Back to the Salt Mines: An Economic & Environmental Rationale for Licensing Saline Groundwater Under Alberta's *Water Act*

Written By
Jacob Marchel

Author Information:
Name: Jacob Marchel
Mailing Address: 7608 89th Ave. NW, Edmonton, Alberta. T6C 1N3
Phone Number: (780) 394-3705
School: University of Alberta, Faculty of Law
Short Bio: Jacob Marchel is a second-year law student at the University of Alberta, Faculty of Law. Jacob's area of focus is environmental and energy law, with a particular interest in issues relating to renewable energy. Outside of study, Jacob acts as the current President of the university's Environmental Law Students' Association (ELSA), which works to encourage student awareness and involvement with diverse legal and non-legal environmental issues, as well as endeavors to reduce the faculty's ecological footprint.

I. INTRODUCTION

In a 2007 Canadian report entitled "Water for Life: Current and Future Use in Alberta", it was projected that by 2025 the province of Alberta's total water usage would increase to over 3,998,600 dam^3 [cubic decametres] (a 21% increase from usage in 2007).[1] Factors such as the growing population (approx. 7.5 million by 2050),[2] a booming economic sector (particularly in the oil and gas industry), and climate change, have made the issue of water usage of the utmost importance in Alberta.[3] Ultimately, the looming prospect of a water-constrained future may force the province to turn to a traditionally lesser-used resource, namely saline groundwater.

What is Saline Groundwater?

'Saline' simply means "containing salt"[4] and 'groundwater' is water (fresh or saline) "found underground in the spaces between particles of rock and soil, or in crevices and cracks in rock."[5] When either water collects into an underground space formation of "permeable rock or loose material", the space is referred to as an 'aquifer'.[6]

In Alberta, there has been no quantitative study on the specific presence of saline groundwater, i.e. a form of non-potable groundwater, sometimes referred to as 'brackish

---

1 AMEC Earth & Environmental, (2007). *Water for Life: Current and Future Use in Alberta.* Online: Legislative Assembly of Alberta <http://www.assembly.ab.ca/lao/library/egovdocs/2007/alen/164708.pdf> at iv.

2 Patrycja Romanowska, (23 July 2013). *Alberta desperately needs a water-management plan: A strategy to manage water use in Alberta must coexist with the oil and gas sector's appetite for this precious resource*. Online: Alberta Oil Online Magazine <http://www.albertaoilmagazine.com/2013/07/alberta-and-the-life-aquatic/>.

3 *Supra* note 1.

4 *Pocket Oxford English Dictionary*, 11th ed, *sub verbo* "saline".

5 Environment Canada, *Groundwater* (09 September 2013), online: Government of Canada <http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=300688DC-1#sub2>.

6 *Ibid.*

water'.[7] Some data has been collected by the Alberta Energy Regulator (formally the Energy Resource Conservation Board), but as none of it can reasonably be considered comprehensive or centralized, the data remains questionable. Despite a lack of exact numbers, estimates regarding the amount of saline groundwater in Alberta, relative to fresh groundwater, are very high.[8] This is notable, given that "[a]pproximately 40,000 cubic kilometres (km^3) of groundwater exists in Alberta."[9]

A plausible reason for this lack of saline-specific information is that historically, i.e. until the 1970s, saline groundwater and aquifers had not been used for anything in Alberta other than industrial waste sites. Since then however, saline groundwater has steadily become a resource for the oil and gas industry, particularly for their in situ thermal operations.[10]

Current Legal Status in Alberta

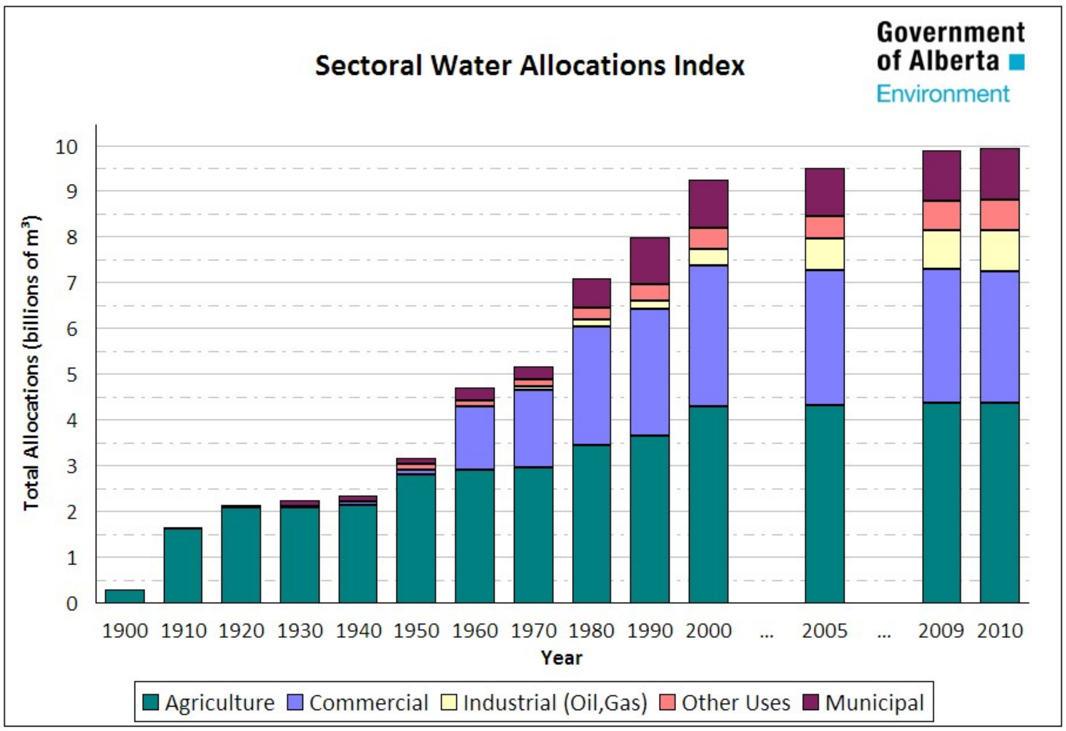
Under section 1(1)(z) of Alberta's *Water Act* (*Water [Ministerial] Regulation*), saline groundwater is defined as "water that has total dissolved solids [TDS] exceeding 4,000 milligrams per litre" (mg/L)."[11] To put that in perspective, average seawater has a salinity of approximately 35,000 mg/L,[12] and potable water (i.e. safe drinking water) has

---

[7] Alberta Water Research Institute, (2011). *Groundwater in Alberta: An assessment of source, use and change.* Online: The Alberta Water Portal. <http://www.albertawater.com/index.php/water-facts-info/groundwater/49-water-research/dynamics-of-alberta-s-water-supply/groundwater-in-alberta/balance-and-inventory/637-what-about-the-saline-water>. at 28.
[8] *Ibid.*
[9] Alberta Environment, (2011). *Focus On Groundwater Use*. Online: Alberta Environment. Retrieved May 15, 2014. <http://environment.gov.ab.ca/info/library/8397.pdf> at 1.
[10] *Supra* note 8.
[11] *Water Act*, RSA 1998 c. W-3. Water (Ministerial) Regulation, s. 1(1)(z).
[12] WateReuse Foundation, (1 October 2007). *Fundamentals: Measures of salinity*. Online: Salinity Management Guide. <http://www.salinitymanagement.org/Salinity%20Management%20Guide/ls/ls_3d.html>.

salinity of less than 3,000mg/L.[13] In Alberta, the *Water Act* requires that a water license be obtained prior to diverting water, including the dewatering of an aquifer.[14] However, the *Act* exempts saline groundwater from this license requirement.[15] This regulatory configuration "effectively bars the transfer or assignment of saline water" and creates a division between the jurisdictional management of saline and fresh water.[16]

Figure 1: Fresh Water Usage and Allocations in Alberta (1900-2010)[17]



---

[13] Government of Alberta, (2010). *Facts About Water in Alberta*. Edmonton, Canada: Alberta Environment Information Centre. At 22.

