Water Entitlement Pricing for Efficiency, Equity, and Sustainability in British Columbia

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December 2015

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ACKNOWLEDGEMENTS

I would like to acknowledge the guidance and support of my client, Oliver Brandes, and my supervisor, Lynda Gagne. I would also like to acknowledge my family, friends and roommates for their support and patience.

EXECUTIVE SUMMARY

Introduction

British Columbia (BC) recently conducted a provincial water rate review, which will come into effect in January of 2016. The new water rates include fees for water licenses, short-term use approvals, permits over crown land and other use approvals; fees for amendments and apportionments charged to domestic, industrial and irrigation water users; and transfers of appurtenance, which allow for the transfer of water rights to other water users (BC Ministry of the Environment, 2015a, p. 1). The review was guided by seven principles: simplicity, fairness and equity, implications for water users, impact on the water resource, cost recovery, efficiency, and food security and public health (Government of British Columbia, 2014, para. 6). These principles are meant to support the *Water Sustainability Act* (WSA), which was brought into legislation in March of 2014 to replace and update the existing *Water Act* that was legislated in 1909 (Government of British Columbia, 2015a, para. 1). The WSA includes provisions for regulating groundwater, regulating water during scarcity, improving water security, water use efficiency and conservation, and measuring and reporting water use (Government of British Columbia, 2013, p. viii). Regulations have the potential to impact municipal water rate structures, water use behaviour, and water sustainability.

The purpose of this report is to inform POLIS in their recommendations for the next projected provincial water rate review by identifying water rate structures, policies and principles in other jurisdictions that could succeed in BC.

Methods and Methodology

This report is based on qualitative research using two methodologies. A literature review examines the economic literature on water pricing policies and structures. A jurisdictional scan identifies pricing structures and policies used in other provinces across Canada, and international jurisdictions in the United States, Australia and the United Kingdom. It examines some of the main issues jurisdictions face when setting rates or planning for a rate reform.

Findings

The research uncovered existing water rate policies and structures in select provinces in Canada and comparable jurisdictions in the United States, Australia, and the U.K.

The economic literature revealed that water rates should be based on both the full cost of providing the resource and the full environmental value. This pricing policy is key in order to achieve economic efficiency, along with financial and environmental sustainability. Without such a policy, groundwater levels will decrease and residential water infrastructure will deteriorate over time.

The literature review examined various pricing structures that can be used, and have different impacts on the pricing objectives. The main types of rate structures are flat rates that are independent of the amount of water consumed, volumetric rates that are based on the amount of water consumed, and two-part rates that include both a flat fee and a volumetric rate. The two-part rate structure is the most common rate structure found in the jurisdictional scan and supports economic efficiency.

Several steps were identified in the literature for conducting a successful water rate reform. These include "public awareness campaigns" prior to the pricing reform; communicating "a clear economic rationale;" "compensation mechanisms" for stakeholders; clearly identifying objectives; thorough preparation; sensitivity to the timing of political events; preparing and presenting the "reform components to minimize opposition;" seeking "external support; and mobilizing supportive stakeholders;" sharing gains from the reform; acknowledging externalities and differences between water sources; recognizing the importance of "a set of institutions and not impos[ing] a generic reform process;" and including the "power and transaction costs associated with reform implementation" (Dinar, 2000, pp. 19-22).

The effects of pricing policies and structures on equity, efficiency, and sustainability were cited as necessary considerations when designing water rates. The most effective rate structure to address fairness and equity among water users is the increasing block rate (IBR), where the cost of water use increases after the first block (Herrington, 2007, p. 3). Economic efficiency is best achieved through the use of marginal cost pricing, which means setting the unit price equal to the cost of increasing the production or consumption of a good or service by one additional unit of output (Renzetti, 2000, p. 130). The most effective type of rate structure for promoting water sustainability is a two-part rate involving an IBR with high upper rates plus a fixed charge (Organization for Economic Co-operation and Development [OECD], 2010, p. 89).

The jurisdictional scan revealed that few provinces charge for industrial water use, yet BC is one that does charge. However, a small increase in water rates for industrial water users in Canada could result in a significant reduction in water consumption. For agricultural users, water is mainly charged using a flat rate, while in BC, irrigation water is charged using a uniform volumetric rate, along with an annual license and storage fee.

BC has some of the lowest water rates in Canada for both residential and industrial use, while other provinces continue to increase their rates on a regular basis. In all provinces in the scan, the most common municipal rate structure was a two-part rate with a fixed fee and a volumetric rate. The United States has the most equitable municipal water rates out of the jurisdictions in the scan, having many low-income assistance programs. California has the highest average water rates and the dominant rate structure used was an IBR. Australia has the most water conservation programs based on water pricing, some of which utilize markets for entitlement trading. Australia also has the most comprehensive pricing policies both at the state level and at the national level. The most common rate structure used was a two-part rate. In England and Wales, water services are privatized and most households pay for water based on the ratable value of their property. Water services in Scotland and Northern Ireland remain public, however, residential water use is subsidized in Northern Ireland. In Scotland, the dominant municipal rate structure for metered customers is a two-part rate, while for unmetered customers, rates are based on the tax band for one's home. Metered non-domestic water customers in Northern Ireland are charged a standing charge based on the diameter of the water supply pipe and a variable charge based on the amount of water used per cubic meters.

Recommendations

The recommendations are directed toward provincial and municipal governments in BC and aim to promote water conservation, while remaining equitable and maintaining economic efficiency. The recommendations can be summarized as follows:

- **Recommendation 1:** Adopt conservation rate structures, such as an IBR.
- **Recommendation 2:** Implement full-cost pricing by building administration, operations and maintenance costs, and environmental costs into water rates.
- **Recommendation 3:** Regulate effluent discharge and enforce the polluter pays principle for industries that pollute water sources or that consume beyond their limit.
- **Recommendation 4:** Improve equity and fairness by offering more discounts and low volume programs for low-income residential water users.
- **Recommendation 5:** Implement regular water rate reviews to gradually achieve full-cost pricing and allow water users to adjust.

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1 INTRODUCTION AND BACKGROUND

1.1 Introduction

For most areas in Canada, including British Columbia (BC), water pricing is regulated by the province and all water resources are owned by the Crown (Renzetti & Dupont, 2015, p. 63). BC has some of the lowest water rates in Canada and is one of the largest water users (Government of British Columbia, 2014, para. 5; Environment Canada, 2011a, p. 4). BC enacted the *Water Sustainability Act* (WSA) in 2014 to replace the existing *Water Act* (Government of British Columbia, 2015a, para. 1). The WSA will come into effect in January of 2016, and focuses on seven key policy directions, which include regulating and licensing groundwater, regulating water during scarcity, and improving security, water use efficiency and conservation (Government of British Columbia, 2015a, para. 4; Government of British Columbia, 2013, p. viii). These directions are particularly relevant to water entitlement pricing, as they include a 30-year review requirement of license terms and conditions, and a provision of beneficial use, which ensures that all water users must use water efficiently (p. x). Residents have indicated that water is highly valued in BC and have supported an increase in water rates, so long as rates are fair and affordable when the new water rate review comes into force in 2016 (Government of British Columbia, 2014, para. 7). Water is viewed as significantly underpriced, as existing fees are not enough to cover basic administrative and water service infrastructure costs (Brandes, 2013, p. 10). POLIS is the client for this research and is interested in research that will identify pricing principles that address efficiency, equity, and sustainability and assist POLIS in recommending appropriate water rate policies and structures for BC.

The objectives of this research are as follows:

- Develop pricing principles that can be used in BC to address efficiency, equity and sustainability.
- Distinguish leading water entitlement (or water license) pricing policies that address efficiency, equity and sustainability.
- Analyze what pricing schemes are the most appropriate or relevant to the BC context.
- Analyze the upcoming BC water rate review structure against other leading Canadian and international jurisdictions.
- Provide recommendations for the next water rate review structure and how BC could develop a better rate system.

Recommendations in this project were informed by a literature review and jurisdictional scan of water policies, programs and pricing principles.

1.2 The Client

The client organization for this project is the POLIS Project on Ecological Governance, a research center based out of the University of Victoria that investigates and promotes sustainability (POLIS, 2015, para. 1). The Water Sustainability Project (WSP) is a component of the POLIS Project on Ecological Governance. It focuses on fundamental governance issues, such as "long-term, comprehensive, watershed-based planning and innovative institutional and ecosystem-based legal reforms" (POLIS WSP, 2015a, para. 1). The objectives of the POLIS Water Sustainability Project

are to explore water issues at a national scale, develop and promote innovative water governance options, further water law reforms and water policy decision-making tools, create a national network of water experts and raise public awareness of water issues in Canada (POLIS WSP, 2015a, para. 5). POLIS is currently working on a project called the Future of Water Law, Policy and Governance in Canada, which identifies good public policy, water conservation, and innovative forms of watershed governance (POLIS WSP, 2015b, para. 4). POLIS recently released a series of submissions and discussion papers addressing the *Water Act* modernization process and water pricing in BC. The papers identify some of the challenges and concerns related to the *Water Act* modernization process and provide recommendations for developing a new water rentals system in BC (POLIS, 2010, p.1; POLIS, 2014, p. 6). The project aims to identify new approaches to modernize water policy and governance (POLIS WSP, 2015b, para. 5). This research is intended to support that aim.

1.3 Background

BC recently enacted the WSA and is undertaking a provincial water rate review. The research will help to prepare for this projected review, and the public engagement that follows. The WSA includes many improvements over the *Water Act*, which it will replace, including provisions for the regulation of groundwater use, requirements for constructing wells and protecting groundwater, along with provisions for enhancing dam safety and distinguishing new offenses and fines related to water use (Government of British Columbia, 2015b, para. 8-11). Under the *Water Act*, industries could extract groundwater at no charge and fines for offenses such as failing to comply with an order to stop the introduction of foreign waste into water sources were less severe (Government of British Columbia, 2015c, p. 2-3). Quebec charges up to $70 per million liters of water for groundwater extraction and Nova Scotia charges over $140 for some uses, while BC charges $2.25 for purposes such as water bottling and oil and gas operations (Fumano, 2015a, figure 1).These new water policies continue to be a source of contention, particularly around the new proposed rates for groundwater extraction for water bottling companies, which are still viewed by many as too low (The Province, 2015, para. 1).

The WSA has been criticized for not using enforceable language or addressing the environmental impact of current water users (Gage, 2014, para. 3-5). For example, the use of the first-in-time-first-in-right (FITFIR) system, which gives older water licenses precedence over new ones, is criticized for not considering environmental flow impacts for existing water licenses and not recognizing First Nations rights to water (para. 19-20). This system applies to both surface and groundwater (para. 21). On the other hand, the WSA better protects fish by ensuring sufficient water flows in rivers and streams to maintain a healthy ecosystem (Gage, 2014, para. 7). However, the wording of this provision is viewed as weak, as the Cabinet can still exempt certain applications from the requirement to consider environmental flows (para. 8). The WSA has also been criticized for not improving public participation in the water decision-making process. For example, objections to granting a license can only be filed by someone who the government considers to be impacted by the license, whereas the former *Water Act* allowed anyone who considered themselves to be prejudiced in the granting of a license to file an objection (para. 31). However, public participation processes are applied to a wider range of decisions in the WSA (para. 31).

This research builds upon the proposed pricing principles that the BC Government has identified: simplicity, fairness and equity, implications for water users, impact on the water resource, cost recovery, efficiency, and food security and public health (Government of British Columbia, 2014, p. 3-4). The pricing objectives of equity, efficiency, and sustainability used in this research were chosen to encompass all of these principles, which are also reflected in the strategies/principles discussed in the literature review and the jurisdictional scan. These three objectives are based on the most common objectives found in the literature, particularly the OECD's report on perspectives on water pricing and financing, which focuses on these three objectives (2009, p. 81). The report refers to ecological sustainability as the protection and preservation of water resources for future generations in order to "provide the desired ecological functions over time" (p. 81). Efficiency is defined as the allocation of water resources to "maximize overall benefits to society" (p. 81). Equity refers to the accessibility and affordability of water services to vulnerable groups, (p. 81). These objectives reflect a distilled approach to perspectives on water as a scarce natural resource, a valuable economic good and a public interest good (p. 81). BC can benefit by using these objectives in their approach to the next water rate review, as equity can promote a thorough and accessible public engagement process and fair water licensing rates, efficiency can promote the concept of beneficial use, and encourage full-cost recovery and regular rate reviews, and sustainability can ensure water source protection and preservation.

Previous to the *Water Act* modernization process, the BC Government created the *Living Water Smart Plan*, which identified two main water efficiency targets to be achieved by 2020: water use in BC will be 33% more efficient and 50% of new municipal demand will be met by conservation, which will require greater monitoring and measurement of water use (Government of British Columbia, 2011, para. 6). The achievement of these targets will be facilitated through the WSA and the new rates proposed in the water rate review.

The goal of the research is to recommend appropriate water rate structures and strategies to achieve water pricing principles for BC that encompass economic efficiency, social equity, and water sustainability by reviewing the literature and comparing and analyzing leading water entitlement or water license pricing policies and principles from other jurisdictions. The research has a large focus on residential water pricing at the municipal level, as the pricing principles and structures for this category of use provide promising examples of water management strategies that may be relevant for other categories of use, such as industrial and agricultural water use at the provincial licensing level. However, some pricing strategies may be better suited for one use or the other.

This research builds upon the research previously conducted by POLIS on water pricing policy and will help prepare for the engagement of the next projected provincial water rate review and future reviews. It will benefit the province and other jurisdictions by providing research that will help guide decision-making over water rates.

1.4 Organization of Report

The remainder of this report consists of the following sections. The Methodology section reiterates the research questions and briefly discusses the process and content of the Literature Review and Jurisdictional Scan, along with limitations and delimitations to the approaches. Next, the Literature Review addresses four issues: the economics of water pricing for sustainability, water pricing structures, water pricing reform processes, and equity, efficiency, and sustainability. In the next

section, the Conceptual Framework provides a context for the project through a lens of economic efficiency, social equity, and sustainability. The Jurisdictional Scan is divided into the four major jurisdictions: Canada, the United States, Australia, and the United Kingdom. It also has 14 sub-sections: industrial and agricultural water pricing in Canada, British Columbia, Alberta, Saskatchewan, Ontario, California, Nevada, Oregon, New South Wales, South Australia, Queensland, England and Wales, Scotland, and Northern Ireland. The Discussion section draws on the Literature Review and Jurisdictional Scan, to addresses the research questions. It analyzes equity and affordability programs, along with conservation strategies and government transparency of water rate policies in the chosen jurisdictions. It then examines the appropriateness of these schemes in BC. The next section provides five recommendations for future water rate reviews in BC and a brief summary of the findings. The conclusion provides a summary of the report and identifies areas for further research.

2 METHODOLOGY

This report is intended to assist POLIS in policy development for the next provincial water rate review. The research to support this report consisted of a literature review and a jurisdictional scan.

The literature review synthesizes the economic literature on water pricing policies and structures. The jurisdictional scan identifies pricing structures and policies used in other Canadian provinces, the United States, Australia and the United Kingdom. It examines some of the main issues jurisdictions face when setting rates or planning for a rate reform.

2.1 Literature Review

The literature review synthesizes the academic literature on water metering and water pricing policy, water conservation, full-cost pricing and social equity, and water resource economics. Searches utilized the University of Victoria Library catalogue and Google Scholar, using terms such as "water pricing," "water rate structures," "water metering," "water conservation pricing," and "full-cost water pricing." Many articles were taken from environmental and resource economics, resource management and water policy literature to provide a broader context and background. References cited in selected articles were checked to locate other potentially useful documents. The economic principles and pricing structures described in the literature review provide a wider context for the pricing principles identified in the jurisdictional scan and the recommendations made on water pricing principles and structures for BC.

2.2 Jurisdictional Scan

The jurisdictional scan examines water laws, regulations and policies in BC, other Canadian provinces, the United States, Australia and the United Kingdom. Internet searches and the literature collected for the literature review were used to identify jurisdictions that have comparable socio-economic positions to BC, and highly developed water pricing policies. Chosen jurisdictions include Alberta, Saskatchewan, Ontario, California, Nevada, Oregon, England and Wales, Scotland, Northern Ireland, New South Wales, South Australia and Queensland. National, provincial/state and municipal websites, and news articles were scanned for water rate policies, structures and programs. Pricing structures in specific municipalities were examined to illustrate the effects of provincial and state pricing policies on municipalities and to provide examples of water conservation and affordability programs that complement rate structures. The scan evaluates these water rate structures using the core principles and policies identified in the literature review, such as marginal and full-cost pricing, to distinguish leading water pricing policies and compare them to those in BC. The majority of the scan refers to residential water pricing, although industrial and agricultural pricing are covered to a lesser extent, as many of the residential water pricing principles and rate structures can be used to inform pricing for large water users such as industrial and agricultural users. The scan will assist in providing recommendations for the next projected water rate review structure in BC by analyzing and comparing best practices and policies in other jurisdictions.

This research method was chosen because it was deemed most appropriate given the research questions and the timeframe of the project. Additionally, the information generated from the literature review and the jurisdictional scan was substantial enough to achieve the project's research objectives.

2.3 Limitations and Delimitations

This research is based on secondary data. Primary research methods, such as interviews, were not used, given the time frame, the scope, and the objective nature of the project. Thus, availability of information for the jurisdictional scan was limited to provincial, state and municipal websites, and academic publications and reports. Together, a comprehensive literature review and jurisdictional scan are sufficient to provide POLIS with the information needed to develop a policy framework appropriate for BC.

The scope of the jurisdictional scan is limited in the number of jurisdictions chosen for each country. Jurisdictions were chosen because of their proximity to BC, or their unique water scarcity situations and innovative pricing policies. However, some applicable jurisdictions, such as Quebec, Nova Scotia, and other American and Australian states, were excluded from the scan due to their distance from BC and/or a lack of available or relevant information.

3 LITERATURE REVIEW

The literature review begins with a discussion of the economics of water pricing for sustainability, and introduces the concept of full-cost water pricing, providing a basis for evaluating effective pricing policies that could work in BC. The next sections examine water pricing reform processes, followed by a description of the rate structures used in Canada and internationally. These sections provide context for analyzing the BC water rate review structure and providing recommendations for future reviews. The final section includes a discussion of the impacts of water pricing on equity, economic efficiency and water sustainability, and the effects of underpricing water, providing a background for identifying a rate structure that balances economic efficiency with equity and sustainability.

3.1 The economics of water pricing

Water pricing processes are informed by several economic concepts, such as cost recovery, efficiency, productivity, elasticity, and marginal cost. These concepts inform the development of full-cost pricing and water rate structures. An understanding of these concepts is necessary in order to manage water efficiently and ensure water sustainability during water rate review processes. They are discussed in detail below.

Cost recovery involves the financing of building and maintaining water infrastructure (Alessi & Treyer, 2013, p. 151). However, if rates are meant to be revenue neutral, any revenue that is generated over and above cost recovery should go toward lowering taxes or initiatives that are aimed at water conservation (National Round Table on the Environment and the Economy [NRTEE], 2011, p. 77). Cost recovery pricing can also include costs associated with wider externalities and resource management (Alessi & Treyer, 2013, p. 151). According to Alessi and Treyer (2013), water efficiency refers to the ratio between the amount of water produced by water infrastructure and the initial water withdrawn in order to measure water infrastructure wastage (p. 151). Productivity refers to the ratio of total output (e.g., crop mass or the market value of output) to the amount of water used to produce it, which describes the value associated with the benefits of water consumed (Wichelns, 2014, para. 2). Water prices should cover the costs of the service, such as investment, maintenance, operating, and opportunity costs, where the opportunity cost refers to "the value of the next-highest-valued alternative use of that resource" (Henderson, 2008, para. 1).

The concept of cost recovery is encompassed in full-cost water pricing, which includes "all the direct and indirect costs associated with providing water" (Goldstein, 1986, p. 56), such as "capital expenditures, depreciation, billing and administration, and services provided to the water system by other municipal departments"[1] (p. 56). Along with these items, full-cost pricing includes environmental externalities, such as the cost of environmental management and source protection (Brandes, Renzetti & Stinchcombe, 2010, p. 14). For jurisdictions that allow water transfers, transaction costs may also be included, such as costs associated with the approvals process and monitoring and enforcement of entitlements (The Allen Consulting Group, 2006, p. 10). Rogers, Bhatia and Huber (1998, p. 7) also make a distinction between the full supply cost and full economic cost in full-cost pricing, where full supply costs includes capital charges and operation and maintenance (O&M) cost; full economic cost includes economic externalities, opportunity

[1] Depreciation is an allocation of depreciable capital investments over its useful life. Hence, depreciation would not be included if the associated capital expenditures are.

cost, capital charges, and O&M cost; and full-cost includes all of the above plus environmental externalities (p. 7). The distinction between economic and environmental externalities is not always clear (p. 8). Environmental externalities are those mainly "associated with public health and ecosystem maintenance," while economic externalities are the "increased production and consumption costs" that can be caused by pollution (p. 10). Another distinction is made between the full value and the economic value of water, where the economic value includes the value to users of water, net benefits from the return of flows, net benefits from indirect uses, and adjustment for societal objectives, while the full value includes all of the above plus the intrinsic value of water (p. 13). The value of water is also locally dependent on when and where the water is used and on its quality (Zilberman & Schoengold, 2005, p. 50). These costs and values apply mainly to residential water pricing, but some of them also apply to water licensing, such as administrative costs and environmental externalities. There are also certain costs that only apply to provincial groundwater licensing, such as the costs of implementing new water legislation and social costs, including the overuse of aquifers, which could limit future water use by nearby water users (Nowlan, 2005, p. 76). All of these costs do not need to be charged on an individual basis through a fixed charge, as they can be encompassed in a two-part rate structure with both a fixed license charge and a volumetric rate. These full-costs incurred in provincial and municipal water pricing are listed in Table 1 below.

Table 1: Full-Cost Pricing for Residential Water Providers and Licensed Users

Residential Providers	Licensed users
Administration	Administration
Environmental externalities	Environmental externalities
Operation and maintenance costs	Social costs
Capital costs	Implementation costs of water legislation
Overhead costs	
Reserves	
Cost of complying with regulations	
Financial costs, such as depreciation and debt servicing (if not included in capital costs)	

Sources: Brandes, Renzetti & Stinchcombe, 2010, pp. 13-14; Nowlan, 2005, p. 76.

There is a trend in OECD countries away from fixed charges toward volumetric charges, based on measures of water consumption through metering (Jones, 2003, p. 11). This trend encourages water conservation and sustainable water supplies, as people are more likely to reduce their water use if they are aware of how much water they are using and have to pay more if they use more (Olmstead & Stavins, 2013, p. 311). If water use is not charged using a volumetric rate, it would be beneficial for water use to be capped at a certain level in order to promote efficiency and sustainability, and

to avoid overconsumption. A main principle of Canada's *National Action Plan to Encourage Municipal Water Use Efficiency* was that municipalities should utilize full-cost recovery rate structures for water and wastewater; the Plan promoted moving toward volumetric pricing through mandatory metering for new construction and all types of water use (Canadian Council of Ministers of the Environment [CCME], 1994, p. 2-5). The impact of price changes on the quantity of water demanded depends on the price elasticity of water demand. While water demand is inelastic for a subsistence amount of drinking water, the price elasticity for residential water will increase after subsistence levels are achieved, decreasing the quantity demanded, which promotes water conservation (Olmstead & Stavins, 2013, p. 311). Price elasticity is generally higher for industrial than for residential water use, and varies by industry (p. 311). Industries with higher water use fees have a higher water demand elasticity (p. 311).

Achieving full-cost pricing may be more politically acceptable through incremental water rate increases, rather than one large increase (Goldstein, 1986, p. 60). However, it is important for this intention to be publicly stated and well ahead of any changes. Rate adjustments that are incremental and occur frequently would allow users to adjust more easily to changes in price and water use (Ayoo & Horbulyk, 2008, p. 95). Otherwise, a sharp increase in water rates would impact low income households disproportionately. Thus, to ensure financial stability, it is necessary to avoid large spikes in price. The incremental rate increase could be part of a regular review of water pricing, along with the assistance of an expert group to ensure a sufficient and appropriate amount of revenue to recover the costs of water use.

It is important not to limit full-cost water pricing to municipalities for residential water or commercial use, as Environment Canada reports that municipal water use accounts for only 9.5 percent of all water use in Canada, and most of that water is later returned to the watershed (Barlow, 2012, p. 6). The majority of water use comes from industries such as thermal power generation, industrial agriculture, and extractive industries, and much of that water is either removed from the watershed or contaminated (p. 6). Most industrial water users are charged provincial water license fees, but many of these industries do not pay anything for water use. Additionally, many large water users, such as large agribusinesses and golf courses are subsidized by the government through residential water rates, and face no-cost or below-full-cost water pricing (p. 8-9). For example, BC has not charged industrial users, such as the oil and gas or water bottling industries anything for water use. After the rate review comes into effect in 2016, only certain types of oil and gas activities and water bottling will be charged up to \$2.25 per 1,000 m^3 (p. 8). For a more detailed rate schedule in BC, see Table A-1 in Appendix A.

Provincial governments have a greater responsibility over water infrastructure than municipalities, and could adopt volumetric and full-cost pricing in industrial water license fees to cover the costs of upgrades that are needed by water agencies (Barlow, 2012, p. 10). However, it is important that all revenues generated by full-cost pricing are returned to citizens through either water service infrastructure or community outreach programs, such as conservation programs (Car-Wilson, Brandes & Dobell, 2015, p. 2). This revenue neutrality requires strong transparency mechanisms and public participation processes to ensure citizens are aware of and involved in decision-making (p. 2). This type of rate adjustment resembles the way that electricity and other energy sources are contracted for.

It is also important to incorporate scarcity values in residential and commercial water prices, which include the scarcity of infrastructure capital for water harnessing and delivery, and the scarcity of natural water supply, and vary according to the region (Griffin, 2006, p. 256-257). In both cases, the economic recommendation is to identify and incorporate marginal costs, which are the costs of producing one additional unit of a resource (Business Dictionary, 2015, para. 1). Other general recommendations for the primary pricing tools include: the growth of water infrastructure by an increase in the number of service connections, and the inclusion of marginal costs in harnessing, treating and transporting additional water supply; the inclusion of the social value of natural water in water pricing; and the return of excess revenue to customers through lowered meter charges or water conservation education programs supply (Griffin, 2006, p. 256-257).

