A Strategic Vision for Enhancing Naturalized Water Retention in Manitoba

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Executive Summary

In Canada and around the world, climate change is increasing the variability of hydrologic conditions, resulting in more frequent and more extreme flooding and droughts. In Manitoba, water retention already represents a strong option for climate adaptation, as highlighted in the new Manitoba Initial Water Strategy Action Plan—it has also commonly been included in policy discussions surrounding provincial water management. A new report by the World Bank also shows how systems of water storage are instrumental in reducing risks related to climate change globally.

Water retention infrastructure on Manitoban landscapes is usually built to minimize flood and drought risks. However, **water retention can also provide numerous other benefits, especially if it is naturalized and is located, designed, and maintained strategically**. These can significantly influence the return on investment for water retention practices and should, therefore, be considered through long-term monitoring to help influence future implementation plans. In this report, we detail these considerations and how they may be adapted to the current state of practice for water retention in Manitoba.

Using an integrated framework developed by the World Bank, the International Institute For Sustainable Development (IISD) has also provided recommendations to advance the current state of practice for water retention projects in Manitoba. In brief, the framework suggests actions for Manitoba to enhance water storage and management, including performing a needs assessment, improving our understanding of potential solutions, and enabling informed decision making. Our recommendations within these broad steps are to do the following:

1. Assess Manitoba's Water Storage Needs

- Compile and use existing data, models, and case studies for realistic target-setting and management strategies to improve our understanding of water storage needs and nutrient hotspots in Manitoba watersheds. In addition, establish cumulative water retention and nutrient reduction targets for Manitoba watersheds.

2. Create and Understand Water Storage Solutions

- Prioritize natural and naturalized water retention systems based on the multiple additional benefits they provide and the improved cost-efficiency over built counterparts.
- Highlight the environmental, social, and economic benefits of water retention projects and enable a better understanding of how these are reducing Manitoba's risks and improving overall resilience. Fund and enable long-term monitoring, data sharing, and research of water retention projects toward this end.
- Fund and deliver tools and resources for practitioners to improve future natural water retention site selection, design, and management through spatial targeting. This will help maximize the return on investment for Manitobans and other investors.

3. Make Decisions Fit for Manitoba

- Strategic and impactful water retention systems will require investments in technical support for water retention implementation. Unlock resources to track progress toward any established cumulative water storage and nutrient reduction targets in the future and to assess specific regional vulnerabilities, risks, and needs from ongoing changes in hydroclimate-related outcomes.

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1.0 Introduction

1.1 Hydroclimate Adaptation in Manitoba

The rapidly changing climate is increasing the variability of hydrologic conditions around the world. In Canada specifically, these variations are resulting in more frequent and more extreme floods and droughts (Bush & Lemmen, 2019), including within the Canadian Prairies (Sauchyn et al., 2020), among other issues. For example, severe multi-year droughts are already considered to be one of Canada's most expensive natural hazards (Institute for Catastrophic Loss Reduction, 2010, as cited by Government of Manitoba, 2016), and these events are expected to only worsen with ongoing climate change.

With the variability of extreme hydroclimatic conditions projected to increase, improved water retention has already stood out as a strong option for adaptation in the Canadian Prairie watersheds, including those found in Manitoba (Government of Manitoba, 2023). A new report by the World Bank (Burke et al., 2023) also shows how systems of water storage (where natural and built systems combine to improve larger volumes of water) can reduce climate change-related risks and provide many other critical benefits.

Water retention can be achieved using natural systems, built infrastructure, or a hybrid of the two and can be either managed or unmanaged. While purely constructed systems like stormwater basins can provide benefits to address flooding and drought concerns, they may not provide all or—even most of—the benefits of a naturalized system (Native Plant Solutions, 2016). Thus, **properly managed and naturalized water retention** is particularly important on the Canadian Prairies for providing the following benefits, described in more detail in Section 1.2:

- reduced flood risk
- increased water supply and reduced drought risk
- removal of sediment and nutrients for improved water quality
- climate change mitigation
- habitat provision and improved biodiversity
- economic benefits to agricultural producers and the watershed

1.2 Benefits of Water Retention

Water retention infrastructure on Manitoban landscapes is usually built to minimize flood and drought risks, and this will continue in our efforts to adapt to climate change. However, water retention also provides numerous other benefits, especially if naturalized and operated with extended water retention times to better replicate the function of natural wetlands (Native Plant Solutions, 2016). When a water retention project is also located, designed, and maintained appropriately (Section 3), all of the additional benefits can be realized, thus improving return on investment.

Reduced Flood Risk

Water retention infrastructure slows and retains water closer to upland sources of runoff and is a well-established flood mitigation practice in Manitoba. Although the exact flood risk reduction benefit of any given water retention practice will vary based on several factors, including site design and the characteristics of its contributing area, these benefits are currently quantified regularly and thoroughly on a case-by-case basis. Various modelling and monitoring exercises have clearly demonstrated the ability of water retention infrastructure to reduce peak flows within prairie river basins and smaller watersheds.

