IISDREPORT

Implementing an Agricultural Water Security Market for Southwestern Manitoba

Vivek Voora
Jason Dion

September 2013

Published by the International Institute for Sustainable Development.

International Institute for Sustainable Development

The International Institute for Sustainable Development (IISD) contributes to sustainable development by advancing policy recommendations on international trade and investment, economic policy, climate change and energy, and management of natural and social capital, as well as the enabling role of communication technologies in these areas. We report on international negotiations and disseminate knowledge gained through collaborative projects, resulting in more rigorous research, capacity building in developing countries, better networks spanning the North and the South, and better global connections among researchers, practitioners, citizens and policy-makers.

IISD's vision is better living for all—sustainably; its mission is to champion innovation, enabling societies to live sustainably. IISD is registered as a charitable organization in Canada and has 501(c)(3) status in the United States. IISD receives core operating support from the Government of Canada, provided through the International Development Research Centre (IDRC), from the Danish Ministry of Foreign Affairs and from the Province of Manitoba. The Institute receives project funding from numerous governments inside and outside Canada, United Nations agencies, foundations and the private sector.

International Institute for Sustainable Development
Head Office
161 Portage Avenue East, 6th Floor, Winnipeg, Manitoba, Canada R3B 0Y4
Tel: +1 (204) 958-7700 | Fax: +1 (204) 958-7710 | Web site: www.iisd.org

Implementing an Agricultural Water Security Market for Southwestern Manitoba
September 2013

Written by Vivek Voora and Jason Dion

Executive Summary

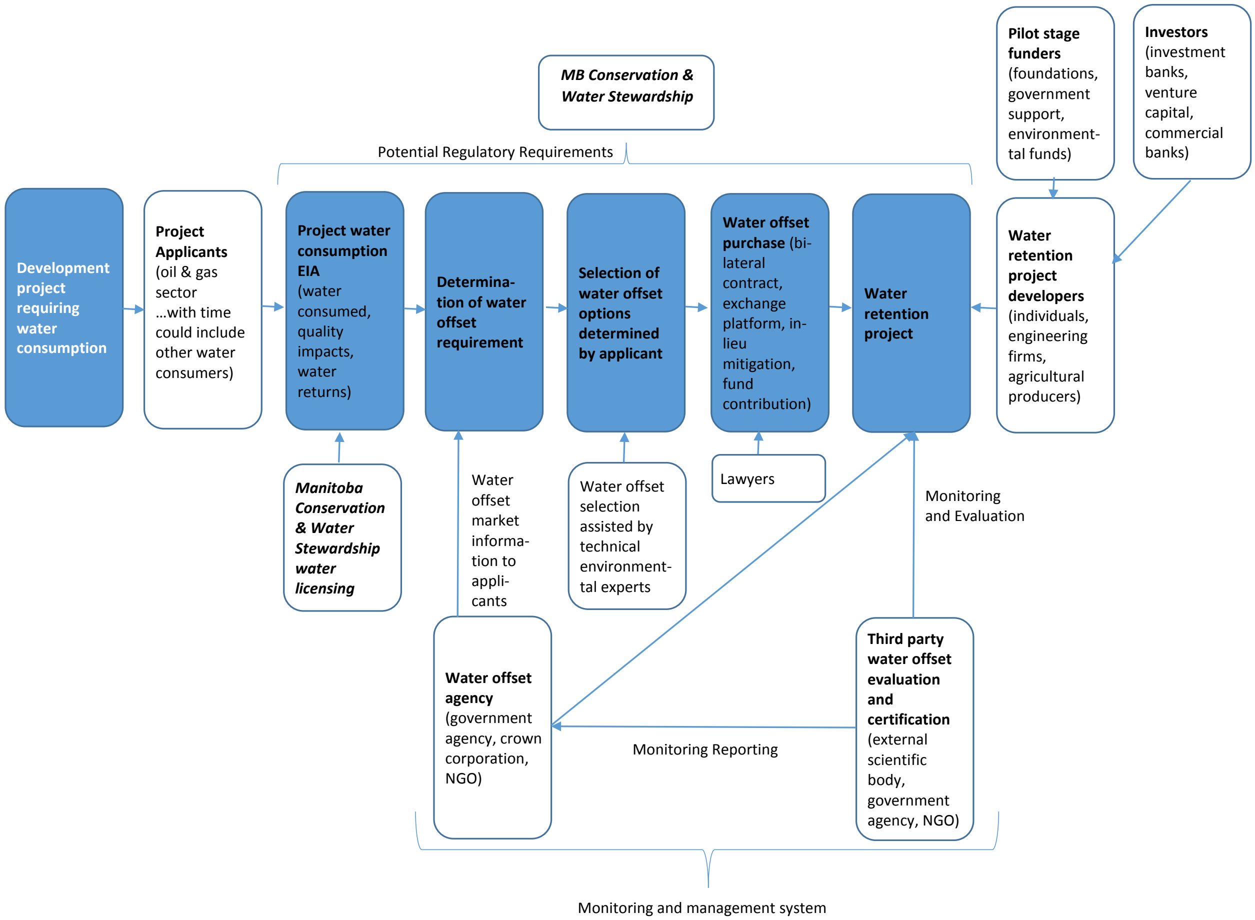
Water security is increasingly becoming a concern in many parts of the world (Bigas, Morris, Sandford, & Adeel, 2012). Changes in hydrological patterns, depleting water supplies and degrading water quality are some of the challenges affecting human well-being. Groundwater management is particularly difficult due to a lack of access to information such as recharge rates. Although southwestern Manitoba is endowed with relatively sufficient water, the rising variability of the supply due to climate change and increasing water resource demands from the agricultural and oil and gas sectors may lead to regional challenges over time. Furthermore, the region has been identified by the Council of Canadian Academies (2013) as an agricultural landscape threatened by limited water availability.

The establishment of an Agricultural Water Security Market (AWSM) for southwestern Manitoba is proposed to prevent water from becoming a limiting factor in the operations of the agricultural and oil and gas sectors. The AWSM would allow the oil and gas sector to offset the water it consumes for hydraulically drilling wells by purchasing water quantity offsets. The offsets would consist of establishing water retention sites on the landscape, which would improve regional water security by holding back water to increase supplies through groundwater recharge and access to additional surface water. The water retention structures could also retain nutrients, improve local water quality, and protect natural infrastructure from flooding events.

A preliminary architecture for the AWSM based on key design considerations and the review of 11 water trading schemes is provided in the table and flow diagram below. The AWSM flow diagram shows how the market would generally function, moving from a proposed oil and gas well development to the water retention project used to offset water consumption. The diagram also shows the different entities that would be involved in the trading scheme. The proposed AWSM is designed to enable market participants to become water neutral by enhancing local water supplies through water retention and groundwater recharge projects.

DESIGN CONSIDERATIONS	PROPOSED
Governance program administrator	Oil Producing Municipalities of Manitoba
Hydrological service goals	Maintaining freshwater supplies
Geographic scale	Watershed
Participants and stakeholders	Oil and gas sector, municipalities, conservation districts, provincial government and non-governmental organizations
Buyer	Industry (could be expanded to include other water users such as municipalities and the agricultural sector with time)
Intervention	Offset water consumption through water retention infrastructure
Driver	Voluntary – to fulfill corporate social responsibility and maintain a social licence to operate. With time the driver could transition to a regulatory system.
Exchange agreement	Water offset purchases, which would go toward establishing water retention and recharge sites
Potential co-benefits	Flood mitigation, nutrient retention, wildlife habitat, biomass production, recreation

FLOW DIAGRAM OF THE AWSM WATER QUANTITY OFFSETS SYSTEM



Although the AWSM will initially be established as a voluntary market so it can be fine-tuned, its design will allow for a smooth transition toward becoming a regulated market if and when this becomes appropriate. The provincial Water Rights Act, Ground Water and Water Well Act, and the Oil and Gas Act provide a legislative basis upon which a regulated AWSM can be designed. The Water Rights Act requires users consuming more than 25,000 litres per day to obtain a water licence.[1] This requirement may need to become more stringent for a regulated AWSM to be viable in southwestern Manitoba. The Ground Water and Water Well Act has provisions for imposing groundwater surveys and preventing groundwater pollution when drilling wells. The Oil and Gas Act provides sustainable development principles to guide the industry, which could be used to entice the private sector to participate in the AWSM in southwestern Manitoba. In addition to provincial acts, the possibility of using municipal bylaws to establish a regulated AWSM may be feasible.

[1] "Manitoba reported the following allocated and actual annual volumes by sector: irrigation (28,848 dam^3 allocated, actual N/A); industrial (18,054 dam^3 allocated; 9,130 dam^3 actual); municipal (13,854 dam^3 allocated, 5254 dam^3 actual); other (13,769 dam^3 allocated, actual N/A); agricultural (5,750 dam^3 allocated, 2,059 dam^3 actual). Aggregated licensed amounts for each category exceed the actual amounts used across each sector."(Nowlan, 2005)

The potential supply and demand for water offsets is estimated to be 6,287 cubic decametres of water storage potential along stream reaches and 400 to 600 cubic decametres of demand by the oil and gas sector per year, or roughly one-tenth of the supply. The supply could be vastly expanded if the potential for developing water retention sites on marginal lands or through wetland restoration was included. The oil and gas sector in southwestern Manitoba is poised to grow, and the demand for water offsets could be significantly greater than the estimate provided in this report (Agnes, 2013; Freyman & Salmon, 2012).

The institutional structure to administer the AWSM will greatly depend on whether the market is voluntary or regulated. If regulated, the most important agency will be Manitoba Conservation and Water Stewardship, due to its role in the sustainable management of Manitoba's water supplies and, more specifically, its responsibility for issuing water licences. If voluntary, the market will require that provincial government agencies such as Manitoba Conservation and Water Stewardship add credibility to the trading scheme by ensuring water offset projects are adequate and correspond to creating an amount of water equivalent to what was consumed.

Entities that could administer and operate the AWSM include municipal or non-governmental organizations with the appropriate networks and knowledge. The Oil Producing Municipalities of Manitoba may be well-suited to administer the AWSM, since they could implement joint bylaws, which could form the legislative basis upon which the market could operate. The Prairie Improvement Networks well-suited to manage the AWSM due to its multi-stakeholder model, which brings a range of economic and technical expertise to bear on its development and operation.

Other NGOs, such as the International Institute for Sustainable Development and Ducks Unlimited Canada, could play an important role in bringing the right kind of expertise to the development and operation of the AWSM. Crown agencies and corporations such as conservation districts, Manitoba Agriculture, Food and Rural Initiatives and Manitoba Habitat Heritage Corporation could also play important roles in various aspects of the market such as monitoring and verification of the water offset projects.

Manitobans value their water resources, and significant investments have been made to protect them. "Manitoba currently has 600 monitoring wells, rain gauges, and soil moisture monitoring stations, forming one of the largest networks of water-level monitoring wells in Canada"(Nowlan, 2005). A valuation study of groundwater resources in the Assiniboine delta aquifer in Manitoba estimated its worth to range from CAD$85 million to $4,000 million (Nowlan, 2005). Nowlan (2005) reports that a review of the water licensing fees found that they should be expanded to "recover costs for water use for all users based on a 'fair' equation."

Based on the rapid projected expansion of the oil and gas sector in southwestern Manitoba and a desire to expand water licensing fees for cost recovery, the establishment of an AWSM could be opportune and appropriate. The southwestern Manitoba AWSM would allow the oil and gas sector to flourish alongside the agricultural sector while enhancing community resilience to potential regional water stresses.

Prairie IMPROVEMENT NETWORK

iisd International Institute for Sustainable Development / Institut international du développement durable

Table of Contents

List of Figures

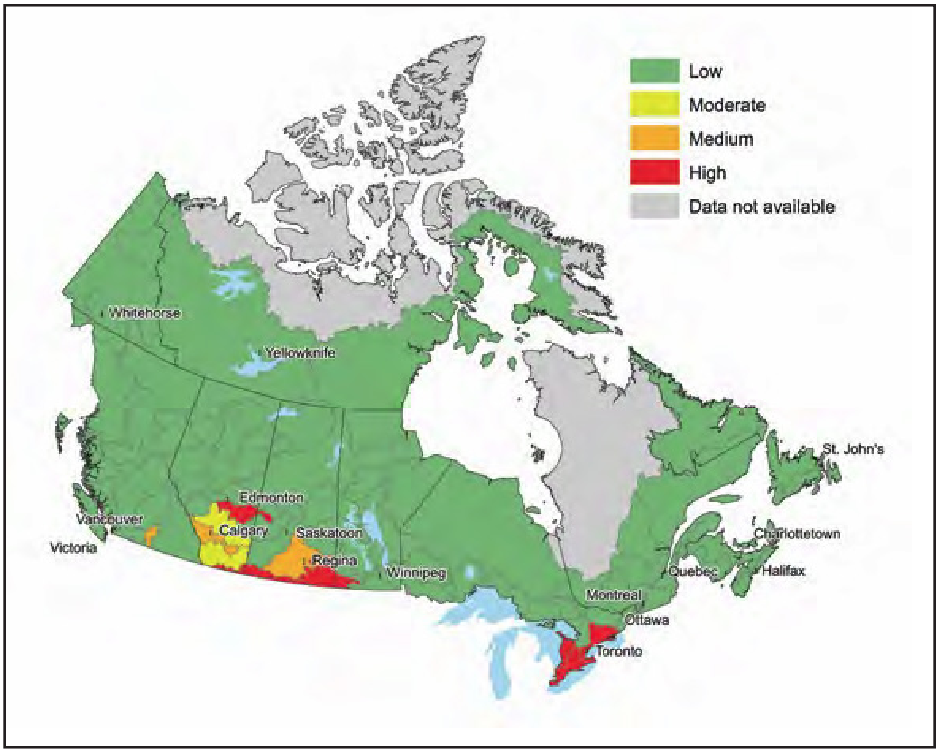
List of Tables

1.0 Introduction

Southwestern Manitoba is endowed with rich, productive soils, which have enabled agriculture to flourish in the region for over a century. Today, the agricultural industry is still the main source of employment and economic activity. To remain viable, agricultural production requires significant quantities of water at specific times. This water is typically obtained through natural precipitation or irrigation.

The Council of Canadians (2013) has identified southwestern Manitoba as an agricultural landscape threatened by limited water availability. In addition, southwestern Manitoba has also experienced flooding in recent years. The total flood damages due to the spring flood of 2011 across the province of Manitoba, which included flooded areas in the southwestern Manitoba portions of the Assiniboine and Souris river basins, exceeded CAD$800 million (Council of Canadian Academies, 2013). Moreover, episodes of water scarcity and excess are expected to become more frequent due to climate change (Council of Canadian Academies, 2013).

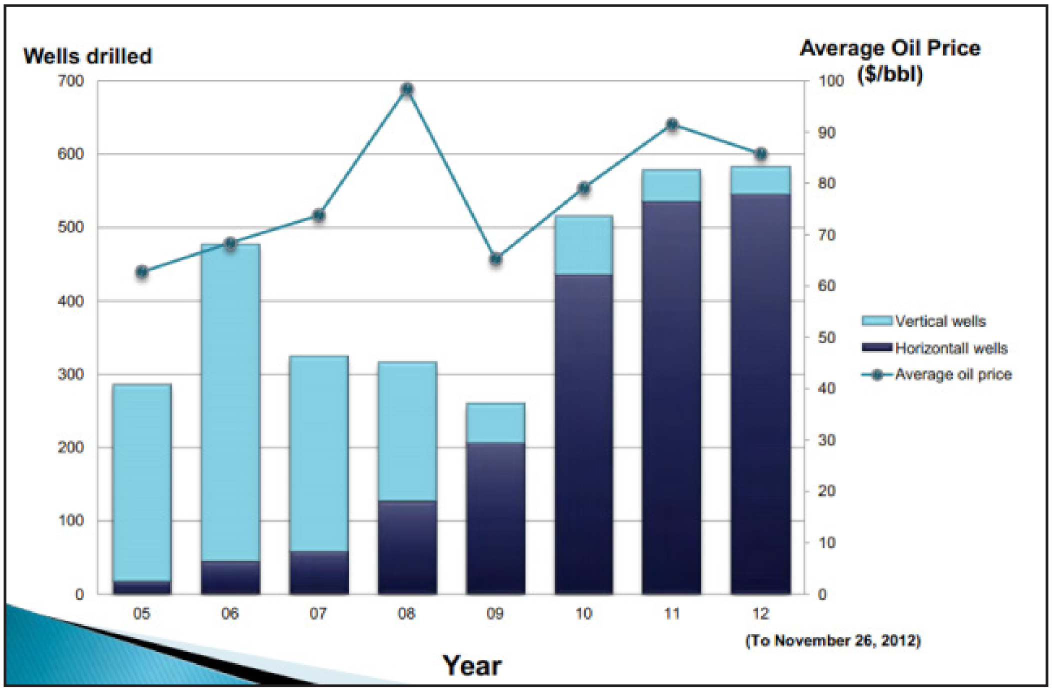
FIGURE 1: AGRICULTURAL AREAS OF CANADA THREATENED BY WATER AVAILABILITY.



Source: Council of Canadian Academies (2013).

Within the last 10 years the oil and gas industry has significantly expanded in the region (see Figures 2 and 3). An estimated 2,749 wells were drilled between 2005 and 2011, and close to 600 wells were added in 2012. The sector is important to the economy of southwestern Manitoba,[2] as it provides over 4,000 direct and indirect jobs, and the value of oil production alone was CAD$1.4 billion in 2011 (up 56 per cent from 2010) (Fox & Nicolas, 2012).

FIGURE 2: NUMBER OF WELLS DRILLED IN SOUTHWESTERN MANITOBA FROM 2005 TO 2012.



Source: Fox & Nicolas (2012).

The oil and gas sector can impact regional water security. Depending on the type of well (oil or gas), the quantity of water consumed per well can reach up z00 cubic metres depending on the drilling method and fossil fuel being extracted(Freyman & Salmon, 2012).[3] With the oil and gas industry poised to continue growing exponentially in the near future, the water consumed by this sector will likely follow a similar pattern (Agnes, 2013; Dyer, Grant, Lesack, & Weber, 2008). In addition to the water quantities being used, oil and gas operations can also impact water quality. For instance, the process of gas fracking[4] uses freshwater with chemical additives, which can pollute groundwater, as

[2] "Oil production was 2.39 million m^3 (15 million barrels), up 27% from 2010; Oil industry expenditures - $1.23 billion; Provincial petroleum revenue - $42.4 million (includes Crown royalties, production taxes, Crown oil and gas rights leasing and fees); Oil royalties paid to private (freehold) mineral owners - $218 million; Payments made to landowners for surface rights - $34 million; Property taxes paid to rural municipalities - $11 million."(Fox & Nicolas, 2012, pp. 48-49)

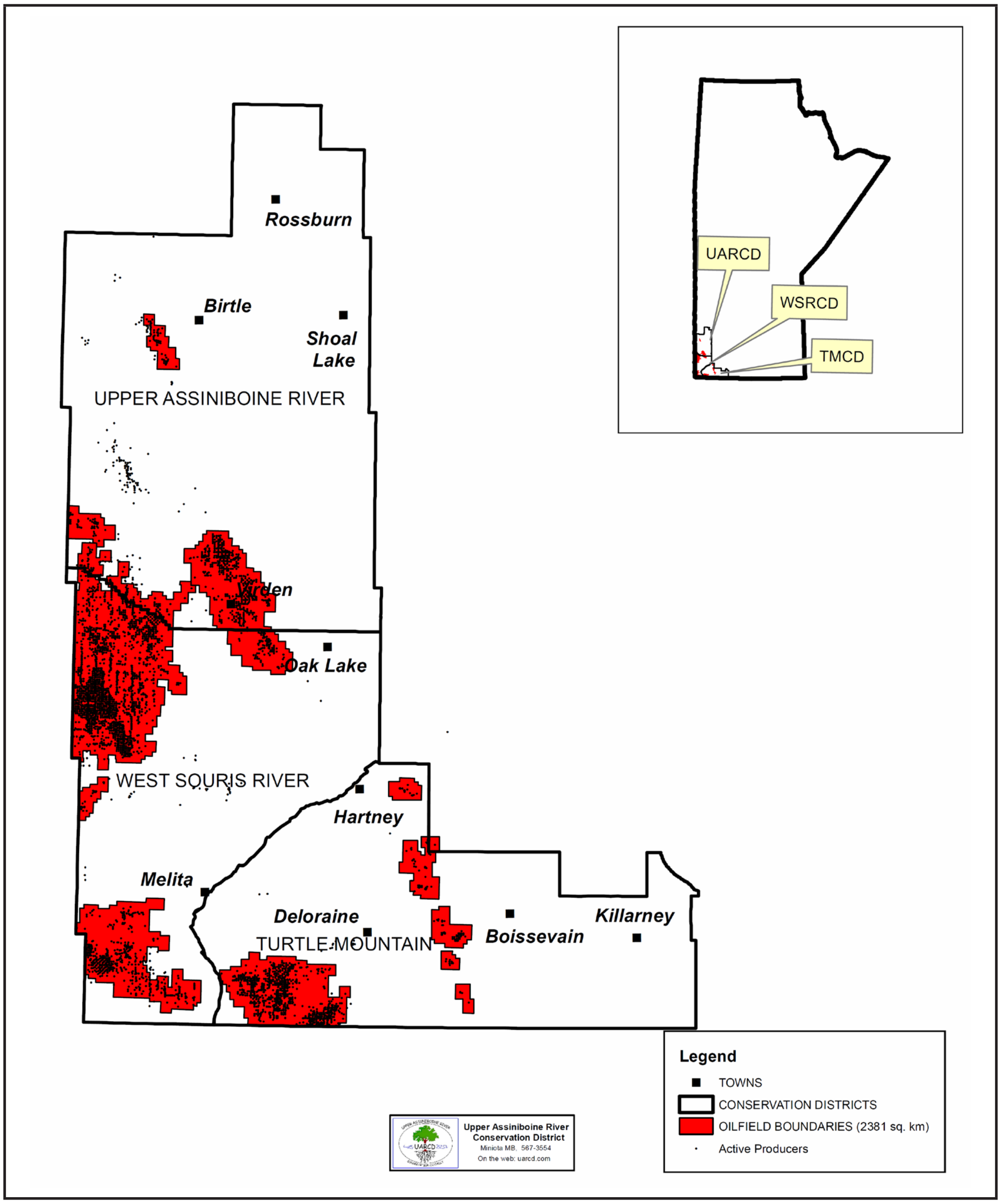
[3] In the United States Ceres reports that water consumption for gas fracking ranges from 7,500 cubic metres to 37,500 cubic metres (2 million to 10 million gallons) per well (Freyman & Salmon, 2012).