In order for residential water use to be economically efficient and financially and environmentally sustainable, these economic principles must be considered and implemented in the local context. Water pricing that does not take into account full-cost pricing, violates the principles of sustainability and reduces efficiency. Underpricing can lead to over-consumption, which increases water scarcity and results in higher costs for using water in the future (Bithas, 2008, p. 225). Once these economic principles are understood, it is possible to choose a suitable rate structure to be applied to a particular jurisdiction.

3.2 Water rate structures

Water price commonly refers to a volumetric price placed on metered water. In the context of this project, water price refers to the price charged for providing water services, including volumetric rates, non-volumetric rates and license fees. A water rate is often used synonymously with water price. Water rates are sometimes called water tariffs, and refer to the entire package of charges required by a water supplier (Griffin, 2006, p. 244). Rate structures address if and how much the price per unit of water increases, decreases, or stays the same on the basis of the quantity consumed. Rates could include a volumetric charge or flat rate charge, a recurring meter charge, which is also referred to as a minimum charge or a service charge, and if the location is new, and a connection charge (Griffin, 2006, p. 251). Existing methods of water pricing can be classified into volumetric, non-volumetric methods and two-part methods, comprised of a fixed charge and a volumetric charge. Volumetric methods depend on the quantity of water consumed and require a metering system (Tsur, 2000, p. 106). These methods include tiered rates, block charges, humpback rates, minimum bills, excess use charges, lifeline rates, time of day and seasonal rates. Non-volumetric pricing is based on non-water inputs or outputs, such as per area pricing, connection charges, flat rates, and water markets (Tsur, 2000, p. 106). These volumetric and non-volumetric pricing methods are described in Tables 2 and 3 below.

Table 2: Types of Volumetric Price Structures

Volumetric price systems	Description
Volumetric rate	Fee based on the amount of water used (a variable charge)
Two-part rate	Includes both a fixed charge and a variable charge

Block charge (increasing, decreasing)	Charges increase or decrease at set volume levels
Humpback rate	Incorporates both increasing block rate for residential customers and decreasing block rate for high water consumers
Excess use charge	Price for water increases after exceeding a base amount
Time-of-day and seasonal rates	Increasing the price for water during peak water use periods
Lifeline rate	Addresses affordability by providing a subsidization that is built into the base amount

Source: Brandt, 2005, p. 243.

Table 3: Types of Non-volumetric Price Structures

Non-volumetric price systems	Description
A connection charge	A one-time charge for a meter connection
A flat (fixed) rate	Fee that is not connected to amount consumed
A per area charge	Fee based an amount of area for irrigation
Water markets	Fee determined by the free market. Requires the privatization of the water sector.

Source: Alliance for Water Efficiency [AWE], 2014, p. 40-41.

There are many benefits and drawbacks to using volumetric or flat rate pricing structures. Both pricing structures can allow for full-cost recovery if the price reflects capital and O&M costs[2]. However, volumetric pricing can encourage greater conservation and reduce the cost of water for small and low-water-using households, thus reducing the possibility of the need to enforce scarce water pricing (Griffin, 2006, p. 265). It also promotes revenue sufficiency and represents greater net benefits to water users, as they are treated as shareholders of the water supply system (Griffin, 2006, p. 265). Barlow argues that a drawback to volumetric pricing is that it places greater responsibility to pay for water services on the user, rather than the government. This is because it makes it easier for the government to increase rates than it would by using flat rates, whereas flat rates can be viewed as a form of taxation (p. 8). Other drawbacks include that it creates larger water bills for large family households and it may discourage people from growing

[2] Full-cost recovery is used here to only reflect the utility's costs and does not include opportunity costs and economic and environmental externalities.

their own food, as that requires a significant increase in water use (Griffin, 2006, p. 265; Barlow, 2012, p. 8). Additionally, customers will not reduce their water use unless they are educated about and aware of their water-using behaviour or how their water bills are computed (Griffin, 2006, p. 265). Flat rate pricing is easier for residents to understand and for utilities to administer (McDonnell and Ní Lochlainn, 2013, p. 17). The drawbacks are that it discourages water conservation and can be more costly for small and low water using households, which tend to be low-income households. These benefits and drawbacks of volumetric and flat rate pricing structures are compared in Table 4 below.

Table 4: The Benefits and Drawbacks of using Volumetric and Flat Rate Pricing Structures

Water Pricing Structure	Benefits	Drawbacks
Volumetric water pricing	Allows for full-cost recovery of water services	Makes it easier for governments to increase rates, placing greater responsibility to pay for water services on the user
	Can reduce the cost of water for small and low-income households	Creates larger bills for large families with higher water usage
	Reduces water use and promotes water conservation by industries and residents	May discourage people from growing their own food
	Customers have a claim to the net benefits produced by the water supply system	Requires meter installation, which is costly to the municipality
	Ensures a more economically efficient allocation of water	It can be difficult to determine all of the marginal costs and benefits in setting the price
Flat rate water pricing	Allows for full-cost recovery of water services	Encourages larger water consumption
	Easy to understand and administer	Does not usually generate a large revenue
	Reduces the likelihood of increasing rates and places more responsibility on the	Can be relatively more costly for smaller and low-income

	government for financing water services	households who consume little water
	More efficient to use a flat rate area pricing for irrigation use	

Sources: Barlow, 2012, pp. 8-9; Griffin, 2006, p. 265; McDonnell and Ní Lochlainn, 2013, p. 16; Johansson, 2000, p. 12; Renzetti, 2007, p. 269.

Tsur and Dinar (2004, pp. 352-353) divide pricing structures for efficient irrigation water allocation into the five categories: volumetric pricing, output and input pricing, area pricing, tiered and two-part tariff pricing, and water markets. An efficient allocation of water is defined as "one that maximizes the total net benefit that can be generated by the available quantity of the resource given the available state of technology" (p. 351). Volumetric pricing is determined by adding the marginal delivery cost to the marginal implementation cost (p. 352). The output pricing method prices water by putting a tax on water output, which refers to a water fee for each unit of agricultural output produced by an irrigator (p. 345, 352). Area pricing refers to a fixed fee per hectare or acre for the right to irrigation water (p. 352). Tiered pricing is used when water supply and demand fluctuate and is meant to equalize them through price (p. 353). During times of excess supply, water is priced according to the marginal cost of supply, while during times of excess demand, water prices are increased by the difference in price between the marginal cost of supply and the scarcity in demand (p. 353). The use of water markets involves the privatization of the water sector and is meant to achieve best economic efficiency under certain conditions and when there are no implementation costs (p. 354). Markets represent a partial solution to water regulation, but administrative pricing is still necessary to achieve full regulation (Tsur, 2000, p. 119). The optimal pricing method depends on the region, and should be the one that provides the highest social benefit (Tsur & Dinar, 2004, p. 354).

There are circumstances where market-based pricing is appropriate and circumstances where administered pricing is better suited to the region. A market-based approach to water pricing typically involves the allocation of water resources through willingness to pay (WTP), which can be considered inequitable in some cases (Olmsted & Stavins, 2014, p. 314). Additionally, market pricing advocates for full-cost recovery, which assumes that the consumer will pay for the full cost of water services, including water infrastructure and protection (Barlow, 2012, p. 6). This type of pricing tends to hit low-income people disproportionally, as full-cost pricing does not necessarily discriminate between different income levels. In a market model where services have been privatized, revenues from full-cost pricing tend to go toward profits, as opposed to public services, which are normally government responsibilities (Barlow, 2012, p. 6). In places where government funds are not fully available for water infrastructure, a market-oriented approach can provide needed infrastructure upgrades and treatment facilities. However, some market-based approaches can lead to the privatization of the water sector, which treats water as a commodity and can result in the reduction of government subsidization for water services (p. 5). The benefits and drawbacks of using administered and market water pricing are displayed in Table 5 below.

Table 5: Benefits and Drawbacks of using Administered and Market Pricing

	Benefits	Drawbacks
Water markets	Water shortages could be resolved automatically and efficiently through market pricing.	Market pricing cannot address equity issues in pricing and provides greater benefit to high-income households than low-income households.
	Water markets can allow for water trading, which can address unequal water supply in different areas.	Water is expensive to transport, so markets tend to be limited and localized.
	Using a market approach in a privatized system can eliminate a large part of implementation costs.	Market pricing does not fare as well in a natural monopoly as it does in a competitive environment. A natural monopoly is not able to cover total costs if price is equal to marginal cost.
	Water markets can provide greater water treatment services in places where government funds for infrastructure is lacking.	Water markets can lead to higher prices and lower quality service, as private institutions are less accountable than governments.
Administered pricing	Administered pricing is able to address equity issues in pricing.	Administered pricing may be insufficient to address scarcity and cover operating costs.
	Administered pricing methods can be paired with other water conservation measures, such as educational programs and seasonal rates to promote water sustainability.	Administered pricing may not determine the optimal price for water pricing strategies.
	Some water related activities, such as flood control and waterborne disease prevention are public goods and cannot be priced for individual use.	The costs of water resource management is a large burden for individual users to finance. Instead, it is included in the overall costs of water agencies, which is economically inefficient.

Sources: de Azevedo & Baltar, 2005, p. 22; Lombardo, 2015; Shaw, 2005, p. 106; Tsur and Dinar, 2004, pp. 352-353.

Research overwhelmingly indicates that using prices to manage water demand is more cost-effective than using non-price conservation programs (Olmsted & Stavins, 2013, p. 318). In an urban American study, it was found that the extra revenues from a price increase outweigh lost

revenue from declining demand (p. 317). The benefits from using pricing to encourage conservation arise from allowing households to choose how they would like to respond to increased water prices, rather than mandating restrictions or conservation technologies (p. 319). There are many different types of volumetric and non-volumetric price structures (see Table 3). Goldstein (1986, p. 55) identifies several questions that should be answered to determine an appropriate water rate:

- Does the rate provide adequate revenues to cover the costs of service?
- Is the rate equitable to each type of consumer?
- Are the rates agreed upon by the public and local officials administering them? and
- Do the rates encourage water conservation?

The process for establishing user charges involves three steps: 1) "identify[ing] revenue requirements", 2) "determin[ing] cost of service," and 3) "design[ing] a rate structure" (Warmath, 2005, p. 180). The first step involves determining the operating and capital costs that must be recovered through water and wastewater user charges (p. 181). The next step requires the allocation of cost requirements to customer classes based on the costs of providing services to them (p. 182). The final step involves deciding on the amount of the fixed charge, and the type of volumetric charge (p. 182). The fixed charge includes a minimum charge, which covers debt service costs, customer service costs, and other capital and operating costs (Stannard, 2005, p. 220). The volumetric charge includes costs that cannot be recovered through the minimum charge and can be measured by dividing total cost by the total projected billed consumption (p. 221). It may also be necessary to determine a conservation price structure, depending on the amount of water resources available.

There are no 'one-size-fits-all' price structures that can be deployed in every region, as structures vary for different water sources, such as rivers, lakes and groundwater, and types of water uses, such as rural or urban residential, agricultural and industrial. Areas that are closer to fresh water sources and water treatment plants would have a lower water supply cost than areas located further away (Brandt, 2005, p. 260). Areas with high volume water users tend to have lower administrative, customer service and transition costs, and thus, water rates can be lower (p. 261). Other factors affecting water rates include the demand during peak periods, the level of treatment required, levels of funding and government subsidization, and the age of the system (p. 261-262). The bottom line is that water users in different watershed locations should pay a price for water that is based on local water resources and access to that water (Horbulyk, 2010, p. 12). For these reasons, a watershed model is recommended for decision-making on the type of water rate system and the price of water (p. 12). Finally, it is necessary to ensure that water rates are sustainable both financially and environmentally. Areas that are suitable for conservation rates include areas where water resources are scarce, locations without a focus on the economic development of a water-using industry, and areas where conservation would be competitive with nearby communities (Brandt, 2005, p. 253).

Conservation pricing for water can be defined as "rates that encourage the efficient use of water" (Brandt, 2005, p. 236). This type of pricing requires a comprehensive planning process, which involves several steps:

1) specifying why conservation is important in the area,
2) establishing a conservation goal or vision,

3) developing conservation objectives that can be regularly evaluated,
4) developing a work plan and schedule, and
5) developing a review and improvement program for regular reviews (p. 240-241).

There are many different types of conservation rate structures and certain areas where conservation structures are more suitable. The main categories of conservation rate structures are uniform rates, where volumetric rates are the same for all customers and classes; IBRs, where rates increase as consumption increases; marginal cost rates, where rates are based on the cost of providing the next unit(s) of service; and seasonal rates, where rates vary during different periods of the year (Brandt, 2005, p. 243). Each have their own advantages and disadvantages, and may be combined in some cases, such as seasonal rates and IBRs. For example, uniform volumetric rates are relatively simple to administer and easy to understand, but they may not fully achieve conservation goals (Brandt, 2005, p. 254). IBRs can be highly oriented toward conservation, but may cause decreased revenue in years with lower than expected usage (p. 243). Marginal cost rates can reward efficient water use, but can have a large impact on higher volume users (p. 243). Other methods of water conservation rates of use in Canada include tax/assessed charges, automated meter reading, summer surcharge water rates, water conservation information with billing, water use bylaws/fines, rebates/installation of efficient appliances and fixtures, customer water audits, and voluntary measures/restrictions (Environment Canada, 2009, p. 13).

Municipalities that enforce seasonal rates, which include household water rationing during dry seasons and imposing higher rates for water use during times when supply is low and demand is high, are more successful when combined with a larger conservation program (Renzetti, 2009, p. 10). A survey of 89 water systems revealed that rates used as part of a conservation program proved most effective at reducing peak demand (Jordan & Albani, 1999, p. 73). This finding suggests that uniform rates combined with increasing seasonal rates and educational programs may be more effective for promoting conservation (p. 73). Educational programs could include community conservation awareness programs, media ads, leak detection programs, and water operations plant tours (p. 73).

Whether or not a rate structure is efficient in terms of revenue and water use will depend on how prices are set in relation to costs and water supply. Rate structures can vary based on the type of water use, the time of year and the water user. Water prices can depend on the location and amount of water use. Both the rate structure and price should be competitive with similar jurisdictions and be subject to regular reviews.

3.3 Water rate reform processes

Water rate structures and prices change over time, as service operations technology advances and climate conditions affecting water levels change. It is up to provincial and municipal governments to determine appropriate pricing structures and rate changes through well-informed water rate reform processes. There are several factors that governments should consider when undertaking reforms. Dinar (2000, p. 19-22) provides a set of recommendations for successful water rate reforms. These include:

- the need for “public awareness campaigns” prior to the pricing reform;
- communicating “a clear economic rationale;”

- "compensation mechanisms" for stakeholders
- clearly identifying objectives;
- thorough preparation;
- sensitivity to the timing of political events;
- preparing and presenting the "reform components to minimize opposition;"
- seeking "external support, and mobilizing supportive stakeholders;"
- sharing gains from the reform;
- acknowledging externalities and "differences between water sources;"
- recognizing the importance of "a set of institutions and not impos[ing] a generic reform process;" and
- including the "power and transaction costs associated with reform implementation" (pp. 19-22).

In order to determine and prioritize objectives leading up to the reform, it is particularly important to involve key stakeholders in the rate structure process, including elected officials and members of the utility board, the utility chief executive, the finance department, operations and maintenance, customer service, engineering representatives and planning representatives (Warmath, 2005, p. 178). It is also important to take into consideration that reforms are subjective, and to acknowledge that there are no perfect solutions to water use and allocation (de Azevedo & Baltar, 2005, p. 26-27). Pricing policies should be developed in accordance with the local social, political and economic context.

According to the American Water Works Association (AWWA), the largest non-profit, scientific and educational association focused on managing and treating water, determining an appropriate rate structure involves at least the three following things: 1) defining the goals and objectives of the rate structure, 2) evaluating the available alternatives in meeting these goals and objectives, and 3) understanding and communicating the potential effects on customers (Zieburtz, 2012, p. 92). Some other suggested objectives to take into account when designing an appropriate water rate structure include revenue stability, the impacts on customers, equity and fairness, demand management and conservation, legality and litigation potential, ease of understanding, rate stability over time, implementation, affordability to disadvantaged customers, competitiveness and economic development (Warmath, 2005, p. 177).

Some of the common goals and objectives for rate setting are that: rates should provide sufficient revenue to offset all costs; rates should maximize efficiency of consumer's net benefits and net present value; consumers with equivalent incomes should pay equivalent rates and rates should be perceived as fair; rates should be easy to understand; and rates should be legally acceptable (Griffin, 2006, p. 251). Setting rates also require understanding consumers' responsiveness to water rate changes and their willingness to pay for improved water services (Renzetti, 2000, p. 136). Additionally, rate setting involves gathering information about the supply costs and consumer preferences, which will allow water agencies to offer more efficient rates to consumers (p. 137).

Some important pricing principles that water and wastewater utilities should consider when setting water and wastewater rates include full-cost accounting, the polluter pays principle and the user pays principle, which refers to the idea that the amount people pay for services depends on the

benefits they receive (Dewees, 2002, p. 590; Renzetti, 2009, p. 8). Some of the costs associated with the full-cost accounting approach can be addressed through enforcing the polluter pays and the user pays principles for industrial and agricultural water users. These principles have been utilized in many OECD countries and ensure that industries pay for damages made to the watershed (Rogers, de Silva & Bhatia, 2002, p. 4). When water rates fail to reflect these costs, the consequences are increased consumption, deteriorating infrastructure and reduced opportunities to innovate (Renzetti, 2009, p. 13). However, when water prices increase over time, research shows that companies and farmers are encouraged to use innovative measures and adopt more water efficient equipment, which can lead to reduced costs and improved social well-being (p. 12). For low-income farmers who may not have the capital to invest in new equipment, measures can be put in place to prevent harm.

During rate reform processes, it is important for governments to develop and implement clear objectives and pricing principles. These objectives and principles must be informed by public feedback and communicated widely in order to be accepted by stakeholders and water users. These principles, such as those developed by the BC government for the 2015 water rate review, can then be used to inform pricing strategies and to shape future water pricing policies.

3.4 Efficiency, equity, and sustainability

The most commonly accepted effects of water pricing policy is on supply, demand, and water consumption, while the lesser known effects are those on efficiency, equity, and sustainability (Rogers, de Silva & Bhatia, 2002, p. 2). Financial sustainability and efficiency ensure that the rate is sufficient to meet the revenue requirements, and reflects the social costs associated with water provision and use (Gaur, 2007, p. 113-114). Social equity and affordability measures how socially equitable the rate structure is (p. 113-114). Lastly, environmental sustainability ensures that the rate structure reflects the scarcity of water (p. 113-114). Designing a water rate system that balances income distribution, environmental sustainability and returns to the water company is difficult (Ruijs, 2008, p. 514). Administered pricing is necessary in order to achieve this balance. A variety of pricing mechanisms may be required, such as income-dependent pricing, seasonal variation, and full-cost pricing.

Prices that increase with consumption are able to improve efficiency, equity, and sustainability if the legal, economic and environmental aspects fit together (Rogers, de Silva & Bhatia, 2002, p. 2). For example, IBRs can reduce demand and increase supply, as well as "facilitate re-allocation of water between sectors from irrigation to domestic and industrial uses [and] from off-stream to in-stream uses" (p. 2). These types of rates can "improve managerial efficiency due to increased revenues" by providing financial resources for "improving maintenance, […] staff training and education, [and] making modern monitoring and […] management techniques affordable" (p. 2). They can also affect environmental sustainability by "reducing the demand on the resource base, [and] reducing pollution due to recycling of industrial water" (p. 2).

The Government of BC describes equitable pricing of water as reflecting "differences in the value of water based on the type of right granted, intended use, location or scarcity of water," and fairness as "similar uses of water … subject[ed] to similar pricing" (Government of British Columbia, 2014, para. 5). In order to determine affordability and fairness for water use pricing, it is important to understand and implement the user pay approach. While there are no universal standards in

regards to equitable water pricing, most utilities use the amount of three to five percent of household income (OECD, 2010, p. 28). The best type of rate structure to address fairness among water users is a volumetric rate involving an IBR, where the cost of water use increases after the first block (Herrington, 2007, p. 3). Thus, water users that use low amounts of water would be rewarded by paying less for their water than large water users. The first block can also be dependent on household size and income level, so as not to disadvantage larger households and low income groups (p. 3). For example, rates can be determined based on surveys, property value or on households that already receive one or more government benefits (p. 3).

Financial sustainability depends on economic efficiency, which refers to the allocation of scarce resources or services based on maximizing welfare (Duff, 2004, p. 296). It is based on achieving optimal distribution of these resources and services based on the consumer's willingness to pay (p. 296). Economic efficiency involves the use of marginal cost pricing. In Canada, the marginal cost of municipal water utilities exceed the marginal price of residential and commercial services (Renzetti, 2000, p. 130). For water use to be economically efficient, the price consumers pay for their water must equal its marginal cost (Renzetti, 2007, p. 266). There are few cases in other countries where marginal cost pricing is used (Renzetti, 2000, p. 130). This deficiency is likely due to the many obstacles in applying marginal cost pricing to water pricing, such as defining and calculating marginal cost, the risk of greater revenue variability and equity-related concerns (p. 130). Additionally, marginal cost pricing is based on the assumption of having a competitive market, which does not exist in municipal water pricing, as water utilities are natural monopolies with large sunk costs (Shaw, 2005, p. 106). However, it is important to take into account the marginal costs of water supply when the overuse of water is promoted through subsidized water (Renzetti, 2009, p. 11). It is possible to overcome the difficulties associated with marginal pricing by using a two-part tariff, which involves a volumetric charge equal to marginal cost and a fixed charge that is adjusted to cover revenue needs and full-cost recovery (Altmann, 2007, p. 9).

Water sustainability in this context refers to the source protection and preservation of water to ensure lasting supplies. This preservation is necessary for maintaining sufficient environmental flow in rivers, lakes, streams and groundwater. It is particularly important in areas that have lower water resources and are vulnerable to climate change. Additionally, a recent study by Gleeson et al. found that groundwater can take much longer than previously expected to replenish itself after use, which adds concern to the rate of groundwater use by industries and irrigators (Nikiforuk, 2015, para. 5). There is a lack of data on groundwater quantities and use in Canada (Nowlan, 2005, p. 25). However, there is a large body of literature that describes how water ecosystems may be impacted by groundwater extraction and how to account for ecosystem benefits (p. 72). Thus, in order for groundwater use to be sustainable, proper monitoring, environmental standards and regulations must be in place for the government to determine water use limits (Brandes, Carr-Wilson, Curran & Simms, 2015, pp. 19-20). Water pricing policies can impact conservation through reducing the demand on the resource base and promoting water recycling by industrial water users (Rogers, de Silva & Bhatia, 2002, p. 2). When pricing for water sustainability, prices should include the environmental cost of using the source, be forward looking and utilize a conservation pricing structure (p. 6). The most effective type of rate structure for water sustainability is a two-tier rate involving an IBR with high upper rates plus a fixed charge (OECD, 2010, p. 89).

Water was first considered an economic good during the Rio Summit in 1992 (Rogers, de Silva & Bhatia, 2002, p. 1). At that time, a global consensus was made that water resource management be based on three fundamental principles known as 'the Dublin Water Principles' (de Azevedo & Baltar, 2005, p. 19). The first is the ecological principle, which relates to the objective of water sustainability and states that water is a finite and vulnerable resource; the second is the institutional principle, which relates to the objective of social equity and purports that water management should be based on a participatory approach; and the final principle is the instrumental principle, which relates to the objective of economic efficiency and argues that water has an economic value and should be recognized as an economic good (p. 19; Global Water Partnership, 2012, para. 1 and 4). Further, it argues that greater incentives are required to improve water allocation and improve quality (de Azevedo & Baltar, 2005, p. 19).

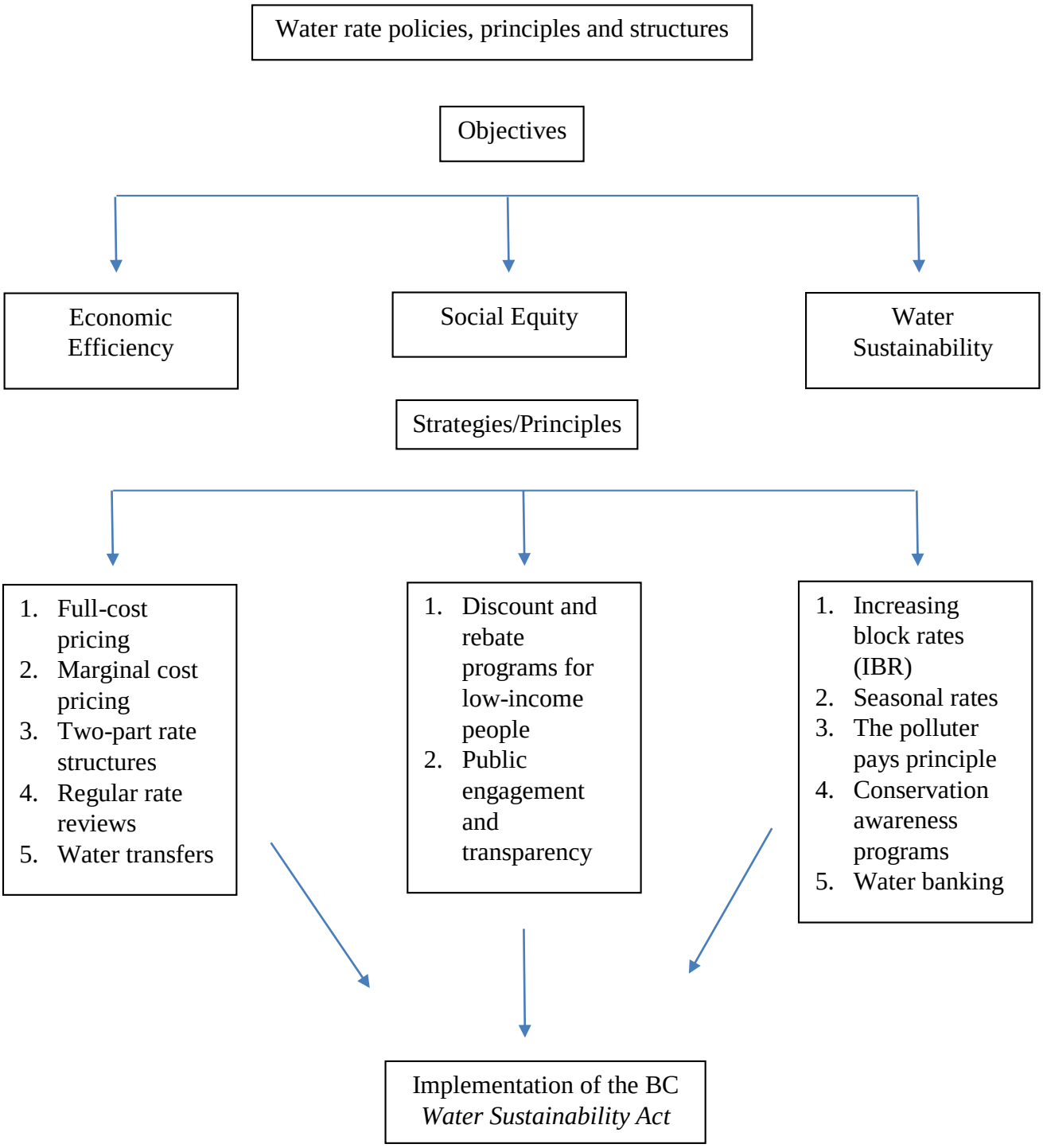
Underpricing water can have significant impacts on the welfare of citizens, such as increased pricing of food and electricity that are supplied by water, if it leads to water shortages. Similarly, water pricing reforms can lead to many societal gains, such as improved detection of system leakages and can even decrease the costs of water use for low-income households (Renzetti, 2000, p. 132-133). Additionally, revenues from water rates could be returned to the public through lowered property taxes or eliminating the monthly flat rate portion of water utility bills (Ayoo & Horbulyk, 2008, p. 98). Revenues could also be used to finance water governance, such as future watershed planning and projects. However, it is important to find a balance between pricing to finance governance and pricing to address sustainability issues.

