability to respond to new information. After completing well construction and submitting a well report to the regulator, non-exempt users apply for a water-use license though the same procedures as surface water license applicants.

6.3.3 Effect of Well Permitting on Criteria Analysis

Table 9 revisits the criteria for the 'same thresholds for all uses,' given options for well permitting as part of the groundwater regulations, which were explored in the last section.

Table 9 – Effect of Well Permitting Options on 'Same Threshold' Licensing

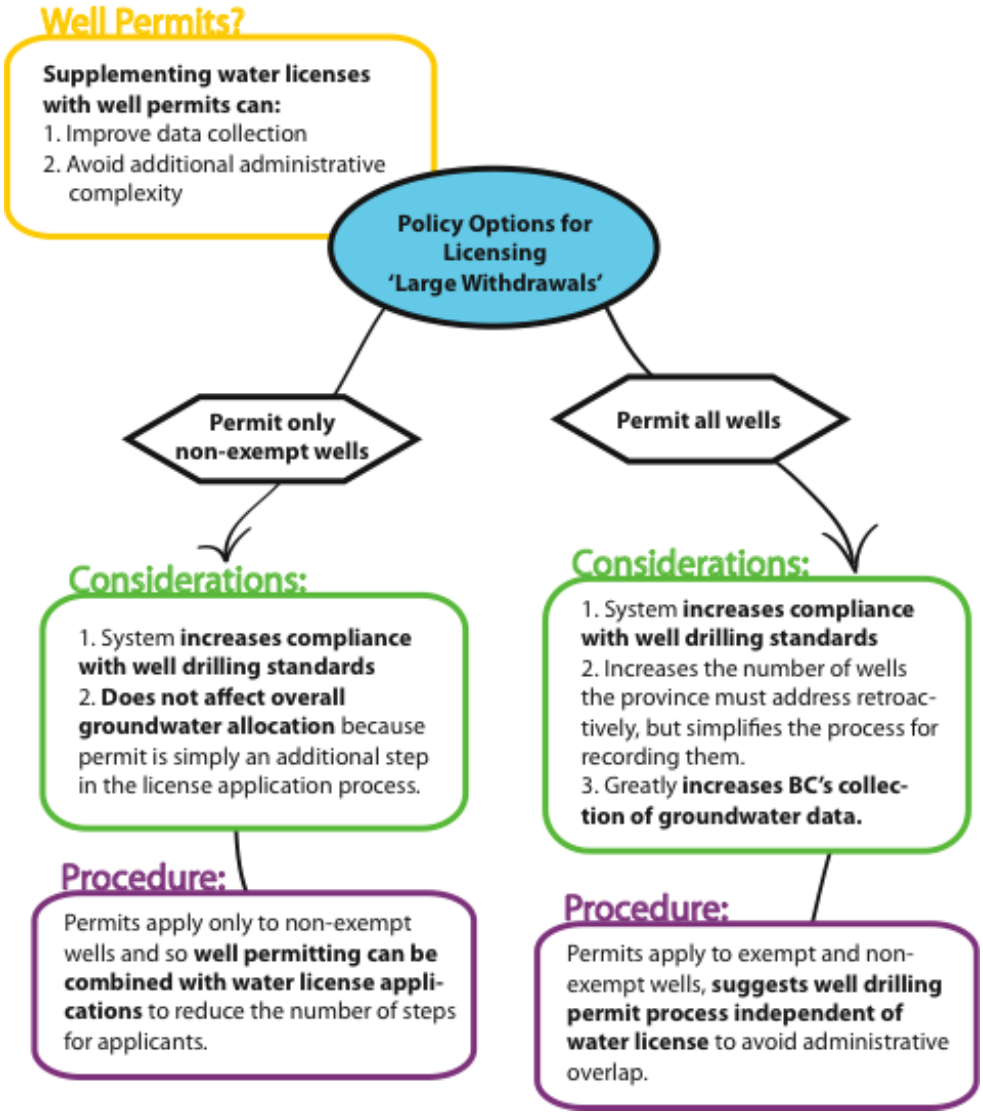
Criterion	***Same thresholds for all uses*** ***(without permitting)***	**Add Permits for All Uses**	**Add Permits for Only Licensable Uses**
Political Feasibility	*Somewhat support:* *Support from stakeholder groups depends on thresholds.*	May increase slightly because permitting uses improves provincial capacity to fulfil environmental commitments. May decrease slightly if communication is poor or implementation process is difficult for current groundwater users.	Does not change
Administrative Complexity	*Variable:* *Depends on thresholds.*	Increases complexity, but does so by a less administratively complex process than licensing all uses.	Does not change
Effectiveness	*Somewhat effective:* *Depends on thresholds.*	Increases. Allows province to better monitor groundwater use, and enables the future use of economic instruments to encourage efficiency and conservation.	Does not change
	Data Supportive: *Extent of data depends on threshold.*	Improves. **Data Heavy**	Does not change
Regulatory precision	*Transparency: Yes* *Complexity: Yes*	All wells, regardless of use or extraction rate, require the same permitting process. Well permitting is an additional step for groundwater license applications	Wells operating at different extraction rates have different requirements. Well permitting is an additional step for groundwater license applications
	Application is the same as surface water licenses, but only applies to non-exempt users.	Additional step for all groundwater users	Additional step for only non-exempt well users.

Analyzing the effect of a well permitting option on a licensing regulation that applies the 'same threshold for all uses' through criteria suggests a number of new considerations. First, by including well permit requirements to all groundwater users, BC can apply a higher or less precise exemption threshold for groundwater users to reduce administrative complexity and increase public acceptability with groundwater licensing. Second, permitting helps diminish the risk of a future problem with exemptions. Building capacity to record and monitor all wells creates a more comprehensive record of groundwater users regardless of whether they are licensed. It helps to achieve provincial sustainability goals for water resources by (1) increasing available groundwater data and (2) communicating the value of groundwater to all groundwater users through registration requirements, even those groundwater users who are exempt from other licensing processes.

6.4 'Well Permits' Decision-Making Framework

The decision-tree, Figure 7 below, highlights some of the dominant benefits of employing well permits, and key considerations for British Columbia to evaluate when moving forward with decisions about groundwater licensing and procedures.

Figure 7 – Well Permit Decision-Making Framework



According to the above decision-making framework, well permitting is most beneficial to BC's overall water allocation scheme if it applies to all (exempt and non-exempt) groundwater users. However, there is inherent value to permitting only non-exempt wells in that well permitting improves compliance with water quality protection regulations.

6.5 BC's Proposed 'Large Withdrawals'

The BC Ministry of Environment proposed maximum exempt extraction rates in the *Water Act* Modernization Discussion Paper, and reiterated in the Policy Direction Paper. Feedback in the Ministry's Report on Engagement suggested that stakeholders generally support regulating all groundwater extraction, except for industrial groundwater users, like the oil and gas industry, who argued in favour of exemptions for non-potable groundwater.