[14] Jason Unger, *Water regulation must define saline versus potable water: Heightened constraints on water supplies increasingly question the line between saline and pure sources of water.* (01 June, 2009*)*. Online: Alberta Oil Magazine. <http://www.albertaoilmagazine.com/2009/06/worth-our-salt/>.

[15] *Ibid.*

[16] *Ibid.*

[17] Alberta Water Research Institute, (2011). *Learn: What is water used for in Alberta?* Online: The Alberta Water Portal. Retrieved on May 14, 2014. <http://www.albert awater.com/learn/what-is-water-used-for-in-alberta>.

Essay Thesis and Structure

This essay, sectioned into three parts, will demonstrate that saline groundwater diversions should be licensed under the *Water Act*. Part 1 briefly explains the historic and current use, as well as the legal management, of saline groundwater in Alberta. Parts 2 and 3 examine the economic and environmental justifications for licensing saline groundwater, respectively. Each part addresses Alberta's oil and gas industry, respective criticisms, and some relevant international saline groundwater developments.

<u>II. PART 1</u>

Management & Reporting: Non-Saline vs. Saline Groundwater

In Alberta, non-saline water is currently managed under the jurisdiction of Alberta Environment (AE), including non-saline water produced by the dewatering process and non-saline water disposal.[18] For saline groundwater, the Alberta Energy Regulator (AER) regulates all of those activities.[19] The different management and process of waste disposal for either water-type highlights the contrasting value that the province has historically placed on them. For example, non-saline water is either disposed of in aquifers of a "similar character" or to the surface with the approval of AE. For surface releases, a federal approval under the *Fisheries Act* may also be required.[20] In comparison, the AER allows highly contaminated/untreatable operational waste from either non-saline water or saline water to remain untreated when injected into deep saline aquifers (waste disposal of any saline water into any non-saline aquifers is prohibited).[21]

By requiring a license for fresh water, reporting has been extremely detailed and

---

[18] *Supra* note 14.
[19] *Ibid.*
[20] *Ibid.*
[21] Canadian Association of Petroleum Producers, (2010). *Responsible Water Management in Canada's Oil and Gas Industry*. Online: CAPP <http://www.capp.ca/getdoc.aspx?DocID=173950>.

quite comprehensive in terms of monitoring quality. A license not only "[i]dentifies the water source, location of the diversion site, volume, rate and timing of [the] water to be diverted," but the "priority of the water right" is also established, along with any conditions the diversion must follow.[22] All of this information is centralized, collected, publically accessible, and managed to ensure maximum efficiency of the water used.[23]

Conversely, for saline groundwater, outside of operational disposal and strict protections for preventing saline water mixing with any fresh water sources,[24] there are no reporting requirements by the AER.[25]

Historic & Current Use

In 2009 the total licensed volume of fresh water in Alberta equaled 9,891,606,000 m^3, with the top 5 allocated sectors being: (1) irrigation, (2) commercial cooling, (3) municipal use, (4) industrial uses, and (5) general commercial use.[26]

Since the 1970s[27] the only significant user of saline groundwater in the province has been the oil and gas industry.[28] Data from the AER shows that, particularly with water injection projects (e.g. in situ thermal operations), the steady transition from non-saline to saline groundwater usage has been substantial. In 1972, over 95% of water injection projects drew from fresh/non-saline water sources (i.e. roughly 85 million cubic

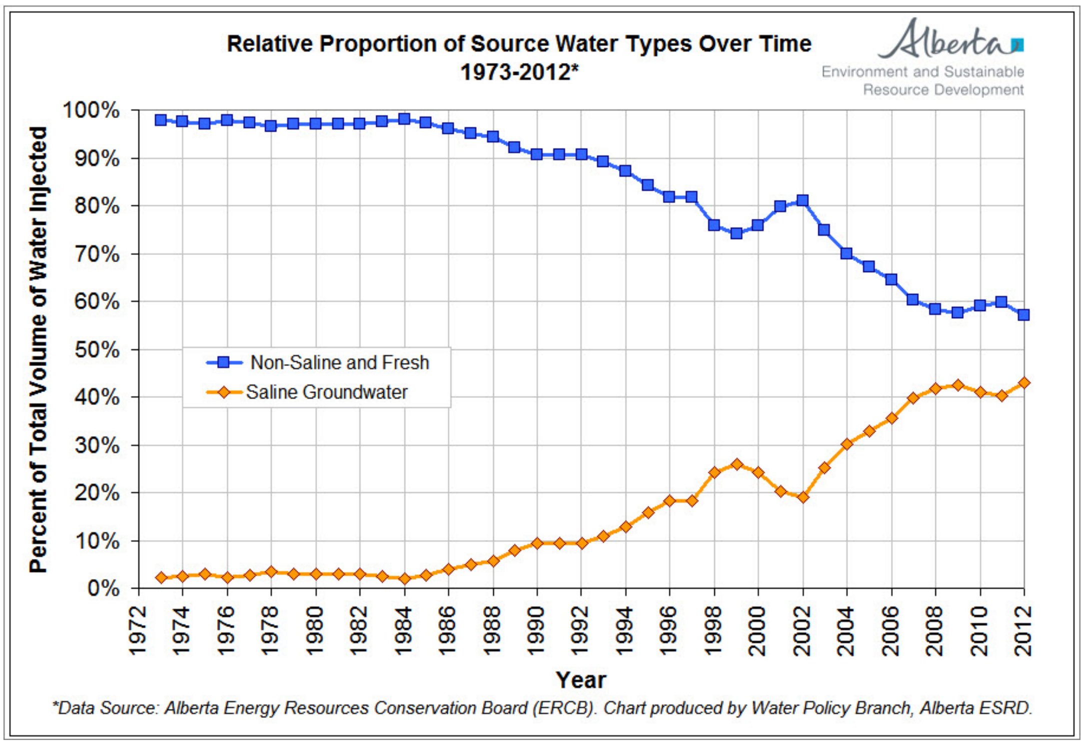
---

[22] Alberta Environment, (2008). *Water Act: Licenses: Facts at your fingertips*. Online: Alberta Environment <http://environment.alberta.ca/documents/WaterAct _Licences_FS.pdf> at 1.
[23] Alberta WaterPortal, (2013). *Learn: Water Licences, Transfers, and Allocation*. Online: Alberta WaterPortal. Retrieved May 15, 2014. <http://www.albertawater.com/learn/how-is-our-water-governed/water-licenses-and-transfers>.
[24] *Supra* note 22.
[25] *Supra* note 14.
[26] *Supra* note 13.
[27] Government of Alberta, (2013). *Water Used for Oilfield Injection Purposes*. Online: Government of Alberta <http://esrd.alberta.ca/focus/state-of-the-environment/water/surface-water/pressure-indicators/water-used-for-oilfield-injection-purposes.aspx>.
[28] *Supra* note 14.

metres in 1972).[29] As of 2012, that percentage has decreased to just below 60% (i.e. roughly 35 million cubic metres in 2012).[30] (Note Figures 2 and 3 on pages 7 and 8)