It is important to understand the influence that water price can have on these factors and to use it as a tool to achieve the intended outcomes in water rate reforms. Water rate structures and prices that encompass principles reflecting economic, social and environmental factors, such as full-cost pricing, fairness and conservation, will be more effective in satisfying the needs of stakeholders, water users and government. If these pricing principles are considered early in the planning stages and communicated widely, it will be easier for governments to gain acceptance and be successful during reform processes.

4 CONCEPTUAL FRAMEWORK

The conceptual framework provides a context and a guide for the findings in the report. In this report, a lens of economic efficiency, social equity and sustainability is applied. This lens will support the search for a rate strategy that will maximize economic efficiency, while also address social equity and sustainability issues. Economic efficiency refers to the optimal allocation and pricing of water resources to their most productive use (Economics Help, 2015, para. 2). In the context of this project, economic efficiency promotes financial sustainability of operations and management costs associated with water services. It can be achieved through pricing structures, and regular rate reviews. Social equity refers to ensuring fair and affordable water rates for different social classes of water users. It should be distinguished from social equality, which would promote equal rates for all water users (Guy & McCandless, 2012, p. 5). It can be achieved through affordability and low volume programs for low-income residential water users. Sustainability, as defined by Agenda 21, includes economic development, social development and environmental protection (United Nations Conference on Environment & Development, 1992, p. 1.1). Water sustainability in the context of environmental conservation refers to the source protection of water to ensure lasting supplies. However, it can also include financial and social sustainability. Water sustainability can primarily be achieved through pricing structures and conservation awareness programs. These strategies are meant to lead to the successful implementation of the WSA, in keeping with the principles of economic efficiency, social equity and water sustainability.

Figure 1: Conceptual Framework



5 JURISDICTIONAL SCAN

The jurisdictional scan examines water laws, regulations and policies in BC, Canada, the United States, Australia and the United Kingdom. These jurisdictions were chosen because of their comparable socio-economic positions to BC, and their unique water scarcity situations and innovative pricing policies. The scan begins by providing an overview of residential, industrial and agricultural water use in Canada. It then discusses provincial water pricing policies and programs in the context of equity, efficiency, and sustainability in BC, Alberta, Saskatchewan and Ontario. The next section examines water use in the United States and discusses similar state water pricing issues in California, Oregon and Nevada. It then provides an overview of water policies and principles in Australia and describe water pricing issues in New South Wales, South Australia and Queensland. The next section examines water pricing policies and principles in England and Wales, Scotland and Northern Ireland. National, provincial/state and municipal websites, and news articles were scanned for water rate policies, structures and programs. These policies, structures and programs are then analyzed to compare water rate structures and policies in BC with other jurisdictions, and to provide a set of recommendations to consider for future provincial water rate reviews.

5.1 Canada

Canadian households are one of the largest users of fresh water in the world (Environment Canada, 2011b, para. 2). The average Canadian household uses 335 liters of freshwater a day for domestic uses (Barlow, 2012, p. 6-7). All large water users in Canada are required to hold a government license, which determines the water source and the volume of water that can be used (Renzetti & Dupont, 2015, p. 64). The main difference between provincial water policies is that provinces in the west have water allocation schemes based on FITFIR principles, while the central and eastern provinces have water frameworks based on English common law riparian rights doctrines (Renzetti & Dupont, 2015, p. 64). FITFIR policies refer to a seniority system, which gives priority to water rights licenses with prior allocation over newer licenses (Christensen & Lintner, 2007, p. 223). English common law riparian rights ensures the owner of land that borders on surface water to have entitlement to riparian rights, such as access to that water source and domestic water use rights on the land (p. 224).

The amount spent on water by Canadian households is below the standards set by international agencies for affordable water supplies (Bodimeade & Renzetti, 2013). Canadians, on average, pay about $0.31 per cubic meters of water used, which is among the lowest in the world (Barlow, 2012, p. 6-7). The Water Survey of Canada found that there is a strong relationship between water price and consumer demand (Lee, 2001). This is confirmed in the 2011 *Municipal Water Pricing Report* that found that average water use per capita was greater for those who used a flat water rate compared to those who used a metered or volumetric rate (Environment Canada, 2011a, p. 8) and in Barlow (2012, p. 7) who reports that the average Canadian household on a flat rate uses 43 percent more water than the average household using a volumetric rate system. However, for more than a third of Canadian households, payments for water are not in any way connected to the amount of water used (Ayoo & Horbulyk, 2008, p. 101).

Between 1991 and 2009, the use of volumetric water rate structures increased in Canada, along with the average volumetric price for residential water use (Environment Canada, 2011a, p. 3; 6).

These factors indicate a movement toward conservation-oriented water pricing in Canada (Environment Canada, 2011a, p. 14). Less than a quarter of the population in British Columbia, Quebec, Prince Edward Island and Newfoundland use flat rate water pricing for municipal water use, while about 90 percent of the population in Saskatchewan, Manitoba, the Northwest Territories and Nova Scotia use water meters and a volumetric rate (Vander Ploeg, 2011a, p. 2). For provincial groundwater use, metering requirements are different. Five provinces in Canada require metering for groundwater extraction (Manitoba, Saskatchewan, Nova Scotia, PEI, and Newfoundland and Labrador), while in the Yukon and the Northwest Territories, metering is a condition of granting a license (Nowlan, 2005, p. 75). The cheapest municipal water rates in Canada are found in Quebec, the Atlantic Provinces and British Columbia, while the highest rates are in the Prairie Provinces and the territories (Lee, 2001). The province with the highest average volumetric rates in 2009 was Manitoba, while the province with the lowest was Quebec (Environment Canada, 2011a, p. 7).

5.1.1 Industrial and Agricultural Water Pricing

The total fresh water intake by the five largest industrial sectors in Canada amounted to about 86 percent of the total water intake in 2005 (NRTEE, 2011, p. 46). The largest water-using industries in Canada are thermal electric generation, followed by manufacturing and agriculture (NRTEE, 2011, p. 69). These industries are very sensitive to changes in water rates, particularly thermal electric generation. It is estimated that an average of a $0.05 increase per cubic meters in water rates would lead to a 20 percent reduction in water usage in most provinces (NRTEE, 2011, p. 92). However, with thermal electric generation removed, an average price increase of $0.55 per cubic meters in water rates would lead to a 40 percent reduction in water usage (p. 93). While water intake for other industries, such as oil and natural gas extraction, is small in comparison, they are expected to increase by an average of 96 percent between 2005 and 2030 (NRTEE, 2011, p. 68).

For most industries in Canada, water is self-supplied, and the only fee a company must pay is for a license or permit (Dachrauoi & Harchaoui, 2004, p. 5). These license fees usually cover the costs of administration and sometimes support the cost of maintenance and improvement of water infrastructure, rather than cover the full cost or full value of the water that is used (NRTEE, 2011, p. 76). License fees and volumetric charges can vary depending on the industry. However, some provinces, such as Alberta do not differentiate charges by the type of water use (Alberta Ministry of Environment and Parks, 2015, sec. 6). Only a few provinces in Canada charge a usage fee for industrial water use, including British Columbia, Saskatchewan, Nova Scotia and Ontario (Dachrauoi & Harchaoui, 2004, p. 14). Recently, Ontario created a volumetric fee on water withdrawals by large industrial and commercial users in certain industries (Horbulyk, 2010, p. 8). However, the fee is criticized for being too low for large commercial water-users at $3.71 per million liters of water used (Horbulyk, 2010, p. 8; Barlow, 2012, p. 8). Some municipalities, such as Toronto, Ottawa and Winnipeg, have offered declining block rates for large water using consumers, which decreases the cost of water for the greater amount of water consumed and promotes increased consumption (p. 8). Self-supplied water for industrial purposes can be priced using taxes, fees or royalties (Vander Ploeg, 2011a, p. 5). Industries could also be charged for the right to use water through larger license fees, rather than for the water itself (Gibbins & Zehnder, 2010, p. 4). However, it is important to have a limit on the amount of water that industries use, as access to unlimited water, even when paying for it, can lead to over-consumption and undermine

conservation objectives. Another means of preventing over consumption is to revoke or suspend the licenses of companies that over-use water (Barlow, 2012, p. 14). This method is similar to the polluter pays principle, except that the penalty is related to water use privileges, rather than monetary payment.

Agriculture accounts for about five percent of national water intake (NRTEE, 2011, p. 57). Current water-use costs for agriculture in Canada range from $0.05 per cubic meter for animal and crop production to $0.60 per cubic meter for food manufacturing (p. 89). Flat water rates are most common in irrigated agriculture, using fees based on area, rather than the volume (Vander Ploeg, 2011a, p. 4). Other types of flat rates used include output pricing, input pricing and betterment levy pricing. Alberta is the province that uses the greatest amount of water for irrigation in Canada (Vander Ploeg, 2011b, p. 4). Alberta uses 73 percent of all irrigation water in Canada and BC is the second largest irrigation user at 12 percent (p. 4). However, water for irrigation use in Alberta increased by more than 150 percent between 2010 and 2012, while in BC, it stayed the same (Statistics Canada, 2012, p. 9). Irrigation water in Alberta is supplied by 13 irrigation districts (Renzetti & Dupont, 2015, p. 65). Farmers pay an annual water charge to irrigation districts, based on the number of acres (p. 65). Some irrigation districts charge users additional flat rate fees for water use greater than the annual allocation (p. 71). In BC, farmers with self-supplied water pay an annual license fee and a storage fee (p. 65). Farmers may also purchase water from irrigation districts or improvement districts, and water is charged either per acre or by the amount used (p. 65).

The use of volumetric pricing on water consumed by irrigation in each district would make a key difference in water financing for Alberta and other heavily irrigated provinces (Horbulyk, 2010, p. 7). For example, some areas, such as the South East Kelowna irrigation district, have installed meters for irrigators, which reduced water use by 10 percent between 1994 and 2000 (Vander Ploeg, 2011a, p. 4). The next phase of this project involves giving each irrigator a set amount of water based on need and using an IBR for any excess water (p. 4). The use of more efficient irrigation technology is also viewed as a key factor in reducing water use (Policy Research Initiative, 2005, p. 31). Some suggest that subsidizing efficient irrigation technologies through taxes on residential water use can address inefficient water use in agriculture (p. 31). However, the costs of water provision are separate from water rates for irrigation, which should not be subsidized by residents, as this would encourage inefficient water use (p. 31). Much of the produce grown in Canada is exported and, thus that water is lost from the water table (Barlow, 2012, p. 9).

5.1.2 British Columbia

BC is one of the largest water users in Canada, with total per capita consumption at 606 liters per day and residential water use per capita at 353 liters per day (Environment Canada, 2011a, p. 4). Public consultations in the recent provincial water rate review revealed that the public agrees that water is highly valued and significantly underpriced in BC, as existing fees are not enough to cover basic administrative costs (Government of British Columbia, 2015d, para. 3; POLIS, 2013, p. 10). BC has historically had much lower water prices than in other parts of Canada and is one of the last provinces to implement a water rate review (The Province, 2015, para. 3). However, rates between municipalities in BC vary greatly. Larger municipalities, such as the Capital Regional District (CRD), where all households are metered, are able to charge lower rates because they can achieve greater economies of scale (WaterBC.ca, 2015, para. 5). For example, the Western

Communities area within the CRD is able to charge $1.81 per cubic meters of water and has a relatively well maintained water infrastructure, while many other municipalities are experiencing a deficit in financing water infrastructure (CRD, 2015, table 1). Large areas, where there is not universal metering such as Vancouver and Surrey, charge an annual flat rate for each single family residence of $568 and $779 respectively (City of Vancouver, 2015, table 1; City of Surrey, 2015, table 1). The municipality with one of the highest water rates in BC is Tofino, which uses a three-tier IBR with a quarterly fixed charge for residential metered customers and a $100 quarterly fixed charge for non-metered residential customers, along with seasonal rates for summer and winter to compensate for increased numbers of tourists in the summer (Corporation of the District of Tofino, 2015, p. 8-9).

There have recently been concerns over water license fees and rates for industrial groundwater users in BC. A petition signed by 225,000 people was delivered to Premier Christy Clark this year, requesting that the government charge water bottling companies "a fair price" for BC's water, meaning a higher groundwater rate than the amount proposed in the water rate review (Gage, 2015, para. 10). For example, water bottling companies are currently not charged for groundwater use and the new review imposes a fee of $2.25 per million liters of water used, along with oil and gas operators and other industrial water users (Woo, 2015, para. 2). However, after the Premier did a final review of the proposed rates for groundwater use to determine if they are considered fair, the government decided to go forward with the previously proposed rate structure of $2.25 per million liters (Fumano, 2015b, para. 1). Critics have said that increasing water rates could lead to the sale and commodification of water in BC (Gage, 2015, para. 5). However, there are many reasons why the government would charge for water that do not imply water is a commodity, such as to cover administrative costs, promote conservation, or to reflect the ecological costs of using water(para. 7).

The public and environmental organizations have also expressed concern over water use for hydraulic fracturing for liquefied natural gas (LNG) in BC. The process of hydraulic fracturing involves injecting large amounts of water mixed with chemicals and sand into the ground at a high pressure in order to loosen the fuel stores and bring the LNG to the surface (Hatzenbuhler & Centner, 2012, p. 983). More than seven billion liters of water were used for hydraulic fracturing in BC in 2012 (Hunter, 2013, para. 1). The oil and gas companies require a short-term water use approval, which is currently up to 24 months, for conducting hydraulic fracturing operations (Gage, 2014, para. 25). However, the WSA will permit companies to renew these approvals for the same purpose and using the same water source (para. 25). This change is viewed as less transparent and accountable, as information on these approvals are not available to the public (para. 27). Water license application fees for hydraulic fracturing will increase from zero to between $1,000 and $10,000, depending on the amount of water use per day, and volume-based rentals from zero to $2.25 per 1000 cubic meters (BC Ministry of the Environment, 2015a, pp. 3 and 5). However, the use of saline groundwater for hydraulic fracturing is exempt from paying an annual rental rate or a volume based rate, which represents a barrier for integrating surface and groundwater management (p. 5; Brandes, Carr-Wilson, Curran & Simms 2015, p. 14). These fee exemptions are criticized for passing costs onto taxpayers, as all wastewater from hydraulic fracturing will have to be treated and disposed of underground, which will cost the government money for monitoring it (CBC, 2013, para. 11-12). While flowback wastewater (the water

recovered from the well) can be treated and recycled, recycling is not a regulatory requirement yet (Precht & Dempster, 2012, p. 8). The lack of regulations for the use of saline groundwater is viewed as not being in alignment with the *Water Sustainability Act*, as making large amounts of water available to oil and gas companies can stifle innovation and it is not yet clear how this could affect shallow fresh water wells (Gage, 2013, para. 11-15). Greater regulations are needed for developing minimum standards for water testing and monitoring throughout the drilling process and post-operations (pp. 16, 17 and 26).

Water transfers have been allowed in BC for many years, as the *Water Act* and now the WSA allow for transfers of water rights that are attached to the land (Brandes, Nowlan & Paris, 2008, p. 24). However, there have been few cases of a transfer going through, as members of the public and environmental groups have blocked them for reasons of environmental risk (p. 24). For example, in 2005 the Environmental Appeal Board denied a water right transfer from Hotel Lake on the Sunshine Coast to a development on Pender Island, as there was a concern over risks to sockeye salmon (p. 24). This case revealed a gap in environmental safeguards and space for public participation in the *Water Act* (p. 24).

The proposed rates for domestic water license application fees will increase from $100/$150 to $250 between 2015 and 2016 (BC Ministry of the Environment, 2015a, p. 1). Minimum annual water rentals will increase from $25 to $50, while the volume-based rental will move from $0.60 to $2.25 per 1,000 m^3 for domestic water use (p. 2). Volume-based rentals for industrial use will range from $0.11 to $2.25 per 1,000 m^3 (p. 4-5). Water license application fees will increase for irrigation use from $100 to $250 for water use under 250,000 m^3 per year, and minimum annual water rentals for irrigation will increase from $25 to $50, while the volume-based rental will move from $0.60 to $0.85 per 1,000 m^3 (p. 1-2). While these increases in license fees represent a step in the right direction, they are likely too low to significantly reduce water usage by large water users. However, they do have the potential to contribute to the financing of the water management regulations set out in the WSA (Brandes, Carr-Wilson, Curran & Simms, 2015, pp. 44-45).

5.1.3 Alberta

Alberta updated its *Water Act* in 2000, which stipulates water license requirements and fees for all levels of water diversion and use (Government of Alberta, 2015, para. 1). Water users that request a license for water use below 62,500 cubic meters annually are not required to pay a fee (Alberta Ministry of Environment and Parks, 2015, sec. 6). License fees for water use above 62,500 cubic meters use an IBR model and are divided into five levels according to the level of water use (sec. 6). For example, for water use between 62,501 and 75,000 cubic meters, the license fee is $90, while for water use between 75,001 and 87,500 cubic meters, the license fee is $105, and fees continue to increase up to $1,500 for water use between 112,501 to 12,500,000 cubic meters (sec. 6). Alberta does not differentiate license fees for different types of water use.

Like many other jurisdictions, Alberta is facing aging water infrastructure, which will require greater investment and different approaches to water management. About 74 percent of the residential population in Alberta were on water meters in 1999 (Vander Ploeg, 2011a, p. 2). A two-part rate with a volumetric and a fixed charge are the most common residential rates for municipal water use (Ryan & Wang, 2012, p. 28). The Alberta Water Council (2007, p. 25) measures performance on the amount of municipal water customers on meters. They also measure the

number of water utilities that adopt a full-cost accounting approach to water pricing, which is based on the cost of the service provided (2007, p. 25). In Calgary, water rates are planned to increase 2 percent each year between 2015 and 2018. This increase equals a monthly service charge for metered households of $15.80 in 2015 to $15.95 in 2018 (City of Calgary, 2015, table 1). For flat rate residential customers, rates will go from $6.00 per thousand square feet of actual lot area in 2015 to $6.37 in 2018 (table 2). As of April, 2012, Edmonton uses an IBR for residential customers, and a fixed monthly service charge based on meter size (Epcor, 2015, para. 1). The consumption charge for 0-10 m^3 of water use is $1.8472, for 10.1-35 m^3 the charge is $2.0179, and for over 35 m^3 the charge is $2.5502 (table 1). This rate structure represents an effective approach that could be adopted in BC, as it encourages conservation and promotes fairness among customers.

Alberta is the only province in Canada that allows for the transfer of a water allocation (Alberta Water Portal, 2013, para. 6). This transfer system was created in 1999 after the passing of the *Water Act* and as a result of a moratorium on the issuing of new water licenses in the South Saskatchewan River Basin (para. 6). Transfers are predominantly used by irrigators for temporary use. However, transfers can be permanent or temporary, where a temporary transfer returns to the original license after a specified time period (para. 8). Transfers are monitored by the Alberta Government, which can withhold a percentage of the transferred water (para. 8). The Government can exercise a holdback of up to 10 percent of the water in the allocation transfer to be held in the water source or to be protected in a Water Conservation Objective license (para. 8).

Alberta has used hydraulic fracturing for oil and gas activities for over 60 years and about 174,000 wells have been drilled (Alberta Ministry of the Environment and Parks, 2015a, para. 1). The number of licenses granted for hydraulic fracturing increased by 647 percent between 2012 and 2013 (CBC, 2014, para. 2). The Government of Alberta requires licenses for all groundwater use, except for the use of saline groundwater (Government of Alberta, 2011, p. 2). The use of saline groundwater for oil and gas injection purposes has increased over the past 30 years and the use of fresh water has declined (Alberta Ministry of the Environment and Parks, 2015b, para. 5). The oil and gas industry is also developing a form of waterless hydraulic fracturing, which uses liquid petroleum instead of water, and is supported by the company, GASFRAC, to have a lower environmental impact (Gage, 2013, para. 10-11). Hydraulic fracturing operations are required to comply with strict environmental standards, which are set by the Alberta Energy Regulator (Alberta Ministry of the Environment and Parks, 2015a, para. 2-3). For example, fracturing operations must occur at a depth greater than 200 meters and fracture treatments are required to use only non-toxic fracture fluids above the baseline groundwater protection (BGWP) point (Precht & Dempster, 2012, p. 15). Chemical parameters in the water are tested before and sometimes after operations for water quality and water well capacity (p. 16). The government requires chemical composition of the fracturing fluid to be disclosed to the public online at FracFocus.ca (p. 19). In Addition, regular monitoring and reporting of groundwater levels and use is required, and annual water use reports are released annually (Government of Alberta, 2011, p. 15).

5.1.4 Saskatchewan

Saskatchewan has one of the highest average volumetric and flat water rates in Canada and about 99 percent of households use water meters (Environment Canada, 2012, p. 8; Vander Ploeg, 2011a,

p. 2). The majority of municipalities in Saskatchewan use a two-part rate structure for residential water use, with a fixed fee and a volumetric fee (Ryan & Wang, 2012, p. 29). However, some cities, such as Saskatoon, utilize an IBR (City of Saskatoon, 2015, table 1). Water rates are based on the Cost of Service (CoS), which uses full-cost pricing and is meant to promote efficient water use and finance the costs of supplying water (Saskatchewan Watershed Authority, 2005, p. 14). Customers in the same area generally pay the same rates, as they are determined by the size and type of a service area (Sask Water, 2015, para. 1). Water rates for potable water are planned to increase seven to nine percent in 2015 and 2016, while for non-potable water, rates are planned to increase by one percent (Sask Water, 2015, para. 8). This increase amounts to an average of $5.10 per month for households in 2015 and $5.45 per month in 2016 (CBC, 2015, para. 3). Additionally, water rates for large industrial customers will increase by seven percent in 2015 (CBC, 2015, para. 6).

Saskatchewan has a history of hydraulic fracturing activities for oil extraction, as over 35,000 wells have been hydraulically fractured as of 2012 (Precht & Dempster, 2012, p. 38). The amount of water used for oil and gas activities comprises only about one percent of industrial water use (p. 49). There are no minimum standards for water testing and requirements for chemical parameters (pp. 43-44). Baseline groundwater testing is not required and the majority of water used in the oil and gas industry is surface water (pp. 43 and 49). Flowback wastewater must be reported to the Department of Energy and Resources for treatment (p. 46). However, there are no requirements to disclose the chemical composition of fracturing fluid (p. 46).

The Saskatchewan Water Security Agency issues water licenses for approval to construct and/or water rights to operate water works for surface and groundwater distribution (2015a, sec 4). The water rights application fee for surface and groundwater use is $100 to $300 depending on the size of the water diversion pipe (Saskatchewan Water Security Agency, 2015b, p. 2). If the application is approved, a fee of $50 is charged for each notice or certificate registered on land titles (sec. 5). The application of approval for commencement of the operation of work is $25 for an individual, $50 for a joint application of two or more people and $100 for other types of applications (Saskatchewan Water Security Agency, 2015c, p. 18). For groundwater use, the application fee is $10 (Saskatchewan Water Security Agency, 2015d, sec. 4). For industrial water use, there is a volumetric charge of either $14.78 or $46.20 per 1,000 cubic meters, depending on where the water is taken from (Saskatchewan Water Security Agency, 2015c, p. 19). This volumetric charge applies to industries using water for processing; mineral exploration and mining; oil exploration and recovery; manufacturing; gravel washing; hydraulic pressure testing; thermal power generation; and other industrial purposes (Saskatchewan Water Security Agency, 2015e, para. 2). All of these industrial water users are required to provide metering devices or other methods of measuring water use Saskatchewan Water Security Agency, 2015e, para. 4). Water users that are exempt from charges are agricultural water users, including livestock operations, and industries that are connected to and supplied from municipal water works systems (Saskatchewan Water Security Agency, 2015e, para. 3).

To support water conservation, the provincial government created a Water Conservation Plan, which aims for all households to be metered and plans to implement water reuse and reduction programs at water and wastewater facilities (Saskatchewan Watershed Authority, 2005, p. 13). To promote efficient water use through pricing, the Water Conservation Plan encourages full-cost

pricing for domestic water users and recipients of provincial water infrastructure grants (p. 14). It also aims to work with industry, municipalities and other groups to promote water efficient fixtures and appliances (Saskatchewan Watershed Authority, 2005, p. 14). Additionally, the 25 Year Water Security Plan has seven principles, including respecting the value of water, which involves the efficient use of water to reflect its economic, social and environmental importance (Water Security Agency, 2012, p. 3).