The Ministry proposal included a two-tiered system that regulates withdrawals over 250 m3/day or 500 m3/day from unconsolidated aquifers and 100 m3/day for confined bedrock aquifers. According to the Ministry's Water Sustainability Act Policy Direction paper, groundwater extraction at rates below these proposed thresholds would be exempt from regulation, regardless of intended use (WAM PP, 2010). I analyzed how British Columbia's proposed thresholds for large withdrawals fulfil the policy criteria in Table 10.

Table 10 – Analysis of BC's Proposed 'Large Withdrawal' Thresholds

Criterion	**Definition**	**250 m3/day unconsolidated and 100 m3/day confined**	**500 m3/day unconsolidated and 100 m3/day confined**
Political Feasibility	*Degree to which the policy option satisfies major stakeholders.*	**Somewhat Oppose**	**Somewhat Oppose**
Administrative Complexity	*Administrative burden on the province.*	**Moderate:** Excludes a majority of wells: licenses 5,000 existing	**Moderate:** Excludes a majority of wells: licenses 3,200 existing
Effectiveness	*Groundwater regulations align with water conservation goals by promoting the value of groundwater to users and congruence with WAM objectives.*	**Somewhat effective**	**Somewhat effective**
	The degree to which the policy provides BC with the ability to gather information, monitor water use and, therefore, respond when circumstances change.	**Data Neutral:** Only provides data from the larger groundwater users.	**Data Neutral:** Only provides data from largest groundwater users.
Regulatory precision	*Transparency for water users:* *(1) Does the regulation employ clear exemption thresholds for all users?* *(2) Are the license processes similar for both ground and surface water?*	**No:** Requires each applicant to determine whether the aquifer is unconsolidated or confined bedrock. **Yes**	**No:** Requires each applicant to determine whether the aquifer is unconsolidated or confined bedrock. **Yes**
	Appropriate licensing complexity for water users	Application same as surface water and only applies to non-exempt users.	Application same as surface water and only applies to non-exempt users.

BC's two-tiered approach requires a greater deal of information and is more complex for groundwater users. Applying different thresholds to different types of aquifers will somewhat limit the reduction in administrative complexity on the province. Like focusing on regulations on Priority Areas, a two-tiered approach treats users with different geographic and resource characteristics differently and the approach may be appropriate in the long run. However, in the short term the mechanism creates unnecessary burden on water users and results in complicated regulations that may decrease rates of compliance and increase administrative complexity for the province. Using a two-tiered approach requires each groundwater license applicant to determine whether the aquifer is unconsolidated or confined bedrock, which is likely to require more provincial intervention in the license application process.

If the BC Ministry of Environment sets a low threshold of 100 m3/day for all uses, closer to Colorado's 82 m3/day exemption threshold, then the province must retroactively address 6,600 wells.[18] However, if BC sets a high threshold, such as the 250 or 500 m3/day proposed in the *Water Act* modernization discussion paper, the province would reduce the number of retroactive licenses to 5,000 and 3,200 existing large groundwater users, respectively. High exemption thresholds reduce administrative complexity for the province and increase public acceptability, but they fall short of meeting provincial goals in that they only provide groundwater data from the largest users, and do not apply the same value to groundwater as surface water for other users. The higher threshold still leaves 195,000 and 196,800 unregulated and unregistered groundwater users, respectively.

[18] Calculated by author based on well size projections from WELLS data, assuming approximately 200,000 existing wells in the province.

6.6 Policy Recommendation

Table 11 summarizes BC's proposed approach to groundwater licensing and regulation, and my recommendations based on case studies and criteria analysis.

Table 11 – Comparison of BC Proposed and Recommended Groundwater Regulations

	BC's Proposed Groundwater Extraction	**Recommendations from Research**
Geographic Focus of Regulation	Licence large withdrawals in all areas.	Same – All areas of BC.
Exemptions threshold	Two-tiered system for large withdrawals, with thresholds at 250m3/day or 500 m3/day for unconsolidated aquifers and 100m3/day for confined bedrock aquifers.	Same withdrawal threshold for all uses, province wide. Exemption threshold is negotiable.
Well Permitting	Well permitting for non-exempt wells only.	Well permitting for all wells.

According to case studies and analysis, I suggest that a basic framework for groundwater regulations should be applied province-wide in BC. Based on the province's current barriers with governance and data availability, it makes the most sense to implement groundwater regulations for wells throughout the province rather than focus in 'priority areas.' After the period of public consultation, the BC Ministry of Environment determined that it would be best not to limit groundwater regulation to priority areas. However, given BC's groundwater status quo, the province must exempt some users from licensing

To avoid overwhelming administrative complexity and encourage public acceptance of groundwater regulations, BC will need to establish a threshold for exempt groundwater uses. Based on the case studies and analysis, I argue that BC should begin to implement groundwater regulations with a uniform threshold for 'large withdrawals' for all areas. An optimal definition of 'large withdrawal' thresholds for groundwater may not exist, as it depends on a number of scientific factors that are fraught with uncertainty. There is not likely a "right" answer for an exemption threshold in BC. Supply and demand for groundwater vary regionally, as do the hydrogeologic characteristics of aquifers. Many jurisdictions base exemptions by defining 'small withdrawals' based on calculated generalizations about beneficial use and 'fairness'. For example, Alberta Environment determined that 6250 m3/yr was a reasonable default quantity for traditional agricultural use based on historical use data (Bayegnak, 2011).

In my recommendation, the exemptions threshold is negotiable assuming the province also adopts well permitting and registration for all wells. Low exemption thresholds, such as those employed in Utah and Colorado, are prohibitively administratively complex because they require the province licenses and enforce a greater number of well licenses. High thresholds exempt a greater number of groundwater users, reduce administrative complexity, but also decrease the policy's capacity for achieving data and resource management objectives. Therefore, high thresholds decrease the effectiveness of groundwater regulations to achieve provincial water management goals of encouraging sustainable water use and better promoting the value of all of BC's water resources.

BC's proposed thresholds include a lower extraction threshold for confined bedrock aquifers because they are hydrologically different from unconfined aquifers and have a slower recharge rate. Underground water flow and aquifer recharge rates also vary regionally by basin and sub-basin depending on soil composition and precipitation patterns. BC does not have accurate data about groundwater flows or the connection between ground and surface water stores to choose appropriate thresholds for each basin, and to do so would be prohibitively complicated for groundwater users. BC proposed a two-tiered system for defining 'large withdrawals' that introduces regional variation for groundwater regulations that is more advanced and nuanced that the province should consider at this phase of developing groundwater licensing.