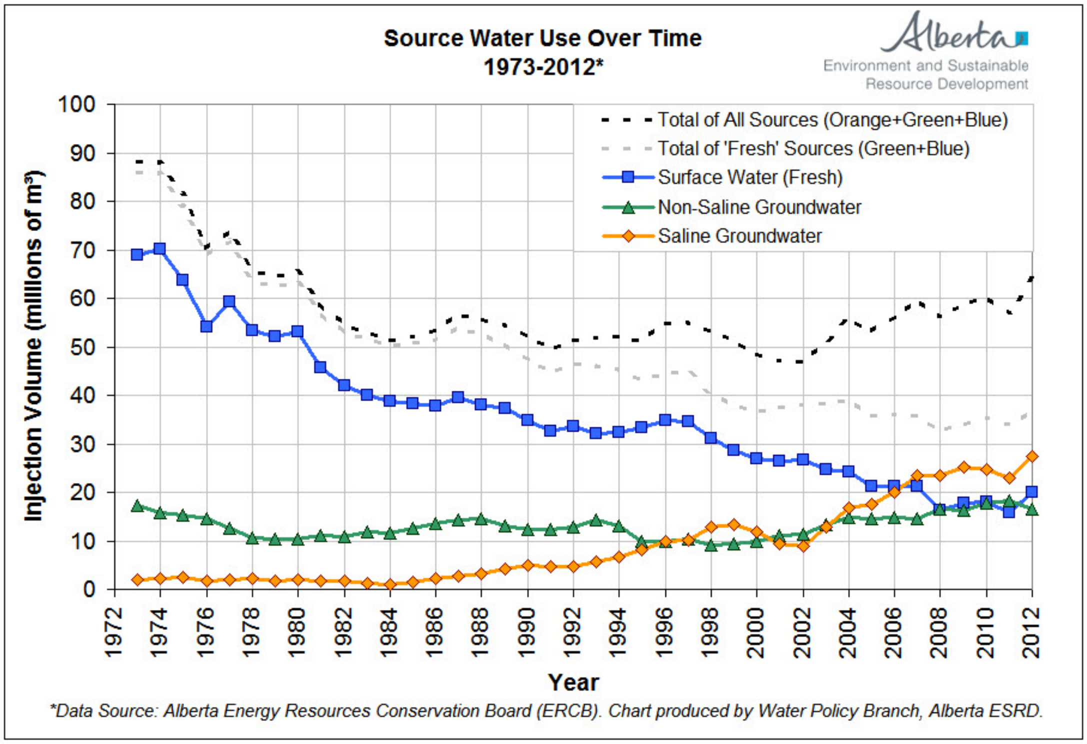
This consistent increase in non-renewable use, in addition to minimal reporting requirements, compromises the future of saline groundwater.[31] However, by allowing the licensing of saline groundwater Alberta can at the very least prolong, if not hopefully secure, the economic and environmental sustainability of this water resource.

Figure 2: Percentage of Oil Field Injection Source Water Usage (1973-2012)[32]



[29] *Supra* note 27.
[30] *Ibid*.
[31] *Ibid.*
[32] *Ibid.*

Figure 3: Volume of Oil Field Injection Source Water Usage (1973-2012)[33]



III. PART 2

Current Status of Water Transfers in Alberta

Even if saline groundwater were to be licensed under the *Water Act*, the regulatory regime in place for the current water allocations transfer system is also preventing saline groundwater from being fully utilized.[34] Under the *Water Act*, the designated 'Director' of the transfer system "may only consider transfers if their use has been authorized by an Approved Water Management Plan or a Lieutenant Governor-in-Council Order."[35] At present, transfers have only been authorized under the Approved Water Management Plan for the South Saskatchewan River Basin (SSRB),[36] and

[33] *Ibid.*
[34] Alberta Water Council, (2009). *Recommendations for Improving Alberta's Water Allocation Transfer System*. Online: Alberta Water Council. <http://www.albertawatercouncil.ca/Portals/0/pdfs/WATSUP_web_FINAL.web_FINAL.pdf>. at 9.
[35] *Ibid.*
[36] *Ibid.*

currently the SSRB is closed off from any further surface water allocations.[37]

Presumably, as Alberta continues to grow, groundwater allocations will also become more restricted, and thus the provincial government will likely have an increased reliance on the trading of water licenses.[38] Ultimately, if watersheds were barred from both ground and surface water allocations, then the only way to access water would be through the transfer of an already licensed allocation.[39] "It is through this transfer system that a market value for water allocations has begun to evolve in the South Saskatchewan river basin."[40]

It should also be noted that there is the option under the *Water Act* to have a license holder temporarily assign its allocation.[41] However, this ability is limited by many restrictions, including the rule that only two license holders can take part in an assignment.[42]

In 2009 the Alberta Water Council released a report that evaluated the province's current water allocation transfer system.[43] One of the key recommendations was that the transfer limitation for the South Saskatchewan River Basin should be greatly restructured.[44] While this essay does support the expansion of this transfer system, it will not explore this separate topic with much depth. Nevertheless, it should be noted that many of the arguments and data regarding the expansion or removal of the water transfer system are directly applicable to the issue of licensing saline groundwater, and thus will be used within that particular context. The arguments and/or data are applicable insomuch

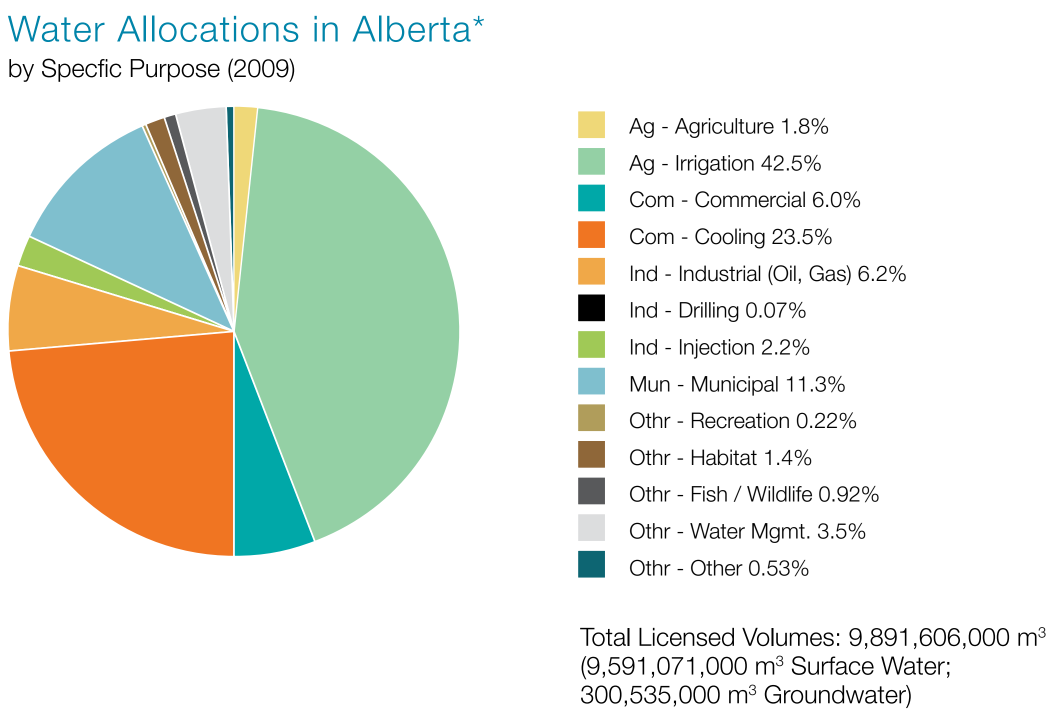
[37] *Supra* note 12.
[38] *Ibid*.
[39] *Ibid*.
[40] *Ibid*.
[41] *Water Act*, RSA 2000 c. W-3., s. 30.
[42] *Ibid*.
[43] *Supra* note 34.
[44] *Ibid* at 58.

as the current regulatory reality effectively bars the transfer or assignment of saline groundwater, and thus stands in the way of taking advantage of the economic and environmental incentives to treat, reuse, and conserve saline groundwater.[45]

The Water Market 'Pie'

Given the current status of water transfers and the projected reliance on trading water licenses, if one were to view the water market in Alberta as a pie graph, one would see that the number of 'slices', i.e. allocations, have become almost stagnate, and each 'slice' is slowly but steadily increasing in price.[46] (Note Figure 4 on page 10)

Figure 4: Fresh Water Allocations in Alberta by Specific Purpose (2009)[47]



In terms of an economic perspective, by licensing saline groundwater, the government could make it a marketable commodity subject to price signals like non-

45 *Supra* note 14.
46 *Supra* note 7 at 9.
47 *Supra* note 23.

saline water,[48] and thus encourage efficient use. Adding saline groundwater to the water market could theoretically expand the 'pie', i.e. supply, by alleviating "pressures on surface water bodies and other potable sources",[49] and thus as supply increases, market forces could presumably stabilize or potentially even decrease price. However, it should also be presumed that there is the potential risk to increase such pressures if the price is incorrectly set.