[4] "Hydraulic fracturing (also called "fracking") is the process of pumping a fluid down an oil and gas well to fracture (crack) the rock formation to increase the production of oil and gas from the well. The frac fluid (usually fresh water with some additives) holds a proppant (usually sand) that flows into the cracks. This layer of sand props open the cracks and allows the oil and gas to flow at higher rates into the well." (Fox & Nicolas, 2012, p. 50).

well as sand to facilitate access to oil and gas within shale rock. Furthermore, the water is injected at depths that often render it no longer accessible. Freyman and Salmon (2012) report that the amount of water consumed per well will depend on the geology of the shale, fracturing stages and amount of water flowing back to the surface. Fifty to 80 per cent of the water consumed during the hydraulic drilling process is no longer accessible (Freyman & Salmon, 2012).

The water consumed by the gas fracking sector represents 2 per cent of the total water consumption in the United States and is undermining water security in some water-stressed parts of the country(Freyman & Salmon, 2012). The gas fracking sector has been able to secure its water resource requirements in Colorado and North Dakota by paying higher premiums and by getting temporary permits. In the wetter states of the northeastern United States, water permits were withdrawn due to low levels in headwater streams. The potential for recycling water for fracking as well as using sources other than freshwater is currently being examined. Freyman and Salmon (2012)point to the need for water management planning to receive more attention where oil and gas developments require water.

FIGURE 3: THE PROJECT AREA ENCOMPASSES THE UPPER ASSINIBOINE CONSERVATION DISTRICT, TURTLE MOUNTAIN CONSERVATION DISTRICT AND THE WEST SOURIS CONSERVATION DISTRICT.



Sustainable water management models for the region are consequently imperative to ensure that the oil and gas industry can coexist with other competing demands for water, such as agriculture. Market-based instruments have proved to be effective in some parts of the world to help conserve water supplies and improve water quality (Bennett, Carroll, & Hamilton, 2012; Russi et al., 2013; Dyer et al., 2008). "Water trading has yielded significant economic benefits in Australia and helped speed the recovery of the agricultural sector after the 'Millennium Drought' of 1997–2009, according to the head of the country's water authority"(Cooper, 2011). Groundwater offsets are an example of one such instrument used to maintain zero net loss in groundwater within a region or watershed over a certain period of time (Bennett et al., 2012). Groundwater offsets involve the direct or indirect funding of projects that recharge groundwater to compensate for the depletion of that groundwater. They usually require water to be recharged to the same watershed it is being drawn from.

If designed and functioning properly, markets can effectively address resource allocation problems and result in publicly valued outcomes such as the protection of the environment by intelligently leveraging the individual interests of private actors. "Through trade, markets create incentives for participants to water more efficiently, responding to price signals that are transparent and responsive to fluctuations in demand" (PricewaterhouseCoopers, 2006, p. 10). The market needs to provide a useful service to attract support from market participants and must be flexible and adaptable over time to achieve evolving objectives.

Design considerations for establishing an agricultural water security market (AWSM) in southwestern Manitoba to enable the oil and gas sector to offset its water consumption through water retention investments are presented in this study. These water retention structures will be designed to provide additional benefits such as flood protection for local residents, water quality improvements by retaining nutrients, and additional water supplies for agricultural irrigation (Tuinhof, Van Steenbergen, & Tolk, 2012).

The report first presents general market design and operation considerations associated with establishing a water quantity offsetting system.[5] A number of national and international water quantity offset models from which design elements could be applied to southwestern Manitoba are then briefly described. The legislative frameworks under which an AWSM could operate and the potential supply and demand for water quantity offsets in southwestern Manitoba are examined before the report concludes with a presentation of a potential water quantity offsetting system for southwestern Manitoba.

[5] Distinguished from a water *quality* offset system, which offsets the contamination or pollution of water.

2.0 Establishing a Water Market

There are several market-based mechanisms to offset water use. Broadly speaking, water markets are platforms where water access entitlements and allocations of water can be traded between buyers and sellers. Theoretically, water markets provide a structure for innovation through competition for water access. The structural elements focused on to facilitate this competition are prospective buyers and sellers, with a competitive tension between them, complete and transparent information, and externalities addressed by the market. Fundamentally, trade occurs only when buyers are willing to pay more for a commodity than its attributed value to a prospective seller. Additionally, a market will only function if there is scarcity of supply and a significant cost associated with accessing an alternative. In the case of the proposed AWSM, water offsets can encourage innovative approaches to lower water consumption costs.

2.1 Design Consideration

This section outlines design considerations for a water quantity offset system. These design considerations, which are discussed in turn below, are drawn from literature on carbon and sulphur dioxide emissions trading systems and water supply markets (Bennett et al., 2012; Carmona, Fehr, Hinz, & Porchet, 2010; PricewaterhouseCoopers, 2006; Stavins, 1998).More specific operational considerations are discussed in the subsequent section. While the design considerations below are generally applicable, this report focuses on the type of water market in which water quantity offsets are bought or sold; i.e., rather than buying the right to use water, the buyer pays for the return of water to the watershed. This type of system is concerned with water *recharge*, where the amount of water sold via the offset refers to the amount *retained* within the watershed, not simply the amount returned to it.

2.1.1 Governance

How is the program administered? Government is the natural administrator in a compulsory water offset system. However, in the case of a voluntary system, any number of groups or organizations could potentially fulfill the role of administrator, and a government may very well appoint a third party to oversee a compulsory system. It should be noted, however, that a program being supported or backed by a government body (but not necessarily run by it) was found in the literature to strongly impact the success of the program, since governmental involvement was seen to grant projects greater legitimacy in the eyes of participants (Bennett et al., 2012). Potential options for program governance include municipalities, industry, provincial governments and independent organizations.

2.1.2 Hydrological Service Goals

What problem is this mechanism trying to solve? It is important that the purpose of the system be made clear and explicit. Multiple objectives are acceptable, but their ranking relative to one another should be clear. Typically, hydrological service goals include addressing limited supply of freshwater and/or improving water quality.

2.1.3 Geographic Level

Scale: At what geographic level do investments occur? This design consideration relates not to the scale of the system, but the scale of a given offset within it (i.e., how far away from a participant's activities should an offset initiative be carried out). The options are best understood as a spectrum, with local scale at one end and international at the other, and include local, watershed, regional, national and international scales.

2.1.4 Participants and Other Stakeholders

Who are the key actors? All the potential stakeholders should be taken into consideration early in the design of the system so that all affected parties have a chance to provide input from the outset. This does not mean that all these groups need to be equally engaged in the design process, but rather that their views and their participation should be considered early on by those designing the system. The following entities could be participants and stakeholders in the design of the water quantity offset system: industry, the agricultural sector, municipalities, provincial governments and non-governmental organizations (NGOs) involved in water, conservation authorities, regulators and ecosystem market service providers.

2.1.5 Buyer

Who pays? The intended purchaser of the offsets should be clear to all involved. Although one type of buyer is usually designated, it is possible for various groups and organizations such as industry, municipalities, agricultural producers, landowners and provincial governments to participate.

2.1.6 Intervention

What does the buyer pay for? The question of what exactly is being bought is important and should be made clear to buyers, clearly defining the commodity being traded in a water market. For instance, there is a difference between water entitlements and allocations. Water entitlement is the share of a consumptive pool of a specified water resource, while water allocation is the volume of water made available under a water access entitlement. As stated above, this report focuses on the purchase of water retention and recharge.

Generally, water offsets traded in a market must exhibit the following characteristics:

- Clearly specified – The benefits and obligations associated with the water offset are clearly understood.
- Secure – The rights of the holder with respect to the water offset are secure and protected from modification but may be subject to attenuation under certain circumstances.
- Exclusive – The holder of the water offset has exclusive rights over it.
- Enforceable and enforced – The right associated with the water offset is enforceable and enforced. The right can be monitored with respect to its trade and use, and there are rules and consequences for infringements on this right.
- Transferrable and divisible – The water offset can be traded in whole or in part.

2.1.7 Driver

Why does the buyer pay? The motivation of the buyer should be understood so that the rationale for their participation can be clearly articulated. Being compelled to participate though regulatory means or enrolment in a voluntary program to maintain or improve good public relations are the main two reasons for participation, but complementary reasons also exist, such as contributing to the development of a market for watershed service payments (e.g., the government or industry may signal its participation in the program to encourage development of offset supply projects), interest in achieving co-benefits (e.g., a buyer may value the flood mitigation effects of a given intervention), or avoiding more costly types of potential regulation (e.g., industry chooses to act voluntarily to demonstrate that regulations or taxes aren't necessary).

2.1.8 Exchange Arrangement

How do they pay the hydrological service provider? The question of how payment is delivered is one of the most central design considerations. There are a number of different means by which funds can be collected and distributed: paying into a fund, bilateral contracts, brokerage and taxation. Project selection to fulfill a water quantity offset will be influenced by the exchange agreement. For example, a fund would likely have projects being selected by the fund administrator, whereas in a brokerage the projects would be selected by the purchaser of the offset. If projects are selected by an administrator, then a defensible, standardized prioritization methodology should be developed and publicized.

2.1.9 Co-Benefits

Does the program have multiple objectives, beyond hydrological services? With many of the offset projects there will be associated co-benefits. These can be included in the offset system simply as accompanying information or as requirements (e.g., some threshold of a given co-benefit being reached, or co-benefits being a prerequisite). All potential co-benefits such as flood mitigation, nutrient cycling, habitat creation, avoided sediment runoff, biomass production and recreation should be established and filtered down to the ones the system wishes to consider.

2.2 Operation Considerations

Once the general design considerations have been established, more detailed considerations are required to determine how the market will actually function. The market's trading rules, its transaction monitoring system, the regulatory regime under which it operates and the information shared will dictate how effective the market can be at achieving its objective. The following sections provide market operational considerations that must be addressed in the design of the trading system's mechanics in order to maximize efficacy and efficiency.

2.2.1 Trading Rules

Trading rules can often dictate how effective a market can be at achieving a particular hydrological goal. "For the effective functioning of a market rules need to be properly constructed, founded on reliable scientific and other data, and should be reviewed periodically to ensure they remain both necessary and effective"(PricewaterhouseCoopers, 2006, p. 84). Removing restrictions on market participation, for instance, may lead to the emergence of innovative products and contract types. The following basic trading rules must be considered when designing a water market (PricewaterhouseCoopers, 2006). This list is not necessarily exhaustive, but it underscores the variety of factors that must be considered in establishing clear and effective trading rules.

1. **Water offsets may be traded permanently or temporarily, through lease arrangements or other trading options.** Clear rules are required to administer transfers of ownership and use of the offset. Rules must be established for trading and owning the offset as well as using the offset.

2. **All trades should be recorded on a water registry.** By recording the transfer of ownership from one party to the other, the registry ensures that market confidence is maintained through accessible and transparent information provided on transactions. The water trading registry needs to be kept current, accessible and available to market participants.[6] The cost of creating and maintaining a water registry should be borne by the market participants.

[6] Waterexchange (https://www.waterexchange.com.au/cms/index.php) and SunWater (http://www.sunwater.com.au/) are examples of water registries in Australia.

3. **Trade restrictions are in place to manage environmental impacts, delivery constraints, and integrity of water resources and features of indigenous, cultural and spiritual significance.** Additional considerations for developing trading rules might include unregulated and regulated streams, delivery capacity constraints, impacts on water demands, impacts on hydrology, riparian rights for livestock and domestic use, and participation requirements.

4. **Trades must be consistent with relevant water plans.** Alignment with water management plans should in theory prevent the trading system from having negative impacts on the hydrological cycle and ecosystems of an area. For instance, groundwater management planning should be a requirement for trading in areas where groundwater is highly connected with surface water and where there may be other environmental concerns.

5. **Trades cannot result in going beyond the threshold of sustainable water consumption.** Trading policies and rules should incorporate thresholds or "trigger points" that initiate the review of market rules and procedures to ensure that they remain relevant and minimize potential impacts and externalities. Information tracking requirements such as water resource use and consumption could be funded by the government entity responsible for its management.

6. **Trading zones may be required to implement exchange rates between regions.** Market design elements should be compatible between jurisdictions, *if* the system will allow offsets to be bought from other watersheds.

Specific rules are required to deal with the prospects of market participation by the government, since government can be a very large buyer that may have significant influence on the value of water compared with other market participants. Rules for the conduct of government agencies wanting to participate in the market must be established to ensure that their valuation approach is aligned with that of market participants (PricewaterhouseCoopers, 2006).

2.2.2 Regulations

Regulating market participation can be achieved through regulatory controls on commerce and fair trading within the system, licensing or registration for market intermediaries (such as brokers), or industry self-regulation such as industry accreditation to comply with certain requirements. The following general regulations and oversight are required for a regulated or voluntary water market to properly function (PricewaterhouseCoopers, 2006):

- Water management regulations
- Regulation associated with water offset registries
- Consumer protection legislation
- Regulation of trade practices
- Regulation of the financial services system

Governments must ensure that the water market is operating as efficiently as possible by, where appropriate, removing restrictions on trade and market participation, providing clear and predictable market regulatory actions, and supporting infrastructure (such as the development of a registry). Governments can assist with the emergence of innovative products by (PricewaterhouseCoopers, 2006):

1. Ensuring that regulatory intervention in the water market is transparent, predictable and targeted toward achieving clear policy objectives.
2. Ensuring that water trading registries and accounting systems are robust, reliable and transparent.
3. Reducing or removing restrictions for market participation to enhance the development of innovative products.
4. Enabling mechanisms for futures trading in water offsets to enable innovative products to emerge.

2.2.3 Effectiveness

For a water offset market to be effective a number of basic requirements and considerations are needed: the offset must be clearly defined (is the market and commodity traded adequately defined?), the process of offset trading must be simple (does the current market structure adequately support competition?), the trading process should be known in advance (are the market transaction rules effective?), the trading process must be periodically reviewed and trade restrictions should be lowered or removed where possible (are there other ways to enhance market efficiencies, such as enhanced market data and information to participants?). Common market features that define their effectiveness are (PricewaterhouseCoopers, 2006):

- Clearly defined commodities traded so that exclusive ownership can be established.
- Clearly defined market trading rules, which set the boundaries for its operation and participant behaviour, reduce transaction costs and facilitate monitoring for compliance.
- Reliable information for informed participant decision making.
- Familiar trading mechanisms used by market participants.
- Clear administrative and effective enforcement processes for facilitating trade.
- Up-front and low transaction costs compared to the value of the trade.
- Few limitations on market participants to positively impact liquidity.
- Timely and effective enforcement of trading rules.
- General community acceptance of the legitimacy of the trade in the commodity or service.

Innovative products and contract types will emerge as market participants seek to minimize water access risks. Market intermediaries can play an important role in improving market efficiencies and developing these products by bundling commodities, aggregating sources of supply and demand, and providing risk management services.

2.2.4 Information

Providing reliable, timely and transparent information can enhance market participants' confidence and consequently market efficiency (PricewaterhouseCoopers, 2006). Some information and tools that can help increase the system's efficiency include the following:

- Transactions assistance (e.g., financial institutions, buyers).
- Physical aspects of the water resource being trading (e.g., water allocations, storage levels, weather forecasts and agricultural industry outlooks).
- Market data in aggregated and disaggregated forms (e.g., trading volumes, activity and prices).
- Trading process (e.g., transactions costs, transaction timeframes, and trading rules and restrictions).
- Commentaries and analysis to enhance knowledge and confidence in the market (e.g., research and opinions on the water market).

3.0 Water Quantity Offset System Examples

National and international models are described to provide design considerations for establishing an AWSM in southwestern Manitoba. Rather than viewing them as discrete options, the following examples should be viewed in terms of their elements—a hybrid of some of these systems would likely be the optimal option.

3.1 National Models

This section will provide an overview of Alberta's and Saskatchewan's respective water management regimes. The two provinces are considered progressive with regard to water management; Alberta enacted a major reform of water law in 1996, and Saskatchewan reorganized its approach in 2002 (Adamowicz, Percy, & Weber, 2010). Both reform initiatives recognized that former water legislative frameworks were maladapted to economic or environmental changes. Table 1 provides an overview of existing water-related regulatory environments in each province and their differences.

TABLE 1: ALBERTA AND SASKATCHEWAN REGULATORY REGIMES.

PROVINCIAL WATER INSTITUTION	ALBERTA LEGAL INSTITUTIONAL WATER STRUCTURE (QUANTITY AND QUALITY)	SASKATCHEWAN INSTITUTIONAL WATER STRUCTURE (QUANTITY AND QUALITY)
Principles under which water is managed	Based on the principle of wise use and most beneficial use of water—economic benefit.	Based on the principle of water as a common good.
Structural organization	Centralized government scheme	Decentralized government scheme
Number of legal formal institutions involved in management and decision making of water resources	One formal institution (based on two acts) responsible for all water issues, under one director (designated by the Minister of the Environment).	Institutional overlap (four formal institutions—including two ministers—based on four acts).
Allocation of water rights and water use priorities	-Water allocation: Statutory model (legislated model). Statutory scheme of priorities of water licences and types of water uses. -Strong director's (one person) discretionary decision making.	Water allocation: Corporation model (at the discretion of the corporation's officials). -Lack of clarity in terms of priorities in allocating water licences and types of uses.
Bulk transfer of water	Does not allow transferring of watershed water between major river basins.	Does not allow transferring of watershed water out of the watershed.
Water allocation dispute resolution	-Legal facilitation of dispute resolution due to statutory scheme for priorities allocation. -Environmental Appeals Board: appeals for decisions made by the director regarding two or more people dispute resolutions. No system for appeals regarding director's cancellations of water rights.	-Lack of guidance for legal dispute resolution, no statutory scheme regarding priorities for water allocation. -Water Appeals Board: appeals for decision of the corporation cancellations and refusal of water rights.
Potable water accountability	Strong at the local level	Strong at the local level

Source: Patiño&Gauthier(2007).

3.1.1 Alberta

Alberta has long had a system of water licences in place through its Water Act. A water licence typically defines "the amount of water that can be diverted, the timing of diversion, the rate of diversion, the source of water, and other terms and conditions, as well as the seniority of the water right" (Water Matters, 2008). Alberta's water allocation is the most market-based compared to other prairie provinces since the province's Water Act allows voluntary transfer of all or part of a licensed allocation from an existing licensee to a new user, usually accompanied by a financial transfer (Adamowicz et al., 2010). This regime was put in place through regulatory changes to enable transfers of water allocations, such as within the water-stressed South Saskatchewan River Basin (Brandes, Nowlan, & Paris, 2008).