5.1.5 Ontario

In 2005, the province initiated an expert panel on Ontario's Water Strategy, which found that Ontario has one of the highest capital expenditures on drinking water plants in Canada and will require about $30 to $40 billion in revenue between 2005 and 2019 to repair existing water infrastructure and to accommodate growth (Water Tap, 2013a, para. 1). Its recommendations included phasing in an increase in prices over seven years and creating an independent economic regulator responsible for reviewing proposed water rates (Government of Ontario, 2005, para. 1). In 2010, Ontario passed a Sustainable Water and Sewage Systems Act, which stipulates that all water and sewage agencies utilize full-cost pricing structures (Vander Ploeg, 2011a, p. 2). As a result, many municipalities in Ontario are adopting volumetric water pricing and increasing water rates. Ontario has one of the highest use rates for residential meter use at about 91.2 percent of the population (Environment Canada, 2009, p. 5). The most common rate structure used is a uniform volumetric rate along with a fixed charge (Ryan & Wang, 2012, p. 31). The City of Niagara Falls began using water meters in 2001 and implemented a water rate review in 2007 based on principles of fairness, conservation, and revenue sufficiency (City of Niagara Falls, 2015, para. 4). Water rates increased by about 20 percent between 2001 and 2007, however, lower alternative rates were proposed for small to average use residential customers (R. M. Loudon Ltd., 2008, p. 20). All of the households and businesses in the City of Markham use meters to measure water consumption (City of Markham, 2015, table 1). It is currently assessing a new water rate structure, as it recognizes that greater capital is needed for pumping water and maintaining aging pipes (City of Markham, 2015, para. 6). In Toronto, water rates increased by nine percent in 2014 and eight percent in 2015 for all costumers (City of Toronto, 2015, para. 1). This increase is being used to finance upgrades to water systems throughout the city (Maloney, 2013, para. 3). As of July, 2014, all water rates are based on meters, and customers who do not have a meter, are charged a non-compliance fee (City of Toronto, 2015, sec. 2).

The Ontario Water Resources Act stipulates that anyone taking more than 50,000 liters of water in a day must obtain a permit (Government of Ontario, 2015a, para. 1). Water use permits in Ontario are divided into three categories of water use for surface water and groundwater. Category one is considered low risk and includes renewals where there is no history of complaints (Government of Ontario, 2015b, sec. 2). It includes water for ponds used for irrigation and agriculture, and water use from the Great Lakes using less than 1,000,000 liters of water per day (Ontario Ministry of the Environment, 2007, p. 6). Category two is for water takings with a greater potential to cause adverse environmental impact (Government of Ontario, 2015b, sec. 2). It includes short-term, non-reoccurring water use, taking less than 30 days, and Great Lakes water use over 19,000,000 liters per day (Ontario Ministry of the Environment, 2007, p. 6). The permit fee for category one and two water use is $750 (Government of Ontario, 2015b, sec. 4). Category three is considered high risk and includes all groundwater and surface water takings that do not

meet category one or two criteria (sec. 2; Ontario Ministry of the Environment, 2007, p. 7). The permit fee for category three water use is $3,000 (Government of Ontario, 2015b, sec. 4). Water use for certain activities do not require a permit fee, such as irrigation for fruit and vegetable crops, aquaculture, and wetland and wildlife conservation (Government of Ontario, 2015b, sec. 8). All industrial and commercial water users must also report their water use and pay a volumetric fee of $3.71 per million liters of water used each year (Government of Ontario, 2014, para. 1). This volumetric fee applies to water users that take more than 50,000 L of water per day, and where water is incorporated into a product including water bottling, beverage manufacturing, fruit and vegetable canning, ready-mix concrete manufacturing, other non-metallic mineral product manufacturing, pesticide and fertilizer manufacturing, and other inorganic chemical manufacturing (Government of Ontario, 2015a, para. 3). The Ministry of the Environment is required to review these charges every five years to determine if they are set at an appropriate amount (Ontario Ministry of the Environment, 2013, para. 5). This amount is based on administrative costs of implementing the Ontario Water Resources Act and any other related Act (para. 5).

To address the issue of aging water infrastructure, the Ontario Ministry of the Environment (2007, p. 6) developed nine principles of financially sustainable water and wastewater services. These principles are:

1) ongoing public engagement and transparency,
2) an integrated planning approach between water, wastewater and storm water systems,
3) revenues collected from water and wastewater services are recycled back to finance the needs of those services,
4) long-term life cycle planning with corrections made mid-cycle,
5) an asset management plan in the development of a financial plan,
6) a sustainable level of revenue, while providing sufficient resources for future needs,
7) the User Pay approach, involving the use of metering and volumetric rates,
8) continuous improvements made to financial plans, and
9) collaboration in the creation of financial plans by various groups, such as engineers, accountants, auditors, utility staff and municipal council (p. 6).

Water source protection planning has gained progress in 2004, after draft legislation was passed, which proposed to identify and measure all water extracted and anticipated to be extracted from a water source, as well as limiting the number of licenses approved in high water use areas (Nowlan, 2005, pp. 38 and 43). An implementation committee on Source Water Protection was formed to address these and other issues (p. 39). Water conservation programs are also being developed and implemented in various municipalities in Ontario. In Toronto, the Capacity Buyback Program offers rebates of $0.30 per liters of water saved by industrial and institutional users (Water Tap, 2013b, para. 4). Another program offers a lower water rate to industrial users who use more than 6,000 cubic meters of water per year and submit a water conservation plan (para. 4). Ottawa developed a water Efficient Plan that offers 10 percent rebates for high volume user retrofits (para. 3). In the Waterloo Region, the Water Efficient Technology (WET) program offers free water use reviews, cost sharing of up to $10,000 for a water use audit and up to $100,000 in funding to commercial, industrial and institutional sectors to help implement water conservation technologies (para. 5). These programs represent an alternative method of promoting water conservation that

can be used alongside pricing policies. Table 6 below compares the dominant municipal rate structures, water license fees, volumetric charges and pricing principles in the chosen jurisdictions in Canada.

Table 6: Comparison of Water Rates, Principles, and Structures in Canada

Province	BC	AB	SK	ON	National Action Plan to Encourage Municipal Water Use Efficiency
Dominant municipal rate structure	Two-part fixed fee and uniform rate	Two-part fixed fee and uniform rate	Two-part fixed fee and uniform rate	Two-part fixed fee and uniform rate	Not applicable
Provincial water license fees	Application fee for domestic water use: $250; Application fee for irrigation water use: $250-$1000; Application fee for bottling water use: $1,000-$10,000 Application fee for mining water use: $500-$10,000; Application fee for oil and gas water use: $1,000-$10,000	Annual water use license fees for water use between 62,501 and 12,500,000 cubic meters: $90-$1500	Water rights application fee for surface and groundwater: $100-$300; Surface water application for approval: $25-$100; $50 per title for surface water;	Water use permit fee for category 1&2 permits (low and medium risk): $750; Water use permit fee for category 3 permits (high risk): $3,000;	Not applicable

	Minimum annual rental fee for industrial water use: $50-$200				
Provincial volumetric charge	Domestic water use: $2.25 per 1,000 m^3 Bottling water use: $2.25 per 1,000 m^3 Irrigation water use: $0.85 per 1,000 m^3 Mining water use: $1.30-$2.25 per 1,000 m^3 Oil and gas water use: $2.25 per 1,000 m^3	Not applicable	Industrial water use: $14.78 or $46.20 per m^3 depending on where the water is taken from (applies to industries using water for processing; mineral exploration and mining; oil exploration and recovery; manufacturing; gravel washing; hydraulic pressure testing; thermal power generation)	Industrial and commercial water use: $3.71 per million litres (applies to water bottling, beverage manufacturing, fruit and vegetable canning, ready-mix concrete manufacturing, other non-metallic mineral product manufacturing, pesticide and fertilizer manufacturing, and other inorganic chemical manufacturing)	Not applicable
Municipal and provincial pricing principles	• Simplicity • Fairness and equity • Implications for water users	Information not available	Information not available	• Public engagement and transparency • Integrated planning approach	• Leadership • Partnership • Harmonization • User pays on the base of volume

• Impact on water resources • Cost recovery • Efficiency • Food security and public health		• Recycled revenue for water services • Life cycle planning • Asset management plan • Sustainable level of revenue • The User Pay approach • Continuous improvements to financial plans • Collaboration	• Full-cost pricing • An informed public

Sources: Alberta Ministry of the Environment and Parks, 2015c, sec. 6; BC Ministry of the Environment, 2015a, p. 1-5; CCME, 1994, p. 2; Government of British Columbia, 2014, p. 3-4; Government of Ontario, 2014, para. 1; Government of Ontario, 2015a, para. 3; Government of Ontario, 2015b, sec. 4; Ontario Ministry of the Environment, 2007, p. 6; Ryan & Wang, 2012, p. 25, 28-29, 31; Saskatchewan Water Security Agency, 2015b, sec. 4-5; Saskatchewan Water Security Agency, 2015a, p. 19; Saskatchewan Water Security Agency, 2015e, para. 2.

5.2 The United States

Out of 18 countries surveyed by the OECD, the U.S. had the lowest percentage of household income going to water (OECD, 2002, p. 38). The average American spends about $523 on water per year (Environmental Protection Agency, 2012, para. 1). The average family of four consumes about 400 gallons of water per day or about 100 gallons daily per capita, which is higher than the average Canadian household consumption (Environmental Protection Agency, 2012, para. 1). Surface water is the main source of water for about half of utilities, while groundwater is the second largest source (Rahill-Marier & Lall, 2013, p. 17).

In the U.S., the AWWA publishes a manual of the principles of water rates, fees and charges. It evaluates the advantages and disadvantages of rate structures based on the principles of simplicity, equity, revenue stability, conservation and implementation (AWWA, 2000, p. 87-88). These principles can be used for selecting an appropriate rate structure, along with defining goals and objectives, evaluating available alternatives and understanding and communicating outcomes (Zieburtz, 2012, p. 92-94). The AWWA also publishes a Water and Waste Water Rate Survey every two years.

Water conservation programs focused on low-income households were established in several American cities during the 1990s. Out of the utilities surveyed in the 2014 AWWA Water and Wastewater Rate Survey, 40 had a low-income assistance programs and 17 had a low volume discount program (2015, p. 13). For example, in Portland, Oregon, a leak fixture repair program was established for low-income households with free material and labour up to USD 1,000 per household (OECD, 2002, p. 101). Affordability programs have also existed in the U.S. for many years, where eligibility for assistance is based on income levels. In a survey of 140 water utilities in 2001, 13 percent of them had low-income assistance programs (OECD, 2002, p. 66). For example, in Oakland, CA, the East Bay Customer Assistance Plan is a program that subsidizes half of standard monthly service charges for qualified low-income residents (Raftelis, 2005, p. 369). Types of water discount and rebate programs in the U.S. include fixed charge waivers, 'lifeline' rates and percentage discounts on water bills (Freeman Saunders, 1998, p. 13).

Water rates in the U.S. increased by 23 percent between 2000 and 2010, taking into account the rate of inflation, and they are continuing to increase by about 5.4 percent annually (Rahill-Marier & Lall, 2013, p. 3; Raftelis & AWWA, 2015, p. 15). At the same time, utility debt increased by 33 percent (p. 3). This increase is correlated with an increase in utility operating costs. Larger utilities have higher rate increases than smaller utilities, despite having lower operating costs (p. 8). Between 2000 and 2010, the median rate increase for larger utilities was 62 percent and 31 percent for smaller utilities (p. 8).

In the 2014 AWWA Water and Wastewater Rate Survey, the main issue for utility respondents related to water system stewardship was the need for the renewal and replacement of aging water infrastructure (2015, p. 6). Only 17 percent of respondents felt that their utility was able to cover the costs of providing services through rates and fees (p. 7). However, many fixed fees and other rate structures are adopted to help cover infrastructure costs, such as the storm water charge used by the Philadelphia Water Department (Rahill-Marier & Lall, 2013, p. 13).

The 2014 AWWA Survey also showed that residential water rates are highest in the Northeast at $34.70 per 1,000 cubic feet (cf) per month and lowest in the Northwest at $30.35 per 1,000 cf per month (2015, p. 16). The average costs of water and wastewater services are rising at a higher rate than the consumer price index (CPI) (p. 15). Water rates for non-residential users in 2014 were an average of $89.78 per month for non-manufacturing and commercial users, $1,363.60 for commercial and light industrial users, $25,886 for medium industrial users and $41,649.78 for large industrial users (p. 14). For residential users, the average fixed rate is $13.20 per month and the average variable charge is $21.81 per month (p. 15).

Most utilities in the survey provide both a fixed charge and a volumetric charge. However, most meter charges vary by meter size, as meter repair and replacement vary by size (Raftelis & AWWA, 2013, p. 8). The most popular water rate structure for residential water use in the U.S. is an IBR structure (50 percent), followed by a uniform rate structure (29 percent) and a declining block rate structure (16 percent). For those using an increasing and decreasing block structure, the most common number of blocks was three (Raftelis & AWWA, 2015, p. 20). Other water surcharges used include service connection fees, system development/capital recovery fees, environmental fees, security surcharges, and infrastructure/rehabilitation surcharges (p. 22-23).

About 89 percent of survey respondents indicated that their utility charges a connection fee for residential water use (p. 22).

About 38 percent of responding water utilities indicated an outside-city differential for residences located outside of city limits, which can be as high as 200 percent (Raftelis & AWWA, 2013, p. 7). This difference exists because smaller utilities, which are usually outside of city limits have higher operating costs (Rahill-Marier & Lall, 2013, p. 4). However, large utilities have more debt commitments and lower fixed charges, despite that they acquire a larger amount of revenue from volumetric consumption related charges and are more likely to recover full costs through rates (p. 4).

Most utilities implement a water conservation program, which can include many different components. The most common programs involve education, source protection, interior plumbing retrofits, landscape audits and integrated resource planning (Raftelis & AWWA, 2013, p. 10-11). In addition to these programs, many utilities provide incentives to conserve water, such as seasonal rates and water restrictions (p. 11). About a third of water providers surveyed utilize seasonal rates (Raftelis & AWWA, 2015, p. 25). For utilities that implement a water reuse structure, 33 percent reported using a base charge, 5 percent had a minimum charge and 63 percent used a volumetric rate (p. 33).

The Alliance for Water Efficiency (AWE), a stakeholder based non-profit organization, published a report called *Building Better Rates for an Uncertain World*, which identifies ratemaking objectives, including revenue sufficiency, revenue stability, rate continuity, recourse sufficiency, affordability for customers, full-cost pricing, fairness and equity, economic development, and public understanding (2014a, p. 30). AWE also published a user guide on water sales forecasting and rate models, which explains the structure of a rate design model and describes how to use the model to evaluate alternative rate structures (2014b, p. 21-35). Additionally, it explains the process used to calculate annual water sales and revenues with the rate design model (2014b, p. 35-45). This guide and pricing report are potentially useful for designing water rate structures in BC for both normal and drought conditions.

The impact of hydraulic fracturing on water sources has received much criticism in the United States. Environmental concerns have been raised relating to water sourcing and the impacts of water pollution on drinking water (Hall, 2011-2012, p. 10). Water use for mining, oil and gas makes up about one percent of all water used in the United States and the majority of that water is surface water (FracFocus, 2015, para. 2-4). One strategy that oil and gas operators are using to conserve water is to utilize seasonal changes in surface water supplies when water levels are higher (para. 6). Some operators are also able to recycle recovered flowback water (para. 7). Regulation of oil and gas activities vary by state and many states have updated their regulations on hydraulic fracturing in recent years to protect fresh water and mitigate waste, such as Texas, Ohio, Louisiana and Oregon (Ground Work, 2015, sec. 3). Regulations in Oregon include a Water Quality Program, which involve a water pollution prevention policy (Oregon Department of Geology and Mineral Industries, 2013, sec. 468B.020**)**. This policy involves "fostering and encouraging the cooperation of the people, industry, cities and counties, in order to prevent, control and reduce pollution of the waters of the state" (sec. 468B.020). Water pollution prevention can be achieved more easily

through monetary deterrence than through policy regulation alone and is less costly than cleaning up water pollution.

5.2.1 California

California has been facing serious water shortages and deteriorating water infrastructure for many years. It is estimated that California will need $39 billion for drinking water infrastructure over the next 20 years. As a result, California Legislature passed the Water Conservation Act in 2009, which mandates increased conservation and efficiency practices (Donnelly & Christian-Smith, 2013, p. 5). It also recently passed the Sustainable Groundwater Management Act (SGMA), which is the first legislation of its kind in the United States that "allows local agencies to customize groundwater sustainability plans to their regional economic and environmental needs" (Government of California, 2015a, para. 1). This legislation will be implemented over a period of 25 years, beginning with creating "regulations to revise groundwater basin boundaries" (Hearden, 2015, para. 7; Government of California, 2015b, para. 1). Some of the other new responsibilities include "adopting regulations for evaluating and implementing Groundwater Sustainability Plans and coordination agreements; identifying basins subject to critical conditions of overdraft; identifying water available for groundwater replenishment; and publishing best management practices for the sustainable management of groundwater" (Government of California, 2015b, para. 1). The new legislation does not require groundwater metering, but it does require groundwater users to report pumping quantities and depth of groundwater wells each year (Gies, 2014, para. 16). Water use reporting for surface water and pumped groundwater are also required each month under the California Water Act (California Environmental Protection Agency, 2014, para. 2 and 12).

In regards to water rates and rate structure, most urban utility providers in California are moving away from fixed and uniform rates toward volumetric structures (Raftelis & AWWA, 2013, p. 6). IBRs are becoming much more common in California, as nearly a quarter of utility agencies in California as of 2013 use an IBR structure, 22 percent use a uniform rate, three percent use another type of rate structure, and one percent use a declining rate (Raftelis & AWWA, 2013, p. 6). The highest average residential rates are about $76 per month, while the lowest average residential rates are about $43 per month (p. 8). The proposed state water use permits and license fees for 2015-2016 are $150 annually plus $0.063 for each acre-foot greater than 10 acre-feet (California Environmental Protection Agency, 2015, p. 1). There is also a one-time application fee of $1000 plus $15 for each acre-foot greater than 10 acre-feet up to $498,665 (p. 2).

Water rates have increased in many urban areas. Between 1991 and 2006, average monthly rates for 15,000 cf of water increased in California from $8.00 to $41.97 (Black & Veatch, 2012, p. 19). In the City of South Pasadena, the water board voted for a 30 percent rate increase, and the implementation of a three-tiered system in order to finance a water infrastructure project (Donnelly & Christian-Smith, 2013, p. 3). In 2011, the City began to incorporate conservation measures into the city code (p. 3). However, one of the consequences of raising rates for infrastructure improvements is that it contributes to unaffordability for low-income households. To overcome this problem, there are a number of water affordability programs in California. For example, Los Angeles has a Lifeline low-income assistance program, which provides credits for water bills plus a 25 percent discount on the first 25 kL of wastewater per month (OECD, 2002, p. 68). This program reduces the percentage of household income for water to 1.7 percent (p. 68).

Water trading has existed in California for several decades in the form of water right transfers and groundwater banking, and now accounts for about five percent of state water use annually (Hanak & Stryjewsk, 2012, p. 2). Water right trading is the transfer of water rights from one party to another for a temporary, long-term or permanent period (p. 7). Groundwater banking involves the storage of groundwater during wet years in order to have more water available during dry years (p. 7). Water trading in California has been successful in promoting water conservation through the trading of water rights for environmental purposes. Water transfers use a "no injury rule," which ensures that the water transfer does not harm any water user, including those downstream (Christensen & Lintner, 2007, p. 231). However, there are criticisms of the equity of water trading arrangements, such as the ability of farmers and businesses to sell water rights for the market value, while taxpayers subsidize the delivery of water (p. 232).

5.2.2 Nevada

In 2005, the Southern Nevada Water Authority (SNWA) adopted the recommendations from a citizen's advisory council which promoted water rates that sustain and advance conservation (2014, p. 11). As water rates have increased using progressive rate structures, water use has declined significantly over the past two decades (p. 11). All utility agencies in Nevada that responded to the AWWA California-Nevada Water Rate Survey used an IBR structure as of 2013, which amounts to a rate increase of 20 percent from 2011 (Raftelis & AWWA, 2013, p. 13). The highest average rates are about $54 per month, while the lowest average rates are about $23 per month (p. 15).

To gain a permit to access surface water or groundwater, one must file an application with the State Engineer (Nevada Division of Water Resources, 2013, para. 1). The fee to file an application is $360 (Nevada Division of Water Resources, 2014, table 1). To change the point of water diversion, the application fee is $240, while the fee for a temporary change application is $180 (table 1). The cost of a permit to appropriate water for any purpose, excluding hydroelectric generation and watering livestock, is $360 (table 1). To change an existing permit, either permanently or temporarily for any purpose excluding the purposes indicated above, the fee is $300 (table 1). To change an existing permit for hydroelectric generation, the fee is $480 plus $50 per every second-foot of water approved, while for watering livestock, the fee is $240 (table 1).

Nevada has developed a number of incentive programs to promote water conservation. The SNWA Water Conservation Plan (2014, p. 8) emphasizing the full use of metering for all SNWA member agencies. It also notes the use of multi-tier IBR structures and rate increases designed for the purpose of conservation (p. 9). For example, the Water Smart Landscape Rebate program offers financial incentives to residents who replace their lawn with water-efficient landscaping (SNWA, 2014, p. 12). The rebate amount is $1.50 for the first 5,000 square feet of lawn removed and $1.00 for additional lawn removed for a maximum of $30,000 per year (p. 13). Additionally, the Water Efficient Technologies program offers financial incentives to commercial and multi-family property owners who install water efficient devices, such as high-efficiency toilets, converting a grass sports field to an artificial turf field, or retrofitting standard cooling towers (p. 13). The program offers a rebate of $8 per 1,000 gallons conserved annually through water use reduction or $25 per 1,000 gallons for water use reduction through technological improvements (p. 13).

5.2.3 Oregon

All water in Oregon is publically owned and water rights are based on the FITFIR principle (Water Resources Department, 2015a, para. 1). Municipalities, farmers and industries must obtain a water use permit, which is obtained from the Water Resources Department for both ground water and surface water (para. 1). Based on the 2015 Oregon Water Rate Survey, 32 percent of utility agencies use a flat rate structure, 28 percent use an IBR, 2 percent use a declining block rate, and 39 percent use another type of rate structure for residential water use (League of Oregon Cities, 2014, p. 47). The highest average rates are about $39.95 per month, while the lowest average rates are $26.21 per month (p. 47).

The water use permit application fee to appropriate surface water is $800 plus $300 for the first cubic foot per second (cfs) and each additional cfs (Oregon Water Resources Department, 2015a, p. 2). For groundwater use, the application fee is $1,150 and the same cfs fees apply (p. 2). A water use license is $280 for the first point of diversion and $30 for each additional point of diversion (p. 4). Water rights can also be transferred either permanently or temporarily (p. 4). The minimum fee for a change to a single water right is $1,000 (p. 4). The Water Resources Commission measures water use statewide by focusing on diversions that have the greatest impact on environmental flow for fish (Water Resources Department, 2015b, para. 1). About 23 percent of water right users in Oregon, including state agencies, cities, and irrigation districts, are required to report their water use on an annual basis (Water Resources Department, 2015c, para. 1).

The City of Portland uses a two-part rate with a quarterly fixed rate and a uniform volumetric charge (Gary Fisk & Associates Inc., 2012, p. 1). The average monthly water bill for a single family household is $31.61 (Portland Water Bureau, 2015a, para. 1). It has many water affordability and conservation programs. For example, the city created a Leak Fixture and Repair Program, which offers financial assistance to repair leaks for eligible households (Portland Water Bureau, 2015b, para. 12). They also created a rewards program for storm water management by residential and commercial properties (City of Portland, 2015, para. 1). This program provides discounts to single-family residences, multi-family properties and commercial sites that control and retain storm water onsite (para. 2). Table 7 below compares the dominant municipal rate structures, water license fees, volumetric charges and pricing principles in the chosen jurisdictions in the United States.

Table 7: Comparison of Water Rates, Principles, and Structures in the U.S.A.

State	CA	NV	OR	AWWA Principles of Water Rates
Dominant municipal rate structure	IBR (residential)	IBR	Flat rate (residential)	Not applicable
State water license fees	Water use license: $150 per year	Application fee: $360;	Application fee for surface water use: $800;	Not applicable

		Water permit fee for any purpose, excluding hydroelectric and livestock watering: $360	Application fee for groundwater use: $1,150; Water use license: $280	Not applicable
State volumetric charge	Water use license: $0.058 per acre-foot greater than 10 af	Not applicable	Surface water use: $300 per cfs Groundwater use: $300 per cfs	Not applicable
State and municipal pricing principles	Information not available	Information not available	Information not available	• Simplicity • Equity • Revenue stability • Conservation • Implementation

Sources: AWWA, 2000, p. 87-88; California Environmental Protection Agency, 2015, p. 1: League of Oregon Cities, 2014, p. 47; Nevada Division of Water Resources, 2014, Table 1; Oregon Water Resource Department, 2015a, p. 1; Raftelis & AWWA, 2013, p. 6, 13.

5.3 Australia

Australia utilizes water markets, and has government regulated water utilities. The country demonstrates a shared commitment to use full-cost recovery by states and water utilities (Dinar, Pochat and Albiac, 2015, p. 3). It utilizes innovated approaches to water conservation and affordability programs that represent useful lessons for others.

The National Water Initiative (NWI), created in 2004, represents a commitment by governments towards water reform to increase water efficiency in Australia (Government of Australia, 2010a, para. 3). As part of the NWI, governments are implementing best practice water pricing practices, such as giving financial incentives for successful government water policy reform (Vander Ploeg, 2011c, p. 3). It states that pricing should be based on volumetric use wherever possible (Crase, Pawsey & Cooper, 2015, p. 17). The government has developed a set of four pricing principles as part of the NWI, which include (1) recovering capital expenditure; (2) setting urban water tariffs; (3) recovering the costs of water planning and management; and (4) reusing recycled water and storm water (Government of Australia, 2010b, para. 3). One of the main issues that is central to the NWI in regards to irrigation was the establishment of interstate water trade through creating a market for water entitlement rights (Quiggin, 2007, p. 43). This policy allows for water trading between rural and urban areas, which is meant to promote economic efficiency in water usage, and proves more cost effective than the alternative option of desalinization (Quiggin, 2007, p. 45). The Independent Pricing and Regulatory Tribunal (IPART) found that water trading was more effective in reducing water consumption by commercial water users than pricing (IPART, 2015a, p. 45). However, arguments against rural and urban trade are concerned with the loss of productive

capacity in agriculture and the possible waste of some types of urban water use (Quiggin, 2007, p. 46).