For example, Simonovic and Juliano (2001), modelled the impact of wetlands on peak discharge reduction within the Rat River watershed in Manitoba during the 1997 flood. They showed that peak discharge could be reduced by 2.2%, 5.6%, and 11.1%, if wetland area increased by 2%, 5%, and 10%, respectively. In another study by Tiessen et al. (2011), the Steppler dam in the South Tobacco Creek in Manitoba was monitored from 1999 to 2007. They found that, on average, the Steppler Dam reduced annual peak flows from snowmelt by 72% and from summer rainfall by 48%. These benefits continue to be modelled by the Government of Manitoba (2017) in distributed water retention studies like those performed for the Roseau River watershed.

Increased Water Supply and Reduced Drought Risk

Patterns of drought and their exacerbation by climate change are stressing existing water supplies for municipalities and affecting agricultural practices in Manitoba. The Government of Manitoba (2020) recognizes this risk and the difficulties of short-term drought response. It has already outlined strategies for pre-emptively planning and designing water retention projects to address these concerns. This is also evident in the Government of Manitoba's (2017) distributed water retention studies like those performed for the Roseau River watershed.

Increasing water retention capacity reduces the risk of drought by buffering flow and increasing groundwater recharge in upland watersheds; it can also help provide new localized sources of surface water for withdrawal. Like flood risk benefits, increased water supply and reduced drought risk from water retention depend on a variety of hydrologic factors but can be quantified on a case-by-case basis. For example, in an application of the Sustainable Asset Valuation methodology by Bassi et al. (2019), the water storage benefits of Pelly's Lake were forecast from 2019 to 2050. They reported that the water retention project could enable 182,264 tonnes of agricultural production through the period, in addition to its other benefits, and would have cost CAD 0.63 million (CAD 2019) to provide the same storage benefit using other means.

Removal of Sediment and Nutrients for Improved Water Quality

The water quality benefits of water retention practices have become well-recognized in Manitoba in the last few decades, and they are often a motivating factor for new projects. A number of applied research programs, such as the Watershed Evaluation of Beneficial Management Practices

(BMPs) program and, more recently, the Living Labs–Eastern Prairies, have demonstrated and quantified this benefit. For example, long-term total phosphorus (TP), total nitrogen (TN), and sediment monitoring data were collected for the Steppler and Madill Dams within the South Tobacco Creek watershed (Tiessen et al., 2011). The performance of these sites to improve water quality varied from year to year, even being a source for nutrient and sediment loading in some years. Tiessen et al. (2011, p. 158) determined that "[b]oth dams/ reservoirs significantly reduced annual loads of sediment, TN, and TP (Steppler dam, average of 77%, 15%, and 12%, respectively; Madill dam, average of 66%, 20%, and 9%, respectively)."

The findings of Tiessen et al. (2011) illustrate the importance of water retention systems for water quality improvements and support the deployment of long-term monitoring and data for water retention evaluation. Specifically, they demonstrate how a single year of monitoring data from either of the sites may have overestimated average annual water quality benefits or suggested degradation to water quality in general. Taken out of context, these individual years of data could make the performance of water retention systems on water quality less certain.

As a result of the known water quality benefits of water retention, the Government of Manitoba (2017) includes water quality as a standard metric for the prioritization of distributed water retention options in the province. However, these assessments of water quality benefits from water retention are limited in scope and do not quantify what those benefits may possibly be or how their performance may change under different conditions. This suggests a clear need for new strategies and guidance on simple and replicable methods for estimating nutrient loading in watersheds and water quality treatment through water retention project location selection and design.

Climate Change Mitigation

Historically, inland aquatic ecosystems, like wetlands and other types of water retention systems on the landscape, have been overlooked with respect to their role in the global carbon cycle. However, we now know that these systems are actually critical pieces of the global carbon cycle, receiving roughly twice the amount of carbon that they export to the oceans (Cole et al., 2007), and organic carbon burial in the sediment of these systems is estimated between 0.2 and 1.6 Pg C yr^{-1} (Mendonça et al., 2017). In particular, water impoundments tend to have high rates of organic carbon burial (mean = 350 g C m^{-2} yr^{-1}, range: 52–2,000; Mulholland & Elwood, 1982), and this is especially the case for eutrophic agricultural impoundments (mean = 2,122 g C m^{-2} yr^{-1}, range: 148–17,392; Downing et al., 2008).

The sediments of eutrophic impoundments appear to be among the most active sites of carbon sequestration due to their high rates of internal production, substantial inputs of terrestrial carbon, and the long-term preservation of organic materials in low-oxygen sedimentary environments promoted by high nutrient concentrations (Downing et al., 2008). While this suggests that this type of infrastructure could potentially help mitigate climate change, there are also likely GHG emissions associated with these systems that will need continued study to better understand if they act as net sinks or sources of greenhouse gases to the atmosphere.