BC stakeholders "expressed concern that, because groundwater and surface water are linked, groundwater thresholds are arbitrary and will likely be abused" without active enforcement (WAM ROE, 2010). This fear relates back to Chapter 4 and the *problem of exemptions*. To avoid the problem of exemptions, other jurisdictions employ well permits. BC's groundwater regulation proposal includes well permitting, but as a part of the water license application process for groundwater users (Wei, 2010) so as to reduce administrative complexity and avoid backlash from rural domestic users. Based on my analysis in Section 6.3.3, this approach has some logistical benefits to the province in terms of reducing administrative complexity and improving water quality. Other jurisdictions require well permitting and registration as a data collection strategy, which is a vehicle for improve groundwater resource management for the future. Permitting only non-exempt wells does not greatly improve BC's collection of groundwater data nor does it expand the province's capacity to improve groundwater regulations in the long-

term. According to my analysis, BC can better collect data in the short term to accomplish long-term objectives for groundwater management by including a process to register and permit wells – regardless of exempt status.

7: CONCLUSIONS

The case studies suggest that groundwater licensing and regulation for all groundwater withdrawals in all areas, such as those approaches assumed by Utah and Australia, would best protect and monitor BC's groundwater resources in the interest of securing future environmental and economic productivity. Thorough regulation also provides the most comprehensive set of data, which would allow BC to monitor groundwater stores and provide opportunity to adapt to changing information. The issue that I analyze in this research is how British Columbia can change from the existing situation where groundwater extraction and use are unregulated to a regulatory environment for groundwater extraction. We have two ways to do that: (1) shift from a situation where there is no regulation of groundwater to one that regulates all extraction, or (2) to develop an approach that incrementally introduces more aggressive groundwater regulations step-by-step.

Because BC is moving from a state where there is no licensing or regulation of groundwater, I developed decision-making frameworks and explored options that move toward the goal of regulating groundwater with the lowest costs for the province for the short term (assuming a broad definition of 'cost' that includes factors such as political and public support.) The decision-making frameworks do not provide firm conclusions with regard to groundwater licensing and permitting for BC. Instead, they focus attention on barriers inherent in BC's groundwater status quo that are important when BC decision-makers consider options for groundwater licensing and regulation in the

province. By focusing on current barriers, the frameworks also suggest first-steps for BC to consider, as well as next steps to manage limited groundwater stocks for the future.

The absence of data is a significant gap in the Ministry of Environment's efforts to understand and management groundwater. Data collection is a high priority that helps develop effective long-term solutions. Given the context in British Columbia and practices in other jurisdictions, the smartest strategy to move from no regulations to some regulations is to begin establishing a set of baseline data for the province through well registration and permitting for all wells. To focus on data collection in the short term, BC could limit administrative complexity by limiting licensing to the largest groundwater users and allow most users to remain exempt from licenses in the short term. The BC Ministry of Environment could consider well permitting for all groundwater uses and licensing for the largest users as the short-term goal.

Short Term Policy Implementation Considerations

In BC, it makes sense to begin introducing groundwater regulations for the largest groundwater users first. Under current legislation, water users that rely on surface water pay the province for the right to use water as part of the water licensing, whereas large-scale groundwater users do not include water fees in their annual budget calculations. The largest groundwater users have the greatest overall impact on water supply because they draw the most 'free' groundwater, are easiest to identify and are typically subject to other Ministry of Environment regulations so they have a standing relationship with the Ministry as a regulator. Most of the largest groundwater users in BC are commercial enterprises that financially benefit from groundwater use, such as pulp mills, large-scale

irrigators, ski resorts and fish hatcheries. Initiating groundwater regulations for the largest users first targets groundwater users who have benefitted from a competitive advantage over similar surface water users due to reduced costs. Table 12 illustrates the characteristics of large groundwater users.

Table 12 – Largest Well Users in BC

Well Size (Extraction Rate)	**100 to 500 m3/day**	**500 to 1000 m3/day**	**1000 to 2500 m3/day**	**> 2500 m3/day**
Type of Use	Mid-sized water supply systems such as large mobile home parks, motels, communities with hundreds of residents, schools, parks, and farms, ranches or golf courses.	Medium to large-sized waters supply systems such as small towns, schools, parks, farms, ranches, golf courses and ski resorts.	Large water supply systems such as towns with thousands of residents, fish hatcheries, farms and ranches, nurseries, ski resorts and industries like gravel pits.	Large water supply systems such as cities with thousands to tens of thousands of residents, pulp mills, fish hatcheries, large farms and ranches.
Approximate proportion of BC wells	1.7%	0.5%	0.5%	0.5%

Source: MOE, 2011a

An alternative strategy for rolling out new regulations would be to focus specifically on commercial groundwater users, which may exempt some larger groundwater users like municipalities from the regulation. Focusing regulations on commercial enterprises closes the competitive advantage that groundwater users currently have over surface water users in BC and applies a charge for groundwater users who profit from unpriced and unregulated groundwater resources. Defining ‘commercial’ users may also present a set of complications. Municipalities that depend on groundwater, for example, supply both non-commercial water users and commercial water users.

However, under the current *Water Act*, municipalities that use surface water supplies are subject to water licensing under the FITFIR system.

As BC determines how specifically to define 'large' or 'commercial' users, the province should make a concentrated effort to explore what different options mean for groundwater users on the local level. Although there is no optimal or 'best' definition for 'large withdrawals' in BC, there are ramifications with regard to horizontal and financial equity among groundwater users. Wherever the line is drawn, some groundwater users are above that line and will be subject to licensing requirements while those below are exempt, and there may be very little difference between the two groups.

Next Steps in Groundwater Regulation

Clearly communicating the long-term intentions for groundwater resource management is an important consideration in the roll-out strategy for implementing new regulations. When a jurisdiction introduces regulation it seems typical to assume there will be push back from the stakeholders who will be regulated under the legislation. However, based on the *Water Act* modernization feedback, the majority of stakeholder groups who would be affected by groundwater regulations support regulation as long as the policy and policy development process is transparent and there is a recognition of the equity concerns inherent in new groundwater allocation legislation (WAM ROE, 2010). Many users, particularly commercial users, benefit from groundwater licensing because licenses guarantee secure rights and a legal procedure for addressing water shortages. Groundwater users express concerns that regulations will not be transparent, clearly

communicated by the province and, as a result, may increase uncertainty for businesses in the future (WAM ROE, 2010).

BC's Living Water Smart suggests that the province focus on regulating large groundwater withdrawals in priority areas. This objective is one of few clear goals for groundwater management in BC, and it is not fully clear whether the Living Water Smart proposal is a first step for groundwater regulation or a long-term endpoint. Since there were not clear long-term goals specific to groundwater in BC, I inferred long-term goals from the province's long-term management goals for water. However, the province of British Columbia has not yet developed a clear long-term vision for the province's groundwater resources as part of its overall water management strategy. Figuring out that endpoint and including it communications regarding new groundwater regulations should become a priority for the Ministry of Environment's future planning process.[19]

Although focusing regulations on priority areas is not an optimal focus for provincial groundwater regulations in this report, some areas in BC will require more aggressive groundwater licensing because water resources are scarce. In regions that struggle with incongruence between water supply and demand, conflict already exists between groundwater and surface water users that must be addressed expediently. These regions are a high priority and require a jurisdiction to develop more aggressive water management strategies for groundwater. Interviews with practitioners in other jurisdictions suggested including some flexibility for place-based management in groundwater regulations (Bayegnak, 2011; Woodcock, 2011). Options for introducing

[19] Other jurisdictions have eased the burden of long-term groundwater management planning by integrating groundwater and surface water in legislative definitions and applying regulations to both equally. In BC, the *Water Act* already applies to ground and surface water except in regard to water allocation regulations.

stronger regulatory mechanisms in priority areas of BC during the short term are an area for further research.