The largest irrigation water conservation program in Australia is the water entitlement purchasing project in the Murray-Darling Basin, which is a watershed area that has been experiencing drought for over the past decade. Under this project, the government of Australia purchases water from irrigators who would like to sell their water entitlements, and returns it to the environment (Government of Australia, 2014, p. 13). The average price per megaliters (Ml) for water entitlements purchased in one area of Victoria went from $150 for a low reliability entitlement class to $1,600 for a high reliability entitlement class in 2012-2013 (Government of Australia, 2015, para. 7-8). In order to avoid adverse social and economic impacts on irrigation dependent communities, the government implemented a 1,500 gigaliter (gl) cap on water buybacks (Government of Australia, 2014, p. 18). This program has saved 1,900 gl of water through Commonwealth and state government recovery programs as of April, 2014 (p. 21). The commonwealth aims to recover 2,750 gl of water through water recovery programs by 2016 (p. 26). Additionally, the government is able to devote almost $9 billion to upgrading communal and private water irrigation infrastructure, such as dams and pipelines (Government of Australia, 2011, p. 2).

Much of the financing for irrigation efficiency projects comes from the Water for the Future program, which provides $5.8 billion toward improving the efficiency of water use on farms (Department of the Environment, Water, Heritage and the Arts, p. 7). Additionally, it is investing $12.9 billion over ten years in water buybacks, infrastructure and policy reforms (OECD, 2010, p. 8). This program includes $3.1 billion for purchasing water entitlements in the Murray-Darling Basin and $4 billion for upgrading and modernizing water irrigation infrastructure (OECD, 2010, p. 8), Department of the Environment, Water, Heritage and the Arts, 2010, p. 8). In addition to buying water entitlements from individual farmers, there are benefits for groups of farmers along the same region to sell their water entitlements collectively. These benefits include the cost assistance in developing alternative stock and domestic water supplies (Department of the Environment, Water, Heritage and the Arts, 2010, p. 8).

The main water rebate programs in Australia are through consumer concession programs, which are organized and funded through state governments (OECD, 2002, p. 64). Low-income people, such as pensioners, are able to use concession cards toward a range of rebates on bills. Additionally, the Victoria Utility Relief Grant Program provides debt repayment assistance to people who have experienced unforeseen financial crises. Sydney Water has a Payment Assistance Scheme, where households that have had difficulty paying water bills are referred to welfare agencies that can offer water vouchers toward their bills (OECD, 2002, p. 65).

5.3.1 New South Wales

In urban areas, water services are provided by three state-owned water utility operators: the Sidney Catchment Authority, Sidney Water and Hunter Water (Crase, Pawsey & Cooper, 2015, p. 19). Economic regulation is administered by IPART, which utilizes full-cost recovery pricing for most regulated rivers (OECD, 2010, p. 37). It utilizes a cost building block approach to calculate business revenue requirements, which are then converted into tariffs for the area in question (IPART, 2015b, para. 1). For areas that are metered, IPART uses a two-part tariff for regulated

and unregulated rivers and groundwater, which involves a fixed access charge and a volumetric charge that are the sum of an entitlement charge and a usage charge (OECD, 2010, p. 37). Metering is generally required for commercial groundwater use and it has an annual extraction limit, while others are required to keep a log book to monitor water use (Government of NSW, 2015, para. 4). For unregulated rivers, customers are billed a water management charge or an area based charge for those living in the Far West (IPART, 2015a, p. 44). The two-part tariffs are divided into a ratio of 70:30 between the fixed and usage charges (p. 44). The fixed charge is an annual minimum charge of $105, which is meant to cover administrative costs (p. 53). Unregulated river and groundwater users are charged a meter service fee and separate charges for manual meter reading, validation of a relocated meter and a deposit for dispute claims (p. 57).

For rural areas, water prices paid by irrigators involve a charge for the delivery of water to the irrigation district, where it is controlled by the irrigation infrastructure operator (IIO) (Crase, Pawsey & Cooper, 2015, p. 22). Farmers, whose water is regulated by an IIO, are required to pay account administration charges, delivery entitlement fees, outlet fees, drainage fees, standard water use fees, and casual water use fees (p. 23). Bulk water charges are comprised of a fixed fee based on the type of water entitlement, the valley where the entitlement is held, and the size of the entitlement plus a variable charge (p. 22).

There are three categories of fees and charges that are set by IPART (NSW Office of Water, 2015a, para. 5) These are: water management charges, which are meant to recover the costs of the Office of Water's planning and management activities; consent transaction fees, which include applications for new licenses and approvals, and are meant to recover the cost of processing these transactions; and metering charges, which recover the cost of reading and servicing meters (NSW Office of Water, 2015a, paras. 6-8). The application fee for a water access license from the NSW Office of Water is $575.04 for administration plus a special assessment fee of $27.81 for a new license (NSW Office of Water, 2015b, table 1). A new work license approval for basic water rights is $241.83, while a new water use license for irrigation is $268.70 for administration plus $404.93 for advertising and $612.67 for basic assessment, as well as $24.34 per hectare (ha) for special assessment for areas larger than 10 ha (table 1). A combined water use and work license is $268.70 plus $404.93 for advertising plus $612.67 for basic assessment and $11.81 per L/s, along with $24.34 per hectare for special assessment (table 1).

The Public Interest Advocacy Center (2005), a government funded non-profit research center in NSW, established six best practice pricing principles. The first is that water usage charges should reflect the long-run marginal costs of water supply, which involves the avoidance of large cross subsidies (p. 46). The second is that residential water usage charges be set to recover at least 75 percent of residential revenue, which has economic and environmental benefits by allowing for the creation of a reserve fund and promoting water conservation through increased pricing (p. 48). The third principle is to encourage conservation by charging large water users an IBR of at least 50 percent for incremental usage above a certain threshold, which should not exceed 450 kL per household (p. 49). The fourth is to adopt a tri-annual or quarterly billing frequency to improve the effectiveness of pricing signals (p. 46). The fifth is to move away from land based charges, and the final principle is to eliminate free and pre-paid water allowances (p. 46).

5.3.2 South Australia

South Australia's water is regulated by the government-owned utility called South Australia Water (Crase, Pawsey & Cooper, 2015, p. 31). Economic regulation of prices is controlled by the Essential Services Commission of South Australia (ESCOSA) (p. 24). ESCOSA is also responsible for conducting public consultations and developing pricing principles, which include resource allocation, equity, financial return, meeting customer needs, water conservation, revenue stability, and ease of customer understanding (ESCOSA, 2015, para. 3). Water rates in urban areas are mostly uniform across the state and any remaining gap between the price paid by users and the upper revenue requirements is funded by the state government (p. 31). The state has the highest drinking water rates in the nation and average residential rates increased by 30 percent in 2012-2013 (ABC News, 2014, para. 1). However, in 2013, the premier and minister of water announced an increase in the amount of rebates on water bills offered to low-income people and pensioners (Crase, Pawsey & Cooper, 2015, p. 31). Water rates increased only slightly in 2015-2016, while standard water and sewer connection charges decreased (South Australia Water, 2015a, para. 1).

Water rates for households are based on a quarterly fixed charge for water supply and a variable charge for water use, which is comprised of a three-tier pricing system with an IBR (South Australia Water, 2015b, table 1). Residential rates are equal across the state, as everyone pays the same rate regardless of where they live (South Australia Water, 2015b, para. 1). For commercial water use, customers are charged a quarterly supply charge based on the capital value of a property and a uniform water use charge (South Australia Water, 2015c, para. 2). For all other non-residential customers, such as farm lands, water rates are based on a supply charge and a single water use charge (South Australia Water, 2015d, para 3-4). Revenues to SA Water was $362 million in 2013, part of which will go toward the building of a $1.8 billion desalinization plant in Adelaide (the Advertiser, 2014, para. 7).

Water license application fees vary by area, with the exception of licensing for well-drilling, which is $248 state-wide (Government of South Australia, 2014, sec. 1). For most areas, the application fee for a new water use license is $223, while the fee for a water license transfer is $415 (sec. 2). Licenses are required for commercial, industrial, irrigation, managed aquifer recharge, and stock and domestic purposes (Government of South Australia, 2015, sec. 2). Each license holder is also required to pay an annual water levy, which is charged on the amount of water entitlement they have (Natural Resources Adelaide and Mt Lofty Ranges, 2015, sec. 3). The levy rates are $0.006 per kiloliter and contribute to the cost of water management in the prescribed area (sec. 6). Permits are required for activities that could impact a water resource or ecosystem, and ensure that these activities are monitored and regulated (Government of South Australia, 2015, sec. 3). Permits are required for most well-related activities, and using imported water or effluent involving a business (sec. 3).

5.3.3 Queensland

In urban areas of Queensland, water for residential and business uses are regulated by South East Queensland (SEQ) Water, which is divided by government-owned water distribution retailers (Crase, Pawsey & Cooper, 2015, p. 28; Queensland Urban Utilities, 2015). Water prices are based on two components – a distribution, retail and sewerage charge, and a bulk water charge (Queensland Government, 2015a, para. 2). During the early 2000's, the Queensland and other

Commonwealth governments constructed a desalination plant and a connecting grid between remote storage areas (Crase, Pawsey & Cooper, 2015, p. 28). To help finance this project, the government of Queensland increased prices over a period of ten years for bulk water use, which is charged on a volumetric basis (p. 28). Charges for bulk water use are monitored by the Queensland Competition Authority (QCA) to ensure that the prices for water paid by households and businesses reflect the costs of providing water services (p. 28; Queensland Competition Authority, 2015a, para. 1). However, recommendations made by the QCA are not binding on governments (Crase, Pawsey & Cooper, 2015, p. 28). Outside of southeast Queensland, the majority of water service providers are local governments that use a two-part tariff with a fixed fee and a volumetric fee (p. 28).

There is currently no application fee for a permit to take water in Queensland (Queensland Government, 2015b, table 11). The application license fee for entities to take water or interfere with the course of water flow by diverting or impounding water is $117 (table 17). The same fees apply to land owners for taking water or interfering with the course of flow (table 18). Additionally, land owners can assign a seasonal water license to another landholder for the remainder of a year for a fee of $156.80, while the fee to transfer a water license to another land owner is $345.30 (table 18). Land owners can also subdivide or amalgamate water licenses for a fee of $117.50 (table 18).

The 2013 water rate review conducted by QCA identified an annual household increase of $0.25 per kL of water use (Queensland Competition Authority, 2015b, p. 1). The same increase applied for 2014-2015, except for regions that have already met the destination price point (p. 1). This increase is due to increasing operational costs and spending on new and existing infrastructure (Killoran, 2014, para. 6). However, certain areas are expected to rise more than others, such as Brisbane, which is set to rise $71 to $1,192 for a home using 155 kL per year (Killoran, 2014, para. 3). Brisbane utilizes a three-tiered IBR plus a quarterly access charge for residential water use (Queensland Urban Utilities, 2015, table 1).

Irrigation water is priced and supplied by two government-owned entities and both are monitored by the QCA (Crase, Pawsey & Cooper, 2015, p. 29). SunWater owns and operates water supply schemes across Queensland for irrigation water, and regional interests, such as mining (Queensland Government, 2015c, para 1). SEQ provides services to nonurban customers, including irrigators in southeast Queensland (Crase, Pawsey & Cooper, 2015, p. 29). Irrigation prices utilize a two-part tariff involving a fixed fee based on the amount of Water Access Entitlements held by irrigators and a volumetric charge per Ml of water used (Queensland Competition Authority, 2013, p. 47). The decision to use this rate structure was based on the criteria of efficiency, flexibility, equity, financial viability and revenue stability, and simplicity (p. 47).

The QCA (2000) published a report on regulatory pricing principles in the water sector, which identified six main pricing principles. These principles are to be cost-reflective of providing the service; to be forward looking and represent the least cost to be incurred in providing water services; to ensure that the revenue needs of utilities are met; to promote sustainable investment in order for services to be maintained in the future; to ensure regulatory efficiency by minimizing intrusion and compliance costs; and lastly, to take into account matters that are relevant to the

public interest as identified in the QCA (2000, p. 3). Table 8 below compares the dominant municipal rate structures, water license fees, volumetric charges and pricing principles in the chosen jurisdictions in Australia.

Table 8: Comparison of Water Rates, Principles, and Structures in Australia

Jurisdiction	QLD	NSW	SA	National Water Initiative
Dominant municipal rate structure	Two-part distribution charge and bulk water charge (residential); Two-part fixed fee and volumetric charge (irrigation)	Two-part fixed fee and volumetric (entitlement + usage charge)	Two-part fixed fee and volumetric IBR (residential); Supply charge and uniform rate (commercial); Supply charge and single water use charge (other)	Not applicable
State water license fees	No application fee for permit to take water; Application fee for entities and land owners to take water: $117.50	Application fee: $602.85; Basic water rights license: $241.83; Irrigation license: $1,286.30 + $24.34 per ha	Well drilling license application fee: $248; New water license application fee: $223;	Not applicable
State volumetric rate	Not applicable	Not applicable	Annual levy: $0.006 per kiloliter (kL) Commercial and non-residential water use: $3.36 per kL	Not applicable
State, National and Municipal pricing principles	• Cost reflective • Forward looking • Revenue adequacy • Sustainable investment • Regulatory efficiency	• Usage charges should reflect the LRMC • Cost recovery • IBR for residential water use • Pricing signals	• Resource allocation • Equity • Financial return • Meeting customer needs • Water conservation	• Recovering capital expenditure • Setting urban water tariffs • Recovering the costs of water planning

• Public interest	• No land value based charges • No free or pre-paid water allowance	• Revenue stability • Ease of customer understanding	and management • Reusing recycled water and storm water

Sources: Crase, Pawsey & Cooper, 2015, p. 28; ESCOSA, 2015, para. 3; Government of Australia, 2010b, para. 3; Government of South Australia, 2014, sec. 2; Natural Resources Adelaide and Mt Lofty Ranges, 2015, sec. 6; NSW Office of Water, 2015a, p. 2; OECD, 2010, p. 37; Queensland Competition Authority, 2000, p. 3; Queensland Government, 2015b, table 11, 17; The Public Interest Advocacy Center, 2005, p. 48; South Australia Water, 2015c, para. 3; South Australia Water, 2015d, para. 4.

5.4 The United Kingdom

All water users in the U.K. are required to pay a water abstraction charge, which is used to finance the costs of administering, regulating and supporting water resource management (Vander Ploeg, 2011c, p. 1). It involves a fixed application and an advertisement charge, along with variable standard, compensation and environmental improvement charges (Vander Ploeg, 2011c, p. 2).

Between 2012 and 2014, the average municipal water and sewerage bill increased by 5.5 percent in the U.K. (uSwitch, 2015, para. 2-3). In response to possible social equity issues, companies are designing social tariffs to put a cap on water rates for low income households between 2015 and 2020 in England and Wales. Under these designs, water rates are planned to decrease by five percent in 2019-2020 compared to 2014-2015 (Ofwat, 2014, p. 13). Additionally, research into developing rising block tariffs and seasonal tariffs was undertaken to promote social and environmental protection (Department of Environment, Food and Rural Affairs [Defra], 2008, p. 79).

5.4.1 England and Wales

In 2009, about a third of households in England and about a quarter of households in Wales were charged for water by volume, yet this varied between 10 percent and 60 percent in different areas (Walker, 2009, p. 31). In England and Wales, legislation made it mandatory for water companies to offer free metering, which has caused many households to switch (OECD, 2002, p. 94). Volumetric charging through metering is increasing in the U.K. by about two to three percent per year (Herrington, 2007, p. 9). Almost all other households pay water rates on a standing charge, which is the same for all unmetered households (Herrington, 2007, p. 9). However, there is a plan to have 61 percent of households in England and Wales on water meters by 2020 (Ofwat, 2014, p. 9).

Water and wastewater services became privatized in England and Wales under the *Water Act* of 1989 (Ofwat and Defra, 2006, p. 33). However, water resource management and pollution control remained publicly controlled. A regulatory agency called Ofwat was created to set price limits on water rates to ensure that customers pay a fair rate and water companies are able to raise sufficient revenues (Ofwat, 2015a, para. 1). Ofwat identified six main price limit principles:

1) target price controls by using appropriate tools for different parts of businesses, focus on incentives to deliver desired outcomes, and reduce or remove regulations where necessary;

2) proportionate price setting by using a risk-based approach to compliance;
3) effective incentives to drive allocative dynamic and productive efficiency;
4) ownership, accountability and innovation to give customers a stronger voice in the process;
5) flexibility and responsiveness to ensure that regulatory tools adapt over time to environmental changes; and
6) transparency and predictability in decision-making involving extensive communication and engagement (2012, pp. 10-12).

In setting price limits, Ofwat must ensure to balance the interests of consumers with the need to finance the delivery of water and wastewater services, along with legal, social and environmental obligations (2015, para. 3). A Drinking Water Inspectorate (DWI) was created at that time to enforce water quality standards (Ofwat and Defra, 2006, p. 54). Ofwat undertakes a price review every five years, which provides incentives for efficiency by allowing shareholders to benefit from performance that exceeds the target rate of improvement (Ofwat, 2015b, para. 2). The most recent review for setting price controls for 2015 to 2020 declares that residential water rates will be five percent lower and that utility companies will increase social tariffs, which set a cap on bills for low-income households (Ofwat, 2014, p. 13).

Ofwat issues water licenses for both retail licenses, which allows the licensee to purchase water wholesale from a water company's supply system, and combined retail and supplementary licenses, which allows the licensee to introduce water into a supply system to supply customers (Ofwat, 2011, sec. 1; Ofwat, 2015b, para. 6). The application fee for a retail license is £2,000, and a combined license application fee is £2,500 (Ofwat, 2011, sec. 6). Before issuing a license, the Environment Agency and Natural Resources assesses the license against the level of impact it could have on the environment (Defra, 2013, p. 12). To ensure sustainable water abstraction licensing, a program was set up called Restoring Sustainable Abstraction (RSA), which is meant to address sites that have possible water removal issues (p. 15). They monitor the environment in existing water removal sites to determine the amount of water for future use (p. 15).

Most households in England and Wales pay for water based on the rateable value of their property, which is based on the size and type of property use (Walker, 2009, p. 31). All new homes in England are metered and all other customers are able to install a meter if they choose (p. 31). However, rates for unmetered households are rising at a higher rate than those that are metered, which provides greater incentive for households to switch (p. 34).

An independent review was commissioned in 2009 on water charging in England. The review concludes that metering is the fairest approach to charging for residential water (Walker, 2009, p. 1). It found that the benefits of metering outweigh the costs for areas with short supplies of water (p. 2). It recommended to create a working group to align with the smart metering program that exists in the energy sector (p. 2). It also recommended a package to help customers on low incomes pay debts for their water bills (p.18). There are a number of water affordability programs in the U.K. already, such as WaterSure, which caps the bills for low income customers with three or more children or with high water use for medical reasons (p. 119). Additionally, it highlights a Community Energy Savings Program, which promotes energy efficiency measures in low income households in order to reduce fuel bills (p. 112). The review also supports that customers should help pay for improvements in water quality and infrastructure (p. 2). However, it notes that it is

necessary for customers to be consulted on these improvements before governments agree on them and recommends greater customer engagement (p. 145).

5.4.2 Scotland

Unlike England and Wales, Scotland's water services have remained public. Water and wastewater services are provided by a public company called Scottish Water. Between 2010 and 2015, Scottish Water invested over £470 in regulatory improvements to water infrastructure, such as upgrading of treatment works, water mains, sewers and networks (Scottish Water, 2015, para. 1). Subsequently, efficiency in operating costs have increased and the level of leakage has decreased from 1,104 Ml per day to 566 Ml per day in 2005-2006 (Water Industry Commission for Scotland, 2014, p. 3). Water charges are planned to increase by 1.6 percent per year between 2015 to 2016 and 2017 to 2018 (p. 3).

The government identified five principles of charging for water services between 2015 and 2021. The first is stable charges, which gives customers certainty about the maximum level of charges they will pay over a regulatory period (Scottish Government, 2015a, p. 1). The second principle is the level of charges, which stipulate that charges do not rise by more than inflation (p. 1). The third principle is full-cost recovery, which ensures that charges cover the full cost of the services provided (p. 1). The fourth is harmonized charges, which requires that charges for similar services provided to customers from a similar category, be the same for all customers in that category (p. 2). The final principle is cost-reflective charges, which ensures that charges are set to recover the cost to Scottish Water nationally of providing that service (p. 2).

The Water Industry Commission for Scotland issues three types of water use licenses: a general license, a specialist license and a self-supply license (2015, para 1). For each type of license, there is an application fee of £4,750 to cover the costs of processing the application (Water Industry Commission for Scotland, 2007, p. 1). However, if it is a single application for both types of licenses, the fee remains the same (p. 1). There is also an annual levy charged to cover the costs of ongoing licensing activities, which are determined by various factors, such as the estimated costs incurred by the Commission for that year (sec. 2). The Commission's total estimated annual costs are averaged at £1.2 million (Water Industry Commission for Scotland, 2010, p. 3). Each license is comprised of a fixed component and a variable component, which depends on the licensee's market share (p. 3). The fixed component is £60,000 per annum, unless the licensee has at least one registered customer, or evidence of its attempts to sign customers, in which case the fixed fee will be £3,000 per annum (p. 3). The variable component will be equal to a portion of the wholesale charges paid by the licensee (p. 3). The maximum variable component that a licensee could pay is £1.194 million (p. 4). Wholesale water is charged on a volumetric basis and varies for potable and non-potable water (Scottish Water, 2014a, p. 3). The volumetric charge for potable and non-potable water use between the allocated standard and up to 250,000 m^3 is £68.36 and £40.81 per m^3 respectively (p. 3). For potable and non-potable water use between 250,001 m^3 and 1,000,000 m^3, the volumetric charge is £57.72 and £31.75 per m^3 (p. 3). For potable and non-potable water use over 1,000,000 m^3, the volumetric charge is £35.43 and £15.16 per m^3 (p. 3).

Municipal rate structures for metered customers use a two-part rate with an annual fixed charge based on the size of the meter, and a declining block volumetric charge, along with a drainage

charge (Scottish Water, 2014b, para. 3). Unmetered water charges are based on the tax band for one's home (Scottish Water, 2014c, para. 1). Households are eligible for discounts if they have two or more adults and they already receive Council Tax Reductions (Scottish Water, 2014c, para. 3). Price limits for water are set by the Water Industry Commission of Scotland through a process called the Strategic Review of Charges (Scottish Government, 2015b, para. 1). This process involves all of the stakeholders of the Scottish Water Industry and aims to establish the lowest overall cost to meet objectives, along with price levels that meet the Minister's Principles of Charging (para. 1). The Ministers initiate the process and determine the length of the next regulatory period, which can vary for each review process (para. 2).

5.4.3 Northern Ireland

In Northern Ireland, water and wastewater services are provided by a government-owned company called Northern Ireland Water (Northern Ireland Water, 2015a, para. 1). The Northern Ireland Authority for Utility Regulation (NIAUR) is responsible for regulating the water and sewerage industry (NI Business Info, 2015, para. 7). The Northern Ireland Environment Agency (NIEA) issues permits and licenses, monitors compliance and is in charge of creating a regulatory charging policy for water use (NIEA, 2015, para. 1). Charging policies are based on the principle of full-cost recovery and are designed using the polluter pays principle (NIEA, 2010, p. 5). These policies also recognize the financial difficulties that businesses and industries face and plan to limit fee increases in accordance with the GDP deflator (NIEA, 2010, p. 7).

The license application fee to withdraw over 20 cubic meters of water per day is £150 and there is no application fee to withdraw between 10 and 20 cubic meters of water per day (NIEA, 2015, sec. 2). An annual charge is applied to license holders who withdraw more than 100 cubic meters per day (sec. 4). The minimum annual charge is £33, and the amount depends on five factors: volume, the source type, seasonality, consumptiveness and finances (NIEA, 2009, sec. 5).

Currently, residential water use is subsidized by the Department of Regional Development and households do not pay for their water use; only businesses and industries must pay for water use (the Journal, 2014, para. 6). However, over 35,000 meters have been installed at households since 2007 in order to detect leakages (the Journal, 2014, para. 1). Additionally, water infrastructure has experienced a severe lack of investment over recent years and requires £3 billion over the next few years to comply with EU water standards (BBC, 2007, para. 9). Water meter charges for non-domestic customers, such as businesses are planned to increase by an average of 2.4 percent between 2015 and 2020 (Utility Regulator, 2014, p. 14-16; O'Neill, 2015, para. 1). Water rates for metered non-domestic water customers are charged a standing charge based on the diameter of the water supply pipe and a variable charge based on the amount of water used per cubic meters (Northern Ireland Water, 2015a, para. 2). Large metered users that use over 100,000 m^3 for non-domestic purposes are also charged a large user tariff and a declining block volumetric rate (Northern Ireland Water, 2015b, para. 1). These rates are the same as the standard metered rate for non-domestic customers, plus a volumetric rate of £1.02 for annual water use up to 100,000 m^3 (Northern Ireland Water, 2014, p. 12). For annual water use between 100,001 and 250,000 m^3, the volumetric rate is £0.816 (p. 12). For annual water use between 250,001 and 500,000 m^3, the volumetric rate is £0.765, and for annual water use over 500,000 m^3, the volumetric rate is £0.714 (p. 12). Rates for unmetered customers are charged a standing charge and a variable charge based on the rateable Net Annual Value of their property (Northern Ireland Water, 2015a, para. 11). If a

meter is not able to be fitted at the property, customers can be billed an assessed charge, which is comprised of a standing charge and a variable charge based on an assessment of water consumption at the property (Northern Ireland Water, 2015a, para. 12). Table 9 below compares the dominant municipal rate structures, water license fees, volumetric charges and pricing principles in the U.K.

Table 9: Comparison of Water Rates, Principles, and Structures in the U.K.