Habitat Provision and Improved Biodiversity

A habitat is the natural environment of an animal, plant, or other organism and provides what they need to survive, such as food, water, energy, air, space, and shelter. Nature-based water retention projects provide these improved wetland habitat conditions, which lead to greater plant and animal biodiversity and overall improved ecosystem function. Watershed-scale wetland creation for water retention and biodiversity improvements benefits both flood protection and biodiversity simultaneously in agricultural landscapes (Thiere et al., 2009), and over time, wetland conditions, such as water chemistry, macroinvertebrates, and submersed aquatic plant communities of restored prairie wetlands, closely resemble those in natural wetlands (Bortolotti et al., 2016). Additionally, active management of water retention wetlands has been found to greatly improve waterfowl and other waterbird diversity and abundance, with 1.4–2.3 times more species in managed versus unmanaged wetlands and 0.8–13.2 times greater abundance from spring to fall (Kaminski et al., 2010).

Ultimately, a greater variety of living organisms (i.e., plants, animals, fungi, and micro-organism communities) increases species and genetic diversity, builds ecosystem function and resilience, and creates resistance against future climate change impacts. Healthy and diverse ecosystems, in turn, help generate additional ecosystem services for people, including through the provision of food and water, climate regulation, and recreational opportunities, demonstrating the mutually reinforcing connection between healthy, diverse habitats and greater community resilience to the impacts of climate change (Lo & Rawluk, 2023).

Economic Benefits to Farmers and the Watershed

In addition to their public environmental benefits, water retention projects have been shown to provide benefits for agricultural producers. Depending on their design, they can improve the efficiency of farm operations and ultimately reduce costs for producers. For example, the constructed berms of a retention project can improve livestock and machinery crossings, extend grazing periods, and save time for hauling water for livestock, all of which reduce the costs of farm operations (Puzyreva et al., 2022). Given these private benefits, water retention projects can become attractive to producers, improving their overall uptake. Puzyreva et al. (2022) found that on-farm water retention projects provide CAD 3.16 in water quality and extended grazing co-benefits, among others (not including the primary benefit of flood protection) for every CAD 1 invested, based on 8 out of 10 projects implemented in the Seine, Rat, and Roseau watersheds (Puzyreva et al., 2022).

It is important to note that the benefits of water retention might not be evident shortly after installation. One producer quoted in Puzyreva et al. (2022) mentioned "[i]t took 2 to 3 years after the installation of a water retention project to realize how big of an impact it would have on the management of his farm." Better understanding of water retention infrastructure's performance and benefits with long-term monitoring and data collection is required to make a stronger economic case for water retention. This monitoring should track both direct and indirect private and societal benefits.

2.0 Policy Context Around Water Retention in Manitoba

Water retention practices have been enabled by policies and programs in Manitoba in a variety of ways. At the broadest level, Manitoba's **2017 Made-In-Manitoba Climate and Green Plan** aims to make Manitoba Canada's cleanest, greenest, and most climate-resilient province through four pillars of focus: Climate, Jobs, Water, and Nature (Manitoba Sustainable Development, 2017). In its focus on climate change adaptation, the plan specifically commits to "no net loss of water retention" and keeping water on the landscape, acknowledging that water retention improves water quality and resilience to flooding and drought. Manitoba supports the development of "multi-purpose, multi-scale retention systems that allow water to be stored on the landscape, thereby reducing local flooding and also providing extra water that can be distributed during times of drought" (Manitoba Sustainable Development, 2017, p. 37). Another overarching policy priority in Manitoba is the carbon savings account, under the **Climate and Green Plan**, which established 5-year cumulative emissions reduction goals for the province (Expert Advisory Council, 2019). Ensuring that water retention-related activities are optimized for their ability to moderate emissions will be important in this context.

More recently, **Manitoba's 2022 Water Management Strategy** (Government of Manitoba, 2022) highlights a number of key focus areas that intersect with the attention on water retention. These include, but aren't limited to, protecting biodiversity and aquatic ecosystem health; building our preparedness and resilience to a variable and changing climate; meeting the water supply needs of current and future generations; and protecting and improving surface water quality. The goal of better water retention is also reflected in the newly released Manitoba's Water Management Strategy in its focus on surface water management aiming to reduce the cumulative impacts from drainage and support the use of both natural and built retention projects with other infrastructure at the watershed scale. This strategy, Manitoba's first update to water management since the previous plan released in 2003, is supported by the Initial Water Strategy Action Plan (Government of Manitoba, 2023, p. 16) that highlights some specific and time-bound actions for managing water in the province, including the need to "improve surface water management at the watershed scale, including retention and drainage" to improve resilience to climate change. The Action Plan makes several suggestions, including that the province "[d]evelop water-based drainage and water retention plans including a pilot project in the Dauphin Lake watershed" (p. 19) and complete a distributed water storage plan in the Souris River watershed to support integrated watershed management planning.