The province of British Columbia has data for surface water supply and demand to identify priority areas for management of surface water; priority areas for surface water provide a good start for determining where BC's groundwater resources are vulnerable. However, underground aquifers do not always exist within the same boundaries of surface water basins and often overlap both basins and jurisdictions. Until BC increases its collection of groundwater supply and demand data, the province will struggle to effectively and accurately identify priority areas for groundwater management and employ appropriate strategies for licensing and regulating the resource.

The regional Water Management Planning approach employed by Alberta Environment is a method that BC could employ to determine priority areas in regions where comprehensive data is unavailable. Alberta's approach that uses 'Approved' Water Management Plan to determine 'priority areas' may be most applicable to the BC context, given similarities in governance structure and available data about water use. In Alberta's local level planning process, stakeholders analyze the local situation and decide whether to submit their water use plan for approval from the Lieutenant Governor to make adherence compulsory. British Columbia has already enabled local governments to initiate a similar planning process on the local level. Areas that are prone to seasonal or chronic water scarcity have developed Water Use Management Plans. Rather than struggling to define criteria and collect measures from around the province to determine priority areas, BC could encourage local stakeholders to self-identify areas of concern by submitting Water Use Plans (WUPs) for formal approval from the Ministry of

Environment and the Lieutenant Governor. Similar to Alberta, local WUPs could include policies that override appurtenance in areas closed to new licenses. These suggestions illustrate the steps British Columbia could take now to move toward comprehensive management of its groundwater resources.

APPENDIX – CASE STUDIES

My capstone research examines how British Columbia can change from the existing situation where groundwater extraction and use are unregulated to a different situation where groundwater extraction is regulated. This is an extremely complex process that, in its totality, is beyond the scope of my work. In British Columbia, provincial legislation and approaches to governance establish a background for policy options to regulation groundwater extraction and use. The case studies suggest that this is also the case for other jurisdictions; groundwater regulatory design takes place as part of a complex framework for water management. It is difficult to entirely separate approaches to groundwater regulation from other factors that affect water allocation such as natural resource law, water governance structure and legislative history. Therefore, these factors are relevant to consider when comparing the approaches different jurisdictions take toward groundwater allocation, 'priority area' designation and, to a lesser extent, 'large withdrawal' definitions.

To limit the impact of external factors on final policy options for groundwater regulation, I chose to explore cases from western Canada and the western United States similar to the British Columbia in that they share aspects of political, historical and geographic background. After a review of possible cases that met the characteristics, I focused my research on Alberta, Oregon, Utah and Colorado. The case studies from Alberta and Oregon seemed to correlate most directly with British Columbia's circumstances. I focused on these two jurisdictions in greater detail and targeted my primary research – interviewing key informants – on better understanding the strategies these jurisdictions have used to manage groundwater allocation, including successes and challenges with their approaches.

For each case study, I provide a brief overview of geographic characteristics of each jurisdiction, and review the primary characteristics of their approach to groundwater allocation and subtle differences. Important factors that I looked at in greater detail included:

1. Governance
2. Application processes to acquire water-use rights, for surface and groundwater sources
3. Exemptions from regulation (large withdrawals)
4. Approach to areas in the jurisdiction with less water (priority areas)
5. Transferability of water-use rights

The cases as they pertain to functional approaches to defining 'large withdrawals' and 'priority areas' are covered in detail in my capstone. Appendix A provides an overview of other factors that affect how a jurisdiction manages groundwater allocation.

Oregon, United States

Oregon's geography is very similar to that in British Columbia. The coastal regions, west of the Cascade Range, and the mountains collect the majority of the precipitation leaving the eastern part of the state much drier (CSES, 2011). Oregon's major industries have historically been based on natural resources such as timber, paper products, farming and mining, however the state's economy is now diversified to include computer equipment and electronics (Pearson, 2011b).

In Oregon, a Water Resource Commission is an overseeing body that establishes state water policies and guiding principles for the state Water Resources Department (Hecox, 2001). The Water Resources Department is responsible for implementing policy regarding surface and groundwater stores, as well as adopting and enforcing rules that protect groundwater and govern the construction or maintenance of wells. The Water Resource Commission has the power under law to classify beneficial uses of water, to prioritize water uses for the highest and best use, and to

restrict uses and quantities of use. For example, the Water Resource Commission could declare recreation and preservation of wildlife or fish the best beneficial use for water in an area, giving water use for this purpose greater priority than other uses in an area. Groundwater use in these areas is affected if the use of the groundwater for other purposes would measurably reduce surface water flows needed for fish and wildlife. This is an important power that affects the type of management tools that Oregon employs in areas where water supply is incongruent with demand.

Under Oregon law, groundwater is generally defined as part of the state's public waters that must be appropriated by the same process as surface water (Oregon Water Resources Department, 2001). To use water from any source, parties must obtain a permit from the Water Resources Department. The Department examines applications for groundwater use for interference with nearby existing wells and surface water, gives the application a tentative priority date, and then distributes it for public comment (Hecox, 2001). The public notice provides other water license holders the opportunity to object to the development. If someone protests the application, the Water Resources Department may hold a public hearing before deciding whether to approve a Final Order to develop the water resource. To develop a groundwater resource, applicants will drill a well and install a pump. An approved Final Order does not constitute a right to withdraw water from the well, only the right to drill the well (Oregon Water Resources Department, 2001). After the well is drilled, a certified water rights examiner from the Water Resources Department inspects the construction and tests the well to confirm water quantity and quality. If the inspection is successful, the Department grants a certificate of water right that authorizes extraction.

However, Oregon law contains some definitions that create irregularities in groundwater management. For example, the definition of 'well' does not include a hole drilled for the purpose of either prospecting, exploration or production of oil or gas, prospecting or exploration for

geothermal resources, production of geothermal resources derived from a depth of greater than 2,000 feet or exploration for minerals (Bryner, 2003). In British Columbia, oil and gas water users are similarly exempt from some surface water licenses processes under the *Oil and Gas Activities Act,* which allows the Ministry of Oil, Gas and Mining to approve short-term water licenses for exploration and mining processes without approval of the Ministry of Environment. This is a loophole being addressed by *Water Act* modernization; the new Water Sustainability Act should, in theory, supplant or take precedence over any other legislation that affects water allocation in the province.