Jurisdiction	England and Wales	Scotland	N. Ireland
Dominant municipal rate structure	Fixed charge based on rateable value of property	Two-part fixed fee and declining block rate	Two-part standing fee and volumetric rate (metered non-domestic)
Regional water license fees	Application fee: £2,000-£2,500	Application fee: £4,750 Fixed quarterly fee: £3,000 or £60,000	Application fee: £150 Min. annual charge: £33
Regional volumetric charge	Not applicable	Potable and non-potable water for use between the allocated standard and up to 250,000 m^3: £68.36 and £40.81 per m^3 Potable and non-potable water for use between £250,001 and £1,000,000 m^3: 57.72 and 31.74 per m^3 Potable and non-potable water use above 1,000,000 m^3: £35.43 and £15.16 per m^3	Annual water use up to 100,000 m^3: £1.02 Annual water use between 100,001 to 250,000 m^3: £0.816 Annual water use between 250,001 and 500,000 m^3: £0.765 Annual water use over 500,000 m^3: £0.714
Regional pricing principles	• Targeted price controls • Proportionate price setting • Effective incentives • Ownership, accountability and innovation • Flexibility and responsiveness	• Stable charges • Level of charges • Full-cost recovery • Harmonized charges • Cost-reflective charges	• Create a balance between the financial needs of businesses and the need to protect water resources • Full-cost recovery • Limit fee increases in line with GDP deflator

	• Transparency and predictability

Sources: Northern Ireland Environment Agency, 2009, sec. 5; Northern Ireland Environment Agency, 2010, p. 5-7; Northern Ireland Environment Agency, 2015, sec. 2-4; Northern Ireland Water, 2014, p. 12; Northern Ireland Water, 2015a, para. 1; Ofwat, 2011, sec. 6; Ofwat, 2012, p. 10-12; Scottish Government, 2015a, p. 1-2; Scottish Water, 2014a, p. 3; Scottish Water, 2014b, para. 1; Walker, 2009, p.31; Water Industry Commission for Scotland, 2007, p. 1.

6 DISCUSSION

The literature review and jurisdictional scan provided useful information that can inform BC's pricing principles. The water pricing principles and strategies that promote economic efficiency are: full-cost pricing, marginal cost pricing, two-part rate structures, water transfers, and regular rate reviews. The principles and strategies that promote social equity and water sustainability are: discount and rebate programs, public engagement and transparency, IBRs, seasonal rates the polluter pays principle, conservation awareness programs, and water banking.

The discussion uses the guiding principles of social equity, economic efficiency and sustainability to address the research questions, which are:

- What are the principles that can be used in BC to address efficiency, equity, and sustainability?
- What are the leading water entitlement (or water license) pricing policies that address efficiency, equity, and sustainability?
- What is the effectiveness of using these pricing schemes in a BC context?
- How does the BC water rate review structure compare against other leading Canadian and international jurisdictions?
- How could BC develop a better rate system?

The discussion begins by comparing water rates in BC with other provinces in Canada and international jurisdictions. It then discusses the prominent rate structures found in the scan, which addresses the fourth research question. Next, it discusses equity and affordability programs, along with conservation strategies, which address the second research question. Lastly, it discusses the pricing principles and strategies developed from the literature review and the jurisdictional scan and examines the effectiveness of using these in BC, which addresses the first and third research questions. The final question of developing a better rate system in BC will be addressed in the recommendations section.

6.1 Comparison of Water Rates in Canadian Provinces

BC has some of the lowest water rental rates in Canada, particularly for industrial water use, and is one of the last jurisdictions in North America to regulate groundwater use (the Province, 2015, para. 3). For example, Quebec charges up to $70 per million liters of water for industrial use and Nova Scotia charges over $140 for some uses, while BC charges $2.25 per million liters for purposes, such as water bottling and oil and gas operations (Fumano, 2015a, figure 1). Additionally, BC has among the lowest average volumetric residential rates in Canada, while Manitoba, Ontario and Saskatchewan have the highest (Environment Canada, 2011a, p. 7). Groundwater rates for industrial use are not adequately priced in the new BC water rate review, as license fees for industrial water use have been waived and residential groundwater is not licensed or regulated at all (the Province, 2015, para. 3). Low groundwater use fees for industrial use, such as oil and gas activities can contribute to water over-consumption and pollution, as higher license fees can help to deter and prevent unnecessary water pollution in those industries. In Ontario, ground water users have to apply for a permit if they extract more than 50,000 liters a day (Fumano,

2013, para. 16). However, Ontario has been criticized by the Ontario Environmental Commissioner for charging large industrial and commercial users too low a rate at $3.71 per million liters of water used (Horbulyk, 2010, p. 8). In BC, the proposed groundwater use fee increased from zero to 2.25 cents per million liters, which is lower than other provinces and there is still no fee for domestic groundwater use (the Province, 2015, para. 3). Table 10 below compares water rates in the four chosen Canadian jurisdictions.

Table 10: Comparison of Water Rates in Canada

Provincial	BC	Alberta	Saskatchewan	Ontario
water license fees	Application fee for domestic water use: $250; Application fee for irrigation water use: $250-$1000; Application fee for bottling water use: $1,000-$10,000 Application fee for mining water use: $500-$10,000; Application fee for oil and gas water use: $1,000-$10,000 Minimum annual rental fee for industrial water use: $50-$200	Annual water use license fees for water use between 62,501 and 12,500,000 cubic meters: $90-$1500	Water rights application fee for surface and groundwater: $100-$300; Surface water application for approval: $25-$100; $50 per title for surface water;	Water use permit fee for category 1&2 permits(low and medium risk): $750; Water use permit fee for category 3 permits (high risk): $3,000;
Volumetric charge	Volumetric fee for domestic water use: $2.25 per 1,000 m^3 Volumetric fee for bottling water use:	Not applicable	Industrial water use volumetric charge: $14.78 or $46.20 per m^3 depending on where the water is taken	Volumetric fee for industrial and commercial water use: $3.71 per million litres (applies to water bottling, beverage

	$2.25 per 1,000 m^3 Volumetric fee for irrigation water use: $0.85 per 1,000 m^3 Volumetric fee for mining water use: $1.30-$2.25 per 1,000 m^3 Volumetric fee for oil and gas water use: $2.25 per 1,000 m^3	from (applies to industries using water for processing; mineral exploration and mining; oil exploration and recovery; manufacturing; gravel washing; hydraulic pressure testing; thermal power generation)	manufacturing, fruit and vegetable canning, ready-mix concrete manufacturing, other non-metallic mineral product manufacturing, pesticide and fertilizer manufacturing, and other inorganic chemical manufacturing)

Sources: Alberta Ministry of Environment and Parks, 2015a, sec. 6; BC Ministry of the Environment, 2015a, p. 1-5; Government of Ontario, 2014, para. 1; Government of Ontario, 2015a, para. 3; Government of Ontario, 2015b, sec. 4; Saskatchewan Water Security Agency, 2015a, p. 19; Saskatchewan Water Security Agency, 2015b, sec. 4-5; Saskatchewan Water Security Agency, 2015e, para. 2.

A main difference between water rate policies in BC and other jurisdictions is the use of water right transfers, such as those policies in place in California, Alberta and many parts of Australia. While BC has allowed the use of water transfers as a method to promote water use efficiency and conservation, these issues are not in agreement with all of the public and environmental organizations, as some of these groups have voiced concerns over environmental risk and the possibility of water privatization (Government of British Columbia, 2011, para. 4; Brandes, Nowlan & Paris, 2008, p. 24). However, these issues could be addressed through stronger safeguards to protect the environment and encourage public participation (p. 24). BC would likely benefit from using a water trading approach similar to California, which utilizes a "no injury rule" to ensure no harm to other water users is caused from water transfers (Christensen & Lintner, 2007, p. 231).

A two-part rate structure with a fixed charge and a volumetric charge is the most common municipal rate structure found in the scan and can help support economic efficiency, and financial stability. Having a higher volumetric component supports economic efficiency by being closer to the marginal cost, while having a fixed charge can guarantee a revenue base. Thus, it is important to have a balance of both, as all jurisdictions share the need to increase fees to maintain and replace aging water infrastructure. Much of this financing has and will come from increasing residential and industrial water rates. In England and Wales, this issue was addressed through privatization and the creation of a private regulatory agency. However, sufficient price regulation for financial sustainability can also be attained through publicly-owned regulatory agencies, as is demonstrated

by some municipalities in Australia. Pricing principles that encompass full-cost recovery are common in Australia and the U.K. and are beginning to increase in Canada and the United States.

6.2 Equity, Affordability and Conservation Programs

Programs addressing social equity and affordability are not as prominent in BC as they are in other jurisdictions to compensate for increasing rates. Equity as described in BC's Pricing Principles refer to "differences in the value of water based on the type of right granted, intended use, location or scarcity of water" (Government of British Columbia, 2014, para. 5). This definition could be expanded to take into consideration affordability and fairness in water pricing, and accessibility and fairness in public engagement processes. Australia, the U.S. and England and Wales provide good examples of special water tariff structures and rebate programs reserved for low-income groups, such as the concession card program in Australia or the Community Energy Savings Program in England (OECD, 2002, p. 186). While these programs may be outside the scope of the provincial water rate review, similar programs would complement BC's Pricing Principles and the WSA.

Water pricing strategies for equity and affordability can go hand-in-hand with conservation pricing. An IBR structure with a low base charge that increases with the amount of water use is an effective strategy for both residential and industrial water use. It is the predominant rate structure in many American states, such as California and Nevada, and is used in several Canadian cities, such as Edmonton and Saskatoon. Rebate programs for water efficient technology, such as low-flow toilets, low water-intensity landscaping and irrigation technology, can make these upgrades more affordable, while also ensuring water conservation. These programs have been implemented in different ways in parts of Ontario, Nevada and South Australia. Similarly, educational awareness programs focused on water conservation can encourage more efficient water use and financial savings on water bills.

While these strategies prove effective for households and industries that comply with conservation and equity principles, other conservation strategies can be enforced, such as seasonal rates, effluent regulations and the polluter pays principle. Seasonal rates, such as water restrictions and increased rates during dry seasons, are common in California and other American states. Stronger water effluent regulations for hydraulic fracturing and other industrial operations can be implemented, as demonstrated in Alberta and some states, through using alternatives to fresh water, such as saline water and liquid petroleum, mandating the recycling of flowback, using seasonal regulations, and reporting the chemical composition of the fracturing fluid used. The polluter pays principle, as followed in Northern Ireland, can be implemented through full-cost pricing that encompasses environmental damages or through penalties on over-consumption. Policies for regulating water pollution, such as the Water Quality Program in Oregon, can also be used in cases where pollution can be prevented or mitigated.

Water conservation strategies through pricing are well established in Australia, as demonstrated by the Murray-Darling River Basin water entitlement purchasing program, the Water for the Future program, the National Water Recovery Strategy, and the National Water Initiative pricing policies. However, the key difference between conservation strategies in Canada and those in Australia is the use of water markets for entitlement trading. While these programs have been successful in Australia, they were developed for drought conditions and there are many arguments against water

trading, such as unequal access to water for some and loss of productive capacity in agriculture. Thus, water conservation programs should be adapted to the pricing structure and water policies in the local jurisdiction.

California's SGMA provides a lesson to BC that groundwater is best managed at the local or regional level and that government intervention is only necessary when local agencies are unable to manage groundwater sustainably. It also provides a useful approach to monitoring and reporting groundwater use by measuring groundwater pumping quantities and depth of wells, if metering is not currently feasible. While BC has different climate and hydrological conditions than California, it is possible for BC to prevent water scarcity situations by following California's lead in groundwater management.

Public engagement and transparency are principles that could help ensure both equity and financial and environmental sustainability, as outlined in Ontario's pricing principles. Engagement and transparency involve accessibility to various methods of communication, such as public forums and information online and/or in person. While much can be done to improve engagement and transparency of water pricing decision-making in jurisdictions in BC, the Government has demonstrated a good effort to ensure public engagement and availability of information on the WSA and the water rate review process. However, it is unclear if and when a future rate review will occur in BC. Other jurisdictions have indicated water rate increases over a defined period. It would be beneficial for the BC Government to do the same and to reveal their plans of a future review well in advance.

Many of the water pricing and management strategies discussed in this report can be applied to both residential water and water licensing governance. This overlap suggests that it would be beneficial for water management strategies to be integrated at different levels of government, including, federal, provincial and municipal governments, in order to achieve objectives. However, some strategies are better suited for one use or the other. For example, full-cost pricing is more commonly applied to residential water pricing. Yet, there are certain costs that are predominantly applied to industrial and agricultural water use, such as the cost of implementing new water legislation and social costs that can arise from the overuse of aquifers, which need to be financed through licensing. Other strategies, such as discount and rebate programs for low-income people are applicable to residential water use. Strategies, such as enforcing the polluter pays principle apply to industrial and agricultural water use. Table 11 below displays how the various water management strategies apply to provincial and municipal water governance.

Table 11: Water Management Strategies for Licensed and Residential Water Providers

User type	Pricing Objectives and Strategies		
	Efficiency	Equity	Sustainability
Licensed users	Full-cost pricing	Public engagement and transparency	The polluter pays principle
	Regular rate reviews		
	Water transfers		Conservation awareness programs

	Two-part rate structures		
Residential users	Full-cost pricing Regular rate reviews Marginal cost pricing Two-part rate structures	Discount and rebate programs for low-income people	Conservation awareness programs Increasing block rates (IBR) Seasonal rates Water banking

6.3 Effectiveness in British Columbia

Full-cost pricing would be most effective in supporting needed infrastructure repairs and improvements (Renzetti, 2007, p. 268). Some argue that employing full-cost pricing has a risk of harming low-income households who are least able to afford water, while others argue that constant rate structures are more harmful to low-income households (p. 269). However, maintaining water infrastructure is of benefit to everyone, and with the inclusion of water rate assistance programs, rates that encompass full-cost pricing are able to be equitable and financially efficient.

Water transfers and water banking have the potential to be effective in promoting water conservation and efficiency in BC if proper safeguards are in place. These transfers and the use of water banking, as practiced in California, would be particularly useful during times of water scarcity. Water conservation and efficiency could also be achieved through temporary transfers by renting water licenses to users, such as irrigators during times of excess water supply. The revenue from these trades could go toward water conservation programs and water service infrastructure or repairs.

Water reserve funds have proven effective in BC municipalities and government Ministries, such as the City of Dawson's Creek and the Ministry of Forests, Lands and Natural Resource Operations (Urban Systems, 2008, p. 11). These funds support financial sustainability and can be used to finance particular projects or to replace parts of water infrastructure. They would also support economic efficiency, as it reduces the need for costly loans and grants. They could be encapsulated in a two-part rate structure, where the fixed charge has a built-in reserve fund charge (Urban Systems, 2008, p. 11).

Water affordability assistance programs would be effective in promoting equity among water users, particularly during periods of water rate increases. However, one of the difficulties with water rate discount programs is that many low-income households are not metered, and not billed for water use (Renzetti, 2007, p. 268). Additionally, there is little consensus on the price for water services to address equity issues (p. 268). Generally though, volumetric pricing is more beneficial for low-income households than constant rate pricing (p. 268).

Regular water rate reviews are beneficial for both residential water use and water licensing. These reviews can help to finance water service infrastructure upgrades for residential water service providers and new provincial water policy legislation, such as the WSA. Frequent rate increases that occur gradually would allow the province to test the feasibility of new rates, while also allowing water users to adjust. England and Wales implement water rate reviews every five years and set separate price limits for retail and wholesale licenses. More frequent reviews are necessary to achieve financial efficiency, and can then decrease in frequency, as desired revenues are achieved.

7 RECOMMENDATIONS

There is much room to increase licensing fees in the next projected water rate review and to consider volumetric conservation rate structures such as IBRs to address future impacts of climate change on water resources. The following recommendation would help municipalities and the Province to support progress on the *Living Water Smart: BC's Water Plan* actions and targets and promote the policies enshrined in the WSA.

1. Adopt Conservation Rate Structures

Volumetric rate structures, such as IBRs for domestic and industrial water use, are best for promoting conservation, and have the potential to promote the BC water principles of environmental and economic efficiency, along with fairness and equity. Issues of equity for large water-using households with lower incomes can be addressed at the municipal level by offering lower rates based on the ratable value of a property, as practiced in the U.K and some jurisdictions in Canada. Seasonal rates with higher charges for summer months is another effective method to promote conservation, and is a more equitable approach, as price changes for summer water use, such as lawn and garden watering, have a lesser impact for low-income households. These new rate structures are relatively simple to administer and understand. However, they require a wider use of metering in the province, which can be promoted through education and incentives to residents. Education and incentives can encourage water conservation by communicating potential cost savings to households, indicating the environmental cost of water use, or by increasing rates for households without meters. Where metering is not feasible, there should be greater monitoring and reporting of water use, particularly for large-scale industrial and agricultural purposes.

2. Implement Full-Cost Pricing

Implementing full-cost pricing for residential, commercial and industrial water use would help ensure financial sustainability, as is demonstrated in the Ontario Water and Sewage Systems Act. Full-cost pricing allows for the finance of source protection and administration costs. For residential water use, it can be achieved through building depreciation values of water infrastructure, environmental costs, and utility improvement, expansion and replacement costs into rate structures (Urban Systems, 2008, p. 8). For water licensing, it can be achieved through including administration, environmental costs, and implementation costs of new legislation into license fees. It is also considered a fair approach to pricing, as customers pay for what they receive. However, full-cost pricing usually requires large rate increases, which should be implemented gradually over five or more years.

3. Regulate Effluent Discharge and Enforce the Polluter Pays Principle

While the government is updating its compliance and enforcement provisions in the WSA, it is recommended that further provisions be made by the province for preventing and penalizing water pollution. For industrial and agricultural water users that do not comply with water pollution regulations, water rate policies should increase penalties related to the polluter pays principle to fully compensate for the cost of damages done to the environment and to act as an incentive to reduce water effluent discharge. While this principle normally applies to wastewater, it can also be applied to industries that consume beyond their limit, which supports the WSA policy directive of water use efficiency, and can involve both monetary and non-monetary penalties. Revenue from

this can be used to support full-cost recovery, and any excess revenue can be returned to citizens through conservation programs. To prevent water pollution, greater regulations can be put in place to limit the number of harmful chemicals used in oil and gas processes and the amount of effluent produced. In addition, alternative approaches to oil and gas development should be promoted to ensure sustainable supplies of fresh water.

4. Improve Equity and Fairness for Low-income Residential Water Users

As rates increase over time for water license holders and residential water service providers, there is a need for municipal governments to put greater focus toward equity and fairness by offering more discounts and low volume programs for low-income water users, such as the Lifeline assistance programs and leak fixture repair programs used in the U.S., or debt repayment programs, as those used in the U.K. and Australia. These types of programs in BC would support the Minister of the Environment, Mary Polak's statement that "fairness and affordability are the cornerstone of our modernized water legislation" (Government of British Columbia, 2015e, para. 8). The province can ensure this by using an integrated approach to water management strategies between provincial and municipal governments.

Two-part rate structures with a fixed and variable charge are considered a fair type of rate structure, as fixed charges can be tailored to different meter sizes and the volumetric charge can be adjusted through usage (Urban Systems, 2009, p. 5). The concept of ability-to-pay is important to consider for creating an equitable rate structure. The OECD's measure of affordability is to ensure fees are below three percent of household income. According to Statistics Canada, the average family household income for BC in 2013 was $74,150, while for a low-income family of four, the average market income in Canada was $39,682 in 2011 (Statistics Canada, 2015, table 1; Statistics Canada, 2011, table 1). Given that three percent of 39,682 is 1,190.46, water rates in BC could increase significantly before being considered inequitable.

5. Implement Regular Water Rate Reviews

It is recommended that water rate reviews for provincial water licenses occur every five to seven years, as practiced by Ofwat in England and Wales, and recommended in Ontario's Water Strategy, because increases to achieve full-cost pricing should occur gradually to allow water users to adjust. However, rate reviews can occur more frequently to begin with, until rates become stabilized and full-cost recovery is achieved over time. As part of these reviews, it is important to have an accessible and transparent public engagement process that involves key stakeholders, environmental non-governmental organizations (NGOs), and citizens. The timing of these reviews should be publicly announced with enough time to allow for a thorough public engagement period. Additionally, it would be useful to create a body of water policy experts that could gather information and be consulted on water pricing for future reviews in order to help determine appropriate pricing policies and rate structures (Brandes, 2014, p. 5). These policy experts could come from NGOs, academia or government bodies.

8 CONCLUSION

The province and residents of BC identified the need to increase water rates and to promote water conservation. This report covers a wide range of topics, including water pricing policies and structures to promote economic efficiency, equity, and water sustainability, and provides recommendations for the next provincial water rate review.

Key findings from the literature are that volumetric user pricing is the most effective method of promoting water conservation. There are some common pricing principles, such as full-cost recovery and marginal cost pricing that can promote economic efficiency in all jurisdictions. However, it is important to tailor the rate structure to the local area in order to balance equity and sustainability issues. Certain rate structures, such as IBRs with base rates below three percent of average household income, can be put in place to address affordability issues, or rebate programs can be created for low-income residential water users. To ensure water sustainability, rates should discourage high consumption and encompass the environmental costs of using the water.

The jurisdictional scan identified 12 jurisdictions with highly developed water pricing policies and structures, some of which could be adopted in BC. It showed that water rates and license fees varied significantly between jurisdictions. The principles and structures identified in the jurisdictions include full-cost and marginal cost pricing and IBRs. The use of these principles and pricing structures, along with other conservation rate structures and affordability programs can support the implementation of the WSA. The majority of jurisdictions used two-part rates with a fixed fee and a volumetric rate and utilized a publicly-owned water regulator responsible for setting and limiting water license fees and rates. However, the amount of these charges varied widely. The government of BC has much space to increase rates to achieve full-cost pricing while still being considered equitable.

As the government begins to implement the WSA in 2016, further research and analysis will be needed to determine if the proposed changes are being followed, and what actions are still needed. As a result of this new legislation, greater local watershed governance will be required to follow through with these changes at the watershed level, and further research will be needed on how best to fund this governance. The proposed water licensing fees are not likely sufficient to significantly affect large water usage or to cover the full costs of water management proposed in the WSA. Thus, further research is needed to determine how to best to manage BC's water for sustainability.

9 APPENDIX A: OVERVIEW OF CURRENT AND 2016 FEES AND RENTALS IN BC

Table A-12: Overview of Current and 2016 Fees and Rentals

Water Use Purpose	Application Fees		Annual Water Rentals (volume-based rate is per 1,000m^3 [or 1,000,000 litres] unless a flat fee is otherwise indicated)			
			Current Rates		2016 Rates	
	Current Rates ($)	2016 Rates ($)	Minimum ($)	Volume-based ($)	Minimum ($)	Volume-based ($)
Irrigation and associated industrial agricultural uses	100-400	250-1,000	25	0.60	50	0.85
Aquaculture	150	250-1,000	100	0.08	200	0.11
Conservation	150	250	25	0.01, 25 (flat)	No change	0.02, 25 (flat)
Land Improvement	150	250-500	25	25 (flat)	50	50 (flat)
Domestic and associated industrial domestic uses	100-150	250	25	0.60	50	2.25
Industrial and Commercial (including Mineral Trading)	$500-2,000	1,000-10,000	100	0.85	200	2.25
Pulp Mills	10,000	1,000-10,000	100	0.85	200	1.30 (use), 0.85 (capacity)
Cooling	500	1,000	100	0.85	200	1.30
Mining	500-5,000	1,000-10,000	100	1.10	200	2.25
Mining (Hydraulic)	5,000	500-1,000	100	0.065	200	1.30
Mining (Placer)	500	500-1,000	100	0.45	200	1.30
Oil and Gas	500	1,000-10,000	100	1.10	200	2.25
Storage (power, non-power)	150-2,000	250-5,000	25	0.01	No change	0.02
Water Bottling	500-2,000	1,000-10,000	100	0.85	200	2.25
Waterworks and Local Authorities	500-10,000	1,000-10,000	100	1.10	200	2.25
Power (Residential)	100	250	100	0.01	200	0.02
Power (Commercial)	5,000	250-10,000	Formula	Formula	No change	No change
Power (General)	5,000-10,000	250-10,000	Formula	Formula	No change	No change
Permit over crown land (dams)	100-2,000	250-5,000	50	120/hectare	100	No change
Permit over crown land (flooding/works other than dams)	100-2,000	250-5,000	10	7.50/hectare	20	No change
Other fees:						
Change approvals	130	250	n/a	n/a	n/a	n/a
Drilling authorizations	-	250	n/a	n/a	n/a	n/a

New rates will come into effect in 2016. Unless specified, all rates apply to both surface water and groundwater. Domestic groundwater users will not pay fees as they are excluded from licensing requirements. Application fees for existing non-domestic groundwater users will be waived for the first 12 months after the *Water Sustainability Act* is brought into effect in 2016.

Note: Adapted from http://www.env.gov.bc.ca/wsd/water_rights/water_rental_rates/cabinet/Overview_of_Fees_and_Rentals_Feb2015.pdf. Copyright 2015b by the BC Ministry of the Environment.

10 REFERENCES

ABC News. (2014). South Australians paying highest water prices in the nation: Essential Services Commission. Retrieved August 13, 2015, from http://www.abc.net.au/news/2014-04-22/south-australians-paying-highest-water-prices-in-australia/5403700

Alberta Ministry of the Environment and Parks. (2015a). Hydraulic Fracturing. Retrieved October 15, 2015, from http://esrd.alberta.ca/water/water-conversation/hydraulic-fracturing.aspx

Alberta Ministry of the Environment and Parks. (2015b). Water Used for Oilfield Injection Purposes. Retrieved October 18, 2015, from http://esrd.alberta.ca/focus/state-of-the-environment/water/surface-water/pressure-indicators/water-used-for-oilfield-injection-purposes.aspx

Alberta Ministry of the Environment and Parks. (2015c). *Water Act : Licenses Facts at Your Fingertips*. Retrieved from http://environment.gov.ab.ca/info/library/8817.pdf

Alberta Water Council. (2007). *Water Conservation, Efficiency and Productivity: Principles, Definitions, Performance Measures and Environmental Indicators*. Retrieved from http://albertawatercouncil.ca/Portals/0/pdfs/CEP_Definitions_Final_Report.pdf

Alberta Water Portal. (2013). Water Licenses, Transfers, and Allocation. Retrieved September 3, 2015, from www.aer.ca

Alessi, M., & Treyer, S. (2013). Economic models and water pricing towards water efficiency. *Intereconomics*, *48*(3), 150–156. http://doi.org/10.1007/s10272-013-0456-9

Alliance for Water Efficiency [AWE]. (2014a). *Building Better Rates for an Uncertain World: Balancing Revenue Management, Resource Efficiency, and Fiscal Sustainability*. Chicago.