Apart from the specific water retention plans, the Government of Manitoba is also currently initiating the development of a comprehensive Provincial Adaptation Framework. This framework is intended as a roadmap for coordinated action to achieve climate resiliency. It's based on the articulated goals of the Manitoba Climate and Green Plan and is meant to complement Canada's National Adaptation Strategy. Acknowledging the effectiveness and momentum of water retention projects in mitigating flood and drought risks and providing adaptation benefits, this adaptation framework should include recommendations related to water retention.

Another example of policy and program support for water retention is the inclusion of the practice in the Sustainable Agriculture Manitoba: Water Management Program Guide's list of BMPs (Sustainable Canadian Agricultural Partnership, n.d.). Its examples related to water retention include excess water assessment and surface drainage design, as well as water retention system design. It also promotes the utilization of drainage water for purposes such as irrigation or livestock watering. Notable in this is that the Government of Manitoba applies an Environmental Benefit Assessment Index to assess "the level to which the project addresses environment risk" and provides a rating of the environmental benefits that a specific project would incur (Sustainable Canadian Agricultural Partnership, n.d.). A more indirect example of policy support for water retention might be previous tax credit programs, such as the Riparian Tax Credit (prior to 2017) and the Waterfront Property Tax Credit (2017–2021), that encouraged farmers to improve the management of their waterfront lands and limit specific activities such as tilling, grazing and watering over a specific period of time (5 years), in part to improve the retention, flow, and quality of waterways.

Finally, a series of Manitoban funding programs, including the Conservation Trust, GROW Trust, and the GROW Wetlands Trust, provide targeted funding for activities that include or complement water retention. This includes the Conservation Trust's focus on mitigating floods and droughts, improved water quality, and greater recreational activities that connect people to Nature. The GROW Trust targets watershed-based activities, and the GROW Wetlands Trust is focused on the conservation of existing temporary wetlands that are not protected by legislation or policy and might be vulnerable to drainage (Manitoba Habitat Heritage Corporation [MHHC], n.d.). The funds also aim to deliver biodiversity- and habitat-related benefits for the range of services that these outcomes support. These programs clearly contribute to the overall goal of improved water retention capacity in the province. As of March 31, 2022, the trusts have made a total commitment of over CAD 28 million, notably providing 6,955 acre-feet of flood storage and recharging 4,089 acre-feet of groundwater while providing other benefits (MHHC, 2023).

3.0 Selection, Design, and Monitoring of Water Retention Projects

To make the most of water retention projects, particularly in achieving the many benefits from this practice, careful site selection, design, operation, and maintenance of projects is important. Without proper monitoring and management, many of these projects are not as effective for flood protection, drought risk management, phosphorus capture, habitat value, and other benefits as they would appear to be in theory. As water retention practices gain popularity and attract more investment, it is important that they produce the maximum possible benefits for the greatest return on investment. To improve the impact and return on investment of water retention practices in Manitoba, the following are recommended elements.

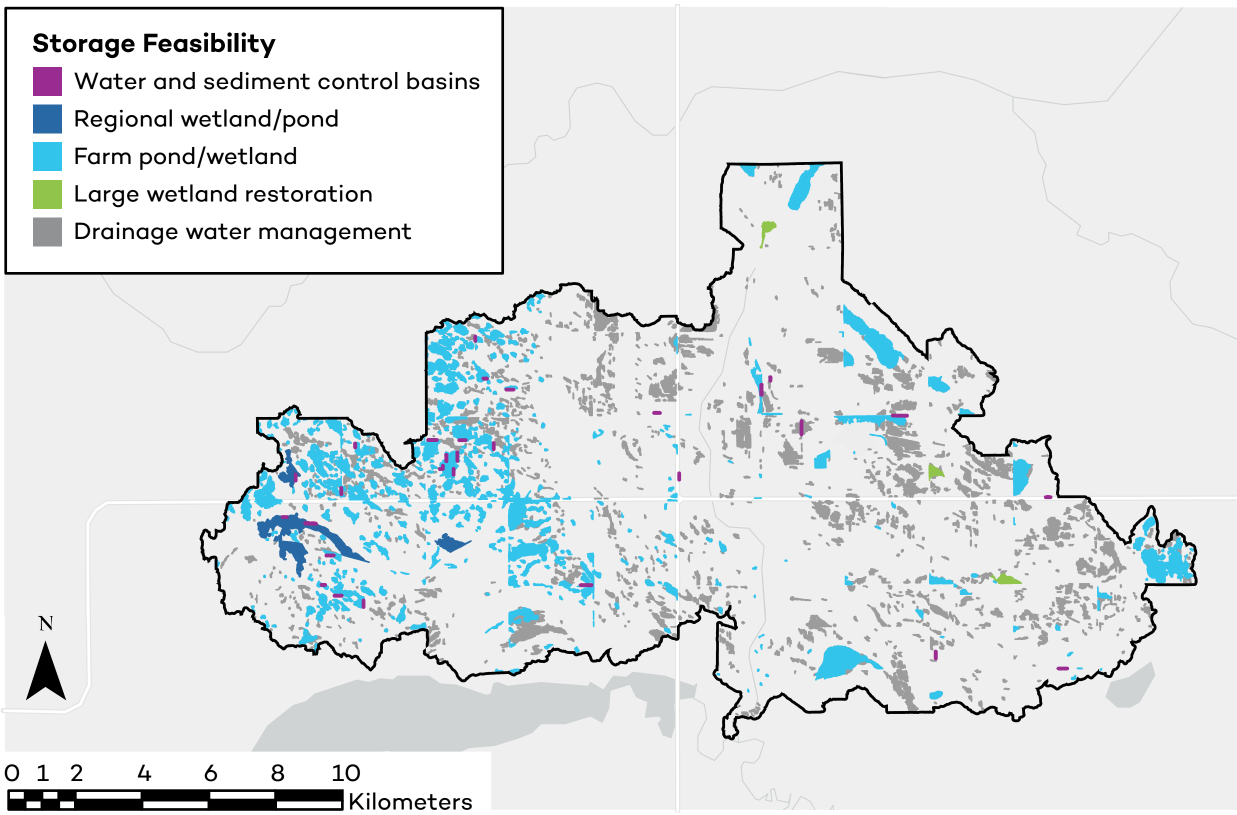
3.1 Target Water Retention Practices in the Best Locations