Ultimately, in order for saline groundwater to have a positive effect on pricing within the marketplace, it must provide desirable utility. With saline groundwater, utility is directly linked to its level of total dissolved solids (TDS), i.e. its level of 'saltiness'. Since saline water can be any water that exceeds 4,000 milligrams per litre" (mg/L),[50] it presents a differing range of potential usefulness.

Ultimately, by allowing saline groundwater licensing the provincial government would not only create and expand the market for saline groundwater users, but also allow the trading of a resource that could become fresh water, a commodity that already has a fully established market.

A Brief Case Study for New Markets for Untreated Saline Groundwater: The Agricultural Sector

Admittedly, outside of the oil and gas industry, untreated saline groundwater still has a limited market in Alberta. Firstly, the majority of Canada's farming sector within the agricultural industry (e.g. the growing of fruits, berries, vegetables, forages, and field crops) requires water that has TDS less than 2,500mg/L.[51] Secondly, potable water (i.e.

---

48 *Supra* note 14.
49 *Ibid.*
50 *Supra* note 11.
51 AMEC Earth & Environmental, *Cost-Benefit Analysis of Treating Saline Groundwater*. (2007). Online: Alberta Environment. <http://environment.gov.ab.ca/info/library/7816.pdf>. at 4.

drinkable water) requires water that has TDS less than 3,000mg/L.[52] Nevertheless, there are some agricultural uses.

Overall, the spectrum for potential usage of untreated saline groundwater in the agricultural sector ranges from 4,000 to about 7,000mg/L.[53] Saline groundwater can fall within that salinity spectrum in two ways: (1) it already possesses that quantity as a natural state, or (2) it was given that quantity as a result of desalination technology. (*It should be noted that option (2) could also result in saline water becoming fresh water).[54]

The Prairie Farm Rehabilitation Association (PFRA), a former branch under Agriculture and Agri-Food Canada, found that water with TDS between 3,000mg/L and 7,000 mg/L can be used with "reasonable safety" for livestock, e.g. beef, cattle, sheep, swine and horses, but should be avoided with pregnant or lactating animals and dairy cattle. Also, after the water started to exceed 3,000 mg/L, it was deemed "poor" for poultry, often causing watery feces, temporary diarrhea, increased mortality, and decreased growth, especially in turkey.[55]

Internationally, for at least the last two decades, saline water has been used on its own, or mixed with fresh water, for irrigation in countries such as Israel, Egypt, Tunisia, Jordan, Pakistan, India and the southern United States (e.g. Texas).[56] Some crops have even benefited from saline water. In their report from 2000, the Institute of Research found that some crops "such as tomatoes irrigated with brackish water produced better/higher quality crops compared to using lower salinity water."[57] Additionally, in Pakistan it was found that their most economical crop, Kallar grass, showed

---

[52] *Ibid* at 22.
[53] *Ibid* at 5.
[54] *Ibid* at 27.
[55] *Ibid* at 4.
[56] *Ibid* at 5.
[57] *Ibid.*

"improvement in soil properties when irrigated with brackish water compared to being irrigated with fresh water."[58]

To be fair, these international usages are rather isolated incidents compared to the current situation facing Alberta. Places like the Middle East and U.S. states like Texas have much more arid climates and water scarcity issues, and thus are being forced to make due with higher concentrated saline water. Also, the overall long-term ecological effects of such usages are still being studied and are currently less relevant to Alberta.

Furthermore, while the examples provided in this section have only highlighted agricultural uses, the inventive, if not desperate, use of saline groundwater shows that it has a greater versatility than can be fully exercised when not licensable. Perhaps the experience of the international community may foreshadow one possible future for Alberta as issues of climate change and water scarcity become more germane.

The Oil & Gas Industry: Saline Groundwater Usage

The Canadian Association of Petroleum Producer's 2013 Crude Oil Forecast predicts that oil production will jump from an average of 3.2 million barrels per day in 2012 to 6.7 million barrels per day by 2030.[59] When compared to oil and gas operations no other industrial sector in Canada has been able to so effectively utilize untreated saline groundwater.

The current trend with in situ production is that total water use is increasing "with the majority coming from saline water sources, while fresh and non-saline water use is becoming relatively flat".[60] In 2012 the total injection volume of saline groundwater for

[58] *Ibid*.
[59] *Supra* note 2.
[60] *Supra* note 27.

that year in Alberta was just under 30 million m^3.[61] Presumably, if saline groundwater were licensable under the *Water Act*, the oil and gas industry would be the most affected.

One of the larger uses for saline groundwater in oil production is for the 'oilfield injection' process.[62] This is when water is pumped into an oilfield with displaced oil formations, causing that oil to move towards wells producing oil. This helps to maintain higher pressure, which in turn helps to maintain production. In addition, saline groundwater is also used in 'thermal oil recovery' in northern Alberta oil sands projects. This is where water is heated to create steam, which is then injected to heat the sticky oil (i.e. bitumen) and thin it. This enables the oil to flow more easily to producing wells.[63]

With oil recovery, the injected water can mix with the naturally occurring water in oil reservoirs. This mix, referred to as 'produced water',[64] can be partially recycled and re-injected many times for maintaining reservoir pressure.[65] However, the accumulating concentration of chemical compounds and salinity can eventually reach a stage where it will be left in the formation or later dumped into a deep disposal site. Either way, the water is taken out of the hydrological cycle, and its local ecosystem, and can no longer be readily available for other uses.[66]

The Oil & Gas Industry: Produced Water

Produced water is an unavoidable part of the hydrocarbon recovery processes and it is "by far the largest volume [of] waste stream associated with hydrocarbon

---

[61] *Ibid* at figure 1.
[62] *Ibid*.
[63] *Ibid*.
[64] *Supra* note 21 at 3.
[65] *Ibid*.
[66] *Supra* note 27 at figure 1.

recovery,"[67] (water production estimates for a water-to-oil ratio are approximately 3:1).[68]

In produced water the "main contaminants of concern"[69] are: (1) high levels of total dissolved solids (i.e. salinity), (2) oil and grease, (3) suspended solids, (4) dispersed oil, (5) dissolved and volatile organic compounds, (6) heavy metals, (7) radionuclides, (8) dissolved gases and bacteria, and (9) chemicals/additives used in production (e.g. biocides, scale and corrosion inhibitors, emulsion and reverse-emulsion breakers, etc.).[70]

The amount of produced water, and its present concentration of contaminants vary "significantly over the lifetime of a field."[71] In the early stages of well development the water generation rate, and presumably its associated costs, can be a small fraction of the oil production rate, but over time it can increase to "tens of times the rate of oil produced."[72]

In 2010 the Canadian Association of Petroleum Producers (CAPP) stated that due to current environmental regulations requiring extensive treatment costs, strict disposal prohibitions, in addition to the development of wells located in water-scarce regions, the oil and gas industry has increasingly considered the beneficial reuse of produced water in their own operations, as well as looked at alternatives for treating produced water for "other beneficial uses."[73]

Besides re-injection (i.e. water flooding), a 'white paper' presented to the U.S. Department of Energy found that properly treated produced water could be recycled and

---

[67] Society of Petroleum Engineers, (12 October 2011). *Challenges in Reusing Produced Water*. Online: SPE Technology Updates. Retrieved May 14, 2014. <http://www.s pe.org/industry/docs/reusingwater.pdf> at 1.
[68] *Ibid*.
[69] *Ibid* at 2.
[70] *Ibid*.
[71] *Ibid*.
[72] *Ibid*.
[73] *Supra* note 26 at 3.

used for crop irrigation, wildlife and livestock consumption, aquaculture and hydroponic vegetable culture, industrial processes, dust control, vehicle and equipment washing, power generation, and fire control.[74] In addition, the 'white paper' also suggested that produced water has the potential to be converted into potable water.[75] However, there is still little research on the "feasibility and cost-effectiveness of direct or indirect potable reuse of produced water from oil and gas production."[76]

Considering such factors, an argument could be made that by allowing the licensing of saline groundwater (which produced water is a form of), the government could create an economic inventive for the oil gas industry to further invest in the research and development of produced water treatment technologies as a way of decreasing their future disposal costs. In addition, this would have the added environmental benefit of helping to minimize the amount of saline groundwater that has to be permanently taken out of the hydrological cycle.