Oregon exempts many uses from the normal water permitting process. Stockwatering and industrial or commercial uses below 5,000 gallons per day are exempt, as is single- or group-domestic use less than 15,000 gallons per year and some non-commercial lawn-watering or school ground use (Oregon Water Resources Department, 2001). Oregon's exemption threshold for domestic use is fairly high compared to domestic use exemptions in other jurisdictions, perhaps because it also applies to group-domestic wells. Exemptions are limited to the amount necessary for beneficial use and apply only in areas where there is no evidence of over-allocation. In Oregon, exempt uses are 'stackable,' meaning a single well user may legally operate several exempt wells for different beneficial uses. For example, an individual may have an exempt domestic use well extracting up to 10,000 gallons/year and an exempt stockwatering well extracting 4,000 gallons/year operating on the same property (Woodcock, 2011); this is important because it potentially allows a single user to extract large quantities of water without applying for a water-use right. If necessary, the Water Resources Department has the authority to regulate exempted uses with priority dates (Bryner, 2003). Recently, in 2009, Oregon began requiring owners of new exempt wells to file their exempt use with the Water Resources Department. The exempt well registration process requires owners to submit a map of the well and a one-time fee that funds the Departments processes for evaluating and monitoring groundwater supplies (Bracken, 2010; Woodcock, 2011).

On the regional level, the Water Resources Department establishes basin programs in which all the land area, surface water bodies, aquifers, and tributaries that drain into a major river are managed together. Basin-level planning helps to organize and monitor actual water use and availability and basin programs are in place for all but two of the state's 20 major river basins (Bryner, 2003). Under the basin program, the Water Resources Department can employ several management tools for water allocation:

1) Classification of water – the WRD can propose and enforce limitations on the type of uses considered beneficial for a basin, effectively shutting out new applications for groundwater uses that would extract water at high rates. This tool affects businesses and other large users seeking to develop a new appropriation in the region, but not applicants for small uses like domestic wells.
2) Withdrawal of new appropriations – closes a basin to new appropriations where necessary to assure sustained supplies for existing water users and to protect important natural resources, which affects all individuals seeking to develop any sized appropriation in the region.
3) Serious Water Management Problem Areas – establishes mandatory measuring and reporting of actual water use, which does not directly impact water consumption but helps the regulator get a better picture of water supply and demand concerns in the region.
4) Critical Groundwater Areas – Designating an area as 'Critical' affects new and existing water license holders in ways described in greater detail below. (Woodcock, 2011)

Some regions have reached or surpassed full allocation in Oregon. When groundwater use exceeds the aquifer recharge rate, the Water Resources Department declares the region a "Critical Groundwater Area" and restricts water use and allocation in that area. Establishing Critical Groundwater Areas is a highly resource-intensive process, as it may likely affect the legal water-use rights in existing licenses (Woodcock, 2011). In Oregon's Critical Groundwater Areas, as in Utah, a priority-of-use system may override FITFIR allocation (Hecox, 2001). The priority-of-use system favours high-priority water needs (such as drinking water and agricultural use) over lower-priority uses in the region. The Water Resources Department must provide a process for adjudicating priority water rights as part of designating Critical Areas. The Oregon Water

Resources Department decrees a Critical Groundwater area in extreme cases where other water management tools have failed to mitigate challenges with water shortage in a region.

Oregon water allocation includes appurtenance, however, groundwater licenses can be unbundled from land-ownership and traded through an application of change of use (Oregon Water Resources Department, 2001). The application process for transfer of water rights is in place to monitor whether change of ownership will negatively impact water quality or other users in the basin. Transfers enable the use of water markets in Oregon. License transfer can be temporary to respond to water scarcity in a basin, or they can be permanent. In Oregon's water markets, licenses can be bought and sold. Legally no profit can be made directly through water markets, but this policy is not strictly enforced (Hecox, 2001).

Alberta, Canada

The Albertan example is highly applicable to the BC context. Alberta has similar governance structure and shares a border with BC. Additionally, Alberta Environment and BC have the benefit of a similar level of scientific information about groundwater resources in the province. Aquifers in both provinces are partially surveyed, mapped, measured and evaluated for vulnerabilities, although both jurisdictions have placed greater emphasis on collecting aquifer data for areas with known water supply issues. Like BC, Alberta's water resources are distributed unevenly throughout the province. The majority of water resources are in the northern area, while ninety percent of Canadians live in the south along the border with the United States. The Rocky Mountains in the western area of the province cast a "rain shadow" over much of Alberta. As the moist air from the Pacific Ocean rises to pass over the mountains on its way to Alberta, it is cooled, and rain or snow fall on the Pacific side of the mountains. As the air descends on the plains of Alberta, it gains heat and produces warm, dry winds (Alberta, 2011a). Major industries

in Alberta are energy (oil and gas), manufacturing (agri-food and beverage, petroleum products and advanced technologies), and construction. Alberta's driest areas are located in the south-central areas of the province, namely the South Saskatchewan River Basin, which is also a major agricultural and industrial hub (Alberta, 2011b).

Alberta's water governance is similar to British Columbia's and is determined to some extent by the constitutional separation of national and provincial powers outlined in Sections 81 and 82 of the *Canadian Constitution Act of 1867*. Provinces take the primary role in determining water allocation policy for the province and have the authority to empower local governments to execute certain aspects of water management. In Alberta, the province maintains ownership of water resources in the public trust and is ultimately accountable to the public for water allocation decision-making and implementation. Alberta Environment is the lead agency responsible for water allocation, although the Ministry has established partnerships with municipalities and non-government actors to aid in developing water policy.

Alberta Environment's policy is that all waters underground that directly influence surface flows are considered surface water (Ohrn, 2010); this approach acknowledges significant hydrological interaction between ground and surface water stocks and is similar to the approach taken in Colorado. The majority (97 percent) of water licensed in Alberta is from surface water sources but groundwater is an important source for individual domestic water supplies in rural areas (Alberta Environment, 2010). Alberta's Water Act requires a license to divert and use both surface and groundwater.

In 1999, Alberta underwent a process to modernizing its water allocation and management policy similar to BC's Water Act modernization. At the time, a new *Water Act* replaced Alberta's long-standing *Water Resources Act*; the new act enabled mechanisms for water management planning and options for increasing water-use efficiency in the province. Under Alberta's *Water Act*, groundwater and surface water are subject to a similar application process.

As in other jurisdictions, Alberta Environment requires an application to drill water wells prior to drilling. After an application for water license has been submitted, Alberta Environment may issue a final license or a preliminary certificate similar to Oregon's Final Order. The preliminary certificate is a "promised" water allocation but does not authorize any activity or diversion until the conditions of the application have been approved and a license is issued. License applications for some areas and some uses require additional information. In areas at risk for scarcity, applications for groundwater extraction require hydrological analysis for water availability. Applications to use water for oilfield injection and natural gas extraction must submit additional information with their application under the Groundwater Allocation Policy for Oilfield Injections. Oilfield injection and natural gas extraction processes use water to increase underground pressure and release the resources, which can have negative environmental impacts on groundwater stores.