To maximize the many benefits of water retention in Manitoba, it is first necessary to ensure that the targeted sites consider the unique characteristics of Canadian Prairie landscapes and hydrology. For example, a spatial targeting strategy prioritizing nutrient reduction should consider the variability of non-point source nutrient loading and the relative efficiency of different feasible water retention projects to treat those loads. Spatial targeting models that aid in selecting water retention projects could even help facilitate the development of funding programs that scale up compensation with any quantified benefits.

Simoes et al. (2023) shared strategies for identifying optimal locations for water retention projects within the Swan Lake watershed (Figure 1), one of four study areas for the Living Labs–Eastern Prairies project (Agriculture and Agri-Food Canada [AAFC], 2023). While the cited report is intended to encourage watershed managers and water resources engineers across the Canadian Prairies to pursue similar efforts, there remain data and capacity challenges that could be supported through policy change. Organizations (like the Lake Winnipeg Foundation) that deliver large-scale community-based water quality monitoring have helped facilitate the advancement of water retention spatial targeting models and must be financially supported to enable important targeting practices. To successfully identify, evaluate, and target practices like water retention, watershed managers also need to facilitate the collection of and publicly share existing culvert data within their districts and document the relevant specifications of any future culvert installation. These data sets are needed to accurately estimate detailed flow paths of water and its quality in models.

Manitoba's Watershed District staff also need to be able to develop and maintain inventories of water retention BMPs to better understand and track their progress toward objectives defined within their integrated watershed management plans and broader targets and priorities, where possible. Watershed practitioners need to be trained in how to best utilize the outputs of models to inform management practices and funding needs to support the timely development of these models by engineers. When these needs are met, more advanced methods of BMP identification and prioritization will become a more mainstream practice across the Canadian Prairies.

Figure 1. Map of physically feasible water retention sites in the Swan Lake study area of the Living Labs–Eastern Prairies



Source: Authors' diagram.

3.2 Benefits of Designing for and Managing Water Retention Time

With the growing momentum for improving water storage in Manitoba, many emerging projects are being categorized as water retention projects. However, some of these might be better defined as water detention sites (Box 1) and are therefore not providing the full suite of expected co-benefits. For instance, in the study by Puzyreva et al. (2022) several of the 10 water retention sites evaluated were estimated to have relatively low nutrient-removal performance due to their limited permanent storage times and volume.

Box 1. The importance of water retention time

Constructed water retention sites are generally stormwater basins that have a permanent storage volume as a defining characteristic. Conversely, for water detention sites (also known as dry dams), the storage volume is largely temporary. The performance of both types of stormwater basins to improve water quality and provide other co-benefits is related to several factors, but of these, retention time is one of the most prominent and influenced by site design and management. This temporal characteristic is significant, as like for wetlands, many of the benefits of water retention sites are derived from having a permanent pool of water with a long holding period, for example, for waterfowl habitat or nutrient removal (Clary et al., 2020).

To ensure that most water retention projects in Manitoba are designed and maintained to provide water quality and wildlife habitat benefits from water retention, it is critical that a higher retention time for water is implemented. In an ongoing study by IISD (Simoes et al., 2022), the treatment wetland model has been used to evaluate changes in nutrient reduction resulting from structural changes to a water retention site. This research found that there are clear trade-offs between construction costs and improving nutrient reduction benefits, and this factor could be optimized in future site designs. However, there remains a lack of long-term monitoring data to test these models more comprehensively and to address uncertainties with using them (Box 2). Filling this gap in long-term monitoring data could result in a paradigm shift in how these sites are designed by engineers, wherein tools exist to optimize the performance to manifest their complete range of benefits simultaneously.