This program is considered an innovative market-based framework for sharing water supplies, but in practice participation in the framework has been modest. There has been criticism that the market is opaque and the process uncertain, expensive (due to high transaction costs), arbitrary and slow (Sandor, Walsh, & O'Hara, 2010). The program has also received criticism for perpetuating historical use patterns by being grounded in the prior allocation principle, which entitles senior licensees to receive the entire allotment of water stipulated in the licence before junior licensees can receive any water (Brandes et al., 2008). The system also has an inaccurate division between surface and groundwater, measures licences granted in absolute quantities (rather than percentages), and separates water rights from potential impacts such as changes in water quality (Schmidt, 2011). While some of these trades rely on conservation improvements that effectively expand supply, others have been found to exacerbate supply constraints (Brandes et al., 2008).

Alberta's Water for Life strategy is working to address the shortcomings of its licence trading program. The Water for Life strategy has been the vehicle for managing Alberta's water resources since 2003. Its broad objectives are to bring about safe and unpolluted water, water availability to support ecosystem services, and water use that supports sustainable economic development. A key action related to its sustainable economic development goal is to develop and implement this enhanced water rights transfer system, something it intends to accomplish by 2015.

The province wishes to institute "an organized, rules-based exchange that can provide Alberta with a low-cost, transparent, regulated, and standardized framework to help its citizens sustainably manage water" (Sandor et al., 2010). Such an exchange would be highly beneficial: "Studies have found that the services provided by an exchange would increase the effectiveness of a water market in helping Alberta satisfy its Water for Life objectives" (Sandor et al., 2010). The benefits expected from such a system include the following:

- Establishing a centralized trading platform.
- Conveying transparent prices.
- Defining pre-established contracts and governance regulations of trading activity.
- Promoting accurate water-use quantification.
- Developing a streamlined approval process for permanent transfers and temporary assignments.
- Implementing contract enforcement mechanisms.

The Alberta Water Council is proceeding with designing a water allocation transfer market, recognizing that it will take significant time and effort to implement an improved and robust water allocation transfer system but also noting that time is of the essence as the province begins closing its basins to new allocations (Alberta Water Council, 2009).

Another noteworthy potential initiative in the province is the implementation of conservation offsets, a tool that can be used to protect ecosystem services. An example of a conservation offset is when "a company protects or restores wetlands in one area to compensate for the impacts of development on wetlands somewhere else" (Alberta Innovates Bio Solutions, 2012). Although not related to water quantity trading per se, conservation offsets could include a quantitative dimension (where one unit of water of a given quality used is offset by the retention of an equivalent unit of water of similar quality elsewhere). Although still in early stages, Alberta Innovates is "working with stakeholders to design and evaluate offset proof of concept projects, researching the impacts of offsets on the environmental liabilities and financial risks of oil sands companies and the province, and developing the new technologies that companies and governments will need to participate in offset markets" (Alberta Innovates Bio Solutions, 2012).

3.1.2 Saskatchewan

Saskatchewan has clearly stated goals for its water management system as articulated in its 25 Year Water Security Plan (Saskatchewan Water Security Agency, 2012). Stated goals and actions relevant to this analysis include the following:

- Action area 1.1: Efficient use of water
  - Promote adoption of best conservation and efficiency practices and technology through education, regulations, water licence conditions and new programming (ongoing).
  - Investigate pricing strategies as a means of promoting water conservation (2016).
- Action area 1.2: New water supply infrastructure
  - Examine alternative ways of instituting the concept of "user-pay" with respect to the development of additional provincially owned multi-purpose water supply infrastructure (2016).
- Action area 1.3: Water allocation system
  - Develop a modern system of water allocation, including a new allocation policy and regulations (2014).
  - Review existing water rights licences and assess current water use (2014 in priority watersheds; 2016 other).
  - By watershed, determine the existing use of water, level of protection of environmental flows and how much water is available for future allocation, and identify areas where water scarcity may be a factor (2014 in priority watersheds; 2016 other).
- Action area 1.7: The value of water
  - Determine economic value of water in alternative uses (2016).
  - Assess how the economic value of water could be used in allocation decision making (2016).

As part of its 2002 water management reform effort, Saskatchewan enacted a number of legalistic and technocratic solutions that recognized that "the source of the problem is that the bulk of available water supplies are tied up in existing licences" (Adamowicz et al., 2010). The solutions created legal mechanisms to take water away from existing licensees so that it could become available to new users or left in place, with decisions about which licensees' water rights were excessive left up to regulators. The reforms gave the Saskatchewan Watershed Authority the express power to issue a water licence for any term and subject to any conditions that it considers appropriate, with the ability to unilaterally cancel any licence it has granted. This cancellation is seldom used in practice, however, and has been usually reserved for cases of non-use (Adamowicz et al., 2010).

There are weaknesses with this approach, however. Although the powers of non-renewal and cancellation would be "effective in allocating water to new users if they were exercised, they create no incentive for water users to reduce the amount of their consumption" and therefore tend to perpetuate the wasteful use of water. The 25 Year Plan endeavours to correct some of the shortcomings of the province's 2002 reforms.

3.1.3 Assessment of Alberta and Saskatchewan's Models

The water management approaches described above, while varying in the degree to which they incorporate market elements, have key shortcomings. Some of these relate to market use in and of itself. One such shortcoming is that market-based approaches for water management tend to displace more ad-hoc and cooperative community-based natural resource management approaches, which have been shown to be surprisingly effective (Ostrom, 1999). In fact, collective action to manage scarce water resources has been fundamental to successfully managing the South Saskatchewan River Basin in Alberta (Long, 2013). Community-based approaches have been replaced by market-based approaches over the past two decades in Alberta. Although market-based approaches can be advantageous, focusing on this instrument precludes other types of management systems that have merit and may be preferable in some cases. It was observed for Alberta that the basins in the province are quite different physically and economically. This means that a "one size fits all" approach to using markets to aid in resource allocation will likely not be possible (Adamowicz et al., 2010). A more ad-hoc, cooperative process may better address these unique basins than the generic application of a market-based trading mechanism. Markets may be a more effective means of allocating scarce water resources in some places, but by their nature they preclude other, equally viable forms of community-based management. A well-designed system would attempt to incorporate elements of local management and engagement into the administration of its trading mechanism.

Market mechanisms were found to be beneficial in reallocating water among users and even protecting ecosystems, but their inability to correct existing poor water management practices was deemed problematic. Much of this criticism was in response to the predominance of licence-based systems in Canada, whose first-in, first-out nature creates persistent over-allocation problems even when trading is introduced (Brandes & Nowlan, 2009). Institutional and legal safeguards were believed to be the solution to the over-allocation problem. Unless the right institutional and legal safeguards are in place, introducing trading among licensees is expected to fail to correct water mismanagement. Trading systems must be complemented with prudential governance and oversight mechanisms that prioritize environmental objectives. This highlights the potential need to move away from the entitlement-driven approach that water licence trading embodies, which has been called the "water lottery" for its tendency to disproportionately reward actors who have grandfathered licences (Adamowicz et al., 2010; Christenson & Droitsch, 2008; Droitsch & Robinson, 2009; Unger, 2010), toward a system that sets caps on aggregate use that reflect safe ecological operating boundaries and that distributes these allocations fairly and efficiently.

In terms of assessments of the specific institutional arrangements found in the two provinces examined above, little documentation was available that critically assessed the water management regime in Saskatchewan, particularly with respect to the use of market-based instruments (Saskatchewan is at this stage only working toward enabling market-based approaches to manage its water resources and currently does not have a functioning water market). One criticism identified with respect to the current system in place related to the potential for water licence cancellation and non-renewal as a means of controlling aggregate use. That is, although the powers of non-renewal and cancellation would be "effective in allocating water to new users if they were exercised, they create no incentive for water users to reduce the amount of their consumption," they are seldom exercised, and therefore the wasteful use of water tends to perpetuate (Adamowicz et al., 2010). This failing, among others, is something that the 25 Year Plan endeavours to correct through the design of better water management institutions (Saskatchewan Water Security Agency, 2012). Although this criticism of Saskatchewan's water management system doesn't directly relate to the use of market-based instruments for water management, it underscores the observation that if aggregate use is not set stringently enough, overuse may become a problem regardless of the design and mechanics of the water management system put in place.

With regard to Alberta, the province's water market system design was found to adhere to international best practices and to provide flexibility for producers to manage water during times of water supply constraints and, consequently, to enhance water use efficiency. Nevertheless, it was also noted that the water market activity in Alberta's system was limited and was likely to remain so under the current water management regime. This program was considered an innovative market-based framework for sharing water supplies, but in practice participation in the framework has been modest due to the fact that the market is opaque and the process uncertain, expensive (due to high transaction costs), arbitrary, and slow (Sandor et al., 2010). So although the system was relatively well-designed, the thinness of the market prevents it from effectively providing the service it was intended to provide. Therefore, in addition to a viable market design, significant supply and demand as well as significant buyer-seller interaction (i.e., use of the market that has been designed) was observed to be a key determinant in developing a healthy, functioning water market (Nicol & Klein, 2006).

Transaction costs were noted as being high in Alberta's system, which could presumably be mitigated by engaging more market participants and consequently increasing trade volumes. And while some of these trades rely on conservation improvements that effectively expand supply, others have been found to exacerbate supply constraints (Brandes et al., 2008). Another challenge noted in Alberta was the need to address social concerns associated with environmental quality, water use and access equity, which complicates the implementation of an exchange (Adamowicz et al., 2010). And legal barriers also exist since "The current licensing regime makes it a problematic base for implementing a water allocation market, and in some respects water markets are opposed to the very ideas that are the foundation Alberta's existing rights regime" (Schmidt, 2011).

Other, broader criticisms include that the program perpetuates historical use patterns by being grounded in the prior allocation principle, which entitles senior licensees to receive the entire allotment of water stipulated in the licence before junior licensees can receive any water (Brandes et al., 2008), and that it also has an inaccurate division between surface and groundwater, measures licences granted in absolute quantities (rather than percentages), and separates water rights from its potential impacts such as water quality (Schmidt, 2011).

3.2 International Models

A number of relevant international models to setting up an AWSM in southwestern Manitoba are presented and summarized in Table 2. They are described in detail below to provide additional water quantity offsetting design insights.

3.2.1 South Africa's Working for Water

Origins and Design:

South Africa's Working for Water (WfW) program was launched in 1995 by the Department of Water Affairs and Forestry to create employment and develop skills through watershed enhancement initiatives (Porras & Neves, 2006). The watershed enhancement initiative focused primarily on the elimination of invasive species, which was found to significantly reduce national runoff by 6.7 per cent (Porras & Neves, 2006). The program has been primarily national government–driven but is expanding to include voluntary payments from private and municipal entities that would benefit from healthier catchments. Private and public sectors have started contributing to the WfW program.

The WfW market is designed to improve water quantity, in-stream flows and erosion control. The commodity traded is the rehabilitation of degraded ecosystems by removing invasive plants species through various physical and ecological or chemical means (Rodricks, 2010). Local contractors negotiate cash payments directly with the Department of Water Affairs and Forestry to undertake invasive species–clearing work.

The supply for the program consists of 10 million hectares of private, communal and public lands that have been identified for clearing in priority catchment areas over a 20-year period (Porras & Neves, 2006). In 2006 rural contractors funded by the program were responsible for carrying out 300 projects (Porras & Neves, 2006). The demand for the program comes primarily from the national government but also from local municipalities and public/private water supply companies. The WfW's budget was estimated at over ZAR70 million in 2006 (Porras & Neves, 2006). The Department of Water Affairs and Forestry, the Department of Environmental Affairs and Tourism and the National Department of Agriculture are directly involved in either administering or facilitating the program.

The socioeconomic and environmental benefits of the WfW are numerous (Binns, Illgner, & Nel, 2001). Revenues from the timber harvested from invasive species represent in some instances an important source of revenue, and the restoration of productive land can represent an important value added to WfW projects (Binns et al., 2001). The program specifically aims to lower poverty within segments of the population that are most affected (women, youth and disabled individuals) (Rodricks, 2010). The employment benefits of the program enable people to build skills. The average employment period is typically four to eight months per year for five years (the program has generated over 15 million person-days of employment) (Porras & Neves, 2006). An important body of knowledge has been developed to control and prevent the proliferation of invasive species in order to protect and enhance local biodiversity. This has led to an improvement in the ecological integrity of South Africa's catchments.

The program is primarily challenged by the need for sustained control of invasive species in cleared areas, which requires ongoing efforts. Since the program is government-led it often experiences bureaucratic delays. Program monitoring and evaluation is also challenging but is being addressed by an M&E unit that has developed a framework to assess the program's achievements based on five broad areas of interest: ecological, agricultural, institutional development, economic development and social-economic empowerment (Porras & Neves, 2006). The lack of enforcement of the program's legislative framework also creates important challenges for its implementation.

Despite these challenges, the WfW has been very successful in achieving its goals. The program has led to tangible improvements in water quantity while alleviating poverty (Binns et al., 2001; Rodricks, 2010). According to Binns et al. (2001), the WfW was already resulting in a number of important side-benefits such as furniture and charcoal production ventures within six years of its existence. The program has inspired a number of other payments for environmental services schemes across the country (Porras & Neves, 2006).

The WfW provides some lessons learned for the southwestern AWSM, which could be designed to create employment opportunities for local populations through water retention and groundwater recharge projects financed by water quantity offset purchases. The potential employment opportunities that the AWSM could create will be dependent on the potential demand for water quantity offsets from the private sector.

Noteworthy Features:

- Commodity traded is the rehabilitation of degraded ecosystems by removing invasive plant species through various physical and ecological or chemical means.
- Primarily national government–driven but is expanding to include voluntary payments from private and municipal entities.
- Local contractors negotiate cash payments directly with the Department of Water Affairs and Forestry.
- Creates employment opportunities and builds capacity for local populations to eradicate invasive species for water retention and groundwater recharge.

3.2.2 Japan's Kumamoto City

Origins and Design:

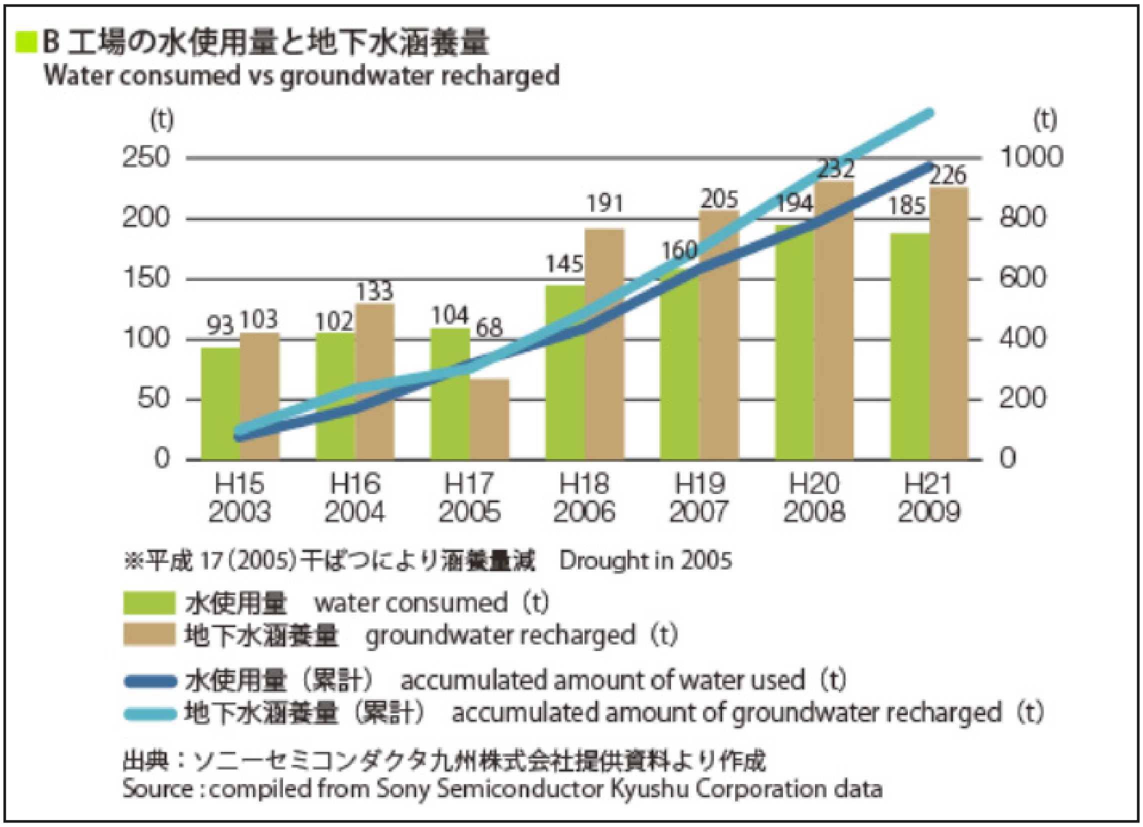
The Kumamoto area, centered around Kumamoto City, has rich groundwater resources that supply its drinking and residential water requirements (200 million tonnes of groundwater is pumped every year). The main source of this groundwater is water that permeates into the soil from rice fields in the middle reaches of the Shirakawa River. Reductions in rice acreage planted and increasing conversion of farmland to residential use is rapidly lowering groundwater recharge in the region.

The establishment of a Sony semiconductor manufacturing facility with significant water requirements was proposed to Kumamoto City in the early 2000s (Bennett et al., 2012). This proposal caused local concerns with regard to the large quantities of water that the plant would consume and what impact this would have on the groundwater resources of the area.

A proposal to offset groundwater use was brought forth by Kumamoto Environmental Network, a local environmental NGO. The proposal was adopted by Sony, making it the first company in Japan to recharge groundwater and become water neutral—to "fully return the groundwater it used" (Japan Ministry of the Environment, 2010a). Since 2003, the Sony Semiconductor Kyushu Corporation Kumamoto Technology Center has been recharging the groundwater it consumes for its semiconductor manufacturing operations (Sony Semiconductor Kyushu Corporation Kumamoto Technology Center, 2004).

The company offsets its groundwater withdrawals by paying agricultural producers in the area to flood fields no longer under rice production to increase infiltration to the aquifer (Bennett et al., 2012). The semiconductor plant asks volunteering local producers to flood rice fields that are currently used for other crops (due to the governmental policy to reduce rice-planting acreage between crops) or organic rice paddies after harvest with water drawn in from the Shirakawa River to let it permeate back into the ground. Cooperating producers are paid a fee of JPY11,000 Japanese per 1,000 square metres to cover management and preparation costs. The accumulated amount of water that has been used by the plant as of 2009 (9.8 million tonnes) has been successfully recharged (estimate of 11.6 million tonnes) (Japan Ministry of the Environment, 2010a).

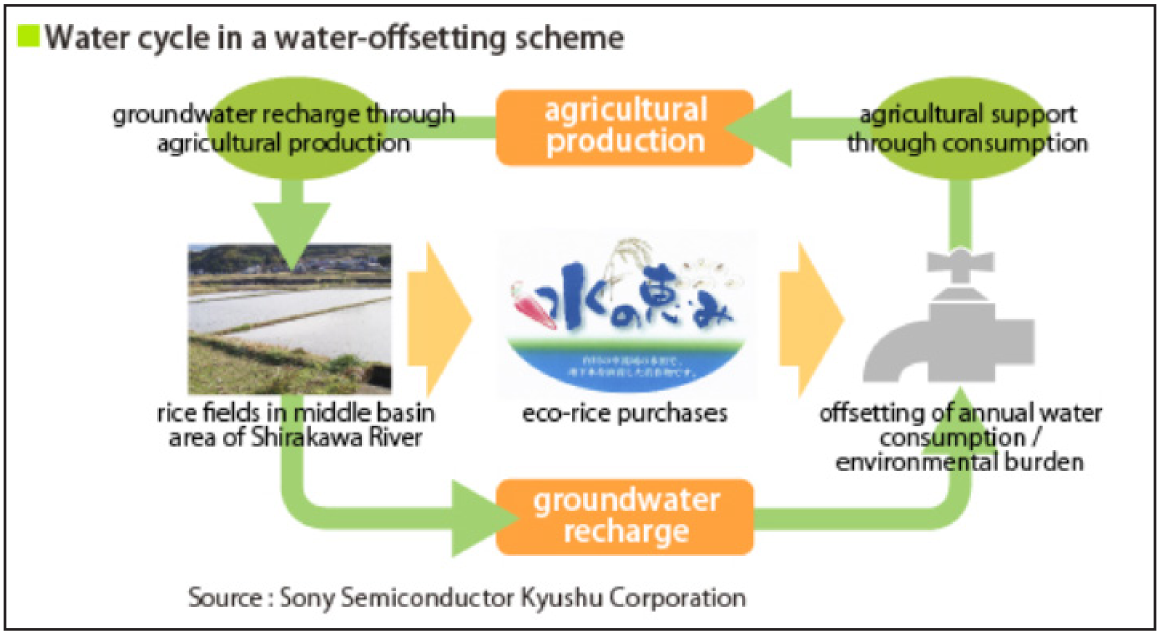
FIGURE 4: WATER CONSUMED VS. GROUNDWATER RECHARGED.