As in Colorado and Oregon, Alberta Environment's licensing system includes exemptions for some groundwater use. Alberta does not require licenses for traditional agricultural use, such as stock-watering, less than 6,250 cubic meters per year or fire fighting. According to Groundwater Policy Specialist Guy Bayegnak at Alberta Environment, exemptions threshold for traditional agricultural uses were introduced in part to accommodate water uses that people were withdrawing for agricultural use pre-1999 under Alberta's Water Resources Act (Bayegnak, 2011). When Alberta's new *Water Act* was enacted, the province wanted to guarantee rights for traditional users. Well-owners able to prove beneficial use for quantity at that time were licensed with priority dates for that quantity. Alberta Environment determined that 6250 m3/yr was a reasonable default quantity for traditional agricultural use based on historical use data. Groundwater for domestic use up to 1,250 m3/year per household is also exempt from licensing in Alberta. Domestic users who require more than 1250 m3/year require a license. Domestic use

is the highest priority use in Alberta regardless of whether the user has a license with priority date; it is followed by water for agricultural use.

All wells in Alberta are registered with the province because driller submits a record of completion of the wells. Registration allows the Alberta to map wells and model groundwater use. However, Alberta does not have a centralized information system that combines the list of allocated resources with estimated available resources, or that can map the effect of individual wells on the water table.

Bayegnak reiterated that groundwater is easy to over-allocate because groundwater is underground and is therefore harder to measure and monitor than surface water. Alberta does not require unlicensed users to have metered wells that record how much water is withdrawn and when, so exempt groundwater uses affect the accuracy of Alberta's projects for water supply and demand (Bayegnak, 2011). Additionally, it is sometimes the case that owners of exempt wells do not report when the wells retired. Domestic users and other small license holders are not required to report water use to the province but large users must annually report how much water they have diverted, consumed and returned to the stream flow (Alberta Environment, 2010). Alberta allocates groundwater licenses one at a time for each basin to avoid over-allocation, according to Bayegnak, and the Ministry tests groundwater quantity and quantity in aquifers before and after each well is activated. Otherwise, the application process for groundwater licenses is consistent with surface water licensing in the province.

At-risk areas of Alberta have undergone substantial water use management planning to manage water scarcity. Like BC, Alberta's *Water Act* enables regional and local governments to create Water Management Plans. The process for developing Water Management Plans is heavily legislated in the Alberta's *Water Act.* Local stakeholders initiate the planning process by alerting Regional Water Managers at Alberta Environment in response to indicators of present or future water scarcity, which include decreasing well levels or surface water flows and an increased

incidence of conflict among water users. Regional Alberta Environment staff and local stakeholders work together to create the watershed-level plans. The plans typically include water conservation and storage objectives as well as a framework for restricting allocation during periods of scarcity. Regulators must consider the principles of a Water Management Plan when making decisions, but are not required to adhere. Under Alberta law, stakeholders also have the option of developing compulsory 'Approved' Water Management Plans, which are endorsed by the Lieutenant Governor. Where Approved Water Management Plans are in place, decision-makers must adhere to the regional water management objective Regulators must adhere to objectives of Approved Water Management Plans. Alberta's South Saskatchewan River Basin (SSRB) is the primary example of an Approved Water Management Plan.

The SSRB Approved Plan began as a regional exercise to address irrigation limits in the SSRB in 2000 that evolved into the process for developing a broad management plan for the region (Ohrn, 2008). Local stakeholders struggling with irrigation limits in the over-allocated basin initiated the planning process, but when larger water allocation issues in the region became clear, a steering committee of senior managers from multiple Ministries (Environment; Sustainable Resource Development; Agriculture Food and Rural Development) took the lead developing the plan (Ohrn, 2008). The most significant outcome of that plan was that the province severely limited the allocation of any new water-use rights in the region. Only applications from First Nations, or applications for conservation and storage purposes that increase overall water supply are eligible for new water-use rights. It was the first time Alberta had closed a basin to new licenses and the SSRB is a region where agricultural development and population are projected to increase, so closing the basin to new water licenses was something of a shock to water users in the Basin (Ohrn, 2008). Approved Water Management Plans enable the regional decision-makers to restrict any new licenses in the priority area and relax traditional appurtenance to allow trading of water-use rights.

In Alberta, water rights are traditionally permanently appurtenant to land. The Cabinet-approved Water Management Plan in the SSRB enables water allocation transfer; all or part of a water allocation can be severed from the original property and relocated to a new property, without sacrificing the priority date on the license (Ohrn, 2008). To transfer appurtenance to a new property, Alberta Environment reviews transfer applications to ensure that relocated the water right will not adversely affect the environment or other water users. Alberta's water trading system in the SSRB explicitly integrates ecosystem preservation. Alberta Environment is entitled to withhold up to ten percent of a water transfer and preserve the water for in-stream flow to achieve ecosystem protection objectives (Nowlan, 2005).

Alberta is investigating options for improve its water allocation system to improve efficiency. Alberta's Water for Life water strategy includes objectives for introducing economic instruments such as water pricing or water-license trading in markets. Opportunities to transfer appurtenance are the foundation of many economic instruments that other jurisdictions have employed to increase efficiency. These features, already employed in Australian and many western-US jurisdictions, and are also under consideration in BC's Water Act modernization.

Colorado, United States

Colorado's mountainous geography is similar to some parts BC and Oregon, but the inland state and sits at a higher overall elevation that its coastal counterparts. Most of Colorado's mountain regions feature a cool but variable climate, which is fairly dry compared to the moist coastal mountains in BC. The orientation of mountain ranges and valleys affects weather of local areas significantly, and the temperature can shift dramatically between night and day (Doesken, 2003). In general, the peaks in the western and central part of the state capture the lion's share of the precipitation moving across the state from the west. This leaves drier, desert-like areas in the

eastern and southern parts of the state. Colorado's economy has historically been based on agriculture and mining, but is now diversified to include service industries and a manufacturing base (Pearson, 2011a). The primary manufacturers are food products, printing and publishing, machinery, and electrical instruments. The farm industry, which is primarily concentrated in livestock, is also an important element of the state's economy. Colorado is a destination for tourists due to world-class skiing and stunning scenery. The state is also a communication and transportation hub for the Rocky Mountain region.

Colorado law declares that groundwater is part of the state water supply and is assumed to be a tributary to surface streams unless rigorous process proves otherwise (Hecox, 2001). As a result, surface water and groundwater are managed concurrently. The Colorado Water Resources Department develops and implements a water policy for the state, but is not solely responsible for issuing water rights. Colorado employs a system of water courts at the basin level to manage water use rights. Water courts in the basin where the water extraction point is located process both surface water and groundwater applications. A water judge receives applications for water resource development and use rights in each of the seven major river basins in Colorado. Groundwater is subject to additional state-wide management.