Alliance for Water Efficiency. (2014b). *Sales Forecasting and Rate Model User Guide*.

Altmann, D. (2007). *Marginal Cost Water Pricing: Welfare Effects and Policy Implications using Minimum Cost and Benchmarking Models, with Case Studies from Australia and Asia*. University of Adelaide. Retrieved from https://digital.library.adelaide.edu.au/dspace/bitstream/2440/39464/8/02whole.pdf

Australian Government. (2010). National Water Initiative Pricing Principles Regulation Impact Statement. Retrieved August 14, 2015, from http://www.environment.gov.au/water/publications/action/pubs/ris-nwi-pricing-principles.pdf

AWWA. (2000). *Principles of Water Rates, Fees, and Charges - Manual of Water Supply Practices* (5th ed.). Denver: American Water Works Association.

Ayoo, C. A., & Horbulyk, T. M. (2008). The Potential and Promise of Water Pricing. *Journal of International Affairs*, *61*(2), 91.

Barlow, M. (2012). *Paying for Water in Canada in a Time of Austerity and Privatization: A discussion paper*. Ottawa. Retrieved from http://canadians.org/sites/default/files/publications/Water-Pricing-June2012.pdf

BBC. (2007). Why doesn't Northern Ireland have water bills? Retrieved August 14, 2015, from http://news.bbc.co.uk/2/hi/uk_news/magazine/6498983.stm

BC Ministry of the Environment. (2015a). *Detailed Fees and Rentals Schedule to be Implemented in 2016* [Table]. Retrieved from http://www.env.gov.bc.ca/wsd/water_rights/water_rental_rates/cabinet/F-R_fees_Table-Feb4_Final.pdf

BC Ministry of the Environment. (2015b). *Overview of Current and 2016 Fees and Rentals* [Table]. Retrieved from http://www.env.gov.bc.ca/wsd/water_rights/water_rental_rates/cabinet/Overview_of_Fees_and_Rentals_Feb2015.pdf

Bithas, K. (2008). The sustainable residential water use: Sustainability, efficiency and social equity. The European experience. *Ecological Economics*, *68*(1-2), 221–229. http://doi.org/10.1016/j.ecolecon.2008.02.021

Black & Veatch. (2012). *2012 Strategic Directions in the U.S. Water Utility Industry*. Retrieved from http://bv.com/docs/default-source/reports-studies/2012_water_utility_survey_book_web.pdf

Brandes, O. M., O'Riordan, T., O'Riordan, J., Brandes, L. (2014). *A blueprint for watershed governance in British Columbia*. Victoria, British Columbia: Polis Project on Ecological Governance, University of Victoria. Retrieved from http://uvic.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwdV1NC8IwDA06L94UFT-hf2BSt3YfRxGHBy-Cd1m2VgXxpPj3TbQDlXlsD6EfIXlJea8AYTCX_k9MkAqljQq0VodxnKAupE2VRkvod5FH-M0mg0oV4lc50RFP_r_P8K9ZlLSa0KTiiwkdu23lXQSkKVUpyewuhuUENYLIiT5VY_Wh_ekibNYBj2kHXWiYaw-Spc

Brandes, O. (2013). *Water Act Modernization Submission*. Victoria. Retrieved from http://poliswaterproject.org/sites/default/files/POLISWAMSubmission_November2013.pdf

Brandes, O. (2014). *Detailed Response from the POLIS Water Sustainability Project to the Pricing B.C.'s Water Discussion Paper*. Victoria. Retrieved from http://poliswaterproject.org/sites/default/files/POLISWSAPricingSubmission_FINAL_Apr1.pdf

Brandes, O., Carr-Wilson, S., Curran, D., Simms, R. (2015). *Awash With Opportunity Ensuring the sustainability of British Columbia's new water law*. Victoria. Retrieved from http://poliswaterproject.org/sites/default/files/POLIS-Awash-L4b.compressed_0.pdf

Brandes, O., Nowlan, L., Paris, K. (2008). *Evolving Water Allocations and the Potential and Limits of Water Markets in Canada*.

Brandes, O., Renzetti, S., Stinchcombe, K. (2010). *Worth Every Penny: A Primer on Conservation-Oriented Water Pricing*. Victoria. Retrieved from http://polisproject.org/files/pub_database/pricing_primer_final.pdf

Brandt, P. (2005). Conservation Pricing: An Alternative to Traditional Rate Structures. In G. Raftelis (Ed.), *Water and Wastewater Finance and Pricing: A Comprehensive Guide* (3rd ed., pp. 236–255). Boca Raton: Taylor & Francis.

Business Dictionary. (2015). Marginal Cost. Retrieved November 26, 2015, from http://www.businessdictionary.com/definition/marginal-cost.html

California Environmental Protection Agency. (2014). Water Rights: Statement of Water Diversion and Use Program. Retrieved November 28, 2015, from http://www.waterboards.ca.gov/waterrights/water_issues/programs/diversion_use/

California Environmental Protection Agency. (2015). Fiscal Year 2015-16 Proposed Fee Schedule Summary. Retrieved October 22, 2015, from http://www.waterboards.ca.gov/waterrights/water_issues/programs/fees/docs/fy15_16_fnl_fee_schd_sum.pdf

Car-Wilson, S., Brandes, O., Dobell, R. (2015). *British Columbia's New Water Pricing Regime*. Victoria. Retrieved from http://poliswaterproject.org/sites/default/files/B.C.'sNewWaterPricingRegimeBrief_FINAL.pdf

CBC. (2013). New B.C. Water Act to regulate industrial groundwater use. Retrieved October 15, 2015, from http://www.cbc.ca/news/canada/british-columbia/new-b-c-water-act-to-regulate-industrial-groundwater-use-1.2125774

CBC. (2014). Alberta fracking licenses up, prompting NDP water concerns. Retrieved October 18, 2015, from http://www.cbc.ca/news/canada/calgary/alberta-fracking-licences-up-prompting-ndp-water-concerns-1.2523398

CBC. (2015). SaskWater to increase drinking water rates in select communities. Retrieved August 13, 2015, from http://www.cbc.ca/news/canada/saskatchewan/saskwater-to-increase-drinking-water-rates-in-select-communities-1.2946397

CCME Water Use Efficiency Task Group. (1994). *National Action Plan to Encourage Municipal Water Use Efficiency*. Retrieved from http://publications.gc.ca/collections/collection_2014/ec/En108-4-66-1994-eng.pdf

Christensen, A., Lintner, R. (2007). Trading Our Common Heritage? The Debate Over Water Rights Transfers in Canada. In K. Bakker (Ed.), *Eau Canada The Future of Canada's Water* (pp. 219–241). Vancouver: UBC Press.

City of Calgary. (2015). Water and wastewater rates. Retrieved August 13, 2015, from http://www.calgary.ca/UEP/Water/Pages/Customer-service/Water-and-wastewater-rates/Water-and-Wastewater-Rates.aspx

City of Niagara Falls. (2015). Water Information. Retrieved May 20, 2015, from https://www.niagarafalls.ca/city-hall/finance/water-information.aspx

City of Portland. (2015). Program Overview. Retrieved September 10, 2015, from https://www.portlandoregon.gov/bes/article/390568

City of Saskatoon. (2015). Water & Wastewater Utility Rates. Retrieved August 14, 2015, from https://www.saskatoon.ca/services-residents/power-water/water-wastewater/water-wastewater-utility-rates

City of Surrey. (2015). Utility Rates. Retrieved August 14, 2015, from http://www.surrey.ca/city-services/4690.aspx

City of Toronto. (2015). Water Rates. Retrieved August 14, 2015, from http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=a916ff0e43db1410VgnVCM10000071d60f89RCRD&vgnextchannel=f554fc2beecb1410VgnVCM10000071d60f89RCRD

City of Vancouver. (2015). Flat utility rates. Retrieved August 14, 2015, from http://vancouver.ca/home-property-development/flat-rates.aspx

Corporation of the District of Tofino. Water Utility Rates and Regulation Bylaw No. 574, 1992 (2015). Canada.

Crase, L., Pawsey, N., Cooper, B. (2015). Water Pricing in Australia: Unbundled Politics, Accounting, and Water Pricing. In J. Dinar, A., Pochat, V., Albiac-Murillo (Ed.), *Water Pricing Experiences and Innovations* (pp. 15–39). Springer International Publishing.

CRD. (2015). Water Rate Comparison. Retrieved August 13, 2015, from https://www.crd.bc.ca/service/drinking-water/account-information-by-area/billing-accounts/rates/water-rate-comparison

Dachraoui, K., & Harchaoui, T. (2004). *Water Use, Shadow Prices and the Canadian Business Sector Productivity Performance*. Ottawa.

De Azevedo, L. G. T., & Baltar, A. M. (2005). Water Pricing Reforms: Issues and Challenges of Implementation. *International Journal of Water Resources Development*, *21*(1), 19–29. http://doi.org/10.1080/0790062042000316794

Department of the Environment. (2014). *Environmental water recovery strategy for the Murray-Darling Basin*. Retrieved from http://www.environment.gov.au/system/files/resources/4ccb1c76-655b-4380-8e94-419185d5c777/files/water-recovery-strategy-mdb2.pdf

Department for Environment, Food, and Rural Affairs. (2008). *Future Water: The Government's water strategy for England*. Norwich. 1-98. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69346/pb13562-future-water-080204.pdf

Department for Environment, Food, and Rural Affairs. (2013). *Managing Abstraction and the Water Environment*. Retrieved from https://consult.defra.gov.uk/water/abstraction-reform/supporting_documents/abstractreformconsultmanage20131217.pdf

Department of the Environment, Water, Heritage and the Arts. (2010). *Securing our water future*. *Australian Planner* (Vol. 41). Canberra.

Dewees, D. N. (2002). Pricing municipal services: The economics of user fees. *Canadian Tax Journal / Revue Fiscale Canadienne*, *50*(2), 586-599. Retrieved from http://www.ctf.ca/ctfweb/Documents/PDF/2002ctj/2002ctj2_dewees.pdf

Dinar, A. (2000). *The political economy of water pricing reforms*. Washington, D.C; Oxford: World Bank. Retrieved from http://uvic.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwfVw9C8IwED20Lm5KFT8hf6ClNkljZ1EcXAT30rQ5F9FSB_Hfe7GtqIhjMhz54t595D0AHvqB9-UTAqEDjDKNKLlSSy2zAGMhNVL0u0gj_ckmg0YV4ls5sSae_OnPhCokiG1Dm5IvS-jY714VF0IrTtFCpatDqCVj0UjwNOPoTfuz8cabHjiWd9CHljm74NP1sa

Dinar, A., Pochat, V., Albiac-Murillo (2015). (Eds.), *Water Pricing Experiences and Innovations* (Vol. 9, pp. 63–81). Springer International Publishing. http://doi.org/10.1007/978-3-319-16465-6

Donnelly, K., & Christian-Smith, D. J. (2013). *An Overview of the "New Normal" and Water Rate Basics*. Retrieved from http://www.pacinst.org/wp-content/uploads/2013/06/pacinst-new-normal-and-water-rate-basics.pdf

Duff, D. G. (2004). Benefit Taxes and User Fees in Theory and Practice. *University of Toronto Law Journal*, *54*(4), 391–447.

Easter, K. W., & Renwick, M. E. (2004). *Economics of water resources: institutions, instruments and policies for managing scarcity*. Burlington, VT; Aldershot, Hants, England: Ashgate. Retrieved from

http://uvic.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwY2AwNtIz0EUrEwxMkgzSzJKT0tJMjc3NLZJMkw3SLE1Mk9KArV_DRLMk1N1kDLBTIdBPToRuPMEzPwOscIGNZGYGZmDnC7ShI9AH3Fc3NQFW88DKHnrkDoxvhHTWJ2zps5sgAwton4EQA1NqngiDDGyDcLFCfppCObABWKRQBB1ZLxZlkHZzDXH20AUZEg8dcI

Economics Help. (2015). Economic Efficiency. Retrieved August 20, 2015, from http://www.economicshelp.org/microessays/costs/efficiency/

Elnaboulsi, J. C. (2009). An Incentive Water Pricing Policy for Sustainable Water Use. *Environ Resource Econ*, *42*, 451. http://doi.org/10.1007/s10640-008-9218-8

Environment Canada. (2009). *Municipal Water and Wastewater Survey Municipal Water Use 2009 Summary Tables* (Vol. 1000). Ottawa.

Environment Canada. (2011). *2011 Municipal Water Use Report*. Ottawa. Retrieved from http://www.ec.gc.ca/Publications/B77CE4D0-80D4-4FEB-AFFA-0201BE6FB37B/2011-Municipal-Water-Use-Report-2009-Stats_Eng.pdf

Environment Canada. (2011b). Residential Water Use in Canada. Retrieved November 1, 2015, from https://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=7E808512-1

Environment Canada. (2012). *2011 Municipal Water Pricing Report Municipal Water Pricing 2009 Statistics*. Ottawa: Government of Canada. Retrieved from http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=992156D4-2599-4026-9B4C-47855D26CCB8

Environmental Protection Agency. (2012). Infrastructure Financing & the Price of Water Services. Retrieved August 14, 2015, from http://water.epa.gov/infrastructure/sustain/financing_priceofwater.cfm

Epcor. (2015). Changes to Your Water Rate. Retrieved August 14, 2015, from http://www.epcor.com/news/2012/pages/04-01-edmonton-water-rates.aspx

Essential Services Commission of South Australia. (2015). Retail Pricing. Retrieved August 15, 2015, from http://www.escosa.sa.gov.au/water-overview/retail-pricing.aspx

Fee Schedule. (2015). Retrieved September 7, 2015, from www.oregon.gov/owrd/PUBS/docs/forms/fee_schedule_1_15.pdf

FracFocus. (2015). Hydraulic Fracturing Water Usage. Retrieved October 15, 2015, from https://fracfocus.org/water-protection/hydraulic-fracturing-usage

Freeman Saunders, M. (1998). *Water Affordability Programs*. AWWA Research Foundation.

Fumano, D. (2013). B.C. can take advantage of lessons learned elsewhere when it comes to water laws. Retrieved August 14, 2015, from

http://www.theprovince.com/news/bc/take+advantage+lessons+learned+elsewhere+when+comes+water+laws/10175131/story.html

Fumano, D. (2015a). Outrage boils over as B.C. government plans to sell groundwater for $2.25 per million litres. Retrieved August 14, 2015, from http://www.theprovince.com/news/Outrage+boils+over+government+plans+sell+groundwater+million+litres/10865416/story.html

Fumano, D. (2015b). B.C. government criticized for water-rates "flip-flop." Retrieved November 17, 2015, from http://www.theprovince.com/news/government+criticized+water+rates+flip+flop/11519206/story.html

Gage, A. (2013). Should industry frack with our water? Retrieved October 18, 2015, from http://wcel.org/resources/environmental-law-alert/should-industry-frack-our-water

Gage, A. (2014). The strengths and weaknesses of the new Water Sustainability Ac. Retrieved September 21, 2015, from http://wcel.org/resources/environmental-law-alert/strengths-and-weaknesses-new-water-sustainability-act

Gage, A. (2015). Pricing the priceless: Why BC's new water prices don't violate NAFTA. Retrieved August 14, 2015, from http://wcel.org/resources/environmental-law-alert/pricing-priceless-why-bcs-new-water-prices-dont-violate-nafta

Gary Fiske and Associates Inc. (2012). *Water Resources Planning and Management*. Portland. Retrieved from https://www.portlandoregon.gov/water/article/408883

Gaur, S. (2007). Policy Objectives in Designing WATER RATES. *Journal (American Water Works Association)*, *99*(5), 112–116. Retrieved from http://uvic.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwlV1JS8QwFA4yJz24j44L5CxUm705ybgMnhRc0FtJ0gQchjpu_9-Xpi3q4EEohdJSmtf240ve976HEKPHefYLE4j2pAicWh1kQYOzrgpFqIxwnnFm-M9qsn4lI4osG5Vgk9MHumRn_gRgN3ZHF6fz1yx2j4pZ1raVRixi5yp2cLg-0z0gk9biu5FhifypkX4uwG

Gibbins, R., Zehnder, A. (2010). *Toward a Unique Solution for Sustainable management of water resources*. *International Journal of Water Resources Development* (Vol. 4).

Gies, E. (2014). As water crisis deepens, California finally passes groundwater regulation. Retrieved November 25, 2015, from http://www.theguardian.com/sustainable-business/2014/sep/03/california-drought-water-groundwater-regulation-bill-law-farm

Global Water Partnership. (2012). IWRM Principles. Retrieved August 14, 2015, from http://www.gwp.org/en/The-Challenge/What-is-IWRM/IWRM-Principles/

Goldstein, J. (1986). Full-Cost Water Pricing. *Journal (American Water Works Association)*, *78*(2), 52–61. Retrieved from http://uvic.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwY2AwNtIz0EUrE4DVGrCkTDGwSDVLNLa0SDNNMUtLM0kxB_brjJNSLJJRd5PBRzJAiyzBqwTBc_rA5lJSTqq-iaGRObDRbmlfUKgLuj0KNMsKvUoDtIndxBx0g4OfkyW8QDaEHvENXoZlahCBuvQQXJG4CTDAJvBhC0jgs8qQzS6YpzSS6jhBBn5oI1PBEZIqhB

Government of Alberta. (2011). *Alberta Environment Guide to Groundwater Authorization*. Retrieved from http://environment.gov.ab.ca/info/library/8361.pdf

Government of Alberta. (2015). Water Act. Retrieved August 14, 2014, from http://aep.alberta.ca/water/legislation-guidelines/water-act.aspx

Government of Australia. (2010a). National Water Initiative. Retrieved August 10, 2015, from http://www.environment.gov.au/topics/water/australian-government-water-leadership/national-water-initiative

Government of Australia. (2010b). National Water Initiative pricing principles. Retrieved August 10, 2015, from http://www.environment.gov.au/topics/water/australian-government-water-leadership/national-water-initiative/national-water

Government of Australia. (2011). *Government Response to Inquiry into the impact of the Guide to the Murray-Darling Basin Plan in Regional Australia*.

Government of Australia. (2014). *Water Recovery Strategy for the Murray-Darling Basin*. Retrieved from http://www.environment.gov.au/system/files/resources/4ccb1c76-655b-4380-8e94-419185d5c777/files/water-recovery-strategy-mdb2.pdf

Government of Australia. (2015). Victoria. Retrieved August 12, 2015, from http://www.nwc.gov.au/publications/topic/water-industry/australian-water-markets-report-2012-13/4.2-victoria

Government of British Columbia. (2011). Progress on Living Water Smart Actions. Retrieved August 10, 2015, from http://www.livingwatersmart.ca/progress.html

Government of British Columbia. (2013). *A Water Sustainability Act for B.C. Legislative Proposal*. Victoria. Retrieved from http://engage.gov.bc.ca/watersustainabilityact/files/2013/10/WSA_legislative-proposal_web-doc.pdf

Government of British Columbia. (2014). Pricing BC's Water: what do you think? Retrieved August 14, 2015, from http://engage.gov.bc.ca/watersustainabilityact/2014/03/14/blog-post-10-pricing-bcs-water-what-do-you-think/

Government of British Columbia. (2015a). Water Sustainability Act. Retrieved August 14, 2015, from http://engage.gov.bc.ca/watersustainabilityact/the-proposal/

Government of British Columbia. (2015a). Fee changes to ensure long-term protection of B.C. water. Retrieved August 14, 2015, from https://news.gov.bc.ca/stories/fee-changes-to-ensure-long-term-protection-of-bc-water

Government of British Columbia. (2015c). Regulations. Retrieved August 23, 2015, from http://engage.gov.bc.ca/watersustainabilityact/regulations/

Government of British Columbia. (2015d). *Strengthening Compliance with British Columbia's New Water Sustainability Act*.

Government of British Columbia. (2015e). Proposed water policies: what do you think? Retrieved August 26, 2015, from http://engage.gov.bc.ca/watersustainabilityact/2015/07/30/blog-post-16-proposed-water-policies-what-do-you-think/

Government of British Columbia. (2015f). Progress on Living Water Smart Actions. Retrieved August 13, 2015, from http://www.livingwatersmart.ca/progress.html

Government of California. (2015a). Legislation. Retrieved November 23, 2015, from http://groundwater.ca.gov/legislation.cfm

Government of California. (2015b). SGM Sustainable Groundwater Management. Retrieved November 23, 2015, from http://www.water.ca.gov/groundwater/sgm/

Government of NSW. (2015). Metering. Retrieved November 25, 2015, from http://www.water.nsw.gov.au/water-licensing/metering

Government of Ontario. (2005). Expert Panel Calls for Major Reforms to Ontario's Water Systems. Retrieved August 14, 2015, from http://news.ontario.ca/archive/en/2005/07/22/Expert-Panel-Calls-for-Major-Reforms-to-Ontario039s-Water-Systems.html

Government of Ontario. (2014). Water taking report and charges. Retrieved September 20, 2015, from http://www.ontario.ca/page/water-taking-report-and-charges

Government of Ontario. (2015a). Water taking report and charges. Retrieved September 23, 2015, from http://www.ontario.ca/page/water-taking-report-and-charges

Government of Ontario. (2015b). Permits to take water. Retrieved September 2, 2015, from http://www.ontario.ca/environment-and-energy/permits-take-water

Government of South Australia. (2014). Licenses and Permits. Retrieved September 20, 2015, from http://www.environment.sa.gov.au/licences-and-permits/water-licence-and-permit-forms/statewide

Government of South Australia. (2015). Water licenses and permits. Retrieved September 20, 2015, from http://www.environment.sa.gov.au/managing-natural-resources/water-use/water-planning/water-licences-and-permits

Griffin, R. C. (2006). *Water Resource Economics: The Analysis of Scarcity, Policies and Projects*. Cambridge: MIT Press.

Ground Work. (2015). Regulations. Retrieved November 15, 2015, from http://groundwork.iogcc.ok.gov/topics-index/hydraulic-fracturing/hydraulic-fracturing-regulations

Guy, M., and McCandless, S. (2012). Social Equity: Its Legacy, Its Promise. *Public Administration Review*, *72*(s1), s5–s13. http://doi.org/10.1111/j.1540-6210.2012.02635.x

Hall, K. B. (2011-2012). Regulations of Hydraulic Fracturing Under the Safe Drinking Water Act. *Buffalo Environmental Law Journal*, *19*, 40.

Hanak, E., Stryjewski, E. (2012). *California's Water Market, By the Numbers: Update 2012*. Retrieved from http://www.ppic.org/content/pubs/report/R_1112EHR.pdf

Hatzenbuhler, H. and Centner, T. (2012). Regulation of Water Pollution from Hydraulic Fracturing in Horizontally-Drilled Wells in the Marcellus Shale Region, USA. *Water*, *4*(4), 983–994. http://doi.org/10.3390/w4040983

Henderson, D. (2008). Opportunity Cost. Retrieved August 14, 2015, from http://www.econlib.org/library/Enc/OpportunityCost.html

Hern, R. (2003). Competition and access pricing in the UK water industry. *Utilities Policy*, *10*(3/4), 117–127. Retrieved from http://uvic.summon.serialssolutions.com.ezproxy.library.uvic.ca/2.0.0/link/0/eLvHCXMw3V3LSsQwFL2IC1FEdFTGF2blZqg2k45pFy5kUAaKCDpdD5kklS4sw1jx971J-kiF-QG3LZS0p9xzn-cCsPFtGPyxCTzRMkqWiudItxGXjItJKCaKocevhFVW8qbJWj3m7tp_AH5qPeGiavqMhV2JOFqtTQ39o-lrzNLRjzACiY

Hearden, T. (2015). Calif. reaches first milestone in crafting groundwater regulations. Retrieved November 23, 2015, from http://www.capitalpress.com/California/20151117/calif-reaches-first-milestone-in-crafting-groundwater-regulations

Herrington, P. (2007). *Waste Not, Want Not Sustainable Water Tariffs*. Bristol.

Horbulyk, T. M. (2010). Water Pricing : An Option for Improving Water Management in Alberta. *Water Management*, 21.