Box 2. Water retention monitoring

Long-term data sets that can relate hydrologic and hydraulic influences on non-flood related benefits like water quality are critical to developing the tools needed to better design, operate, and maintain water retention sites. Generally, these datasets include high-frequency flow, elevation, and sediment/nutrient concentration data to assess internal site dynamics and complete mass balances. These datasets, both new and existing, are necessary to test models under a range of conditions, including both average and extreme conditions, as well as to perform robust calibration, validation, and uncertainty analyses. Existing long-term datasets, such as the historical WEBs program (Tiessen et al., 2011), would aid in the development of new models or tools in the Prairies, but in many cases, the raw data required to do so are not publicly available and cover only a limited number of sites.

Current water retention monitoring efforts by organizations like the Lake Winnipeg Foundation, AAFC, and IISD (Simoes et al., 2022) are relevant and ongoing (Figure 2) but have not yet accumulated datasets that would be considered long term and do not account for a comprehensive range of average and extreme events. It is, therefore, critical that government funding programs provide for regular monitoring programs to continue advancing this field of research and building long-term datasets.

Figure 2. Manual flow (left) and automated water elevation (right) measurement at the De Salaberry water retention site

Source: Authors' photos.

3.3 Benefits of Designing for Private Landowners and Agricultural Producers

Since water retention projects in Manitoba are often installed on the lands of private landowners and agricultural producers, it is important that these solutions not only work for communities in the watershed and provincial policy-makers but also for the needs of those individual. Water retention projects need to be carefully designed in order to achieve multiple benefits (Section 1), supported by effective communication and relationship building with landowners by watershed districts (or other implementing parties). Puzyreva et al. (2022) noted that the design of a water retention project is key and can provide a win–win option for both farm owners and their neighbours. It is also worth mentioning that, in addition to direct cost savings for agricultural operations, landowners may be motivated by helping downstream neighbours by providing flood storage and improving the environment. However, if they bear material losses (e.g., productive land is flooded and cannot be used for agricultural purposes), they need to be compensated for the losses and the service they provide to the surrounding community.

In the case of Pelly's Lake, a large wetland complex located in south-central Manitoba, local landowners signed conservation agreements with MHHC to allow for temporary water storage on their lands. These agreements ensured the protection of the natural habitat and water retention function of 750 acres of wetland and riparian area while also allowing landowners full access to their pastures and hay land later in the growing season (Government of Manitoba, n.d.). In this case, a design that enabled both societal and private benefits led to an effective agreement.

3.4 Ongoing Management of Water Retention

The continued operation of water retention sites is another key factor in ensuring they perform as specified by their design, while monitoring is necessary to track that performance over time. Sites that are designed and operated with hydraulic control structures, like gated culverts, can reap the extent of water quality benefits that water retention sites offer, but can also still be drained in times of flood to behave like a dry dam as necessary (Roy & Grosshans, 2017). That is, dry dams offer critical flood storage capacity that may not always be guaranteed by retention sites with permanent pools of water and that are not built with hydraulic control structures to be able to drain excess pooled water.

Another important consideration for water retention site performance is the continued long-term maintenance of sites. The overgrowth of vegetation, accumulation of sediment and debris, and blockages by beaver activity can occupy flood storage volume or obstruct conduits and flow into or out of water retention sites. These factors can limit water quality benefits and result in additional flood damage during high flows, as has been observed at the De Salaberry water retention site in southern eastern Manitoba (Simoes et al., 2022).

3.5 Capacity, Guidance, and Tools in Maximizing Benefits From Water Retention

It is evident that in much of the Canadian Prairies, the state of practice for water retention is on the right course. Many organizations are aware of the benefits that water retention can provide, particularly in the face of rapid climate change and how they help us to adapt, and many are taking action to increase their adoption across the Prairies. However, there are clearly opportunities to improve the benefits we receive from these practices by improving how they are implemented, managed, and monitored. For instance, while some water retention projects might only focus on mitigating flood risks by temporarily storing water in a dry dam, where possible, we should focus on accruing as many other benefits as possible. For this, we need technical guidelines, capacity building, and training on the various aspects of water retention planning we have highlighted in this paper.

4.0 An Integrated Framework for Water Retention Planning in Manitoba

The new Manitoba Initial Water Strategy Action Plan highlights the role of water retention. We recommend that a later iteration of this action plan include an integrated framework for water retention in Manitoba. Such an integrated framework would highlight the important role of water retention as a means of delivering urgent and necessary ecosystem services.

The World Bank (Burke et al., 2023) proposed an integrated framework which can be used to improve the broad range of benefits to be obtained and to ensure that local retention efforts contribute to closing the global water storage gap. Based on the proposed steps for such a framework (and based on region-specific expertise and experience), we recommend the following Manitoba-specific actions:

1. Assess the Water Storage Needs of Manitoba

The cumulative water storage needs and non-point source nutrient hotspots in Manitoba watersheds need to be understood for future planning efforts. While a range of federal and provincial programs support the implementation of water retention projects (including the Federal Lake Winnipeg Basin Fund and the Manitoba Conservation and Wetland GROW Trusts), specific funding and support are required to develop an overall target and watershed-specific targets for cumulative water storage needs and nutrient reduction in Manitoba. This work will need to leverage existing data and modelling efforts and apply case study approaches to explore different storage scenarios and the impacts of pilot projects. Outputs from such analyses can be extrapolated to help develop realistic cumulative water storage and nutrient reduction targets as well as specific management strategies for Manitoba's watersheds over the short, medium, and long terms.