Sony's Kumamoto Technology Center is now environmentally neutral as it returns to the aquifer an equivalent amount of water used by the centre. But as stated by Shoichi Mizoguchi, Sony Semiconductor, Kyushu Corporation Environmental Strategy Department: "We must not be satisfied with merely recharging by the amount we have used, but Sony Semiconductor Kyushu Corporation as a whole must continue to strive to reduce the amount of water used."

This innovative groundwater recharge scheme has successfully evolved into covering a wider area, involving other local firms as well as the Kumamoto City government, which has incorporated it into the municipal water conservation program.

FIGURE 5: WATER CYCLE IN A WATER-OFFSETTING SCHEME.



Noteworthy Features:

- Groundwater recharged by voluntarily paying agricultural producers in the area to flood fields no longer under rice production, to increase infiltration to the aquifer.
- First company in Japan to recharge groundwater and become water neutral.
- Joint effort by local government, local groups, an environmental NGO and Sony.
- Incorporated into a municipal water conservation program.

3.2.3 Bionade Corporation (Germany)

Origins and Design:

Bionade Corporation, a privately owned German company situated in Bavaria in a biosphere reserve, is very interested in the quality and quantity of drinking water, the main ingredient of Bionade, an organically manufactured non-alcoholic refreshment drink (UNECE/FAO Forestry and Timber Section, 2012). The company has therefore partnered with the NGO Trinkwasserwald e.V. (Drinking Water Forest Association) to create '"drinking water forests" in Germany by afforesting and reforesting private and public lands with deciduous broad-leaved trees, which are understood to enhance groundwater replenishment. Water is recharged by conversion of coniferous forest into deciduous broadleaf forests. In Germany, in general, 10 to 12 years after a forest has been changed in this way, it provides an annual average of 800,000 litres of additional available groundwater per hectare (UNECE/FAO Forestry and Timber Section, 2012).

Bionade aims to voluntarily offset its own water use through this groundwater recharge, with a target of about 100 million litres each year or 130 hectares of reforested lands (Bennett et al., 2012) Trinkwasserwald e.V. is in charge of organizing the process of creating new drinking water forests together with public or private forest owners. Private contracts are signed between Trinkwasserwald e.V. and the public or private forest land owners for a period of more than 20 years (UNECE/FAO Forestry and Timber Section, 2012). Payments are made by Trinkwasserwald e.V. to the forest land owners as the actual costs occur (Greiber, van Ham, Jansse, & Gaworska, 2009).

Through this project, Bionade Corporation has covered most of the costs arising during the process of converting the forest land from conifers to broadleaves. Such conversion requires financial resources for ground preparation, nursery stock, planting and fencing, possible re-plantings, care of the cultures for several years, etc. (UNECE/FAO Forestry and Timber Section, 2012). Bionade has worked with Trinkwasserwald e.V. under the slogan "We plant drinking water" to transform a total of 62.5 hectares of German monoculture coniferous forest into mixed forests since 2008, creating 50 million litres of additional ground water and drinking water (Bionade, 2012).

Noteworthy Features:

- Private company voluntarily offsets all its water use through recharge.
- Recharges water with forest sector interventions.
- NGO acts as intermediary for payment and contract arrangement with landholders.

3.2.4 Costa Rica's National Power and Light Company

Origins and Design:

As part of a broader water management strategy, all watershed projects in Costa Rica aim at increasing or protecting forest cover as a means to reduce potential sedimentation and flash floods. As a result, Costa Rica's national power and light company, Compañía Nacional de Fuerza y Luz S.A. (CNFL), faced with costly sedimentation and aquifer depletion issues, has since 2001 supported upstream landholders in switching to agroforestry.

For the CNFL, hydroelectricity remains its main business, and all administration of contracts with farmers is delegated to the national intermediary, FONAFIFO, which allocates payments to farmers and manages the programme so that the CNFL is not required to engage in activities that are not the objective of the company (Bond & Mayers, 2010). FONAFIFO pays upstream agricultural producers USD$40 per hectare of land converted to agroforestry per year and also deals with payment to the government (SANREM CRSP, 2007).

The overall market in ecosystem services is significant in Costa Rica. The water-based ecosystem services market was USD$89 million in 1996 and the price per hectare of forest conserved ranged from USD$40 to $100 per hectare (Food and Agriculture Organization of the United Nations, 2007). The CNFL makes up a small but growing part of this market.

While the program is seemingly well designed and intentioned, evidence of improved water quality and water recharge effects is uncertain. CNFL's sponsorship of FONAFIFO and the national PSA scheme in Costa Rica is taken as evidence by some that the scheme must be improving water quantity and quality. Nevertheless, since supporting the scheme improves company image and its costs are easily absorbed, the true value of the program would have to be determined by studying the water recharge that can be attributed to it (Bond & Mayers, 2010).

Noteworthy Features:

- Addresses both sedimentation and aquifer depletion.
- Water recharge accomplished through upstream agroforestry projects.
- Private company pays voluntarily through an intermediary.

3.2.5 Bonneville Environmental Foundation's Water Restoration Certificate Project

Origins and Design:

The Bonneville Environmental Foundation (BEF)'s water restoration certificate project is a voluntary initiative, which aims to offset water consumption by restoring dry or critically dewatered rivers (BEF, 2013b). The initiative primarily targets the private sector by offering companies water restoration certificates to offset their water footprint or total water consumed for their operations. The certificates represent an equivalent volume of water restored for water consumed by the private party, thus providing another means by which water consumers can contribute to water resource conservation (BEF, 2013b). All water restoration certificates are certified by the National Fish and Wildlife Foundation, which ensures that river flows are restored within locations and at times that will optimize environmental benefits.

As of 2013 the BEF has eight active projects in various parts of the United States (BEF, 2013a). Continuous year-round flow within the Prickly Pear Creek in Montana, which typically does not flow during the irrigation season and runs dry during the summer, is expected to be restored, which will provide an additional two river miles of habitat to support fish and wildlife. Evan's Creek in Oregon has improved its summer stream flow by 50 per cent, which has led to the return of wildlife and fish to the area. The Middle Deschutes River has four times its historical flow since implementing water restoration measures via the program ("Bonneville Environmental Foundation," 2009).

The flexible means offered by the BEF by which entities can offset their water consumption has been particularly attractive for companies that depend on water for their production. A number of companies have purchased water restoration credits not only to become water neutral but also to protect the resource that they depend on for their bottom line. The initiative also provides custom water restoration certificates for companies with large water footprints. For instance, the Widmer Brothers have signed up to offset 8 million gallons over three years (Williams, 2010). Although this will cost the company CAD$10,000 per year, it will also enable the company to claim that its Drifter Pale Ale is water neutral (Williams, 2010).

One certificate, which costs one dollar, represents 1000 gallons of water restored to a river or stream (Williams, 2010). The sale of water restoration certificates has allowed BEF to raise money, which can be used to compel water right holders that do not necessarily need the water to keep it in the rivers. In 2010 BEF made commitments to restore billions of gallons of water over several years (Williams, 2010). Other notable participating organizations include Intel Corp, NHL, Big Sky Brewing, Eco Teas and National Resources Defense Council.

Noteworthy Features:

- Voluntary initiative that aims to offset water consumption by restoring dry or critically dewatered rivers.
- Targets the private sector by offering companies water restoration certificates to offset their water footprint or total water consumed.
- Certificates are certified by the National Fish and Wildlife Foundation.
- Companies have purchased water restoration credits not only to become water neutral but also to protect the resource that they depend on for their bottom line.
- Sale of water restoration certificates have allowed BEF to raise money, which can be used to compel water right holders that do not necessarily need the water to keep it in the rivers.

3.2.6 US Pacific Northwest's Groundwater Mitigation Banks

Origins and Design:

Water supplies in the Pacific Northwest in the United States are becoming increasingly scarce. For this reason, restrictions on new water withdrawals are becoming more stringent to ensure that out-of-stream and in-stream needs are being met. Water banking, defined by the Washington State Department as a mechanism that facilitates legal transfers of water,[7] has evolved from the water right transfer process and has become a useful new tool for water managers (Cronin & Fowler, 2012).

There are currently four existing groundwater mitigation banks operating in the US Pacific Northwest: the Walla Walla Water Exchange, Yakima Basin Water Banks, Dungeness Water Exchange and the Deschutes Groundwater Mitigation Bank. These groundwater mitigation banks are all unique, as they have been setup to meet local water supply needs.

The Walla Walla Water Exchange was established to protect the Walla Walla River from drying, which impacted two fish species listed under the federal Endangered Species Act. In 2007 the Washington State Department of Ecology made amendments to the Walla Walla in-stream flow rule to prevent additional withdrawals from surface and groundwater feeding the Walla Walla River. The new permit exemption for water abstractions from the shallow aquifer feeding the Walla Walla River went from 5,000 gallons (the accepted state limit) per day to 1,250 gallons per day (Cronin & Fowler, 2012).

To enable homebuilders to better deal with the new rules, the Washington Water Trust was asked to establish a mitigation exchange, which would enable homebuilders to purchase mitigation credits for their water use in the form of a one-time in-lieu fee of USD$2,000 (Cronin & Fowler, 2012). Activity within the mitigation exchange has been slow due to the economic downturn. As of May 2012 three transactions had been made, offsetting approximately 15 acre-feet of water with an average price of USD$616 per acre-foot (Cronin & Fowler, 2012).

The Yakima Basin experiences heavy water consumption due to irrigation and rapid population growth. New demands for water are being felt within a basin that already cannot meet existing demands. To remediate the situation, the Washington State Department of Ecology introduced the Upper Kittitas Groundwater Rule in 2009, requiring mitigation for all new permit-exempt wells. This new rule to address water scarcity in the basin led to the development of water banks and transfer mechanisms to meet the mitigation demands.

[7] "An institutional mechanism that facilitates the legal transfer and market exchange of various types of surface, groundwater, and storage entitlements" (Cronin & Fowler, 2012).

Mitigation is currently achieved by purchasing existing water rights from water banks who then transfer them to the State Trust Water Rights Program and by making flow restoration investments between a willing buyer and seller. This water mitigation system is primarily driven by private parties, and transactions are approved on a case-by-case basis by the Washington State Department of Ecology and the Water Transfer Working Group, which oversees water transfer technicalities. The Washington State Department of Ecology determines which areas should retire water rights, and private water mitigation banks establish prices for prospective buyers. Mitigation credits costs anywhere from USD$8000 to USD$15,000 per household depending on the location of the household, the hydrogeology of the proposed well and the bank from which the credit is purchased (Cronin & Fowler, 2012).

The Dungeness basin, located in the shadow of the Olympic Mountains, receives only 13 to 15 inches of rainfall a year (Cronin & Fowler, 2012). The basin has been supporting irrigated farms for over a century. Water demands for maintaining in-stream agricultural production as well as population growth initiated the establishment of a new rule in 2012 to prevent new withdrawals from surface and groundwater with minor exceptions if mitigation is secured (Cronin & Fowler, 2012). The Washington Water Trust is working with stakeholders to establish a water bank designed to meet groundwater requirements and restore river flows. The water bank will facilitate transactions for the transfer of agricultural water rights, recharge of shallow groundwater, improved irrigation efficiency and other alternatives to create mitigation credits (Cronin & Fowler, 2012).

Within the Deschutes River Basin water has been over-appropriated since the 1920s. Restrictions on surface water withdrawals were followed by restrictions on groundwater withdrawals after the US Geological Survey determined that surface water and groundwater were closely hydrologically connected in the basin. Legislation was brought in to establish water banks and mitigation credits under the Deschutes River Basin mitigation program for the purposes of 1) maintaining flows for scenic waterways and senior water rights, 2) restoring flows in the middle Deschutes and its tributaries, and 3) sustaining existing water uses and allowing for new water withdrawals through new groundwater development.

Under the new law, entities have been authorized to become chartered water banks. There are currently two water banks operating in the Deschutes River Basin selling mitigation credits. These water banks have enabled transactions for mitigation credits. Temporary and permanent mitigation credits are offered depending on water consumption and credit availability. Each mitigation credit, representing 1 acre-foot of water use, is worth USD$105 per year, while a permanent credit, if available, costs $2,000(Cronin & Fowler, 2012).

The groundwater mitigation banking programs in the US Pacific Northwest provide many important lessons for establishing similar programs in other jurisdictions. Cronin and Fowler (2012) identify the following lessons to be learned from these programs:

1. Establishing collaborations and involving stakeholders in designing and implementing the mitigation mechanism are paramount. This will lead to a smoother uptake for mitigating new water consumption through groundwater mitigation banks. A lack of stakeholder engagement could lead to costly conflict and litigation, which should be avoided.
2. Matching the supply and demand for mitigation credits is imperative to establish a successful mitigation program or water quantity offset system. This requires an adequate examination of not only potential sellers and buyers of mitigation credits and water quantity offsets but also of the biophysical suitability of the types of mitigation measures or offsets proposed (i.e., groundwater recharge, stream flow restoration, etc.). The

proximity of the mitigation measure to the new water use may also be a design consideration. Nevertheless, it was not possible to carry out the mitigation measures in close proximity to the new water use in the cases presented above.

3. The legislative frameworks that allow for water banking can take the form of transferring existing water rights to meet new water demands or can consist of converting out-of-stream water rights to in-stream water rights. The administrative processing of water rights has been a significant challenge to enable timely and predictable water right transfers or transactions.
4. Accountability is important for the proper implementation of a water use mitigation or quantity offsetting system. Ensuring that the appropriate organizations are accountable for communicating with all the appropriate stakeholders for rolling out a water use mitigation or water quantity offset program is fundamental.

Noteworthy Features:

- Four regional groundwater mitigation banks are all unique as they have been setup to meet local water supply needs.
- Washington Water Trust: established a mitigation exchange, which would enable homebuilders to purchase mitigation credits for their water use in the form of a one-time in-lieu fee of USD$2,000.
- Yakima Basin: requires mitigation for all new permit-exempt wells, achieved by purchasing existing water rights from water banks who then transfer them to the State Trust Water Rights Program and by making flow restoration investments between a willing buyer and seller.
- Dungeness Basin: working with stakeholders to establish a water bank that will facilitate transactions for the transfer of agricultural water rights, recharge of shallow groundwater, improved irrigation efficiency and other alternatives to create mitigation credits.
- Deschutes River Basin: under a new law entities have been authorized to become chartered water banks, which have enabled transactions for temporary and permanent mitigation credits

3.2.7 The Philippines' City of San Carlos

Origins and Design:

Large portions of the city of San Carlos in Negros Occidental are critical watersheds that cover 5,017 hectares. These are the main water sources that supply both domestic and agricultural consumers in and around the city. To address denudation of the watershed areas, the city government designed a Watershed Development and Rehabilitation Project using an innovative financing scheme to rehabilitate the denuded watersheds (SANREM CRSP, 2007).

The local government convinced its constituents to pay a water levy of seventy-five centavos (roughly USD$0.02) per cubic metre of water that they consume. The water levy generates PHP1.2 million annually, which goes to a trust fund managed by the San Carlos Development Board (SCDB). The Watershed Development and Environmental Protection Fund, which supports watershed restoration projects, together with additional contributions by other organizations and stakeholders, guarantees resource availability for future use and expansion purposes and is being used as leverage to get additional funding. This unique system for raising financial resources for rehabilitation sets apart this local government initiative (SANREM CRSP, 2007). And the fund is further boosted by contributions from stakeholders and other organizations ("Hope for San Carlos' Dwindling Watershed," 2008).

Unique to the Watershed Development and Rehabilitation Project is the consortium of four multi-sectoral organizations—Genesys Foundation, JF Ledesma Foundation, Inc., Multi-Sectoral Alliance for Development and the SCDB—that jointly manage and implement the project. These organizations oversee nursery planting and maintenance, capacity-building on agroforestry and livelihood programs, as well as community organizing. Policy and technical support is further provided by the Philippine Department of Environment and Natural Resources (DENR) and the German Development Service. These organizations contribute their specific expertise to attain a holistic approach to sustainable development (SANREM CRSP, 2007).

The project employs an integrated forest land-use approach that determines the type of reforestation and agricultural activity based on land slope. Specific areas are designated for settlement, livestock, fruit-bearing plants, production forest and protection forest. The strategy balances the needs of the communities with conservation concerns. Since it started in 2005, the project has brought tangible results. To date, a total of 211,348 trees have been planted. Fourteen species of plants and trees now thrive in the area, with over 200,000 trees already planted. Some are short-rotation species for fuel and charcoal, while others are long-rotation species for timber production. Some landowners and private corporations have joined in by setting a portion of their land as protection forest. A total of 140.8 hectares of private lands are now covered by the project ("Hope for San Carlos' Dwindling Watershed," 2008).

The program was initially politically unpopular in San Carlos. But the payoffs have been evident as the city recovers and regenerates over 5,000 hectares of critical watersheds, representing the main water source of domestic and agricultural consumers in and around the city. Public acceptance of the project has also been increasing. Communities living within the watershed areas are provided with livelihood opportunities (such as livestock and agricultural production) to ensure that they do not use critical environmental areas for economic activities such as illegal logging, unsustainable charcoal production and shifting cultivation on steep slopes. The estimated income of the farmers from livestock and agricultural production is PHP60,000 annually. The communities are also able to earn approximately PHP1 million in labor payments for three years of planting operations and nursery maintenance (SANREM CRSP, 2007). These employment effects and the efficacy of the program in terms of water recharge have helped win over the program's detractors.

It is important to note though that people's involvement, particularly the formation of the Community Watershed Management Association, is not just an issue of participation and empowerment but primarily of sustainability. This ensures that the community will maintain and take care of the watershed long after the project has been phased out (SANREM CRSP, 2007).

Noteworthy Features:

- Financed via a water levy where money goes into a trust.
- Involves employment benefits for local communities.
- Broad stakeholder engagement and strong community participation component.

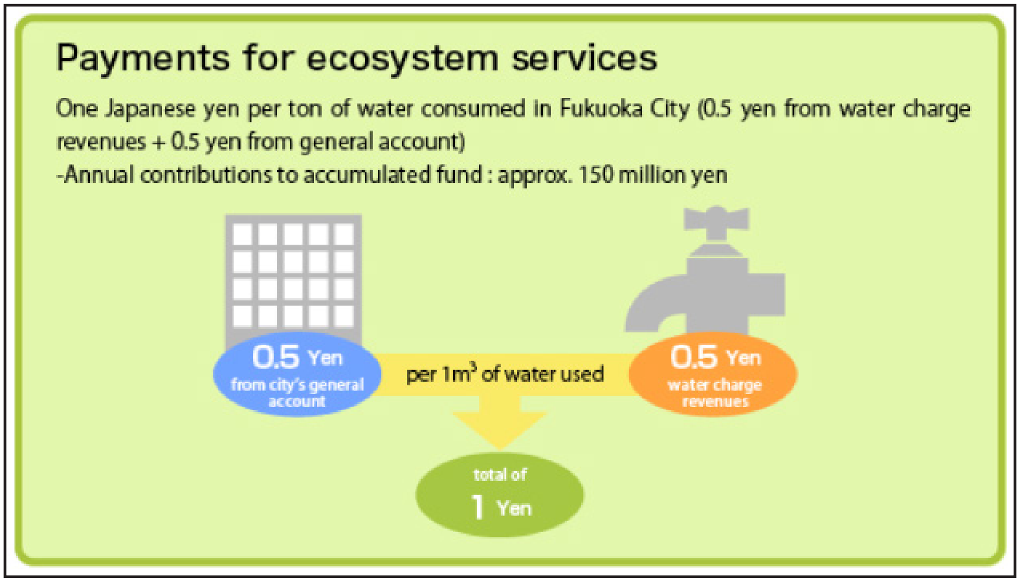
3.2.8 Japan's Fukuoka City

Origins and Design:

Fukuoka City is the only major city in Japan without a large river flowing through it. It has relied on extraction from the nearby Chikugogawa River for one-third of its needs, as well as on desalinating seawater and on supplies from eight dams. However, the degradation of forests surrounding the dams began impairing their water supply function, jeopardizing the city's water supply (UN Water, 2011).

To protect the water supply around these dams, the Fukuoka City Foundation for Water Resource Conservation Projects was established in 1997 to serve as a fund for forest conservation and management in the city's water supply catchments. These projects are funded via an add-on fee on water users that is channelled into a dedicated fund, which is matched by an allocation from the city's general account—altogether amounting to a bit over $0.01 per cubic metre of water used. The water source conservation fund pays for forest management, reforestation and land acquisition in catchments around the dams that supply the city and supports small municipal governments' watershed management efforts in areas upstream of the city (UN Water, 2011). JPY100 million (approximately USD$1.3 million) is allocated annually for forest management in water source areas, local exchange programs and contributions to a river basin–based partnership fund composed of neighbouring municipalities, as well as investments in the protection and improvement of biodiversity. The total fund stood at JPY1.06 billion in 2009 (Japan Ministry of the Environment, 2010b).