Howarth, W. (2009). Cost recovery for water services and the polluter pays principle. *ERA Forum*, (April), 1–23. http://doi.org/10.1007/s12027-009-0134-3

Hunter, J. (2013). No Is LNG fracturing worth its weight in water? Retrieved October 15, 2015, from http://www.theglobeandmail.com/news/british-columbia/is-lng-fracking-worth-its-weight-in-water/article16121900/

IPART. (2015a). *Review of prices for the Water Administration Ministerial Corporation*. Sydney. Retrieved from http://www.ipart.nsw.gov.au/Home/Industries/Water/Reviews/Rural_Water/Review_of_prices_for_the_Water_Administration_Ministerial_Corporation_commencing_1_July_2016/22_Jun_2015_-_Issues_Paper/Issues_Paper_-_Review_of_prices_for_the_Water_Administration_Mini

IPART. (2015b). IPART Cost Building Block and Pricing Model. Retrieved August 10, 2015, from http://www.ipart.nsw.gov.au/Home/Industries/Research/Reviews/Financial_Models/IPART_cost_building_block_and_pricing_model

Johansson, R. C. (2000). *Pricing Irrigation Water: A Literature Survey* (No. 2449). Washington, DC. Retrieved from http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2000/11/04/000094946_00101705305778/Rendered/PDF/multi_page.pdf

Jones, T. (2003). Pricing water. *Organization for Economic Cooperation and Development. The OECD Observer*, (236), 11. Retrieved from http://uvic.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMw3V07awMxDBZNlhZK6Sv0CdnDhYvtO5-HDm2a0i1Dkjn4_IBCXjTp_4_O9j3S0qVj1zPGSDbSJ90nCYCSfhx9swkDYQaZZSQXNs2IVbnSNrNaJspQRiU7rCarZrbW3_7DxReD3F2GVZbM24A9fdnltmYXlkXJaBTWGxOegqcmV0yivuNkjEfD1944LzK4NZt3ul

Jordan, J. L., & Albani, R. (1999). Using conservation rate structures. *Journal (American Water Works Association), 91*(8), 66–73. Retrieved from http://uvic.summon.serialssolutions.com.ezproxy.library.uvic.ca/2.0.0/link/0/eLvHCXMwjV3fS8MwED5EQRRRp1utP6CIr61Nk7TNow6HIPNJYfhS2vT6IGM4nP-_l6Qdm7_wpZDS0nJJc9_1vvsOgCdRHH7ZE3SaC8YqcrCoSslVzlBorVie0wkpcL2aDLoGg4ZkaVmCNqdPcKma4rUgF5VmwsTpQmSmXcPjrVruvqzV87

Killoran, M. (2014). Queensland Urban Utilities' pricing scheme for 2014-15 shoes water price hike for southeast Queensland. Retrieved August 14, 2015, from http://www.couriermail.com.au/news/queensland/queensland-urban-utilities-pricing-scheme-for-201415-shoes-water-price-hike-for-southeast-queensland/story-fnihsrf2-1226866518079

League of Oregon Cities and the Community Planning Workshop. (2015). *Water, Wastewater and Stormwater Rate Survey*. Retrieved from http://www.orcities.org/Portals/17/Library/Water%20Rate%20Survey%203-17-15.pdf

Lee, P. (2001). Why Canada's water systems are failing us. Retrieved August 14, 2015, from http://environment.probeinternational.org/2001/08/12/why-canadas-water-systems-are-failing-us/

Lombardo, C. (2015). Water Privatization Pros and Cons. Retrieved August 14, 2015, from http://www.visionlaunch.com/water-privatization-pros-and-cons/

Maloney, P. (2013). Toronto water rates going up 9 per cent. Retrieved August 14, 2015, from http://www.thestar.com/news/city_hall/2013/12/18/toronto_water_rates_going_up_9_per_cent.html

City of Markham. (2015). Water Rate. Retrieved August 14, 2015, from https://www.markham.ca/wps/portal/Markham/Residents/Water/RatesBills/WaterRates/!ut/p/a1/hY7LDoIwEEW_xR_ojBTbsiwiiC_wQcBuTDWIqIBBI78vGjcu1FndSc7JvaAgAVXqe57pW16V-vz8FduYYiH77gzn3Ft10R-EAzfk09HSZi2wboG-J4cmnyBi5Dno87kdBdMxRZ99-m5oWK3vDKnvBVQE-Pbxy0n81x-Dei

McCann, E. (2014). Water charges: North has lessons for campaigners. Retrieved August 14, 2015, from http://www.irishtimes.com/opinion/water-charges-north-has-lessons-for-campaigners-1.2024617

McDonnell, T. and Ní Lochlainn, A. (2013). *Paying for Water: Equity, Efficiency and Sustainability*. Retrieved from http://www.tasc.ie/download/pdf/tasc_paying_for_water2.pdf

National Round Table on the Environment and the Economy. (2011). *Charting a Course: Sustainable Water Use by Canada's Natural Resource Sectors*. Ottawa. Retrieved from http://www.blue-economy.ca/sites/default/files/reports/charting-a-course-eng.pdf

Natural Resources Adelaide and Mt Lofty Ranges. (2015). NRM Water Levy. Retrieved September 20, 2015, from http://www.naturalresources.sa.gov.au/adelaidemtloftyranges/about-us/nrm-water-levy

Nevada Division of Water Resources. (2013). Nevada Water Law. Retrieved September 19, 2015, from http://water.nv.gov/waterrights/waterlaw/water_permits.cfm

Nevada Division of Water Resources. (2014). Fees. Retrieved September 19, 2015, from http://water.nv.gov/waterrights/fees.cfm

New South Wales Office of Water. (2015). Application Fees. Retrieved September 7, 2015, from http://www.water.nsw.gov.au/water-licensing/applications/application-fees

NI Business Info. (2015). Water and sewerage charges. Retrieved August 14, 2015, from https://www.nibusinessinfo.co.uk/content/water-charges

Nikiforuk, A. (2015). Groundwater Not as Renewable as Thought, Study Finds. Retrieved November 23, 2015, from http://thetyee.ca/News/2015/11/21/Groundwater-Not-Renewable-Study/?utm_source=daily&utm_medium=email&utm_campaign=231115

Northern Ireland Environment Agency. (2009). A Scheme of Fees and Charges to Recover the Costs of Processing License Applications Under the Water Abstraction and Impoundment (Licensing) Regulations. Retrieved September 9, 2015, from http://www.doeni.gov.uk/niea/abstraction_and_impoundment_licensing__fees_and_charges__scheme_2015__.pdf_148kb_.pdf

Northern Ireland Environment Agency. (2010). *Regulatory Charging Policy 2010 to 2013*. Belfast. Retrieved from http://www.doeni.gov.uk/niea/fees_and_charges_2010_to_2013.pdf

Northern Ireland Environment Agency. (2015). Regulatory Fees and Charges. Retrieved August 14, 2015, from http://www.doeni.gov.uk/niea/business_and_industry-2/charges.htm

Northern Ireland Water. (2014). *Northern Ireland Water Scheme of Charges 2015-16*. Retrieved from http://www.niwater.com/sitefiles/resources/pdf/watercharges/201516/niwater2015-16schemeofcharges.pdf

Northern Ireland Water. (2015a). Your bill and our charges. Retrieved July 24, 2015, from https://www.niwater.com/understanding-your-bill/

Northern Ireland Water. (2015b). Large user tariff. Retrieved July 24, 2015, from https://www.niwater.com/large-user-tariff/

Nowlan, L. (2005). *Buried Treasure: Groundwater permitting and pricing in Canada*. Retrieved from http://qspace.library.queensu.ca/bitstream/1974/8509/1/Buried Treasure_Groundwater Permitting and Pricing In Canada.pdf

NSW Office of Water. (2015a). Setting fees and charges. Retrieved November 28, 2015, from http://www.water.nsw.gov.au/water-management/fees-and-charges/price-setting

NSW Office of Water. (2015b). Application fees for water access licenses, water supply work and use approvals and dealings. Retrieved November 20, 2015, from http://www.water.nsw.gov.au/water-licensing/applications/access-licences-supply-work-use-approvals-dealings

O'Neill, J. (2015). NI Water puts up charges for non-domestic customers. Retrieved August 14, 2015, from http://www.bbc.com/news/uk-northern-ireland-32072091

OECD. (2002). *Social Issues in the Provision and Pricing of Water Services*. Paris: OECD Publishing. http://doi.org/10.1787/9789264099890-en

OECD. (2009). *Managing Water for All An OECD Perspective on Pricing and Financing*. Retrieved from http://www.oecd.org/tad/sustainable-agriculture/44476961.pdf

OECD. (2010). *Pricing water resources and water and sanitation services*. Paris: OECD Pub. http://doi.org/10.1787/9789264083608-en

Ofwat. (2011). *Guidance on applying for a water supply license Version 3*. Birmingham. Retrieved from https://www.ofwat.gov.uk/competition/wsl/gud_pro_wslappguid.pdf

Ofwat. (2012). *Future price limits – statement of principles*. Birmingham.

Ofwat. (2014). *Setting price controls for 2015-20 – framework and approach*. Birmingham.

Ofwat. (2015a). Ofwat. Retrieved August 15, 2015, from https://www.ofwat.gov.uk/

Ofwat. (2015b). Setting price limits. Retrieved August 14, 2015, from https://www.ofwat.gov.uk/pricereview/setting/

Ofwat and DEFRA. (2006). *The Development of the Water Industry in England and Wales*.

Olmstead, S., Stavins, R. (2013). Comparing price and non-price approaches to urban water conservation. In C. Quentin Grafton, R., Pittock, J., White (Ed.), *Water Security, Economics and Governance* (pp. 306–323). Prahan: Tilde Publishing.

Ontario Ministry of the Environment. (2007). *Guide to Permit to Take Water Application Form*. Retrieved from http://www.ontario.ca/document/guide-permit-take-water-application-form

Ontario Ministry of the Environment. (2013). Findings of the Regulatory Water Charges Review. Retrieved September 24, 2015, from http://www.ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTE4MjAw&statusId=MTc2ODc0&language=en

Oregon Water Resources Department. (2015). *Fee Schedule*. Retrieved from http://www.oregon.gov/owrd/PUBS/docs/forms/fee_schedule_1_15.pdf

Organization for Economic Co-operation and Development. (2003). *Improving Water Management: Recent OECD Experience*. London: OECD Publishing. http://doi.org/10.1787/9789264099500-en

Policy Research Initiative. (2005). *Economic Instruments for Water Demand Management in an Integrated Water Resources Management Framework - Synthesis Report*. Retrieved from http://www.obwb.ca/fileadmin/docs/economic_Instruments_water_demand_management.pdf

POLIS. (2010). *RE : Water Act Modernization Submission : Towards a Modern Water Act – A University of Victoria's POLIS Project on Ecological Governance Position Paper*. Retrieved from http://poliswaterproject.org/publication/349

POLIS. (2014). *Water Sustainability Act—Response by the University of Victoria's POLIS Water Sustainability Project to the March 2014 Discussion Paper Pricing B.C.'s Water*. Retrieved from http://poliswaterproject.org/publication/623

POLIS. (2015). About POLIS. Retrieved March 15, 2015, from http://www.polisproject.org/about

POLIS WSP. (2015a). About. Retrieved August 23, 2015, from http://poliswaterproject.org/about

POLIS WSP. (2015b). Current Projects. Retrieved August 17, 2015, from http://poliswaterproject.org/projects/current

Portland Water Bureau. (2015a). Rates and Charges. Retrieved August 12, 2015, from https://www.portlandoregon.gov/water/29415

Portland Water Bureau. (2015b). Financial Assistance. Retrieved August 18, 2015, from https://www.portlandoregon.gov/water/article/337930

Precht, P. and Dempster, D. (2012). *Jurisdictional Review of Hydraulic Fracturing Regulation*. Retrieved from https://www.novascotia.ca/nse/pollutionprevention/docs/Consultation.Hydraulic.Fracturing-Jurisdictional.Review.pdf

Public Interest Advocacy Center. (2005). *NSW Water Pricing Guidelines and Country Town Communities: Assisting vulnerable residents*. Sydney. Retrieved from https://www.erawa.com.au/cproot/2924/2/Public Interest Advocacy Centre - Attachment.pdf

Queensland Competition Authority. (2013). *Seqwater Irrigation Price Review*. Brisbane.

Queensland Competition Authority. (2000). *Statement of regulatory pricing principles for the water sector*. Brisbane. Retrieved from www.qca.org.au/files/PricingPrinciples.pdf

Queensland Competition Authority. (2015a). *SEQ Bulk Water Price Path 2015-18*. Brisbane. Retrieved from http://www.qca.org.au/getattachment/0cddd37b-2d7b-499c-81c4-bd477c3db2dc/Seqwater-s-Bulk-Water-Prices-2015-18.aspx

Queensland Competition Authority. (2015b). Water. Retrieved August 14, 2014, from http://www.qca.org.au/Water

Queensland Government. (2015a). Bulk water prices. Retrieved August 14, 2015, from https://www.dews.qld.gov.au/policies-initiatives/water-sector-reform/water-pricing/bulk-water-prices

Queensland Government. (2015b). Licenses, permits and forms. Retrieved September 20, 2015, from https://www.business.qld.gov.au/industry/water/managing-accessing/accessing-water/authorisations/water-application-forms#entities

Queensland Government. (2015c). Irrigation water pricing for SunWater and Seqwater schemes. Retrieved August 14, 2015, from https://www.dews.qld.gov.au/policies-initiatives/water-sector-reform/water-pricing/irrigation-water-pricing

Queensland Urban Utilities. (2015). Rates and charges 2015-16. Retrieved August 14, 2015, from http://www.urbanutilities.com.au/residential/accounts-and-billing/rates-and-charges-2015-16

Quiggin, J. (2007). Issues in Australian Water Policy. *Economic and Political Overview*, 38–47.

R. M. Loudon Ltd. (2008). *Water and Sewage Rate Structure Review Public Consultation Session*.

Raftelis Financial Consultants Inc. and AWWA. (2013). *AWWA Survey Highlights and Observations Part III*. Denver. Retrieved from http://www.awwa.org/store/productdetail.aspx?ProductId=31940398

Raftelis Financial Consultants Inc. and AWWA. (2015). *2014 Water and Wastewater Rate Survey*. Denver: AWWA and Raftelis Financial Consultants Inc.

Raftelis Financial Consultants Inc. and the California-Nevada Section of the AWWA. (2013). *2013 Water Rate Survey*.

Rahill-Marier, B., & Lall, U. (2013). America's Water : An exploratory analysis of Municipal Water Survey Data, 1–45.

Renzetti, S. (2000). An Empirical Perspective on Water Pricing Reforms. In A. Dinar (Ed.), *The Political Economy of Water Pricing Reforms* (pp. 123–140). New York: Oxford University Press.

Renzetti, S. (2007). Are the Prices Right? Balancing Efficiency, Equity and Sustainability in Water Pricing. In K. Bakker (Ed.), *Eau Canada The Future of Canada's Water* (pp. 263–279). Vancouver: UBC Press.

Renzetti, S. (2009). Wave of the future: the case for smarter water policy. *C.D. Howe Institute Commentary*, (281), COV. Retrieved from http://uvic.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMw3V1LT8MwDLbYLnBBvN8oJy5Tqz7S0iJxQIVpnCZgwHFK00TaYS3aCvv7xE36GNL-AJeqSiW3-VzFTvzZBvA927H-rAluLNxIUi-NZRh5kqc8k5HMWMCFT31G17PJmgao7dh_UPwn9hMykX9dMaTmbnBlsSpa4XJeMTkHK4bXr7Y0cF2ywH60B6NiJTpcAswkQZ

Renzetti, S., & Dupont, D. P. (2015). Water Pricing in Canada: Recent Developments. In J. Dinar, A., Pochat, V., Albiac-Murillo (Ed.), *Water Pricing Experiences and Innovations* (Vol. 9, pp. 63–81). Springer International Publishing. http://doi.org/10.1007/978-3-319-16465-6

Renzetti, S., Bodimeade, C. (2013). Full-Cost Rates for Water and the Chimera of "Affordability." Retrieved August 14, 2015, from http://watercanada.net/2013/full-cost-rates-for-water-and-the-chimera-of-affordability/

Rogers, P., de Silva, R., & Bhatia, R. (2002). Water is an economic good: How to use prices to promote equity, efficiency, and sustainability. *Water Policy*, *4*, 1–17. http://doi.org/S 1 3 6 6 - 7 0 1 7 (0 2) 0 0 0 0 4 - 1

Rogers, P., & Bhatia, A. Huber, R. (1998). *Water as a Social and Economic Good: How to Put the Principle into Practice* (Vol. 2). Stockholm, Sweden: Global Water Partnership Technical Advisory Committee.

Ruijs, A., Zimmermann, A., van den Berg, M. (2008). Demand and distributional effects of water pricing policies. *Ecological Economics*, 506–516.

Ryan, S. and Wang, J. (2012). *Residential Water Metering and Pricing Structures for the District of Mission*. University of Victoria.

Sask Water. (2015). My SaskWater Rate. Retrieved August 13, 2015, from http://www.saskwater.com/services/customer_service/my_saskwater_rate.php

Saskatchewan Water Security Agency. (2012). *25 Year Water Security Plan*. Retrieved from https://www.wsask.ca/Global/About WSA/25 Year Water Security Plan/WSA_25YearReportweb.pdf

Saskatchewan Water Security Agency. (2015a). Surface Water Approval Process. Retrieved September 11, 2015, from https://www.wsask.ca/Permits-and-Approvals/Regulatory-Info/Surface-Water-Approval-Process/

Saskatchewan Water Security Agency. (2015b). *Instructions to Complete Application for Water Rights Licence and Approval to Construct and Operate Works under The Water Security Agency Act*. Retrieved from https://www.wsask.ca/Global/Permits and Approvals/Apply for a Permit or License/Instructions to complete Application for Approval to Construct and Operate Drainage Works.pdf

Saskatchewan Water Security Agency. (2015c). *The Water Security Agency Regulations*. Regina.

Saskatchewan Water Security Agency. (2015d). Ground Water Approval Process. Retrieved October 1, 2015, from https://www.wsask.ca/Permits-and-Approvals/Regulatory-Info/Ground-Water-Approval-Process/

Saskatchewan Water Security Agency. (2015e). Industrial Water Use Charges. Retrieved September 23, 2015, from https://www.wsask.ca/Permits-and-Approvals/Regulatory-Info/Industrial-Water-Use-Charges/

Saskatchewan Watershed Authority. (2005). *Saskatchewan Water Conservation Plan*. Retrieved from http://www.southsaskriverstewards.ca/ckfinder/userfiles/files/SK%20Water%20Conservation%20Plan%20%282%29.pdf.pdf?PHPSESSID=7cbeusfacb34rtcfulb6upf274

Scottish Government. (2015a). *General Statement of Policy - Principles of Charging for Water Services 2015-2021*.

Scottish Government. (2015b). How are my charges set? Retrieved August 14, 2015, from http://www.gov.scot/Topics/Business-Industry/waterindustryscot/watercharges/chargesset

Scottish Water. (2014a). *Wholesale Charges for the Supply of Water and Sewerage Services for the Fiscal Year 2014/15*. Retrieved from https://www.scottishwater.co.uk/assets/business/files/licensed provider portal/wholesalebilling/part2wholesalechargesscheme201415140123.pdf

Scottish Water. (2014b). Metered Charges 2015 - 2016. Retrieved August 14, 2015, from http://www.scottishwater.co.uk/you-and-your-home/your-charges/2015-2016-charges/2015-2016-metered-charges

Scottish Water. (2014c). Unmetered Charges 2015 - 2016. Retrieved August 14, 2015, from http://www.scottishwater.co.uk/you-and-your-home/your-charges/2015-2016-charges/2015-2016-unmetered-charges

Scottish Water. (2015). Investment Programme. Retrieved August 14, 2015, from http://www.scottishwater.co.uk/investment-and-communities/investment-programme/investment-programme

Shaw, W. D. (2005). *Water resource economics and policy: an introduction*. Northampton, MA; Cheltenham, UK: E. Elgar. Retrieved from http://uvic.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwfZwxC8IwEIUPrYubUkWtQsC5EpukqbNYHFwEwbE0bTKK1P8PXtpUtBTHZDiSEC73LnwPgEU7GnZyAuWKmrhQxggmZaJEQc2BC2Ww-t3nsfqlyaB1heg6Jzrw5M__jMCCx9qDDlF8WaDjemm4cYkiPxLOcuczZl9eny2nk07As5zBFAb64cP2jjVfRSrXTCfa8c

South Australia Water. (2015a). 2015-16 water and sewerage pricing announcement. Retrieved August 14, 2015, from http://www.sawater.com.au/accounts-and-billing/current-water-and-sewerage-rates/2015-16-water-pricing-announcement

South Australia Water. (2015b). Residential Water Prices. Retrieved August 14, 2015, from http://www.sawater.com.au/accounts-and-billing/current-water-and-sewerage-rates/residential-water-supply

South Australia Water. (2015c). Commercial Water Prices. Retrieved August 14, 2015, from http://www.sawater.com.au/accounts-and-billing/current-water-and-sewerage-rates/commercial-water-prices

South Australia Water. (2015d). Non-Residential Water Prices. Retrieved August 14, 2015, from http://www.sawater.com.au/accounts-and-billing/current-water-and-sewerage-rates/non-residential-water-supply

Southern Nevada Water Authority. (2014). *Southern Nevada Water Authority Water Conservation Plan 2014-2018*. Retrieved from http://www.grandforks.ca/wp-content/uploads/KWL-Water-Conservation-Plan-Final-Report.pdf

Stannard, W. (2005). Designing a Water and Wastewater Rate Structure. In G. Raftelis (Ed.), *Water and Wastewater Finance and Pricing: A Comprehensive Guide* (3rd ed., pp. 219–234). Boca Raton: Taylor & Francis.

State of Oregon Department of Geology and Mineral Industries. Water Quality, Pub. L. No. 468B (2013). United States. Retrieved from https://www.oregonlegislature.gov/bills_laws/lawsstatutes/2013ors468B.html

Statistics Canada. (2011). Low income measures by income concept, for household size of four persons 1976 - 2011. Retrieved December 4, 2015, from http://www.statcan.gc.ca/pub/75f0002m/2014003/tbl/tbl03a-eng.htm

Statistics Canada. (2012). *Agricultural Water Use in Canada*. Ottawa.

Statistics Canada. (2015). Median total income, by family type, by province and territory. Retrieved August 12, 2015, from http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/famil108a-eng.htm

The Advertiser. (2014). Down the drain: South Australia's water bills the highest in the country. Retrieved August 14, 2015, from http://www.adelaidenow.com.au/news/south-australia/down-the-drain-south-australias-water-bills-the-highest-in-the-country/story-fni6uo1m-1226891608524

The Allen Consulting Group. (2006). *Transaction costs of water markets and environmental policy instruments*. Melbourne. Retrieved from http://www.pc.gov.au/inquiries/completed/water-study/transaction-costs/waterstudyreport.pdf

The Journal. (2014). Sinn Féin: Northern Ireland's 35,000 water meters does not affect our stance on charges. Retrieved July 24, 2015, from http://www.thejournal.ie/water-metres-northern-ireland-sinn-fein-1800554-Nov2014/

The Province. (2015). Price isn't right if we want to protect B.C.'s water supply. Retrieved from http://blogs.theprovince.com/2015/03/22/ian-stephen-price-isnt-right-if-we-want-to-protect-b-c-s-water-supply/

Tsur, Y. (2000). Water Regulation via Pricing: The Role of Implementation Costs and Asymmetric Information. In *The Political Economy of Water Pricing Reforms* (pp. 105–120). New York: Oxford University Press.

Tsur, Y., Dinar, A. (2004). The Relative Efficiency of Implementation Costs of Alternative Methods for Pricing Irrigation. In M. Easter, K., Renwick (Ed.), *The Economics of Water Resources*. Burlington: Ashgate.

United Nations Conference on Environment & Development. (1992). *United Nations Conference on Environment & Development Agenda 21*. Rio de Janerio. Retrieved from http://docs.google.com/gview?url=http://sustainabledevelopment.un.org/content/documents/Agenda21.pdf&embedded=true

Urban Systems. (2008). *City of Dawson Creek water cost study*. Kamloops. Retrieved from http://www.dawsoncreek.ca/wordpress/wp-content/uploads/2011/10/ReportWaterCostStudy26-02-08.pdf

Urban Systems. (2009). *City of Dawson Creek water rate structure review.* Kamloops. Retrieved from http://www.dawsoncreek.ca/wordpress/wpcontent/uploads/2011/10/WaterRateStructureReport.pdf

USwitch. (2015). Water prices - how UK water rates are calculated. Retrieved from http://www.uswitch.com/water/price-of-water/

Utility Regulator. (2013). *Report on NI Water's Scheme of Charges for 2013-14*. Retrieved from http://www.uregni.gov.uk/uploads/publications/13-14_SoC_report_final.pdf

Utility Regulator. (2014). *Water & Sewerage Services Price Control 2015-21*. Retrieved from http://www.uregni.gov.uk/uploads/publications/UR_PC15_FD_-_Final_Determination_-_Main_Report_0200_Redacted.pdf

Vander Ploeg, C. (2011a). *Water Pricing Policy in Canada*. Retrieved from http://cwf.ca/pdf-docs/publications/Water_Backgrounder_7_Sept_2011.pdf

Vander Ploeg, C. (2011b). *Water Usage in Canada*. Retrieved from http://cwf.ca/publications-1/Canadian_Water_Policy_Backgrounder_3

Vander Ploeg, C. (2011c). *Water Pricing Approaches in the UK, Israel & Australia*. Canada West Foundation. Retrieved from http://cwf.ca/publications-1/Canadian_Water_Pricing_Backgrounder_9

Walker, A. (2009). *The Independent Review of Charging for Household Water and Sewerage Services*. *UK Government Reports*. London.

Warmath, A. (2005). Water and Wastewater Pricing Process. In G. Raftelis (Ed.), *Water and Wastewater Finance and Pricing: A Comprehensive Guide* (3rd ed., pp. 175–184). Boca Raton: Taylor & Francis.

Water Industry Commission for Scotland. (2007). *Form of Fees Scheme*. Retrieved from http://www.watercommission.co.uk/view_Licence_fees.aspx

Water Industry Commission for Scotland. (2010). *License fees for the retail market – a policy statement*. Retrieved from http://www.watercommission.co.uk/view_Licence_fees.aspx

Water Industry Commission for Scotland. (2015). Types of License. Retrieved September 10, 2015, from http://www.watercommission.co.uk/view_Types_of_licence.aspx

Water Resources Department. (2015a). Water Rights. Retrieved August 14, 2015, from http://www.oregon.gov/owrd/pages/wr/index.aspx

Water Resources Department. (2015b). Water Measurement. Retrieved October 9, 2015, from http://www.oregon.gov/owrd/pages/mgmt_measure.aspx

Water Resources Department. (2015c). Water Use Reporting. Retrieved October 15, 2015, from http://www.oregon.gov/owrd/Pages/wr/water_use_report.aspx

Water Tap. (2013a). Capital Expenditures and O&M Costs. Retrieved August 14, 2015, from http://www.watertapontario.com/asset-map/utilities/capital-expenditures

Water Tap. (2013b). Financial Incentives and Prices for Water. Retrieved August 14, 2015, from http://www.watertapontario.com/asset-map/utilities/financial-incentives

WaterBC.ca. (2015). Water Pricing. Retrieved August 14, 2015, from http://waterbc.ca/community/programs/long-term-financial-planning/water-pricing-plan/

Wichelns, D. (2014). Water productivity: Not a helpful indicator of farm-level optimization. Retrieved November 6, 2015, from http://www.globalwaterforum.org/2014/11/11/water-productivity-not-a-helpful-indicator-of-farm-level-optimization/

Woo, A. (2015). B.C. to review proposed groundwater pricing. Retrieved August 14, 2015, from http://www.theglobeandmail.com/news/british-columbia/bc-to-review-proposed-groundwater-pricing/article25512023/

Zieburtz, B., A. (2012). *Principles of Water Rates, Fees, and Charges* (6th ed.). Denver: AWWA.

Zilberman, D., & Schoengold, K. (2005). The use of pricing and markets for water allocation. *Canadian Water Resources Journal*, *30*(1), 47. Retrieved from http://uvic.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMw3V1JS8NAFB5qT3oQt2rVwpy8SCTJJJPk4KEURfEgYovHMGsttIl0wb_vm0y2FvoHvGYSkrxvePPW7yFE_AfX2dEJcKyBppRurCgjSaxDSbUOZAR-HeEyFtvdZJ2qXra59l-A39gI_c_S5M1tE-KiaG8u2Bfuf5mhRjQpd9EAs0tX8FXcVIX3V1Xiuo40zww7Vh