2. Create and Understand Water Storage Solutions

Prioritize natural and naturalized water retention projects, recognizing the additional benefits that they provide over their built counterparts (Native Plant Solutions, 2016). Apart from the benefits of reducing flood risks and improving water availability, natural retention systems provide additional water quality, habitat, and climate-mitigation benefits. These additional benefits also lead to an improved return on investment from natural water retention projects.

Continued long-term monitoring and research of water retention projects is needed to better document their multiple benefits, which can vary by year and by season. Monitoring and data collection needs to include environmental, social, and on-farm economic benefits and costs (e.g., regarding water quality and storage, flood protection, greenhouse gases, improved on-farm operations efficiency, etc.). It is also recommended that data be open access and anonymized for researchers, policy-makers, producers, and others to use where possible—this will enable better business case development for future water retention projects and create new opportunities to optimize project design and management.

The relationship between water retention system performance and Manitoba's hydroclimate needs to be better understood before projects are constructed to ensure their full suite of benefits is maximized. Key outcomes can be ensured by using spatial targeting for strategic water retention implementation efforts. Knowledge of nutrient and biodiversity hotspots can be leveraged to improve the cost-effectiveness of implemented practices. Specific efforts, such as targeting, will rely heavily on existing and future data, including the efforts of the Lake Winnipeg Foundation's Community-Based Monitoring Network (Lake Winnipeg Foundation, 2019) and others (such as those undertaken by IISD and AAFC) on specific water retention projects to better generalize their performance for the Canadian Prairie context. These monitoring programs also need continued funding to support targeting efforts.

There are also opportunities to improve individual water retention site designs, including comprehensive integrations of natural elements, as well as more adaptive operation and maintenance schedules. Tools and resources need to be developed and delivered to site designers and operators, which will be necessary to inform how to maximize the benefits of these sites in practical ways. These tools and resources will also need to be well communicated and accessible, including training opportunities that can be provided for key practitioners. Capacity building across the board in both spatial targeting and improved site design is urgently needed to keep pace with the current rate of water retention projects being implemented in Manitoba.

3. Make Decisions Fit for Manitoba

Funding toward existing and new programs under the upcoming Manitoba water strategy needs to address capacity concerns related to the adoption of more sophisticated water retention implementation plans. Without the necessary technical support, the targeting and design of water retention systems will remain opportunistic and provide fewer benefits and could contradict what existing data and models already suggest we do to improve them. Investments are also needed for long-term monitoring of water retention systems, particularly those developed using any future targeting and design guidance, to ensure that we continue to learn more and can identify precisely what is working and where we might still need to improve. Again, long-term monitoring is also needed, but here to track progress toward any cumulative water storage and nutrient reduction targets established in the future. This information can be used to better understand which regions are currently most vulnerable to the changing hydroclimate and where future action may be most equitable.

References

Agriculture and Agri-Food Canada. (2013). *Areas of non-contributing drainage within total gross drainage areas of the AAFC watersheds project*. https://open.canada.ca/data/en/dataset/adb2e613-f193-42e2-987e-2cc9d90d2b7a

Agriculture and Agri-Food Canada. (2023). *Living Lab – Eastern Prairies.* https://agriculture.canada.ca/en/science/living-laboratories-initiative/living-lab-eastern-prairies

Assiniboine West Watershed District. (n.d.). *Reference maps: Culvert inventory.* https://myawwd.ca/awwd-maps/

Bassi, M. A., Bechauf, R., Casier, L., & Cutler, E. (2021). *How can investment in nature close the infrastructure gap?* International Institute for Sustainable Development. https://nbi.iisd.org/wp-content/uploads/2021/10/investment-in-nature-close-infrastructure-gap.pdf

Bassi, M. A., Pallaske, G., & Stanley, M. (2019). *An application of the Sustainable Asset Valuation (SAVi) methodology to Pelly's Lake and Stephenfield Reservoir, Manitoba, Canada.* International Institute for Sustainable Development. https://www.iisd.org/system/files/publications/savi-pellys-lake-stephenfield-canada-en.pdf

Bortolotti L. E, Vinebrooke R. D, St. & Louis V. L. (2016). Prairie wetland communities recover at different rates following hydrological restoration. *Freshwater Biology, 61*(11), 1874–1890. https://doi.org/10.1111/fwb.12822

Burke, E. R., Tront, J. M., Lyon, K. N., Rex, W., Castera Errea, M. I., Varughese, M. C., Newton, J. T., Becker, A. N., & Vale, A. L. (2023). *What the future has in store: A new paradigm for water storage*. World Bank Group. http://documents.worldbank.org/curated/en/099454002022397507/IDU031e759b40be950485909796045bca5d8e378