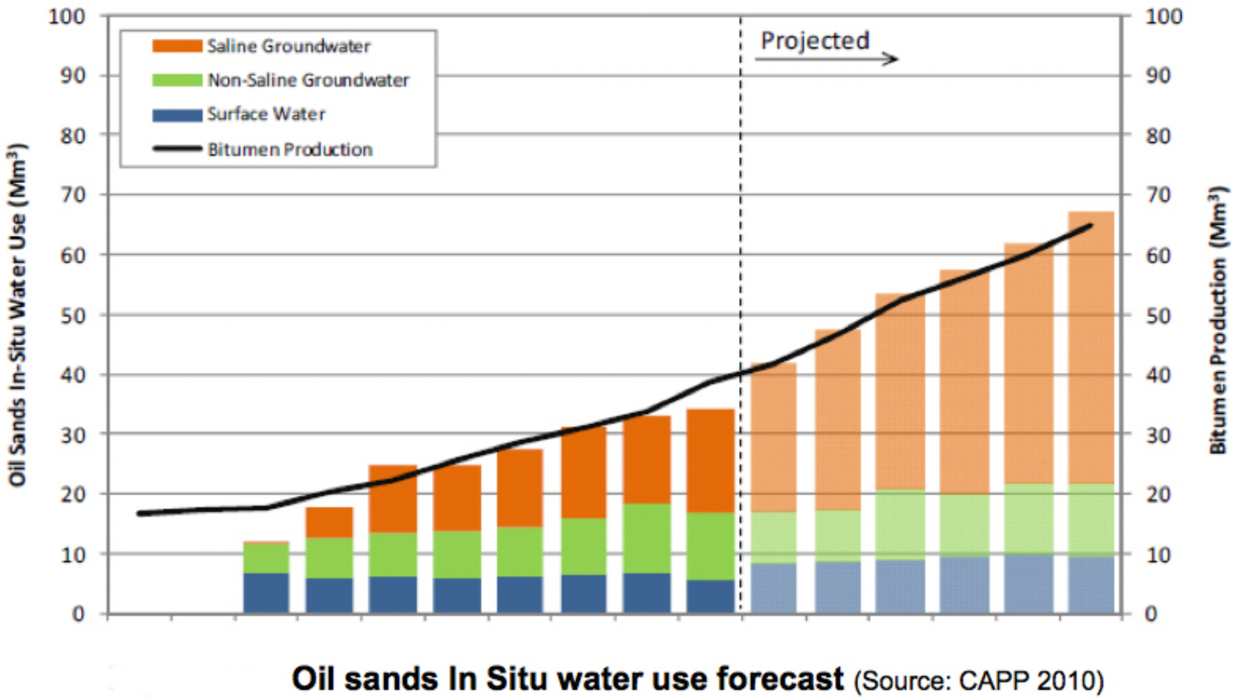
---

[74] John A. Veil et al, *A White Paper Describing Produced Water from Production of Crude Oil, Natural Gas, and Coal Bed Methane*, (University of Chicago, Department of Energy: U.S. Department of Energy, Energy Technology Laboratory, 2004) at 53-55

[75] *Ibid* at 10.

[76] *Supra* note 67 at 1.

Figure 5: The Canadian Association of Petroleum Producers' Anticipated Future Water Usage Trends (2010)[77]



The Oil & Gas Industry: The Differing Costs of Fresh & Saline

Although governmental pressure from Alberta Environment, and the search for easier to access water, are factors that have encouraged increasing saline groundwater use,[78] a fundamental reason why the oil and gas industry has been so steadily shifting to saline groundwater for the last four decades is cost.[79]

It must be remembered that for non-saline water, under the jurisdiction of Alberta Environment, a license requires an extensive amount of reporting and management. It requires: (1) identification of the water source, (2) location of the diversion site, (3) water volume, (4) rate and timing of the water to be diverted, (5) priority of the water right, (6)

---

[77] Alberta WaterPortal, (2013). *Learn: What about the Saline Water?*. Online: Alberta WaterPortal. Retrieved May 15, 2014. <http://www.albertawater.com/groundwater/balance-and-inventory/what-about-the-saline-water>.
[78] *Ibid.*
[79] *Supra* note 14.

any conditions that the diversion must adhere to,[80] and (7) disposal must take place in aquifers of a "similar character" or to the surface with the approval of AE, as well as federal approval under the *Fisheries Act* may also be required.[81] All of this information is centralized, collected, and made accessible, i.e. it is public, thereby making such users accountable to third-party scrutiny.

In comparison, saline groundwater costs for the oil and gas industry are a bargain. Under the Alberta Energy Regulator the primary, if not only, critical responsibility for saline groundwater users is to ensure that neither their saline water, nor any saline water operational waste, mixes with any fresh water sources, including any fresh water disposal sites.[82] Otherwise, the only costs associated with saline groundwater usage for oil companies is (1) infrastructure for directing (e.g. transporting/shipping) the water to locations where it will be used, (2) recycling costs, (3) basic inter-company administration reporting for organizational purposes, and (4) disposal costs.

Whereas saline groundwater users would presumably only have these lesser-associated costs, fresh water users might also have to incur these associated costs in addition to the reporting and management costs. Notably, these associated costs for saline groundwater users can remain almost completely private. Therefore, as a result of this current privacy, no reliable data on the average cost for private saline groundwater usage can be reliably gathered.

If saline groundwater were licensable it would be reasonable to presume that a reporting system at least structurally similar to the current system for fresh water would need to be established. Even if the reporting and maintenance requirements of saline

---

[80] *Supra* note 22.
[81] *Ibid.*
[82] *Supra* note 21.

ground water would be just half that of fresh water, that could still be a substantial increase in operating/reporting costs, which essentially takes away a key motivation for using saline groundwater. (Note: Accessibility of the resource could also by a primary motivation, but presumably accessibility relates to the larger issue of cost)

As already stated, the average of 3.2 million barrels per day in 2012 required an injection volume of just under 30 million m^3 of water during production for that year.[83] Now, if it can assumed that the efficiency of saline groundwater recycling technology will be able to improve at least roughly equal to the growing number of oil sands projects and users, and that the current trend of water volume stays steady, this would mean that by 2030, when production will equal the projected 6.7 million barrels per day, total saline groundwater volume could equal (or be less than) approximately 62.8 million m^3 per year. Granted, improved recycling will allow for more re-use, but the remaining amount could still produce a massive quantity of saline groundwater that would have to eventually be taken out of the hydrological cycle.

By not licensing saline groundwater the provincial government is taking a considerable risk by removing such a large amount of water that could become appreciably more valuable as desalination technology develops. If desalination technology gets to a stage where it could be cost effective for some industries in Alberta to use, it would mean that with every day that saline groundwater remains unlicensed there is a continuing decrease in the usability and accessibility of a critical future resource. Admittedly this idea is based on a premise that has yet to occur, but global trends tend to support it,[84] and so the protection of immediate success for one industry,

---

83 *Supra* note 2.