The State Engineer, head of the Water Resources Department, issues permits to drill wells and divert groundwater and must be consulted before applications can be submitted to the water court. Once the State Engineer issues a well permit, an application can be submitted to the water court where all applications follow the same process. Attorneys facilitate processing applications through the courts. Upon submission to the court, the judge grants a tentative priority date. Attorneys and the water judge review the application and subject it to a public notice process. In Colorado, the judge at the water court grants or denies the water right based upon factual issues from the application and the public notice period, as well as relevant precedent

from statutory and case law. Approved applications for water rights are called "decreed water rights" (Hecox, 2001).

Small wells that pump less than 15 gallons per minute are exempt from application through the water court, but still require a well permit from the State Engineer. Exemptions in Colorado follows a policy that the state's exemptions to groundwater allocation laws is "intended to allow citizens to obtain water supply in less densely populated areas for in-house and domestic animal uses where other water supplies are not available" (Bracken, 2010). In Colorado, eligibility for exemption depends on:

1) The location of the well;
2) The date well production begins;
3) The rate of withdrawal;
4) The beneficial uses to which well water is put;
5) For new wells, the size of the lot to be serviced by the well; and often,
6) The legal process by which that lot was created.

The State Engineer evaluates applications for well permits for these criteria before issuing a permit for the well and an exemption. Exempting small use wells from licensing the water court process increases administrative efficiency, but the State Engineer is notified of all groundwater extraction by requiring well permits and is better able to monitor overall groundwater use in a basin with a fair degree of accuracy (State of Colorado, 2008). The exemption criteria do not apply to "designated ground water basins," as these locations are subject to other regulations, explored further below. Colorado also prohibits exempt wells when the municipality or water district could provide water to the property (Bracken, 2010). In all remaining areas, the exemptions apply.

Well data from the State Engineer informs the Colorado Groundwater Commission, which is the agency responsible for identifying areas where groundwater supplies have been heavily depleted and water supply is a concern. In these areas, the Commission has the authority to form Groundwater Management Districts to preserve groundwater stocks and protect vested

water rights. Groundwater Management Districts are authorized to adopt and enforce additional regulations to help administer groundwater within the district. Additional regulations typically restrict the number of new well permits and limit new water allocations in the region (Colorado Division of Water Resources, 2010).

In Colorado, water rights are real property and not appurtenant to land. Water rights can be transferred by a Change of Water Rights application to the Water Court that requires evidence that the change of license causes no harm to other vested water rights. Because water rights are real property, licensees in Colorado have naturally used markets for the buying and selling of water use rights for some times. The water courts and State Engineer's Office do not record data on water markets or prices, so prices and profits from water markets are somewhat difficult to uncover. Like other market goods, prices vary from sale to sale and are affected by a bundle of characteristics of the water right (e.g. by the seniority of the right, proximity to buyer, water quality, costs of physical transfer, and level of legal opposition by other water users) (Howe, 2003).

Utah, United States

The state of Utah is much drier than BC, but Utah is distinct among western states in that it has the most comprehensive approach to regulating groundwater resources. The wetter areas of the state occur in the mountainous central regions and the northeast, with arid regions in the west and southern portion of the state (Pearson, 2011c). Utah is rich in natural resources and its traditional industries of agriculture and mining are complemented by increased tourism and growing aerospace, biomedical, and computer-related businesses (Pearson, 2011c). Agriculture in Utah depends heavily on irrigation practices.

Surface water and groundwater appropriation are treated identically under Utah law, except for slight adjustments in the criteria to review water license applications so that application approval appropriately considers subtle differences in state objectives for ground or surface water. Whether above or under ground, all Utah waters are public property and are administered by the Utah Department of Natural Resources on behalf of the public. The State Engineer is the head officer in the Division of Water Rights of the Utah Department of Natural Resources, and is responsible for the administration of water rights including the appropriation, distribution, and management of the state's surface and groundwater. This office has broad discretionary powers to implement the duties required by the office.

Utah has no exempt water uses so there is no separate permitting process for 'exempt use' wells (Bryner, 2003). Anyone seeking to drill a well must apply to the State Engineer for a new water-use right or buy an existing right and apply to the State Engineer to transfer appurtenance; the State Supreme Court has consistently upheld that there are no exceptions to this rule. After receiving an application, the State Engineer publishes a notice for public comment on well applications and subjects the application to a thorough investigation. The Department of Natural Resources approves applications if, at the discretion of the State Engineer:

1. There is unappropriated water in the proposed source;
2. The proposed use will not impair existing rights or interfere with a more beneficial use of the water;
3. The proposed plan is physically and economically feasible and would not prove detrimental to the public welfare;
4. The applicant has the financial ability to complete the proposed works; and
5. The application was filed in good faith and not for the purposes of speculation or monopoly.

When the State Engineer approves permits, the office also assigns a date by which water must be put to beneficial use. The Engineer may offer extensions up to fifty years if the developer shows reasonable cause for delay and public agencies can received longer-term extensions if they can demonstrate that postponing a water source's development will have long-term contributions

to the public good. However, other applicants interested in developing the water source can challenge extensions (Bryner, 2003).

According to Boyd Clayton, the Deputy Engineer for Utah's Division of Water Rights as cited by Alan Bracken (Bracken, 2010), Utah is able to bear the administrative burden of a system without exemptions for small groundwater users because "[t]he burden has always been there so we just consider it part of the necessary workload." However, Clayton indicated that "[d]elays have been an issue for all water right applications and a backlog of 5,000 applications has accumulated over a period of 25–30 years" and that "there has been a significant push" during the past five years "to provide adequate funding to get the work done and focus on eliminating the backlog" (Bracken, 2010). As a result, "[t]he backlog is now under 3000 applications and improved processes are in place which reduce time to process [and] which will get even better once the workload decreases as a result of backlog elimination" (Bracken, 2010). Clayton also reported that Utah relies heavily on a state-wide groundwater monitoring program cooperatively operated with the United States Geological Survey to monitor small domestic and groundwater wells and collect pertinent groundwater data, including water levels and estimated well withdrawals (Bracken, 2010).

Utah's water allocation system is founded on prior appropriation doctrine, like in BC. Beneficial use is the basis of all water rights in Utah and is used to limit and measure all rights to use water in the state (Bryner, 2003). Beneficial use is a requirement in other states, but its designation plays a more assertive role in Utah's water allocation than in other jurisdictions. The state has defined quantities of water that fulfill beneficial use requirements based on calculations about how much water is required for different purposes. For example, the regulator has calculated the average amount of water a rancher could reasonably require, without waste, per head of cattle based on historical practices. In many regions of Utah, the majority of water resources are already fully allocated. In these cases, individuals seeking to obtain water rights

must acquire a right from an existing water license holder, a process enabled in water policy that allows transfer of appurtenance.

The state engineer can issue groundwater management plans for priority geographic regions where the safe yield of the aquifer may soon be reached. Currently there are twelve management plans throughout the state. To identify these areas, the State Engineers office studies regions to find the annual precipitation, recharge rate and discharge rate based on data collected annually through water metering. The Engineer is also able to estimate future needs and demands. As in other jurisdictions, Utah's groundwater management plans for priority areas establish guidelines that are specific to the region's water supply, demand and hydrogeology. The plans may enable policies that promote efficient use, maximize beneficial use, and protect existing rights. Through management plans, the State Engineer may limit the number of new appropriations, set total maximum annual withdrawals, or even close the area to any new appropriations.