FIGURE 6: PAYMENTS FOR ECOSYSTEM SERVICES.



Source: Japan Ministry of the Environment (2010b).

Watershed forests in catchment areas near the dams are established to supply drinking water by planting broad-leaved forests, clearing underbrush and thinning trees. For other dams, the Waterworks Bureau is engaged in efforts to purchase forests in catchment areas in order to enhance water recharge capacities and prevent water contamination from excessive development. The project fosters cooperation between local governments upstream and downstream, with conservation activities implemented jointly by Fukuoka City and municipalities in water source areas. As of fiscal year 2008, approximately 30 percent (505 hectares) of the catchment areas of the three local dams had been bought by the city. For the appropriate management of these forests, the city formulated the Fukuoka City Water Source Forest Management Plan, covering 60 years, in fiscal 2004 (UN Water, 2011).

The project also includes awareness-raising amongst the citizens of Fukuoka City about the origin of its water supply and the value of forest ecosystem services, exchange programs for citizens to participate in activities such as silvicultural management, rice planting and trout fishing in the water source areas and grants for tree planting and clearing underbrush (UN Water, 2011).

Noteworthy Features:

- Recharge programs funded 50/50 by a fee on water users and government contributions.
- Projects address forest sector interventions to restore catchment areas.
- Upstream and downstream governments work together through the initiative.
- Has a public outreach and education component.

3.2.9 Eugene Water & Electric Board (EWEB)

Origins and Design:

This program is still in its infancy, but enough is known about it at this stage to warrant its inclusion. EWEB envisions the development of an investment mechanism that makes payments for ecosystem services as a way to maintain and improve water quality within the McKenzie River watershed, Eugene's sole source of drinking water. The public name for this concept is the Voluntary Incentives Program (VIP). Under the envisioned VIP, EWEB will provide annual dividend payments to landowners on the natural capital their properties provide. These dividends would recognize the value of the natural capital provided by these lands and their benefits to the residents of Eugene (Conservation Registry Marketplace for Nature Portal, 2012).

The program would compensate private landowners in the McKenzie River watershed for protecting and restoring riparian zones, whose purpose would be to maintain and enhance water quality within the McKenzie River basin (Conservation Registry Marketplace for Nature Portal, 2012). A fund with sustainable financing would be established to support the dividend payments and the infrastructure necessary to operate the VIP. Financing, initially endowed through an existing water fund (under existing rate structure), would come from a variety of sources such as development impact fees, state and federal mitigation programs, utility budget allocations and corporate contributions (Conservation Registry Marketplace for Nature Portal, 2012).

EWEB would establish a stewardship boundary identifying riparian forests and floodplains that are eligible to enrol in the VIP. Participation would be open to private landowners, local governments and non-profit organizations that own land within the designated boundary. Based on EWEB's preliminary analysis, an estimated 6,500 acres of riparian and floodplain areas along the McKenzie and major tributaries are eligible to enrol. Land within the stewardship boundary will need to meet a threshold to receive payments. This threshold will be determined by adapting existing riparian forest and wetland habitat standards and definitions from Natural Resources Conservation Service, United States Forest Service, Defenders of Wildlife and other entities to establish the criteria for participation in the VIP (Conservation Registry Marketplace for Nature Portal, 2012).

The VIP will rely upon a coalition of existing organizations which will form a watershed investment district to provide this critical infrastructure, without which successful implementation of the VIP is highly unlikely (Conservation Registry Marketplace for Nature Portal, 2012). EWEB has hired Earth Economics to conduct a watershed valuation that assigns dollar values for natural processes that benefit society to establish the program's required financial flows.

Noteworthy Features:

- Incorporates water quality considerations.
- Compensates private landowners for protecting and restoring riparian zones.
- Financing model as yet undecided but many options being considered.
- Based on a natural capital accounting and ecosystem services framework.

3.2.10 Idaho's Water Resource Board

Origins and Design:

Idaho's Water Resource Board operates a water supply bank and a number of rental pools to facilitate the marketing of water rights for in-stream flows and water storage in reservoirs. The board's bank manages natural flow rights and privately held storage. The majority of rental contracts are for irrigation purposes, although a number of agreements have been for the purposes of restoring in-stream flows. (Bennett et al., 2012).

The history of the Idaho water bank system began in the 1930s. Before the current statutory mechanism was enacted, creating an Idaho water supply bank, a rental pool had been employed for many years by the water users in eastern Idaho. The rental pool allowed entities with surplus storage water to make it available to others who found themselves short in a particular year. The first known annual rental pool transfers occurred during the drought period of the 1930s, when 14,700 acre-feet of water were rented for 17 cents per acre-foot in 1932. Then in 1934, 40,000 acre-feet of water were rented for 25 cents per acre-foot. In the following years the annual rental price increased to 75 cents per acre-foot in 1978, with part of the fee going to the entity supplying water to the rental pool and part going to the water district to cover administrative costs (Idaho Water Resource Board, n.d.-b).

In 1979 the Idaho Legislature formalized the program of annual leases of storage water entitlements. The legislation set into law a 1976 policy recommendation of the state water plan, which had called for the creation of a "water supply bank [...] for the purpose of acquiring water rights or water entitlements from willing sellers for reallocation by sale or lease to other new or existing uses" (Idaho Water Resource Board, n.d.-b). The responsibility for the water supply bank was placed under the Idaho Water Resource Board. In 1988 a second water bank was started, this time in the Boise River drainage basin. This system serves about 300,000 acres of irrigated farmland with natural flow and about 1 million acre-feet of storage in three federal reservoirs. And in 1990, a third water bank rental pool was formed encompassing the Payette River drainage. There is also a fourth water bank rental pool which involves the Sho-Ban Tribes.

The purposes of Idaho's water supply bank are to encourage the highest beneficial use of water, provide a source of adequate water supplies to benefit new and supplemental water uses, and provide a source of funding for improving water user facilities and efficiencies. In its most simplistic sense, the bank is a water exchange market operated by the Idaho Water Resource Board to facilitate the use of water rights to natural flow water or water stored in Idaho reservoirs. Water right holders can offer unused water rights to the bank. From there, the water can be rented to people who do not have adequate water rights to meet their needs.

The local rental pool committees set the price, which the board must approve, for water that can be rented or sold from their rental pool. This price may be different for each rental pool and can be determined based on the location where the water is to be used. The current rental rate for the board's water supply bank is $17 per acre-foot of water. An applicant may enter into an agreement with a water right holder to negotiate a rental fee other than the current rental rate. Ten percent of the gross rental fee will be retained by the Board for administrative costs of operating the bank. The lesser (usually the water right holder) will receive 90 percent of the gross rental fee as payment.

Noteworthy Features:

- Water exchange market operated to facilitate the use of water rights to natural flow water or water stored in Idaho reservoirs.
- Leverages an existing, long-standing system of leases and water rights transfer mechanisms in its program design.
- System funded by taking 10 per cent of rights transfer agreement funds.

3.2.11 Australia's Interstate Water Trading Project

Origins and Design:
A number of trading initiatives and platforms were incorporated or spearheaded in Australia's comprehensive National Water Initiative, a broad water management strategy that has water trading as one of its elements. An interesting example of these integrated trading markets is the Interstate Water Trading Project, a pilot project within the Murray-Darling Basin that was initiated in 1998.

The pilot project facilitated interstate trade by establishing a set of formalized processes, which, up until recently, included the application of an "exchange rate" to account for differences in the specification and characteristics of water access entitlements in New South Wales, Victoria and South Australia. This expanded trading platform enjoyed significant uptake, permitting trade of over 22 megalitres in its first five years of operation. Interestingly, much of this came from a high volume of small trades rather than a low volume of large trades, meaning the market was active and robust.

Although the project and Australia's broader water trading systems incorporated novel design features such as integrated markets brought together through exchange rate adjustments, much of its broader success in terms of uptake can be attributed to the placement of an aggregate cap on water use. This prevents over-allocation of water and thereby builds scarcity in to the market system design. Rather than the market being an ancillary means of allocating and managing water, it becomes centrally important, with its increased use reinforcing this position as the primary means of allocating water. The institutional and legal safeguards that frame the system are just as important as its design.

Noteworthy Features:

- Trade has been concentrated in systems where industries that rely on water as an input to production, such as irrigated agriculture, are located, signalling that market trading mechanisms are particularly valuable in contexts where there is industrial demand.
- Water access and use can be sold on a permanent or a temporary basis; however, much of the permanent trade was attributable to land sales, where the water access was tied to the property being bought or sold.
- Project creates trading among different platforms, using an exchange rate to adjust for differences between them.
- Trade between systems caused a net loss to some water systems and a net gain to others; this means the system was flexible but this may not always be a desirable outcome.
- Trading system is made more valuable and effective due to cap set on aggregate water use.

TABLE 2: DESIGN ELEMENTS OF PROFILED INTERNATIONAL PROGRAMS.

PROGRAM NAME	GOVERNANCE	HYDROLOGICAL SERVICE GOALS	SCALE	PARTICIPANTS AND STAKEHOLDERS	BUYER	INTERVENTION	DRIVER	EXCHANGE AGREEMENT	CO-BENEFITS
South Africa's Working for Water	Working for Water (WfW)	Poor water use efficiency	National (South Africa)	Private sector, NGOs	Private sector	Offsets (WfW projects)	Voluntary	Pay WfW projects	Native environments restored
Japan's Kumamoto City	Kumamoto Environmental Network	Aquifer/ watershed depletion	Municipal	Industry, agricultural producers	Private sector	Aquifer recharge	Voluntary	Direct payment to producers	Agricultural land preserved
Germany's Bionade Corporation	Drinking Water Forest Association	Heavy water use	National (Germany)	Industry, NGOs	Private sector	Groundwater replenishment	Voluntary	Payment for third party conservation efforts	Reforestation and afforestation
Costa Rica's National Power and Light Company	Compañía Nacional de Fuerza y Luz S.A (CNFL)	Aquifer/ watershed depletion	Aquifer	CNFL, upstream landholders	Utility	Switch to agroforestry	Voluntary	Direct payment to landholders	Reduced sedimentation
BEF's Water Restoration Certificate	Bonneville Environmental Foundation (BEF)	Heavy water use	National (US)	Private sector, NGOs	Private sector	Offsets (Water Restoration Certificates)	Voluntary	Pay BEF for Certificates	Aquatic Ecosystems Restored
US Pacific Northwest's four groundwater mitigation banks	Relevant State Government Agencies	Groundwater over-use	Basin	Private sector, utilities	Major basin water users	Goundwater offsets	Compelled	Brokerage	Water quantity only
The Philippines' city of San Carlos	Municipality	Limit flooding	Municipal	Water consumers, municipality	Water consumers	Right to use water	Compelled	Pay into a fund that funds projects	Limit soil erosion

PROGRAM NAME	GOVERNANCE	HYDROLOGICAL SERVICE GOALS	SCALE	PARTICIPANTS AND STAKEHOLDERS	BUYER	INTERVENTION	DRIVER	EXCHANGE AGREEMENT	CO-BENEFITS
Japan's Fukuoka City	Municipality	Limited water supply	Municipal	Water consumers, municipality	Water consumers	Right to use water	Compelled	Pay into a fund that funds projects	Reforestation
Oregon's Eugene Water & Electric Board	Eugene Water & Electric Board (EWEB)	Shoreline erosion	Municipal	Water users, industry, government	Water users, utilities, industry, funds	Right to use water	Compelled	Pay into a fund that funds projects	Natural Environment Restoration
Idaho's Water Resource Board	Water Resource Board	Heavy water use	State-wide	Government, landholders, water users	Agricultural producers, NGOs	Right to use water or leave unused	Compelled	Licence rental agreements	Water quantity only
Australia's Interstate Water Trading Project	Water Resource Board	Heavy water use	State-wide	Government, landholders, water users	Agricultural producers, NGOs	Right to use water or leave unused	Compelled	Licence rental agreements	Water quantity only

3.2.12 Insights for Southwestern Manitoba

The case studies reviewed provide insights related to developing an AWSM for southwestern Manitoba. Relevant details associated with the objectives, design and operation from the international water markets examined are discussed below.

South Africa's WfW is a government-driven program that focuses on improving water supplies while alleviating poverty. The program is designed to offer employment for local people to eradicate invasive species and in doing so improve water supplies. The same kind of program could be replicated for southwestern Manitoba, where employment associated with the establishment of water storage sites for the AWSM could be established. The provincial government would require the oil and gas sector to offset its water consumption through water retention sites built by local individuals requiring employment.

Japan's Kumamoto City program is of direct relevance to the AWSM for southwestern Manitoba. It employs groundwater recharge by preserving agricultural land and is financially supported by a private company, which offsets its own water use and earns social licence to operate in the community. Offering the possibility for one company in the oil and gas sector to claim water neutrality by offsetting its water consumption would provide it with a marketing and corporate social responsibility competitive advantage in the region, as well as an opportunity to highlight this work in other places it wishes to obtain a social licence to operate. This could be the impetus for the whole oil and gas sector in southwestern Manitoba to aim for water neutrality. The program demonstrates how voluntary water offsets can work effectively and as a result can be scaled up.

The case studies of Bionade Corporation and Oregon's EWEB highlight the possibility of using natural environments to improve water resources. The Bionade Corporation uses natural environments to "offset" water consumption, as it can modify the local hydrological cycle to improve water supplies (i.e., slow runoff, enable groundwater recharge and support microclimates for recurring precipitation). The use of reforestation interventions to recharge groundwater highlights the wide variety of cost-effective options to offset water consumption. The program is an interesting example of a private company's efforts to offset its water consumption through an intermediary that facilitates contracts and payments to maintain access to groundwater resources and improve its social licence to operate. Oregon's EWEB's program provides an example where the valuation of watershed ecosystem services can be used to demonstrate the benefits of restoring natural environments to improve water resources. Within the context of the AWSM, restoring natural environments such as wetlands can be used to offset water consumption by improving water security.

The actual efficacy of Costa Rica's national power and light company's program is an important consideration for the AWSM. Any voluntary initiative that grants a private company social licence to operate may seem worthwhile if the costs are relatively low compared to its profits. It is therefore important to design programs that deliver real value. In the case of the AWSM it will be imperative to ensure that the actual volume of water consumed that is not returned to the watershed is offset through the establishment of new water retention and recharge sites. The water offset could be designed to require an equivalent amount of groundwater recharge or an equivalent amount of surface water retained, which will have an impact on the design and cost of the water retention sites. Measuring the potential co-benefits (e.g., water quality improvements and flood protection) of the water retention sites will also be important to ensure that the investment leads to tangible benefits for local populations.

BEF's water restoration certificate project is a flexible voluntary water quantity offsetting model. The certification of the offsets by governments provides the program with a level of credibility that has been important for it to expand and flourish. The AWSM will likely be initiated as a voluntary market with the prospect of eventually transitioning to a regulated market. The advantages and disadvantages of setting up the AWSM as a voluntary or regulated market will have to be closely examined. For instance, rapidly expanding the AWSM to other parts of Canada and the United States may only be feasible if the program is voluntary. Nevertheless, the AWSM should be designed with flexibility to allow it to transition to a regulated system.

The groundwater mitigation banking programs in the US Pacific Northwest were all motivated by the establishment of new stringent rules requiring mitigation for the establishment of new water rights. Although Manitoba has a legal framework for requiring water use licences, the stipulations in place that trigger the need to obtain a licence may have to be much more stringent to develop a regulatory need for mitigating or offsetting water consumption. Establishing the AWSM as a regulated market would require modifications in the Manitoba water licensing process to compel water users to offset their water consumption. This modification could be developed strictly for the water constrained regions of southwestern Manitoba where the oil and gas sector is currently operating. Local modifications to state-wide regulations were adopted in the US Pacific Northwest to facilitate the development of a groundwater offsetting program.

The Philippines' city of San Carlos and Japan's Fukuoka City demonstrate the importance of community buy-in, which can greatly encourage market participation. The programs highlight the difficulties encountered when organizing a program with compulsory fees. Such programs need to have demonstrable benefits such as employment for local populations, genuine engagement and co-management. Japan's Fukuoka City serves as a useful example of a compulsory program where users are required to pay for their water consumption but is unique in that the payments are matched by the government. Such a program in Manitoba could one day be adapted to encourage a smooth transition of the AWSM from a voluntary to a compulsory system.

Idaho's Water Resource Board is an interesting example of using existing program infrastructure. Idaho had a long history of water banks and rights transfers and chose to build its program to fit with this infrastructure rather than replace it. It is instructive for systems that may employ water rights that are interested in the optimal allocation and trading of those rights. This type of system could conceivably be extended to accommodate water use offsets as well, such that water users could use water without holding a licence if they compensated lease holders for not using their allotted amount of water. The Idaho Water Resource Board is a useful example for the design of the AWSM for southwestern Manitoba as it points to the benefits of building on an existing program or system that is already accepted by local stakeholders. Agricultural programs in Manitoba could be extended to include a water offsetting system to address regional water consumption by the oil and gas sector.

The Australian case study shows the importance of ensuring that the market is designed to allow for coherence between jurisdictions or at least leaving the door open to this possibility through intelligent system design early in the process. This coherence facilitates market scale-up and ensures that the market will remain viable and effective. In addition, the case study demonstrates the benefits of imposing a cap on water consumption within a particular region to encourage water trading between users. The AWSM could benefit from capping water consumption in southwestern Manitoba to ensure that it remains viable. Nevertheless, it would require significant government intervention to impose and enforce a water consumption cap.

Overall, the case studies demonstrate that a voluntary system may be easier to get off the ground than a regulatory system, as it provides for flexibility and could be more easily expanded. Nevertheless, the system should be set up to allow for a transition toward a regulated system. The establishment of the AWSM could be initiated by offering the oil and gas sector the opportunity to become water neutral, which could strengthen its social licence to operate. To establish a regulated AWSM in southwestern Manitoba, the water licensing rules may have to become more stringent. Trading rule coherence across jurisdictions may be an important consideration if the market is to be scaled up.

The case studies also point out the important role that the government may have to fulfill in establishing a viable AWSM in southwestern Manitoba. Additionally, public buy-in is an important consideration when designing a water market to encourage market participation. This could be achieved by ensuring that the AWSM provides tangible benefits to the local population, such as improved local water quality or employment creation through the establishment of water retention sites. Restoring natural environments to better manage water resources can be beneficial and lead to the realization of important co-benefits.

4.0 A Water Quantity Offset System for Southwestern Manitoba

A water quantity offset system design for southwestern Manitoba is presented based on the general design and operational considerations reviewed above. The legislative context and anticipated water quantity offset supply and demand for southwestern Manitoba are first examined. The design elements of the water quantity offset system are then presented. The water quantity offset system design is intended to serve as a working example. Design considerations and a process summary are provided for the system.

4.1 Legislative Frameworks

Although the AWSM will initially be established as a voluntary program, identifying the federal and provincial legislative frameworks within which it could operate in southwestern Manitoba can be useful to determine its potential viability as a regulated market. Federal acts that may have some relevance for the establishment of the AWSM include the Canada Water Act and the Canadian Environmental Protection Act. Relevant Manitoba acts include the Water Rights Act, Water Protection Act, the Water Resources Conservation Act, the Ground Water and Water Well Act, the Manitoba Water Services Board Act, the Water Resources Administration Act and the Sustainable Development Act. These acts, which are described in more detail below, provide some legislative guidance with regard to how a regulated southwestern Manitoba AWSM could operate.

4.1.1 Federal Acts

The Canada Water Act has provisions for establishing comprehensive water management programs to ensure that water demands are adequately managed within Canada. Part I, section 5 of the Act has provisions for establishing joint federal/provincial water management programs for waters of significant national interest in accordance with the following subsections described below (Government of Canada, 2005):

a) Establish and maintain an inventory of those waters.

b) Collect, process and provide data on the quality, quantity, distribution and use of those waters.

c) Conduct research in connection with any aspect of those waters or provide for the conduct of any such research by or in cooperation with any government, institution or person.

d) Formulate and implement comprehensive water resource management plans, including detailed estimates of the cost of implementation of those plans and of revenues and other benefits likely to be realized from the implementation thereof, based on an examination of the full range of reasonable alternatives and taking into account views expressed at public hearings and otherwise by persons likely to be affected by implementation of the plans.

e) Design and implement projects for the efficient conservation, development and utilization of those waters.

f) Implement any plans or projects referred to in paragraphs (*d*) and (*e*).

Although all subsections of the act listed above may have some relevance to the proper establishment of an AWSM, subsection (e) is particularly pertinent as the AWSM could potentially enable the "efficient conservation, development and utilization of those waters" in southwestern Manitoba.