84 Rosenberg International Forum on Water Policy, (2007). *Report of the Rosenberg International Forum on Water Policy to the Ministry of Environment, Province of Alberta.* Online: Water for Life <http://www.

namely oil and gas, could cost the province the future security of its other economic sectors. Ultimately, the successful development of desalination technology will play a vital role in determining how successful the licensing of saline groundwater could be.

The Cost-Benefits of Desalination Technology: Making Saline Water 'Fresh'

A 2007 AMEC Earth & Environmental Report on the cost-benefit analysis of treating saline groundwater found that Alberta's untreated fresh water is approximately \$0.10 per m^3 for rural supplies.[85] It was also found that the cost to process saline water through a desalination facility to produce fresh water would be approximately \$0.30-0.50 per m^3 (i.e. 3 to 5 times higher).[86] On page 34 of their report AMEC sets out how this cost ratio is constructed.[87]

AMEC's eight general factors that affect the costs of desalination include the following: (1) the water's initial level of salinity, i.e. the more salt to be removed, the more expensive the desalination process. (2) The capacity of desalination plants. Due to the economy of scale principle larger plants are generally more economical. (3) Energy. The energy required is the most significant cost factor, because it contributes about "20% to 50% of the operating cost, depending on technology used and fuel prices."[88] Energy is a key factor, especially for Alberta, because if the value of the fresh water produced is less than the total value of the saline groundwater used to produce the energy, it would not be economically feasibility to actually carry out the desalination process. Conversely, this also positively suggests that by having cheaper energy prices it makes this

---

waterforlife.gov.ab.ca/docs/Rosenberg_Report.pdf> at 15.
[85] *Supra* note 51 at 41.
[86] *Ibid*.
[87] *Ibid* at 34.
[88] *Ibid*.

desalination process more affordable. (4) Concentrate Management. Concentrate is the mineral byproduct of the desalination process. Its management typically ranges from 5% to 33% of produced water cost. (5) The amount and type of pretreatment required, i.e. how low does the total dissolved solids need to be. (6) Regulatory Issues, (7) land costs, and finally, (8) water conveyance costs.

Based on present and projected costs, "suitability for the quality of the potential source water (saline)," and the established "use of these same methods in other areas such as Saskatchewan and Texas", the applicable desalination technologies for Alberta are currently limited to (1) electrodialysis (for total water dissolved solids up to ~5000 mg/L) and (2) reverse osmosis (for water of total dissolved solids of 5,000 – 45,000 mg/L).[89] In addition to the 3 to 5 multiplied rate for operation/maintenance costs of desalinating saline water, there would also be the cost of construction for the actual desalination infrastructure, e.g. processing facilities and distribution centers. Granted, these latter costs are more of an initial capital investment and less of a continuing operating expense.

Although investing in desalination might not currently seem cost effective, there are opportunities available to offset these costs, e.g. "use, reuse and recycling of concentrate are among the possibilities."[90] Furthermore, it should be noted that since the 1970's saline water desalination costs have on average decreased by approximately a factor of three.[91] So if you take the current saline to non-saline water cost ratio, add the average trending decrease in cost of desalination technology for saline groundwater, as well as assume future improvements with technological efficiency, and then add the predicted increase for growth in Alberta's population and non-oil and gas industries, it's

[89] *Ibid* at 37.
[90] *Ibid* at 41.
[91] *Ibid*.

conceivable to foresee that by 2030, the cost ratio could shift from 3 to 5, down to equal or just 2 times the cost. If equal cost is within the bounds of reason, then a demand for desalination within the next 2-3 decades is a considerable possibility.

Developing an economically feasible, if not a successful, desalination sector requires that saline groundwater be licensable under the *Water Act*. Without easy access to saline groundwater sources the government creates a large obstacle between those in possession of a raw material, i.e. the saline groundwater, and those who can transform it into a highly valuable product, i.e. fresh water. Clearly, amending the *Water Act* to allow licenses is a critical component. Once you allow the desalination sector easy access to saline groundwater it encourages greater development for the economical efficiency of the technology. As the technology becomes more efficient, saline groundwater increases its level of utility, the market expands, and costs would presumably go down.

IV. PART 3

The General Environmental Position

Be it a pessimistic or pragmatic view, one could assert that the economic argument in favor of amending the *Water Act* to allow saline groundwater licenses, compared to the environmental argument, is more compelling in terms of motivating government action in Alberta. Nevertheless, it is important not to underestimate the value of an environmental justification for such an amendment. The two points that encapsulate the environmental stance in favor of saline groundwater licensing is that (1) by doing so would "alleviate pressures on surface water bodies and other potable sources"[92], and (2) by not doing so takes away the "environmental incentives to [better] treat, reuse and

[92] *Supra* note 14

conserve water".[93] As clearly demonstrated with point (2), while there are environmental benefits and issues with licensing saline groundwater, what becomes an environmental benefit is inherently due to the greater economic value it would attain through licensing.

Direct & Indirect Environmental Benefits

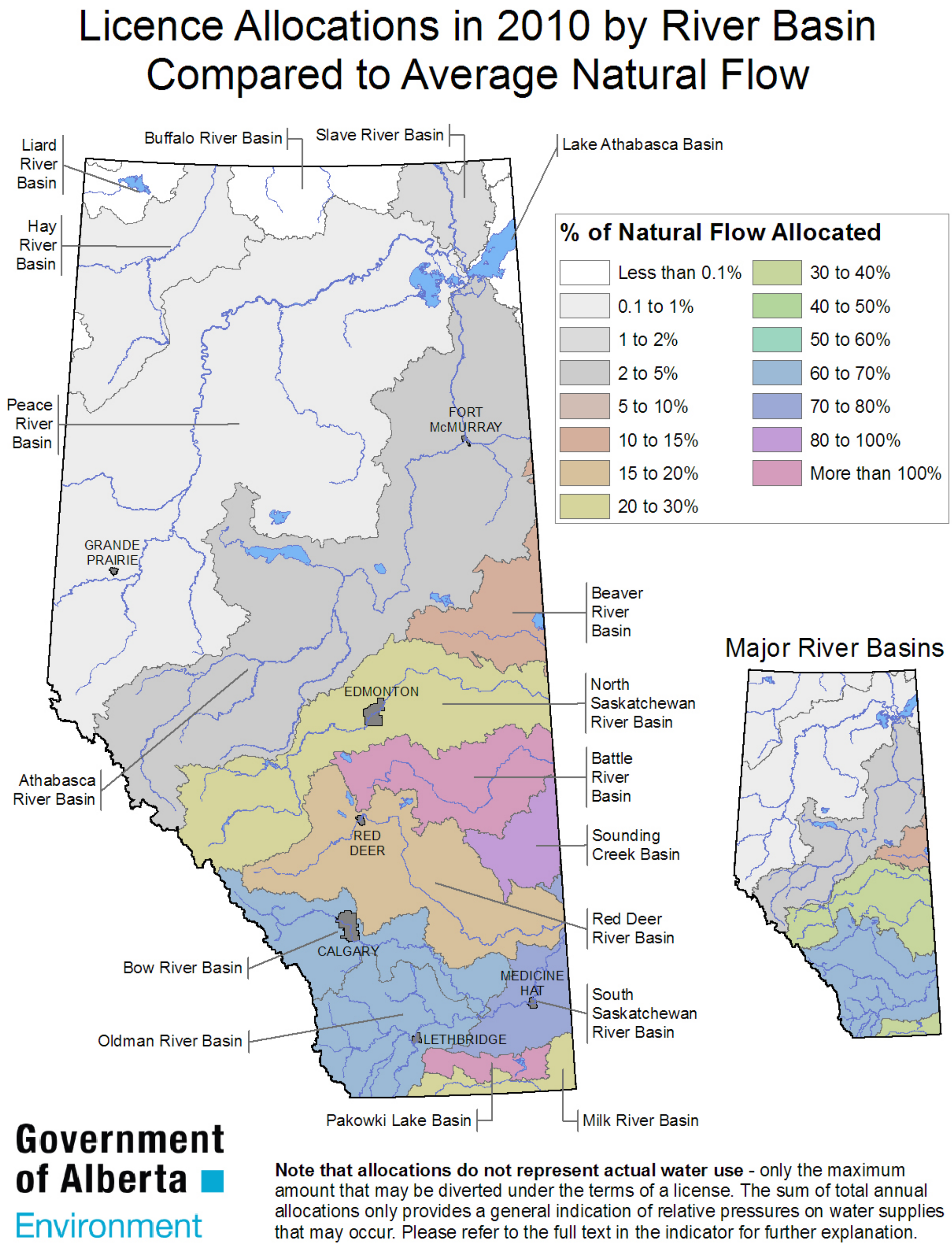
The management and protection of saline groundwater, as a result of licensing, would be consistent with the *Water for Life Strategy* that is currently employed in Alberta.[94] In particular, by providing the alternative of saline groundwater it (1) helps to meet the objectives of a "Healthy Aquatic Ecosystem"[95], and (2) works to ensure "Reliable, Quality Water Supplies for A Sustainable Economy."[96]