In some cases where areas are designated 'high priority,' the State Engineer can decree that a 'priority-of-use' approach overrules Utah's prior appropriation system (Bryner, 2003). Under priority-of-use structures, the better or higher precedence right goes to some purposes for water use over other purposes. If surface flows are not sufficient to supply all rights, both surface and groundwater rights are distributed according to priority use (Bryner, 2003). Typically highest priority uses include domestic water use and agricultural water use, which secure water for human consumption and food production when water resources are scarce. In Utah, for example, that rights for domestic purposes and agriculture can take precedence regardless of priority dates.

According to Bracken, ensuring compliance with Utah's no exemptions policy has sometimes been an issue in priority areas that are closed to new appropriation. In these areas, those seeking to install a new domestic well must purchase an existing water right and file an application to change the right to the new domestic use. It "takes additional time and money to

find a suitable existing water right," and the cost for purchasing such a right for a domestic use typically ranges from $1,000 to $5,000, although it varies by region and can be substantially more expensive in some areas (Bracken, 2010). Water right owners are "much more protective of [their] rights once an area is closed because the water rights become significantly more valuable" (Bracken, 2010). The additional cost has created some controversy because "not all water rights are created equal" and "[i]t takes longer to process change applications [than new applications] because the existing water right must be evaluated" (Bracken, 2010).

Case Study Summary Elements

In my research, I focused primarily on approaches to 'priority areas' and 'large withdrawals,' however the cases suggested other overarching similarities in their approach to water management that affect groundwater management. The most important of these was the jurisdiction's approach to water governance. Water governance includes a great number of variables that influence ground and surface water and is beyond the scope of my research, but decisions about water governance play a substantial role in how the province is able to manage water resources.

Secondly, a common characteristic among all case studies was water policy that allows the transfer of appurtenance. The transfer of appurtenance is a mechanism that plays a greater role in priority areas than province-wide, which is why it was not an area of focus for my work. However, policies that allow appurtenance transfer enable adaptability within the water allocation framework without sacrificing certainty for water license holders and are a valuable tool worth exploring in some detail in this Appendix.

Governance

According to the BC Ministry of Environment, water governance refers to "the decisions and supporting arrangements that help to achieve long term sustainability of the water resource. Water governance is about the processes and framework that enable decision-makers and stakeholders to manage a resource. It includes the laws and regulations, the agencies and institutions that are responsible for decision-making and the policies and procedures they use to make decisions" (MOE, 2011a). Governance relates to networks of influence and includes both formal and informal ways that authority is exercised and recognizes both state and non-state actors are equally important (MOE, 2011a). Governance is different from management, which focuses on the operational, on-the-ground activity to regulate a resource and conditions of its use

(MOE, 2011a). Clearly water governance decisions have a significant impact on groundwater regulation framework for BC.

Case studies illustrate approaches taken in other jurisdictions to structure water governance; notably, they all feature unified governance for water resources and regulations consolidated under a single, overarching regulatory body for groundwater extraction and use. Oregon's water allocation is coordinated by the Water Resources Department and, in Utah, by the Department of Natural Resources. In Colorado, water courts handle water allocation at the regional level, but all groundwater is subject to approval of the State Engineer at the Colorado Water Resources Department. Alberta's current governance structure is most like BC's in that they centralize water allocation within the Ministry of Environment, which coordinates water allocation operations with other ministries and local stakeholders who share a vested interested in water rights.

Cases suggest that BC needs a cohesive and transparent governance structure for water management that includes local stakeholders in water management decision-making and policy implementation. They also suggest that the regulator should employ similar processes in the allocation regulations and procedures for both groundwater and surface water. Currently, a plethora of legislation affects surface water use in British Columbia (WAM DP, 2009). Evidence from the cases suggests that the Ministry of Environment should work to streamline legislation so that the new Water Sustainability Act consolidates and supersedes other legislation that affects aspects of water allocation in the province. As part of modernizing the Water Act, the BC Ministry of Environment is working with experts to develop policy options for approaching provincial water governance and streamlining legislation that affects water resources in BC. Water governance experts include Oliver Brandes, director at the POLIS Project on Ecological Governance at the University of British Columbia, and Linda Nowlan, Director of Pacific Conservation for World Wildlife Fund Canada, who have written extensively on water

governance issues and have invested a great deal of research in strategies that could improve BC's water governance.

Appurtenance

Case studies indicate that the most effective way to mitigate water supply problems and conflict in priority areas is to impose restrictions on new allocations in that area such that no new licenses are issued, or licenses for new allocations are limited to specific uses. In all the cases, jurisdictions have introduced legislation that allows water licensees to transfer water rights to different users or purposes. Legislation in Oregon, Utah and Alberta explicitly enables the permanent or temporary transferability of water rights. In these cases, transfer of appurtenance is limited to designated priority areas. Water-use rights in Colorado are not subject to appurtenance; rather they are real, tradable property. By facilitating a process for unbundling land ownership and water rights, jurisdictions enable a number of policy levers that help to accomplish environmental protection and efficiency objectives.

Appurtenance provides security for water license holders, but it also prevents new enterprises from reliably accessing water when a basin is closed to new allocation. Water access is an economic driver and restricting new licenses may have negative economic impacts for a basin (Ohrn, 2008). A primary benefit of water rights transfer is that it allows new or growing businesses to secure water from existing water license holders. When a water license is transferred to another parcel or another water use, the license maintains its original priority date so acquiring a more senior water license provides an enterprise greater security than a junior water license.

Water license transfer also creates an incentive for existing water license holders to use water more efficiently. Where there is a market for water licenses, existing water license holders have the opportunity to 'sell' or 'trade' the un-used portion of their water allocation for an overall

economic or ecological benefit. Trading for unexpended water allocation provides water licensees incentives to conserve, effectively increasing water available due to water savings (increased efficiency). The implicit side effect of conservation and efficient water use is that it aligns action with environmental protection goals and opens the door for prioritizing available water resources for highest beneficial uses available for each basin or aquifer (Brandes et al., 2008). Eventually, lifting appurtenance potentially allows the government to direct available water into the most beneficial or highest priority uses based on regional goals.

Finally, the ability to transfer water rights to different uses increases flexibility for regulators to respond to new information. For example, Alberta Environment is entitled to withhold up to ten percent of any water allocation transfer to preserve in-stream flows (Ohrn, 2008). Since 2005, Alberta has enabled unbundling of water rights from land through a permanent or temporary water transfer application in areas with Approved Plans. Tradable water rights also enables aggressive options to preserve in-stream flows and protect water supply in priority areas, such as temporary or permanent government buy-backs of allocated water licenses in over-allocated areas (Brandes et al., 2008).

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Oregon

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