The Canadian Environmental Protection Act focuses on harmful substances to the environment and provides a way for developing environmental quality objectives, guidelines and codes of practice. The elements of the Act which focus on water are limited to water quality issues. Nevertheless, the Act does have provisions for using market-based instruments for environmental protection. Section 327 of the Act gives "the Minister (of Environment) the authority to establish guidelines, programs and other measures for the development and use of economic instruments and market-based approaches to further the purposes of this Act, respecting systems relating to (a) deposits and refunds; and (b) tradable units (Government of Canada, 2012)." Although these market-based provisions are included to fulfill the purpose of the Act which is focused on protecting water quality, they could potentially be applied toward addressing water quantity concerns.

4.1.2 Provincial Acts

The Water Rights Act provides detailed provisions for water consumption in the province of Manitoba. The Act specifies that water licences are required for all municipal and industrial uses and if an entity uses more than 25,000 litres a day for all other purposes. The Water Use Licensing Section governs allocation of licences within the province, which is typically based on a first-come, first-served basis. Water licences typically specify the following (Government of Manitoba Water Stewardship Division, n.d.-b):

- The name and location of the water source from which water may be taken or stored.
- The legal description of the intake location of the water source.
- The annual withdrawal rate.
- The maximum quantity of water that may be used in any one year.
- The purpose for which the water may be used.
- The installation of a meter or timing device on the water source.
- That records be kept and forwarded to the Water Use Licensing Section, either upon request or by February 1 of the following year.
- Other clauses that may be required by the particular circumstances of the project.

This act is of great relevance to the establishment of the AWSM, as the water licences specify the amount of water that can be extracted for a particular use. Within southwestern Manitoba the oil and gas sector sources its water primarily via water purveyor companies that have water use licences. Tracking the amount of water consumed by the oil and gas sector will require either sale information from the water purveyors or purchasing information from the oil and gas industry.

Under the Act the minister can conduct studies to determine how unlicensed water may be used "to the greatest advantage of the province" (Nowlan, 2005, p. 44). The minister also has the power to cancel or restrict existing licences in areas where the potential sustainable water yield has been reached to accommodate new applications with higher priority use. This was done for the Winkler Aquifer, which was threatened by saltwater intrusion due to over-pumping. The stakeholders reliant on the aquifer negotiated a solution where most of the licensees obtained treated surface water allocations (e.g., the Red River) in replacement of their groundwater allocation (Nowlan, 2005). There are also provisions for individuals to object to proposed licences if the application has been published. The establishment of an AWSM could potentially prevent water limitations by offsetting water consumption via the creation of additional water supplies that can be accessed to meet various needs.

The Water Protection Act provides for the protection and stewardship of Manitoba's water resources and aquatic ecosystems, primarily to maintain water quality. Nevertheless, subsections 10 and 11 have provisions for managing water conservation programs and addressing serious water shortages, which could be relevant for the establishment of an AWSM within southwestern Manitoba. For instance, where potential sustainable water yields may be surpassed water licence applications are waitlisted. Manitoba water licensing reports in Nowlan (2005)show that 71 applications were waitlisted for six of the 13 sub-basins on the Assiniboine Delta Aquifer since the potential sustainable water yield had been reached. The Act is also motivated by a recognition of "the benefits of providing financial incentives for activities that protect or enhance water, aquatic ecosystems or drinking water sources" (Government of Manitoba, 2013b), which could be helpful when justifying the need for establishing a water quantity offsets system.

Licence holders are obligated to install a flow-measuring device to report groundwater use on an annual basis. The data can then be used for water allocation, planning and management, which are especially important during water shortages. Nevertheless, the capacity to enforce this requirement is for the most part limited (Nowlan, 2005). This regulatory requirement will help with ensuring that the AWSM does not lead to water security challenges for the region, as keeping track of water consumption is imperative to maintain the integrity of the water resources within a particular region.

Under the Manitoba Ground Water and Water Well Act one must obtain a licence before drilling a well to access groundwater or collect scientific data on groundwater (Government of Manitoba, 2013b). Personal land owners drilling a well using their own equipment on their land to access groundwater for domestic purposes are exempted from the Act. Provisions for the minister to impose groundwater surveys or conservation, development and groundwater use studies are included in the Act (Nowlan, 2005). It also specifies that drilling must not lead to the pollution, contamination or diminishment in purity of groundwater in the area.

In addition to acts designed to protect water resources, the provincial Oil and Gas Act has sustainable development principles to guide the industry, which could be used to justify the establishment of an AWSM in southwestern Manitoba. These principles primarily promote the requirement of the oil and gas industry to develop the resource while minimizing impact on the environment so that it is preserved for future generations of Manitobans (Government of Manitoba, 2002).

4.2 Supply and Demand

Accurately estimating the supply and demand for the AWSM will depend on 1) the supply of adequate water retention sites for groundwater recharge dictated by biophysical characteristics and the willingness of agents and organizations (private or public land owners) to develop and sell water retention sites on their lands and 2) the demand for water quantity offsets dictated by the oil and gas industry's water consumption within the region and its voluntary willingness to participate in the AWSM.

The oil-producing region of Manitoba is dominated by a rolling prairie pothole landscape with many defined watercourses such as creek and river valleys that are often used as potential water storage sites. These water retention sites vary in storage cost–effectiveness, depending on local relief and the occurrence of natural and manmade structures used to impound water. The infiltration potential of stored water to recharge groundwater or aquifers will be influenced by a range of factors such as soil characteristics, aquifer depth and ground water pressure.

Water storage availability or "supply" is best estimated by examining the topography and physical geography of the region and estimating potential storage volumes and recharge potential based on rough calculations. This then provides a basis upon which one can estimate potential viable water quantity offset projects that could be developed and sold within the market. More accurate data may be acquired through groundtruthing the potential water retention sites. Existing water retention infrastructure can be used as a starting point to estimate a potential water storage volume. A comprehensive but coarse estimation of the total water storage potential in the project area will require the use of existing current digital elevation maps.

Within the Turtle Mountain Conservation District preliminary assessments identify a potential of 287 cubic decametres of water storage across the watersheds analyzed. Given that this sub-watershed contains 1,807 kilometres of stream channel, with the most elevated and greatest change in topography one can estimate that 1,200 cubic decametres of water could be stored per kilometre of stream. This would translate to a ball park total, conservation district–wide supply capacity of 2,800 cubic decametres of water storage available. A consultant report for the conservation district details the water storage potential in the Waskada Creek and Medora Creek sub-watersheds, which include non-linear impoundment locations such as field back floods.

The Upper Assiniboine River Conservation District and West Souris River Conservation District have not yet completed studies of this nature but have accurate stream length data. With respect to the Upper Assiniboine River Conservation District, excluding the large Birdtail, Oak and Assiniboine river systems, as well as first-order streams, which are not conducive to typical water impoundments, and applying the same technique of estimating total potential storage or supply available, it is estimated that there are 2,550 cubic decametres of potential water storage in the watershed. Applying the same estimation approach to the West Souris Conservation District, there are 937 cubic decametres of water storage.

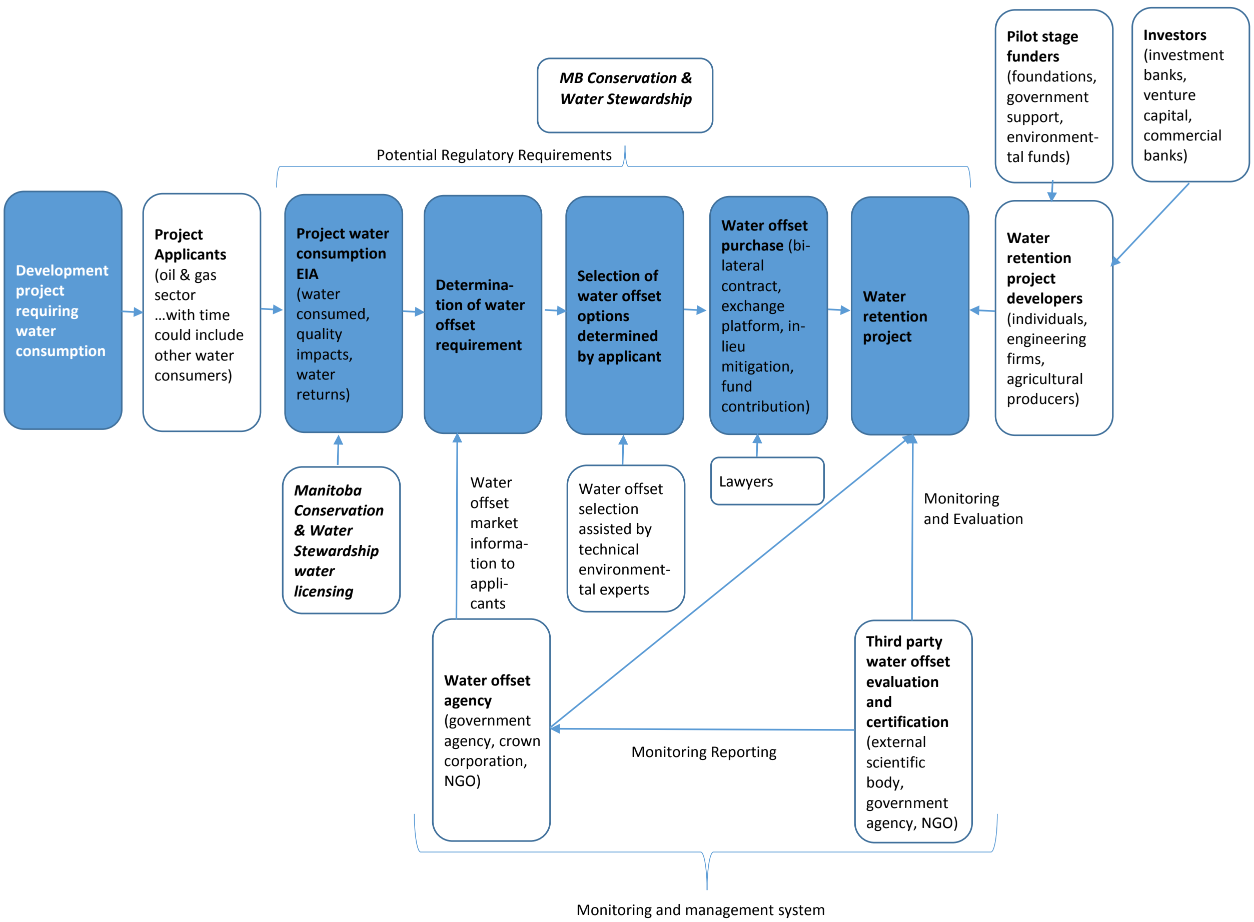
These coarse estimations represent a total potential water storage potential of 6,287 cubic decametres within the project area, which could potentially be translated into water quantity offsets for the oil and gas industry. Based on a running average, generated from past construction and projects completed, water storage is valued at USD$1000 per acre-foot. This estimates a total value of water storage or water quantity offset of approximately USD$5 million. Additional calculations would be required to estimate the total groundwater recharge that would be facilitated by these water retention locations. The soil composition and subsurface hydrology will be required to estimate the rate and total water infiltration potential (see Appendix A). In addition, the viability of projects will depend on whether or not there are proponents willing to develop them based on their economic viability and socio-cultural acceptability.

Estimating the water demand or water consumed by the oil and gas industry may be equally challenging but less hypothetical if based on existing water consumption records. Presupposing that industry would be willing to share this data, aggregating total water use by calendar year would be possible given time and resources to collect and refine the data. Relying on drill reports for water consumed per well developed and using the total well activity per year, it is estimated that the sector uses between 400 cubic decametres and 600 cubic decametres consumed per year, or roughly one-tenth of the water storage potential estimate within the project area.

4.3 Proposed Design

The proposed water quantity offset system design is provided below and is based on the design elements and market operation considerations provided in Section 2. Transactions facilitated by the proposed market design are illustrated using a process diagram and example registry. Additional design considerations for moving the proposed market from voluntary to compulsory, developing the water offset system using an ecosystem services framework and the potential for a bilateral approach are examined.

FIGURE 7: FLOW DIAGRAM OF THE AWSM WATER QUANTITY OFFSETS SYSTEM.



4.3.1 Design Elements

Who runs the program? Municipalities: Since municipalities intend to create the system, it is logical that they would administrate it. Whether they would do so directly or via an arm's-length body is an open question.

What problem is this mechanism trying to solve? Limited supply of freshwater: The problem this system is intended to solve is the limited supply of freshwater. Other secondary goals could be added to this.

At what geographic level do investments occur? Watershed: The watershed scale is the most sensible since local scale is too limiting and since watershed recharge is the desired impact from the perspective of those whose water supply is being depleted.

Who are the key actors? Industry, agricultural sector, municipalities, provincial government, NGOs involved in water, conservation authorities, regulators and ecosystem market service providers: This list is simply intended as a draft list of potential stakeholders; it would likely vary little between the different proposed systems.

Who pays? Industry; possibly other groups as well: The system would be designed with industry in mind; however, the door should be left open to other groups who value watershed recharge, such as government and conservation groups, also funding projects.

Why does the buyer pay? Voluntary (good PR): The system would be initially set up as a voluntary one; however, it should be designed to be flexible so that if the system were desired to be compulsory in the future, it could be so transitioned without having to start from scratch.

What does the buyer pay for? Offset of water use: What would be purchased via the system would be an offset of one's own use of water, where the watershed would be recharged with an amount equal to or greater than that which was used.

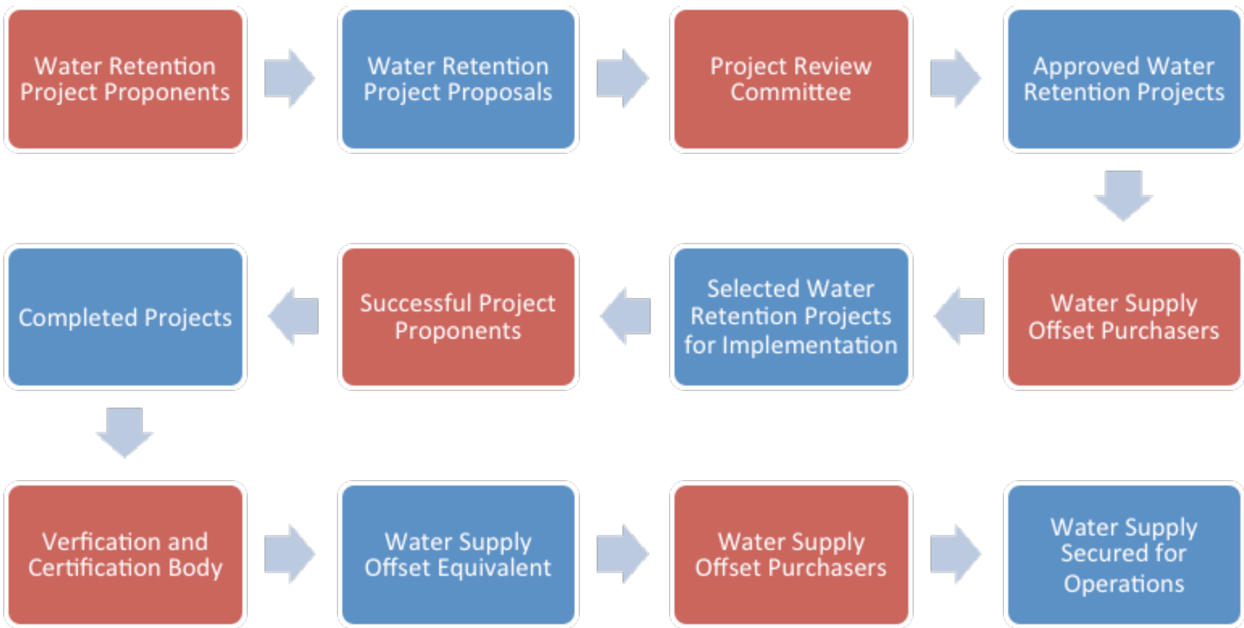
How do they pay the hydrological service provider? Brokerage: A brokerage is one of many possible options but has the advantages of being a repository of available water recharge projects, serving as a communications platform for those working in the area, and allowing flexibility in project prioritization and selection. It would allow any interested groups to search a registry in terms of their parameters of interest. For example, a buyer may be interested in projects that offer recharge *and* substantial flood mitigation benefits and could rank the projects according to these preferences, or a buyer could choose to consider only flood mitigation impacts and rank the projects purely according to this metric. Exchange agreements should be understood to reflect project bidders' *best estimates* of project impacts; the ultimate amount of recharge that a buyer could claim to have resulted from the project would have to be verified by an administrating body.

Does the program have multiple objectives, beyond hydrological services? Flood mitigation, nutrient cycling, habitat creation, avoided sediment runoff, biomass production and recreation: These co-benefits are believed to be important aspects that would warrant consideration in the offset system. Some would be quantifiable (e.g., kilograms of phosphorus retained), while other would be binary (e.g., yes/no).

4.3.2 Market Transactions

Figure 8 describes the process that would occur for a transaction to take place under the proposed AWSM design. The red and blue squares identify the actors and actions required to fulfill a water quantity offset exchange. Water supply offset transactions take place between water retention project proponents and water supply offset purchasers. The transactions are facilitated via an intermediary such as a brokerage firm that manages a registry of water retention projects that can be viewed by entities seeking to purchase water supply offsets.

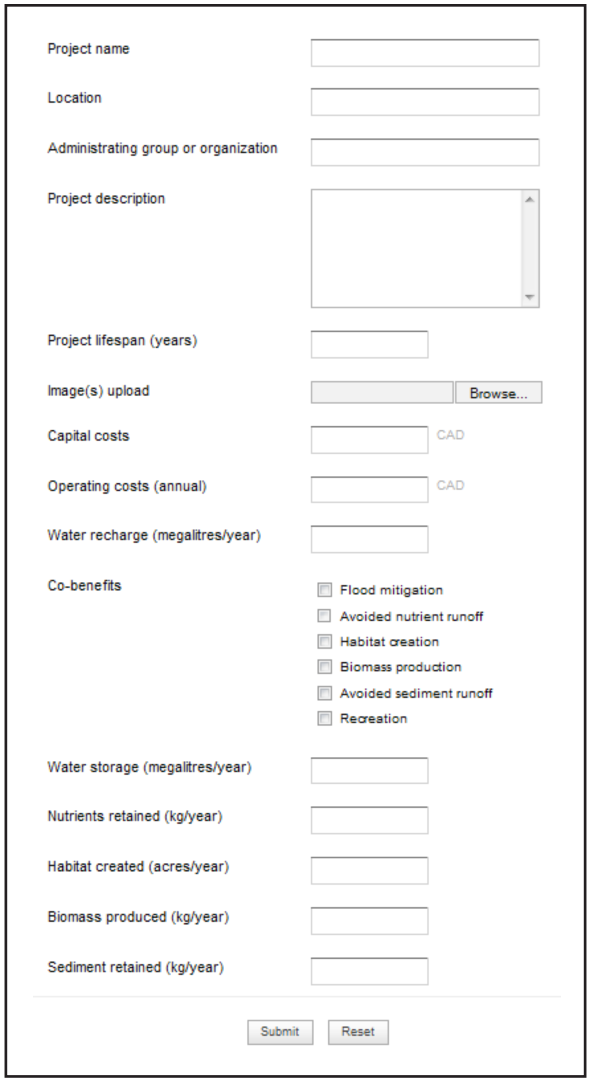
FIGURE 8: POTENTIAL EXCHANGE MECHANISM.



Building a registry of projects for this type of exchange system would be straightforward. Free online resources exist that could facilitate access and keep costs low. An example registry has been created that aligns with the potential design outline shown in Figure 8. A project bidder would simply have to fill in the form seen in Figure 9, and then the registry could automatically calculate useful accompanying information such as the cost per cubic decametres of recharge or cost per co-benefit (e.g., the cost of creating one acre of habitat or the cost of creating one cubic decametre of water storage). Quantifying the benefits associated with a project could assist prospective buyers in their water quantity offset purchase decision (see Appendix B for an example of cost benefit information for three types of distributed water storage systems).

This registry could then be searched by potential buyers, who could filter and sort projects in terms of their water recharge cost-effectiveness or other priorities that they are interested in. Although establishing a registry requires additional effort, it can be useful as an information portal for groups who may want to independently fund projects and as a resource that allows projects to be ranked and compared along a number of dimensions.

FIGURE 9: INPUT FORM FOR EXAMPLE REGISTRY.