Where as point (2) is more so an indirect environmental benefit that comes from an economic inventive to reuse/conserve water, point (1) is a direct environmental benefit. The province's rivers, streams, lakes, aquifers, and wetlands make up the diverse collection of aquatic ecosystems in Alberta. The role of aquatic ecosystems in the hydrological cycle makes their ability to function essential for maintaining safe and stable drinking water supplies.[97] In addition, these ecosystems provide important habitats for wildlife and fish while "offering opportunities for human use and recreational development on Alberta's water bodies."[98]

---

[93] *Ibid.*
[94] *Supra* note 51 at 27.
[95] Government of Alberta, (2008). *Water for Life: A Renewal*. Online: Government of Alberta. <http://environment.gov.ab.ca/info/library/8035.pdf> at 10.
[96] *Ibid* at 11.
[97] Government of Alberta, (2009). *Water for Life: Action Plan*. Online: Government of Alberta. <http://environment.gov.ab.ca/info/library/8236.pdf> at 12.
[98] *Ibid*.

Figure 6: 2010 Licence Allocations by River Basin vs. Average Natural Flow [99]



[99] *Supra* note 23.

Take for example the highly important South Saskatchewan River Basin (SSRB). The SSRB exists within 5 of the 6 natural regions in Alberta, i.e. the Rocky Mountains, Foothills, Boreal Forest, Parkland, and Grassland natural regions.[100] These regions, and their many sub-regions, share characteristics such as climate, geology, soil composition, vegetation, and wildlife; all of which are directly dependent on the basin's water quality and quantity.[101]

In terms of wildlife, the SSRB is home to many different fish species. "In the cold mountain headwaters, and throughout several of the sub-basins, species such as mountain whitefish, rainbow trout, bull trout, and brown trout occur." In addition, in the Parkland and Grassland regions, "cool water fish species such as gold-eye sauger, northern pike, and walleye can [also] occur."[102] Lake sturgeon, which is listed as an endangered species by the Committee on the Status of Endangered Wildlife in Canada, can also be found in the South Saskatchewan River.[103]

In terms of performing an ecological function, the SSRB riparian areas act as "transition zones between aquatic areas and their terrestrial uplands."[104] Riparian ecosystem functions include, "trapping sediment to maintain and build stream and river banks, recharging groundwater supplies, storing flood water and energy, filtering runoff water, reducing and dissipating stream energy, maintaining biodiversity, and creating primary productivity."[105]

If a decrease in the quantity or quality of water were to occur it would result in

---

[100] AMEC Earth & Environmental, (2009). *South Saskatchewan River Basin in Alberta: Water Supply Study*. Online: Legislative Assembly of Alberta. Retrieved on December 2 2013. <http://www1.agric.gov.ab.ab.ca/$ Department/deptdocs.nsf/all/irr13053/$FILE/ssrb_main_report.pdf> at 32.
[101] *Ibid*.
[102] *Ibid*.
[103] *Ibid*.
[104] *Ibid* at 33.
[105] *Ibid*.

excessive removal or alteration of vegetation of the riparian zone. This in turn would "[decrease] friction on the banks and [increase] stream rate of flow, which can increase erosion."[106]

Land use in the SSRB ranges from "relatively undisturbed in the mountainous headwaters to agricultural, urban, and industrial land uses further east."[107] Water quality and other "aquatic resources are relatively pristine at the headwaters, but become more degraded along the length of the basin as land use, water use, and water withdrawals increase." [108] By alleviating pressures from water systems like the SSRB, the licensing and utilization of saline groundwater could contribute to the prevention of things like erosion that negatively effect the overall health of riparian ecosystems.

Greater Transparency & More Effective Aquifer Management

As it has already been alluded to, although saline groundwater is tracked and reported on for the AER, there is little public information available about the cumulative or average quantity/quality of the water involved.[109] However, once licensable, users (i.e. primarily the oil and gas companies) will be required to provide much more comprehensive reporting, as well as be subject to greater government oversight. This transition would result in more publically accessible information by establishing greater transparency between the general public and industry. Ultimately, by having greater access to this type of information it allows groups, such as under-financed grassroots environmental organizations, to have a more effective 'watchdog' role. Although not as powerful as governmental oversight and intervention it nonetheless adds social pressure

---

[106] *Ibid*.
[107] *Supra* note 100.
[108] *Ibid*.
[109] *Supra* note 14.

on users to fulfill their environmental responsibilities.

An additional environmental benefit from licensing saline groundwater is that it could result in better aquifer management. 'Could' is used because it is not a certainty. However, given how fresh water sources are so closely monitored (due partly to the growing challenges of water scarcity, etc.) one could assume that at least some increase in aquifer management would occur given how closely linked they are with saline groundwater activity.

If Alberta were to revise how it manages its aquifers, the one province to most emulate in terms of groundwater protection would be British Columbia. British Columbia is the only province in Canada to classify its aquifers based on "degree of use and vulnerability."[110] This sort of BC-like aquifer protection regime, combined with the mapping efforts currently underway by the Alberta Geological Survey, would be valuable in establishing overall groundwater resources regarding, "hydrogeology, geology, soil suitability, water well distribution, and the origin of the saline groundwater within the province."[111]

The combination of information that would result from a BC-like classification and the current Alberta Geological Survey would also be incredibly helpful in the prioritization and mapping of water scarce areas with potential saline groundwater availability.[112] The province could also better identify communities suitable for pilot programs for treatment of marginally saline groundwater. As part of these pilot studies the government could "conduct research into the application and optimization of the

[110] *Supra* note 99 at 26.
[111] *Ibid* at 44.
[112] *Ibid* at 44-45.

viable desalination/concentrate management technologies."[113] Ultimately, this management could help determine how the desalination sector would be organized within the province.

Environmental Risks from Improper Concentrate Management

If the desalination industry became an established economic sector in Alberta as a result of saline groundwater licensing a key environmental issue to consider would be the managing of desalination 'concentrate', i.e. the mineral (salt) byproduct of the desalination process.[114] The environmental danger of mismanaging concentrate is that it has the potential to contaminate fresh water sources and their surrounding ecosystems, leading to impaired vegetation growth or even biological degradation.[115] If that were to occur it would undermine the whole original purpose of the desalination industry.