Project name
Location
Administrating group or organization
Project description
Project lifespan (years)
Image(s) upload — Browse...
Capital costs — CAD
Operating costs (annual) — CAD
Water recharge (megalitres/year)
Co-benefits
- Flood mitigation
- Avoided nutrient runoff
- Habitat creation
- Biomass production
- Avoided sediment runoff
- Recreation

Water storage (megalitres/year)
Nutrients retained (kg/year)
Habitat created (acres/year)
Biomass produced (kg/year)
Sediment retained (kg/year)
Submit — Reset

Minimizing transaction costs is fundamental to ensuring market viability. Although there may be advantages in ensuring transaction cost consistency across trades regardless of their size or complexity, establishing a scheme for variable transactions costs may be able to accommodate and encourage smaller trades and adequately reflect the cost involved in complex and time-consuming transactions. The incorporation of exit fees provides an example for the need to carefully consider transaction costs and how they may affect trade. Exit fees may be justified to ensure that remaining market participants do not pay more cost for running the market. An exit fee framework could result in a trade barrier if not designed adequately for the context in which it is being applied.

4.3.3 Potential Market Actors

The institutional structure of the AWSM will depend greatly on its final design. Various entities such as provincial and municipal agencies, research organizations and private businesses could fulfill the various roles within the AWSM structure. The roles, functions and potential entities that could fulfill them are described in Table 3.

TABLE 3: POTENTIAL MARKET ACTORS.

ROLE	FUNCTION	POTENTIAL ENTITIES THAT WOULD FULFILL THIS ROLE
Buyers	Purchase water quantity offsets to fulfill voluntary requirements to offset water consumption.	In general these could include any water consumers that affect water availability through water consumption, such as the oil and gas industry, municipalities and large livestock operators.
Sellers	Design and implement projects that provide water availability to offset water consumption by large water consumers affecting the water availability.	Private land owners, municipalities, conservation districts and private businesses.
Financial and Technical Service Providers	Provide analysis and recommendations for the design and management of the AWSM.	These could include relevant federal and provincial government agencies such as Agriculture and Agri-Food Canada, Manitoba Agriculture, Food and Rural Initiatives and Manitoba Habitat Heritage Corporation. These could also include research organizations and NGOs such as PIN, DUC and IISD.
Credit Exchangers	Entity involved in facilitating the transactions between buyers and sellers of water quantity offsets. They may be involved in strictly managing a platform where trading can occur (offset registry) or may be involved in selecting water offset projects in terms of their cost and water offset effectiveness as well as co-benefits.	Relevant local level agencies such as the Oil Producing Municipalities of Manitoba or third party organizations such as PIN could potentially facilitate water quantity offset trades.
Monitoring and Verification	An entity that undertakes the monitoring and verification of water quantity offset projects, which will inform the management of trading platform and requirements.	Entities that provide conservation and rural extension services such as Manitoba Habitat Heritage Corporation, Manitoba Agricultural Services Corporation, Manitoba Agriculture, Food and Rural Initiative, conservation districts and private businesses.
Potential Regulators	An entity with regulatory power that can establish regulatory requirements for water consumers that affect water availability to be compelled to purchase water quantity offsets for their consumption.	Relevant entities with regulatory power include Manitoba Conservation and Water Stewardship and municipalities (Oil Producing Municipalities of Manitoba) via the establishment of bylaws.

Government Agencies and Organizations

Agricultural and Agri-Food Canada's Agri-Environment Services Branch (AESB) has historically been involved in abroad range of relevant projects including human resettlement in drought stricken areas, infrastructure developments, land-use improvements and geographic information systems for agriculture (Corkal & Adkins, 2008). The AESB, with its agro-environmental management mandate, along with partners from provincial departments responsible for agriculture and water resources management, is well-suited to enable the establishment of the AWSM.

Manitoba Agriculture, Food and Rural Initiatives (MAFRI) works toward strengthening the agricultural sector and rural communities in Manitoba. "MAFRI has three divisions and a network of local offices delivering services directly to farmers, agribusinesses and communities" (Manitoba Agriculture Food and Rural Initiatives, n.d.). MAFRI provides programs and services supporting the growth of the agricultural sector and rural economy. MAFRI could provide financial and technical support for the establishment and management of the AWSM.

The Manitoba Habitat Heritage Corporation (MHHC) is a non-profit crown corporation established to conserve, restore and enhance fish and wildlife habitat. The MHHC works with private landowners, farm organizations, corporations, conservation groups and government agencies to carry out conservation projects. MHHC promotes conservation practices that benefit habitat, sustain farm family income, and encourage the productive use of land. The MHHC board has representation from provincial departments of water and agriculture, the federal Department of the Environment, NGOs such as DUC and Delta Waterfowl foundation, private citizens, and producer and local groups such as Keystone Agricultural Producers, Association of Manitoba Municipalities and Manitoba Conservation Districts Association. The MHCC is well placed to provide not only financial and technical assistance for the establishment of the AWSM, but also monitoring and verification services.

Manitoba Conservation and Water Stewardship is the provincial government agency responsible for issuing water permits within the province. It is the entity that could potentially bring in legislation to establish a regulated water quantity offsets program in southwestern Manitoba. The Manitoba Water Council, a senior advisory board that reports to Manitoba Conservation and Water Stewardship, could provide guidance and insight into the development of a water market.

The Oil Producing Municipalities of Manitoba is composed of 18 municipalities in southwestern Manitoba and was established in 2011 to address specific issues related to the industry (McMechan, 2013). Its main goal is to ensure the long-term protection of its communities and infrastructure while facilitating the flourishing of the oil industry within the region. To this end the organization lobbies the government for improved transportation infrastructure (McMechan, 2013). The Oil Producing Municipalities of Manitoba could potentially play a role in enabling water quantity offset transactions. It could also play a role in establishing joint bylaws to compel water consumers who affect water availability to purchase water quantity offsets.

Conservation Districts are composed of neighboring rural municipalities that work with the provincial government to sustainably manage the natural resources within their area(Government of Manitoba Water Stewardship Division, n.d.-a). Within the oil-producing zone of Manitoba there are three conservation districts that could play an important role in selling water quantity offsets by carrying out water retention projects or monitoring and verifying water quantity offset projects.

Non-Governmental Organizations

The **Prairie Improvement Network's** range of expertise and knowledge can provide financial and technical expertise for the proper functioning of the AWSM (Heppner, 2012). The network is well placed to provide oversight to monitor the AWSM and make required modifications so that it can function effectively and achieve its objective: maintaining southwestern Manitoba's water supply. It can play an important role in starting up the AWSM by brokering discussions with government and industry entities willing to establish an AWSM pilot project that could be used for enrolling additional market participants. The network could also initiate discussions with relevant government agencies to implement water quantity offset programs within freshwater-limited regions through modification to provincial legislation and/or municipal bylaws.

Ducks Unlimited Canada (DUC) is a non-profit organization with expertise in waterfowl and wetland conservation and restoration. DUC has technical expertise in natural habitat conservation and restoration. Its technical capacity in the field of ecology and remote sensing could be leveraged to facilitate water quantity offset projects. DUC could potentially be involved in providing financial and technical service provisions for water quantity offset projects.

The International Institute for Sustainable Development (IISD) is a not-for-profit organization focused on establishing a sustainable future for all. IISD has been actively involved in establishing market approaches to improve the ecological integrity of rural Manitoba for close to ten years. The institute has been actively involved in developing innovative approaches such as distributed water storage systems and cattail harvesting to improve the water quality of Lake Winnipeg, the most eutrophied large lake in the world. IISD could provide technical support for the establishment and implementation of the AWSM.

4.3.4 Additional Design Considerations

Additional considerations for implementing an AWSM in southwestern Manitoba are briefly discussed. A good understanding of the water resources within the region and potential stressors that could impact the resources is required for a water market to be adequately designed. Selling water neutrality to large water consumers in the oil and gas sector could be strategic and enable the AWSM to grow. Moving the water quantity offset system from a voluntary to a compulsory system will require a legislative framework that is context-specific and adapted to the hydrological regime of the area in which it is being implemented. The potential for adopting an ecosystem services design framework for the water quantity offset system could be advantageous to minimizing impacts on the integrity of local ecosystems.

Biophysical Considerations

The completion of regulatory and water planning frameworks is imperative to ensure that the water trading scheme does not undermine the viability of the resource. This should be a prerequisite to enabling water trading within a particular area. In Manitoba the conservation districts' integrated watershed management plans provide the basis upon which the AWSM could be developed sustainably to ensure that water resources in southwestern Manitoba are traded responsibly. Since Integrated Water Resources Management plans do not take into account water trading, they may need to be revisited to include additional provisions for the establishment of the AWSM.

Water resource metering is important to track the amount of water that is actually being used through water offset trading. It may be important to invest in the enforcement of metering and reporting in southwestern Manitoba before allowing a water offsets system to move forward. The challenge in Manitoba and in many jurisdictions across Canada is the lack of groundwater data, which makes managing water resources sustainably challenging. Additional information related to groundwater resources may be required to design the AWSM in the best possible way to maintain the long-term viability of the groundwater resources within southwestern Manitoba. Nevertheless, the proper functioning of the AWSM would enhance water supplies generally across the region compared to the current model of water consumption by the oil and gas sector where the water is generally consumed and taken out of the hydrological cycle.

The market may have to adapt to unanticipated shocks such as droughts or commodity price shifts. It is therefore important to think about these potential shifts and build in mechanisms to deal with them. This could include trading restrictions during times of drought. Changes in land use could potentially have an impact on the hydrological cycle and hence the integrity of the water market. There has been some reflection in terms of bringing land-use changes to the water market, but uncertainties related to their actual impact on the water cycle remain a challenge.

Return flows is another challenge that can add complexity to adequately designing the water offset, since there may be a desire to account for the volume of water that is not used and returned to the water cycle. In the case of southwestern Manitoba and water consumed by the oil and gas industry, we can assume that 50 to 80 per cent of the water used is lost and is for all intents and purposes taken out of the water cycle (Freyman & Salmon, 2012).

Water quality should also be considered when designing the water market to ensure that trading does not lead to its degradation. In some cases, water quality considerations may be incorporated into the design of the water offset, where water quality improvement requirements may be a prerequisite for selecting water quantity offset projects.

Basing the design of the AWSM on an ecosystem services framework could be advantageous to 1) limiting water consumption so as to maintain ecosystem capacity to provide services (some being directly relevant to maintaining water security, such as microclimates, erosion control and waste assimilation) and 2) adequately designing the water quantity offset system so that ecosystem services that are lost can be recovered when designing the water quantity offset project through the provision of co-benefits. EWEB's plan to provide private landowners with payments for services that their natural environments on their lands provides a good example of how an ecosystem services–focused water offset system could be designed. South Africa's Working for Water program is another example where restoring ecosystem integrity by eradicating invasive species and rehabilitating native plant species can be very effective in terms of enhancing water supplies.

Voluntary vs. Regulatory

It is important to note that multiple forms of water trading (water exchange and bilateral trades) can coexist. Decentralized, bilateral trades as well as centralized trades occurring in exchanges or via intermediaries such as brokers can function alongside each other, as they offer flexibility and suitability to fit various contexts. To initiate the water quantity offset system a voluntary bilateral agreement with a large water consumer in the oil and gas sector within the region to offset water consumption would be advantageous. This would provide the program administrator with a pilot project with which lessons could be learned before expanding the AWSM to include additional voluntary market participants.

The first company to participate in the bilateral agreement would have the first-time mover advantage by enhancing its social licence to operate by claiming to be the first water neutral oil and gas company in southwestern Manitoba. Similarly to the Sony semiconductor manufacturing facility in Kumamoto City, being water neutral can be used to improve the company image and social licence to operate. Furthermore, the nature of the water offsets being proposed for the AWSM, the establishment of water retention structures on the landscape, are such that they will provide multiple benefits in the form of groundwater recharge, flooding protection and improved water quality, which is important regionally and provincially.

Rules governing market participation should be designed to include additional market participants as the market matures to maintain and improve its liquidity. Unless there is a clear public policy justification to restrict market participation, restrictions should be kept at a minimum. Within the context of Manitoba the AWSM could expand with time to include all water users such as municipalities and agricultural producers. There is a distinction that needs to be made in terms of the return water associated with the water use. For instance, water consumed for hydraulic drilling by the oil and gas sector is lost, whereas water used by municipalities and the agricultural sector is almost always returned to the hydrological cycle of the area.[8]

Transitioning the proposed design from a voluntary to a compulsory water offset system will require legislation, which could originate from the provincial government or through municipal bylaws. The legislation established would have to be context-specific (applied to a given watershed or municipality) so that it remains relevant to the entities operating in specific watersheds. The legislation would compel large water users within specific watersheds to participate in a water quantity offset system likely administered by an entity representing a group of municipalities such as a conservation district or watershed-based organization. Large water users would be identified within each watershed based on water availability and total water consumption, as well as on whether the water is returned to the watershed.

Taxation provides governments with another means to encourage water conservation and generate resources to offset water consumption. Levies could be collected at a predetermined rate for each cubic decametres of water used that is not returned to the watershed. The taxes collected would then be earmarked for projects that enhance water supplies and availability in affected watersheds. The program administrator would decide what projects would be implemented, either by accepting proposals or conducting research on optimal water supply restoration projects.

Scaling Up

For the water market to work effectively toward comprehensively improving water use efficiencies in southwestern Manitoba, a system of tradable water rights and entitlements for the entire water cycle would have to be implemented. This would include water consumption from groundwater and surface water sources, return flows and others (PricewaterhouseCoopers, 2006).

For the market to function effectively across municipal jurisdictions, consistency in how water offsets are defined and structured may be important. Ensuring consistency across jurisdictions may be challenging due to a range of factors that go beyond the administrative and legislative frameworks in place to facilitate water trade (PricewaterhouseCoopers, 2006). Tagging and exchange rates may be a way to accommodate for trading water between jurisdictions and even between watersheds.

Exchange rates are used to account for adjustments related to the location of water extraction. For inter-jurisdictional trading an exchange rate could account for differences in the administration of a water offset. For inter-watershed trading exchange rates could be applied to account for differences in water supply reliabilities or thresholds. In an exchange rate system the water quantity offset would be administered by the jurisdiction in which it is being purchased.

[8] The water used by municipalities and the agricultural sector is typically returned to the hydrological cycle in a different state than it is taken.

Tagging consists of maintaining the responsibilities of managing the water resource within the jurisdiction in which it is being extracted while providing the jurisdiction where it is being used with the responsibility to regulate extraction and use. Therefore, the risks and responsibilities of sustainably managing the water resource are shared between the jurisdictions where the water is being traded for extraction and use.

Scaling up AWSM strategically across Manitoba may require assistance from the provincial government. Major water consumers within discrete watersheds across the province could potentially offset their water consumption by paying into a fund that supports water offset projects. Harmonizing AWSM with existing means of collecting funds (i.e., water permitting system) from major water users for their water consumption would be necessary. The province would administer the fund and decide what projects would be implemented through the fund, either by accepting proposals or by conducting its own research into which projects would be optimal for maintaining and improving water supplies.

5.0 Conclusion

With over 3,600 active oil wells, the oil and gas sector in Manitoba is rapidly expanding (Agnes, 2013). Although its impact on water resources remains unknown, the potential for depleting local freshwater supplies and impacting groundwater quality remains a reality that must be addressed.

Although efforts are being made to address these uncertainties, much remains to be done. The provincial government has recently committed to developing public information systems (a Manitoba version of FracFocus) to share data on the chemicals used for hydraulic fracking by the oil and gas sector (Agnes, 2013).

Establishing an AWSM where water consumed by the oil and gas sector is offset through water retention sites would help minimize the potential impacts on local freshwater supplies. The water offset program would initially be introduced as a voluntary program offering oil and gas companies the prospect of being water neutral. It could then become regulated by increasing the stringency of water licensing requirements for southwestern Manitoba.

The current water offset supply to demand ratio for the region was estimated to be 10:1 based on the water storage potential of stream reaches and project water consumption by the oil and gas sector in southwestern Manitoba. Supply as well as demand could expand significantly over time with the prospects of developing land-based water retention sites and the oil and gas sector's possibility of including additional sectors in the market.

The institutional structure for the design and operation of the AWSM could take a number of forms with Manitoba Conservation and Water Stewardship playing a prominent role if the market is to be regulated. The Oil Producing Municipalities of Manitoba as well as the Prairie Improvement Network were both identified as potentially suitable organizations to manage and operate the AWSM.

The sustainable management of freshwater resources in southwestern Manitoba is essential to maintaining the socioeconomic as well as the ecological vitality of the region. Market-based approaches, if designed properly, could facilitate economic development that enhances human and ecological well-being. The establishment of an AWSM for southwestern Manitoba would allow the oil and gas sector to flourish alongside the agricultural sector while enhancing community resilience and offering environmental co-benefits.

Bibliography

Adamowicz, W. L., Percy, D., & Weber, M. (2010). *Alberta's water resource allocation and management system: A review of the current water resource allocation system in Alberta*. Alberta Water Research Institute. Retrieved from http://www.seawa.ca/reports/Alberta's_Water_Resource_Allocation_and_Management_System.pdf

Agnes, M. (2013, July 2). Fracking on the rise in Manitoba. *Winnipeg Free Press*. Retrieved from http://www.winnipegfreepress.com/local/Fracking-on-the-rise-in-Manitoba-213970561.html

AlbertaEnvironment. (2008). *Water for life: A renewal*. Retrieved from http://environment.gov.ab.ca/info/library/8035.pdf

Alberta Innovates Bio Solutions. (2012). *Project profile: Conservation offsets (Success Story, August, 2012).* Retrieved from: http://bio.albertainnovates.ca/media/46132/aibio_story_project_profile_conservation_offsets.pdf

Alberta Water Council. (2009). *Recommendations for improving Alberta's water allocation transfer system*. Retrieved from: http://www.albertawatercouncil.ca/Portals/0/pdfs/WATSUP_web_FINAL.pdf

Alberta Wilderness Association. (2007). *Concerns*. Retrieved from http://albertawilderness.ca/issues/wildwater/concerns

Bennett, G., Carroll, N., & Hamilton, K. (2012). *Charting new waters: State of watershed payments 2012.* Washington, DC: Forest Trends.

Bigas, H., Morris, T., Sandford, B., & Adeel, Z. (2012). *The global water crisis: Addressing an urgent security issue*. Hamilton, ON: United Nations University – Institute for Water, Environment and Health.

Binns, J., Illgner, P., & Nel, E. (2001). Water shortage, deforestation and development: South Africa's working for water programme. *Land Degradation and Development, 12*(4), 341–355.

Biodiversity in Good Company Initiative. (2010). *From commitment to action: Member companies report.* Retrieved from http://www.business-and-biodiversity.de/fileadmin/user_upload/documents/Die_Initiative/final_FactBook_web.pdf?PHPSESSID=2509c9dcd8b0bd463e307d0447c03475

Bionade GmbH. (2012). *Progress Report Bionade GmbH 2011/2012. On the leadership declaration of the 'Biodiversity in Good Company' initiative.* Retrieved from http://www.business-and-biodiversity.de/fileadmin/user_upload/documents/Die_Initiative/Fortschrittsbericht/BIONADE_Progress_Report_2012_EN.pdf?PHPSESSID=6b8d95a4b8fb714d4a1f5d32b0030099

Bond, I., & Mayers, J. (2010). *Fair deals for watershed services: Lessons from a multi-country action-learning project* (Natural Resources Issues No. 13). Retrieved from International Institute for Environment and Development website: http://pubs.iied.org/pdfs/13535IIED.pdf

Bonneville Environment Foundation. (2013a). *Active projects*. Retrieved from http://www.b-e-f.org/our-solutions/water/water-restoration-certificates/project-portfolio/active-projects/

Bonneville Environment Foundation. (2013b). *Our water solutions*. Retrieved from http://www.b-e-f.org/our-solutions/water/water-restoration-certificates/why-wrcs/

Bonneville Environmental Foundation unveils first-ever voluntary water restoration marketplace. (2009, August 18). *Business Wire*. Retrieved from http://www.thefreelibrary.com/Bonneville+Environmental+Foundation+Unveils+First-Ever+Voluntary...-a0206035060

Brandes, O.M., & Nowlan, L. (2009). Wading into uncertain waters: Using markets to transfer water rights in Canada - possibilities and pitfalls. *Journal of Environmental Law & Practice, 19*(3), 267–287. Retrieved from http://poliswaterproject.org/sites/default/files/Brandes%20&%20Nowlan%20_Recent%20Research_%20Water%20Markets.pdf

Brandes, O.M., Nowlan, L.,& Paris, K. (2008) *Going with the flow? Evolving water allocations and the potential and limits of water markets in Canada*. Ottawa, ON: Conference Board of Canada. Retrieved from http://poliswaterproject.org/sites/default/files/09_going_w_flow_1.pdf

Canada Water Act, R.S.C., 1985, c. C-11. (2005, April 1). Retrieved from http://laws-lois.justice.gc.ca/eng/acts/C-11/page-2.html#docCont

Canadian Environmental Protection Act, 1999, S.C. 1999, c. 33. (2012, November 1). Retrieved from http://laws-lois.justice.gc.ca/eng/acts/c-15.31/

Carmona, R., Fehr, M., Hinz, J., & Porchet, A. (2010). Market design for emission trading schemes. *Siam Review*, *52*(3), 403-452.