For land-locked Alberta simple seawater disposal is not available. However, in their 2007 report AMEC Earth & Environmental showed that three out of the seven concentrate management methods examined were applicable in Alberta: (1) Zero liquid discharge, where any solid by-product is simply disposed in landfills. (2) Deep well injection, effective for permeable low water quality aquifers. (3) Evaporation ponds, where shallow man-made ponds are set up to allow saline brine to evaporate and then have the solid waste either be left or later collected for another solid disposal site.[116]

While the operational cost of concentrate management is covered under general desalination expenses (note pages 20-21 of this essay), some of the cost of this process could be offset by proper application of the resulting byproduct. For example, on "smaller

---

[113] *Ibid.*
[114] *Ibid* at 13.
[115] Environmental Sciences Division, (2001). *Salt Contamination Assessment & Remediation Guideline*. Online: Government of Alberta <http://environment.gov.ab.ca/info/library/6144.pdf> at 1.
[116] *Ibid* at 39.

scales, use of concentrate for dust suppression, roadbed stabilization, soil remediation, or other local activities may be considered."[117] Ultimately, concentrate management would become a vital aspect of any potential desalination industry; and while it would be an expense for the industry, if managed properly, such expenses could be minimized.

V. CONCLUSION

By amending the *Water Act* to allow saline groundwater diversions the province of Alberta could (1) take advantage of market forces in relation to water allocations, (2) alleviate stress on surface water bodies, (3) conserve their diverse surrounding environment and/or ecosystems, (4) allow for greater public access to the environmentally impactful activities of the oil and gas industry, and (5) establish greater environmental protections for saline groundwater, which has historically been underappreciated and comparatively mistreated as a water resource.

Admittedly, there are many challenges that could result from implementing this proposed amendment, be they the potentially negative economic effects on the oil and gas industry, or the economic infeasibility of current desalination technologies. Nevertheless, based on global trends, there is a strong possibility that Alberta's growing population and expanding (heavily water reliant) industries face a future of constrained water supply.[118]

Now, at a time of relative economic boom, Alberta has the opportunity to set the foundation needed for more effective management of a currently abundant and potentially vital resource. Ultimately, to help secure the future of Alberta's environment and economy the *Water Act* must be amended to allow the licensing of saline groundwater.

---

[117] *Ibid* at 34.
[118] *Supra* note 84 at 15.

BIBLIOGRAPHY

LEGISLATION

Water Act, RSA 1998 c. W-3. Water (Ministerial) Regulation.

Water Act, RSA 2000 c. W-3.

Fisheries Act, RSA 2000 c. F-16.

SECONDARY MATERIAL: MONOGRAPHS

Alberta Environment, (2011). *Focus On Groundwater Use*. Online: Alberta Environment. Retrieved May 15, 2014. <http://environment.gov.ab.ca/info/library/8397.pdf>.

Alberta Environment, (2008). *Water Act: Licenses: Facts at your fingertips*. Online: Alberta Environment. Retrieved November 9, 2013. <http://environment.alberta.ca/documents/WaterAct _Licences_FS.pdf>.

Alberta Water Council, (23 November 2009). *Recommendations for Improving Alberta's Water Allocation Transfer System*. Online: Alberta Water Council. Retrieved November 30th, 2013. <http://www.albertawatercouncil.ca/Portals/0/pdfs/WATSUP_web_FINAL.web_FINAL.pdf>.

AMEC Earth & Environmental, (2009). *South Saskatchewan River Basin in Alberta: Water Supply Study*. Online: Legislative Assembly of Alberta. Retrieved on December 2 2013. <http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/irr13053/$FILE/ssrb_main_report.pdf

AMEC Earth & Environmental, (2007). *Water for Life: Current and Future Use in Alberta.* Online: Legislative Assembly of Alberta. Retrieved on November 25, 2013. <http://www.assembly.ab.ca/lao/library/egovdocs/2007/alen/164708.pdf>.

AMEC Earth & Environmental, (2007). *Cost-Benefit Analysis of Treating Saline Groundwater*. Online: Alberta Environment. Retrieved on November 15, 2013. <http://environment.gov.ab.ca/info/library/7816.pdf>.

Government of Alberta, (2009). *Water for Life: Action Plan*. Online: Government of Alberta. Retrieved on November 28, 2013. <http://environment.gov.ab.ca/info/library/8236.pdf>.

Government of Alberta, (2008). *Water for Life: A Renewal*. Online: Government of Alberta. Retrieved on November 28, 2013. < http://environment.gov.ab.ca/info/library/8035.pdf>.

Environmental Sciences Division, (2001). *Salt Contamination Assessment & Remediation Guideline*. Online: Government of Alberta. Retrieved on December 1, 2013. <http://environment.gov.ab.ca/info/library/6144.pdf>.

Rosenberg International Forum on Water Policy, (2007). *Report of the Rosenberg International Forum on Water Policy to the Ministry of Environment, Province of Alberta.* Online: Water for Life. Retrieved November 20, 2013. <http://www.waterforlife.gov.ab.ca/docs/Rosenberg_Report.pdf>.

Veil, J.A., et al. (2004). *A White Paper Describing Produced Water from Production of Crude Oil, Natural Gas, and Coal Bed Methane*. University of Chicago, Department of Energy: U.S. Department of Energy, Energy Technology Laboratory.

SECONDARY MATERIAL: ARTICLES

Alberta Water Research Institute, (2011). *Groundwater in Alberta: An assessment of source, use and change.* Online: The Alberta Water Portal. Retrieved on November 13, 2013. <http://www.albertawater.com/index.php/water-facts-info/groundwater/49-water-research/dynamics-of-alberta-s-water-gas/groundwater-in-alberta/balance-and-inventory/637-what-about-the-saline-water>.

Canadian Association of Petroleum Producers, (2010). *Responsible Water Management in Canada's Oil and Gas Industry*. Online: CAPP. Retrieved November 17, 2013. <http://www.capp.ca/getdoc.aspx?DocID=173950>.

Government of Alberta, (2013). *Water Used for Oilfield Injection Purposes*. Online: Government of Alberta. Retrieved on November 12, 2013. <http://esrd.alberta.ca/focus/state-of-the-environment/water/surface-water/pressure-indicators/water-used-for-oilfield-injection-purposes.aspx>.

Government of Alberta, (2010). *Facts About Water in Alberta*. Edmonton, Canada: Alberta Environment Information Centre.

Romanowska, P. (23 July 2013). *Alberta desperately needs a water-management plan: A strategy to manage water use in Alberta must coexist with the oil and gas sector's appetite for this precious resource*. Online: Alberta Oil Online Magazine. Retrieved November 10, 2013. <http://www.albertaoilmagazine.com/2013/07/alberta-and-the-life-aquatic/>.

Unger, J. (01 June 2009*). Water regulation must define saline versus potable water: Heightened constraints on water supplies increasingly question the line between saline and pure sources of water.* Online: Alberta Oil Magazine. Retrieved October 15, 2013 <http://www.albertaoilmagazine.com/2009/06/worth-our-salt/>.

OTHER MATERIALS

Alberta WaterPortal, (2013). *Learn: Water Licences, Transfers, and Allocation*. Online: Alberta WaterPortal. Retrieved May 15, 2014. <http://www.albertawater.com/learn/how-is-our-water-governed/water-licenses-and-transfers>.

Alberta WaterPortal, (2013). *Learn: What about the Saline Water?*. Online: Alberta WaterPortal. Retrieved May 15, 2014. <http://www.albertawater.com/groundwater/balance-and-inventory/what-about-the-saline-water>.

Environment Canada, (09 September 2013). *Groundwater*. Online: Government of Canada. Retrieved November 15, 2013. <http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=300688DC-1#sub21>.

Pocket Oxford English Dictionary, (11th ed.), (2013). Oxford, United Kingdom: Oxford University Press.

Society of Petroleum Engineers, (12 October 2011). *Challenges in Reusing Produced Water*. Online: SPE Technology Updates. Retrieved May 14, 2014. <http://www.spe.org/industry/docs/reusingwater.pdf>.

WateReuse Foundation, (1 October 2007). *Fundamentals: Measures of salinity*. Online: Salinity Management Guide. Retrieved November 15, 2013. <http://www.salinitymanagement.org/Salinity%20Management%20Guide/ls/ls_3d.html>.