Christenson, R., & Droitsch, D. (2008). *Fight to the last drop: A glimpse into Alberta's water future*. Retrieved from Ecojustice website: http://www.ecojustice.ca/publications/reports/fight-to-the-last-drop-a-glimpse-into-alberta2019s-water-future/attachment

Clay, L. (2011). Going global with water trading. *American Water Intelligence, 2*(11). Retrieved from http://www.americanwaterintel.com/archive/2/11/analysis/going-global-water-trading.html

Clifton Associates Ltd. (2009) *Saskatchewan Water Innovation and Technology Alliance: A project proposal and business case: Final report*. Retrieved from Communities for Tomorrow website: http://www.communitiesoftomorrow.ca/LinkClick.aspx?fileticket=LcNsbr%2BI2n8%3D&tab

Conservation Registry Marketplace for Nature Portal. (2012). *Eugene Water and Electric Board (EWEB) Voluntary Incentives Program (VIP).* Retrieved from http://marketplace.conservationregistry.org/projects/100813

Cooper, G. (2011, July 11). Water trading helped Australian economic recovery. *Environmental Finance*. Retrieved from http://www.environmental-finance.com/content/news/water-trading-helped-australian-economic-recovery-.html

Corkal, D., & Adkins, P. (2008). *Canadian agriculture and water*. Paper presented at the 13th IWRA World Water Congress.

Council of Canadian Academies. (2013). *Water and Agriculture in Canada: Toward Sustainable Management of Water Resources.* Ottawa, ON: The Expert Panel on Sustainable Management of Water in the Agricultural Landscapes of Canada - Canadian Council of Academies.

Cronin, A. E., & Fowler, L. B. (2012). Northwest water banking. *The Water Report*(102), 10–16.

Dion, J., & McCandless, M. (2013). *Cost-benefit analysis of three proposed distributed water storage options for Manitoba*. Winnipeg: IISD.

Droitsch, D., Robinson, B. (2009). *Share the water: Building a secure water future for Alberta*. Retrieved from Water Matters Society of Alberta website: http://www.water-matters.org/docs/share-the-water.pdf

Dyer, S., Grant, J., Lesack, T., & Weber, M. (2008). *Catching up: Conservation and biodiversity offsets in Alberta's boreal forest.* Ottawa, Canada: Canadian Boreal Initiative.

Eugene Water & Electric Board. (2012). *Voluntary incentives program*. Retrieved from http://www.eweb.org/sourceprotection/vip

Food and Agriculture Organization of the United Nations. (2007). *The state of food and agriculture: Paying farmers for environmental services.* Retrieved from http://www.fao.org/docrep/010/a1200e/a1200e00.htm

Fox, J. N., & Nicolas, M. P. (2012, December 15). *Oil in Manitoba: Exploration, production reserves and revenues.* Retrieved from the Association of Professional Engineers and Geoscientists of the Province of Manitoba website: http://www.apegm.mb.ca/pdf/PD_Papers/FoxAndNicolas_OilInManitoba.pdf

Freyman, M., & Salmon, R. (2012). *Hydraulic fracturing &water stress: Growing competitive pressures for water.* Boston, MA: Ceres.

GENESYS Foundation. (2006). *RHA training at baticulan watershed*. Retrieved from http://www.genesysph.org/index.php?option=com_content&view=article&id=3:rha-training-at-baticulan-watershed&catid=7:publications

Government of Canada. (2005). *Canada Water Act 1985*. Retrieved from http://laws-lois.justice.gc.ca/eng/acts/C-11/page-2.html#docCont

Government of Canada. (2012). *Canadian Environmental Protection Act 1999*. Retrieved from http://laws-lois.justice.gc.ca/eng/acts/c-15.31/

Government of Manitoba. (2002). *TheOil and Gas Act*. Retrieved from https://web2.gov.mb.ca/laws/statutes/ccsm/o034e.php

Government of Manitoba. (2013a). *The Ground Water and Water Well Act*. Retrieved from http://web2.gov.mb.ca/laws/statutes/ccsm/g110e.php

Government of Manitoba. (2013b). *Water Protection Act2012*. Retrieved from https://web2.gov.mb.ca/laws/statutes/ccsm/w065e.php

Government of Manitoba Water Stewardship Division. (n.d.-a). *Conservation districts*. Retrieved from http://www.gov.mb.ca/waterstewardship/agencies/cd/

Government of Manitoba Water Stewardship Division. (n.d.-b). *Water use licensing - Frequently asked questions*. Retrieved from http://www.gov.mb.ca/waterstewardship/licensing/wlb/faq.html

Government of Saskatchewan, SaskH20. (n.d.). *Saskatchewan Acts and Regulations specific to water*. Retrieved from http://www.saskh20.ca/WaterInformationLegislation.asp

Greiber, T., van Ham, C., Jansse, G., & Gaworska, M. (2009). *Final report study on the economic value of groundwater and biodiversity in European forests.* Luxembourg: IUCN Regional Office for Europe & IUCN Environmental Law Centre. Retrieved from http://ec.europa.eu/environment/forests/pdf/grounwater_report.pdf

Heppner, K. (2012, November 26). MRAC re-Invents itself as "Prairie Improvement Network."*Portage Online*. Retrieved from http://www.portageonline.com/index.php?option=com_content&task=view&id=29805&Itemid=526

Hope for San Carlos' dwindling watershed. (2008, April 26). *Good News Pilipinas!* Retrieved from http://goodnewspilipinas.com/2008/04/23/hope-for-san-carlos-dwindling-watershed/

Hurlbert, M. (2006). Water Law in the South Saskatchewan River Basin (IACC Project working paper No. 27). Regina, SK: University of Regina.

Idaho Water Resource Board. (n.d.-a). *History of the water supply bank.* Retrieved from http://www.idwr.idaho.gov/WaterManagement/WaterRights/waterSupply/history_of_bank.htm

Idaho Water Resource Board. (n.d.-b). *Water supply bank*. Retrieved from http://www.idwr.idaho.gov/WaterManagement/WaterRights/waterSupply/ws_default.htm

Japan Ministry of the Environment. (2010a). *Payments for ecosystem services (PES): An introduction of good practices in Japan: Conserving water by recharging groundwater in Kumamoto*. Retrieved from http://www.biodic.go.jp/biodiversity/shiraberu/policy/pes/en/water/water03.html

Japan Ministry of the Environment. (2010b). *Payments for ecosystem services (PES): An introduction of good practices in Japan: River basin tariffs for trans-border water source management in Fukuoka City*. Retrieved from http://www.biodic.go.jp/biodiversity/shiraberu/policy/pes/en/water/water02.html

Keewatin Publications. (2003).*Supply, quality and use of water in the prairie provinces: Saskatchewan edition.* Retrieved from http://www.climatechangesask.ca/images/water_prairie_provinces_sk_eng.pdf

Landry, C. (1998). Market transfers of water for environmental protection in the western United States. *Water Policy 1*(5), 457-469. Retrieved from http://www.waterexchange.com/UserFiles/File/dataroom/Markettransfersofwaterforenvironmentalprotection.pdf

Long, F. (2013). *The water transfer system in southern Alberta: Scope and implications for a future provincial water market* (Master's thesis, The University of Guelph). Retrieved from https://dspace.lib.uoguelph.ca/xmlui/bitstream/handle/10214/5333/Long_Feinan_201301_Msc.pdf?sequence=3

Manitoba Agriculture Food and Rural Initiatives. (n.d.). *About MAFRI*. Retrieved from http://www.gov.mb.ca/agriculture/about/index.html

McMechan, D. (2013, April 12). Oil Producing Municipalities of Manitoba working toward long-term solutions to vital industry issues. *Manitoba Oil & Gas Review*. Retrieved from http://manitobaoil.ca/oil-producing-municipalities-of-manitoba-working-toward-long-term-solutions-to-vital-industry-issues/

Montana River Action. (n.d.). *Water leasing for instream flows*. Retrieved from http://www.montanariveraction.org/water-leasing.html

Nicol, L.A.,& Klein, K.K. (2006). Water market characteristics: Results from a survey of Southern Alberta irrigators. *Canadian Water Resources Journal*, *31*(2), 91–104. Retrieved from http://www.tandfonline.com/doi/pdf/10.4296/cwrj3102091

Nowlan, L. (2005). *Buried treasure: Groundwater permitting and pricing in Canada.* Toronto, ON: The Walter and Duncan Gordon Foundation.

Ostrom, E. (1999). Coping with tragedies of the commons. *Annual review of political science*, *2*(1), 493-535.

Patiño, L.,&Gauthier, D.(2007). *South Saskatchewan River legal and inter-jurisdictional institutional water map.* Derived by L. Patiño and D. Gauthier, mainly from M. Hurlbert, Margot. 2006. Water Law in the South Saskatchewan River Basin. (IACC Project working paper No. 27.) Retrieved from http://www.parc.ca/mcri/pdfs/papers/iacc054.pdf

Porras, I., & Neves, N. (2006). *South Africa-Working for Water (WfW): South African pro-poor watershed rehabilitation projects.* London: International Institute for Environment and Development.

PricewaterhouseCoopers. (2006). *National Water Initiativewater trading study.* Australia: Department of the Prime Minister and Cabinet.

Rodricks, S. (2010). *Working for Water Programme in South Africa.* Geneva: The Economics of Ecosystems and Bioversity.

Russi, D., ten Brink, P., Farmer, A., Badura, T.,Coates, D.,Förster, J. . . Davidson, N. (2013). *The economics of ecosystems and biodiversity for water and wetlands.* London: IEEP.

Sandor, R. L., Walsh, M. J., & O'Hara, J. K. (2010). *The potential benefits of an organized exchange for the sustainable use of water in Alberta*. Alberta Water Research Institute. Retrieved from http://www.seawa.ca/reports/The_Potential_Benefits_of_an_Organized_Exchange_for_the_Sustainable_Use_of_Water_in_Alberta.pdf

Saskatchewan Water Security Agency. (2012). *25 year water security plan*. Retrieved from http://www.gov.sk.ca/adx/aspx/adxGetMedia.aspx?mediaId=1798&PN=Shared

Schmidt, J. (2011). *Alternative water futures in Alberta*. Retrieved from Parkland Institute website: http://parklandinstitute.ca/research/summary/alternative_water_futures_in_alberta

Stavins, R. N. (1998). What can we learn from the grand policy experiment? Lessons from SO_2 allowance trading. *The Journal of Economic Perspectives*, *12*(3), 69-88.

Sony Semiconductor Kyushu Corporation Kumamoto Technology Center. (2004). *Returning groundwater to the earth: Protecting water resources: Groundwater recharge for a sustainable society.* CX-NEWS Vol. 35. Retrieved from http://www.sony.net/Products/SC-HP/cx_news/vol35/sideview.html

Sustainable Agriculture and Natural Resources Management Collaborative Research Support Program (SANREM CRSP). (2007). *USAID PES sourcebook volume 2: Supplemental reading on best practices for pro-poor payment for ecosystem services*. Retrieved from Virginia Tech Office of International Research, Education & Development website: http://www.oired.vt.edu/sanremcrsp/documents/research-themes/pes/FurtherReading.pdf

Sustainable Prosperity. (2011, September). *Economic instruments for water management in Canada: Case studies and barriers to implementation* (Policy Brief). Retrieved from http://www.sustainableprosperity.ca/dl709&display

Tuinhof, A., Van Steenbergen, F., & Tolk, L. (2012). *Profit from storage: The costs and benefits of water buffering.* Wageningen, Netherlands: 3R Water Secretariat.

UNECE/FAO Forestry and Timber Section. (2012). *Payments for forest-related ecosystem services: What role for a green economy?* Retrieved from http://www.unece.org/fileadmin/DAM/timber/meetings/20110704/06062011pes_background_paper.pdf

UN Water. (2011). *Developed countries* [Case tables]. Retrieved from http://www.un.org/waterforlifedecade/green_economy_2011/pdf/cases_table_developed_countries.pdf

Unger, J. (2010). *Water markets and winning the lottery*. Retrieved from Environmental Law Centre website: http://environmentallawcentre.wordpress.com/2010/10/15/water-markets-and-winning-the-lottery/

University of Alberta Environmental Research and Studies Centre and University of Toronto Munk Centre for International Studies. (2007).*Running out of steam? Oil sands development and water use in the Athabasca River-Watershed: Science and market based Solutions*. Retrieved from http://www.ualberta.ca/~ersc/water.pdf

Waterfind. (2008). *Get the Best Price*. Retrieved from http://www.waterfind.com.au/index.html

Water Matters. (2008). *Understanding Alberta's emerging "water market."* Retrieved from http://www.water-matters.org/story/219

Williams, C. (2010, September 15). BEF builds new model for water offsets *Sustainable Business Oregon*. Retrieved from http://www.sustainablebusinessoregon.com/articles/2010/09/bef_builds_new_model_for_water_offsets.html?page=all

Appendix A – Water Infiltration Estimation Methods

There are a number of water infiltration methods that can be used to estimate the total amount of groundwater recharge that will occur as a result of water retention and storage. The following methods can be used to estimate water infiltration volumes and rates into soils. Additional considerations may have to be taken into consideration when estimating aquifer recharge.

The following mathematical formulas were taken from Wikipedia (canada2020.ca/event/the-canada-we-want-carbon-pricing/) and the US EPA (www.epa.gov/ada/csmos/ninflmod.html#philip). These equations provide a means to estimate water infiltration characteristics within soils.

HORTON'S EQUATION

Horton's equation is an empirical method used for measuring ground infiltration rates or volumes. The formula assumes that infiltration starts at a constant rate (f_0) and is decreasing exponentially with time (t). When the soil saturation level reaches a certain value, the rate of infiltration levels off (f_c).

$$f_t = f_c + (f_0 - f_c)e^{-kt}$$

f_t = infiltration rate at time t

f_0 = initial infiltration rate

f_c = infiltration rate after the soil has been saturated

k = decay constant specific to the soil

The following equation can be used to calculate the total volume of infiltration, f, after time t.

$$F_t = f_c t + \frac{(f_0 - f_c)}{k}(1 - e^{-kt})$$

KOSTIAKOV EQUATION

The Kostiakov equation is an empirical method, which assumes that the intake rate declines over time according to a power function shown below.

$$f(t) = akt^{a-1}$$

Where a and k are empirical parameters.

The Kostiakov-Lewis variant ("Modified Kostiakov") equation corrects for the reliance on the zero final intake rate by adding a steady intake term to the original equation.

$$f(t) = akt^{a-1} + f_0$$

Integrating the equation above provides the cumulative volume equation below:

$$F(t) = kt^a + f_0 t$$

f_0 = approximate final infiltration rate

DARCY'S LAW

Ponded water is assumed to be equal to h_0 and the head of dry soil that exists below the depth of the wetting front soil suction head is assumed to be equal to $-\psi-L$.

$$f = K\left[\frac{h_0 - (-\psi - L)}{L}\right]$$

ψ = wetting front soil suction head

h_0 = depth of ponded water above the ground surface

K = hydraulic conductivity

F = total depth of subsurface ground in question

GREEN-AMPT

The Green-Ampt infiltration estimation method accounts for soil suction head, porosity, hydraulic conductivity and time.

$$\int_0^{F(t)} \frac{F}{F + \psi\,\Delta\theta}\,dF = \int_0^t K\,dt$$

ψ = wetting front soil suction head

θ = water content

K = hydraulic conductivity

F = total volume already infiltrated

Integrating the equation above can then be solved for calculating volume of infiltration or instantaneous infiltration rate:

$$F(t) = Kt + \psi\,\Delta\theta \ln\left[1 + \frac{F(t)}{\psi\,\Delta\theta}\right].$$

The equation above can be used to calculate volume by solving for $F(t)$. However, the variable being solved for is in the equation itself, so when solving for this one must set the variable in question to converge on zero or another appropriate constant. A good first guess for F is the larger value of either Kt or $\sqrt{(2\psi\,\Delta\theta Kt)}$.

To use this formula one must assume that the water head or the depth of ponded water above the surface (h_0), is negligible. Using the infiltration volume from this equation one may then substitute F into the corresponding infiltration rate equation below to find the instantaneous infiltration rate at the time, t, F was measured.

$$f(t) = K\left[\frac{\psi\,\Delta\theta}{F(t)} + 1\right].$$

Appendix B – Water Quantity Offset Co-Benefits

The cost and benefits of developing three types of distributed water storage sites were examined by IISD for Manitoba(Dion & McCandless, 2013).

RE-GRADED DITCHES

VARIABLES	UNITS	MONETARY VALUE (CAD)	IMPACT (IN UNITS)	MONETIZED IMPACT (CAD)
Benefits				
Avoided drought	Megalitres of water	150.00	201.91	30,286
New wetland habitat	Acres of wetland	82.13	50.61	4,156
Cattails produced	Tonnes of cattails (total biomass)	16.59	122.90	2,039
Carbon credits	Tonnes of carbon credits	15.00	129.05	1,936
Avoided flooding costs	Megalitres of flood mitigation	1,297.14	201.91	261,903
Reduced eutrophication	Kilograms of phosphorus	10.00	270.38	2,704
Total				**303,024**
Costs				
Capital costs (annualized)	Capital costs	150,000.00	20 year amortization	150,000
Annual operating costs	Operating costs	3,000.00	2% of amortized capital cost	3,000
Opportunity costs	Hectares of lost farmland	60.00	50.61	3,037
Total				**156,037**
Annual Benefit				146,987
Benefit:Cost				194%

FILTER FIELD AND POND

VARIABLE	UNITS	MONETARY VALUE (CAD)	IMPACT (IN UNITS)	MONETIZED IMPACT (CAD)
Benefit				
Avoided drought	Megalitres of water	150.00	100.95	15,143
New wetland habitat	Acres of wetland	82.13	7.17	589
Cattails produced	Tonnes of cattails (total biomass)	16.59	93.60	1,553
Carbon credits	Tonnes of carbon credits	15.00	98.28	1,474
Avoided flooding costs	Megalitres of flood mitigation	1,297.14	100.95	130,952
Reduced eutrophication	Kilograms of phosphorus	10.00	205.92	2,060
Total				**151,771**
Costs				
Capital costs (annualized)	Capital costs	115,000.00	20 year amortization	115,000
Annual operating costs	Operating costs	2,300.00	2% of amortized capital cost	2,300
Opportunity costs	Hectares of lost farmland	60.00	26.44	1,586
Total				**118,886**
Annual Benefit				32,885
Benefit:Cost				128%

BACK FLOOD DAMS

VARIABLE	UNITS	MONETARY VALUE (CAD)	IMPACT (IN UNITS)	MONETIZED IMPACT (CAD)
Benefits				
Avoided drought	Megalitres of water	150.00	0.00	-
New wetland habitat	Acres of wetland	82.13	80.00	6,570
Cattails produced	Tonnes of cattails (total biomass)	16.59	388.50	6,445
Carbon credits	Tonnes of carbon	15.00	407.93	6,119
Avoided flooding costs	Megalitres of flood mitigation	1,297.14	12.77	16,561
Reduced eutrophication	Kilograms of Phosphorus	10.00	854.70	8,547
Total				**44,242**
Costs				
Capital costs (annualized)	Capital costs	7,000.00	20 year amortization	7,000
Annual operating costs	Operating costs	140.00	2% of amortized capital cost	140
Opportunity costs	Acres of lost farmland	60.00	80	4,800
Total				**11,940**
Annual Benefit	Section			32,302
Benefit:Cost	Ratio			371%

Published by the International Institute for Sustainable Development.

International Institute for Sustainable Development
Head Office
161 Portage Avenue East, 6th Floor, Winnipeg, Manitoba, Canada R3B 0Y4
Tel: +1 (204) 958-7700 | Fax: +1 (204) 958-7710 | Web site: www.iisd.org

About IISD

The International Institute for Sustainable Development (IISD) contributes to sustainable development by advancing policy recommendations on international trade and investment, economic policy, climate change and energy, and management of natural and social capital, as well as the enabling role of communication technologies in these areas. We report on international negotiations and disseminate knowledge gained through collaborative projects, resulting in more rigorous research, capacity building in developing countries, better networks spanning the North and the South, and better global connections among researchers, practitioners, citizens and policy-makers.

IISD's vision is better living for all—sustainably; its mission is to champion innovation, enabling societies to live sustainably. IISD is registered as a charitable organization in Canada and has 501(c)(3) status in the United States. IISD receives core operating support from the Government of Canada, provided through the Canadian International Development Agency (CIDA), the International Development Research Centre (IDRC) and Environment Canada, and from the Province of Manitoba. The Institute receives project funding from numerous governments inside and outside Canada, United Nations agencies, foundations and the private sector.