Bush, E., & Lemmen, D. S. (2019). *Canada's changing climate report: Government of Canada,* https://changingclimate.ca/CCCR2019/

Clary, J., Jones, J., Leisenring, M., Hobson, P., & Strecker, E. (2020). *International stormwater BMP database: 2020 Summary statistics.* The Water Research Foundation. https://www.waterrf.org/system/files/resource/2020-11/DRPT-4968_0.pdf

Cole J. J., Prairie, Y. T., Caraco, N. F., McDowell, W. H., Tranvik, L. J., Striegl, R. G., Duarte, C. M., Kortelainen, P., Downing, J. A., Middelburg, J. J., & Melack, J. (2007). Plumbing the global carbon cycle: Integrating inland waters into the terrestrial carbon budget. *Ecosystems, 10*, 172–85.

Downing, J. A., Cole, J. J., Middelburg, J. J., Striegl, R. G., Duarte, C. M., Kortelainen, P., Prairie, Y. T., & Laube, K. A. (2008). Sediment organic carbon burial in agriculturally eutrophic impoundments over the last century. *Global Biogeochemical Cycles, 22*(1).

Expert Advisory Council. (2019). *Report of the Expert Advisory Council to the Minister of Sustainable Development, A carbon savings account for Manitoba, June 2019.* https://www.gov.mb.ca/asset_library/en/eac/eac_carbon_savings_report2019.pdf

Government of Manitoba. (n.d.). *Manitoba Conservation Districts Program 2014-15 annual report.* https://www.gov.mb.ca/sd/water/pubs/water/watershed/2014_15_cd_annaul_rpt.pdf

Government of Manitoba. (2016). *Manitoba Drought Management Strategy.* https://www.gov.mb.ca/sd/pubs/research_data_maps/drought_management_strategy.pdf

Government of Manitoba. (2017). *Roseau River watershed distributed retention study.* https://www.gov.mb.ca/sd/water/watershed/iwmp/roseau_river/documentation/roseau_watershed_distributed.pdf

Government of Manitoba. (2020). *Manitoba water management strategy. Seeking perspectives: An engagement document. Manitoba's Expert Advisory Council under The Climate and Green Plan Implementation Act.* https://engagemb.ca/15724/widgets/61784/documents/38154

Government of Manitoba. (2022). *Manitoba's Water Management Strategy.* https://www.gov.mb.ca/sd/pubs/water/water_mgmt_strategy2022.pdf

Government of Manitoba. (2023). *Initial Water Strategy Action Plan.* https://www.gov.mb.ca/sd/pubs/water/water_action_plan2023.pdf

Kaminski, M. R., Baldassarre, G. A., & Pearse, A. T. (2010) Waterbird responses to hydrological management of wetlands reserve program habitats in New York. *Wildlife Society Bulletin, 34*(4), 921–926, 2006. https://onlinelibrary.wiley.com/doi/abs/10.2193/0091-7648%282006%2934%5B921%3AWRTHMO%5D2.0.CO%3B2

Lake Winnipeg Foundation. (2019). *Lake Winnipeg Community-Based Monitoring Network.* https://www.lakewinnipegfoundation.org/lake-winnipeg-community-based-monitoring-network

Lo, V., & Rawluk, A. (2023). *Enhancing biodiversity co-benefits from nature-based solutions.* International Institute For Sustainable Development. https://www.iisd.org/publications/report/biodiversity-co-benefits-nature-based-solutions

Manitoba Habitat Heritage Corporation. (n.d.). *About the Conservation Trust, Grow Trust, and Wetlands Grow Trust.* https://mhhc.mb.ca/the-conservation-trust/ct-about

Manitoba Habitat Heritage Corporation. (2023). *2021/2022 Progress report: A summary of Trust commitments and outputs to March 31, 2022.* https://mhhc.mb.ca/wp-content/uploads/2023/06/2021-22-Trust-Progress-Report-_for-Dissemination_-June-15-23.pdf

Manitoba Sustainable Development. (2017). *A made-in-Manitoba climate and green plan Hearing from Manitobans.* https://www.gov.mb.ca/asset_library/en/climatechange/climategreenplandiscussionpaper.pdf

Mendonça R., Müller, R.A., Clow, D., Verpoorter, C., Raymond, P., Tranvik, L. J., & Sobek, S. (2017). Organic carbon burial in global lakes and reservoirs. *Nature Communications, 8*(1), Article 1694.

Mulholland, P. J., & Elwood, J. W. (1982). The role of lake and reservoir sediments as sinks in the perturbed global carbon cycle. *Tellus, 34*(5), 490–499.

Native Plant Solutions. (2016). *Naturalized stormwater systems.* https://www.nativeplantsolutions.ca/assets/2016/01/naturalized-stormwater.pdf

Pembina Valley Watershed District. (2023). *Featured programs.* https://www.pvwd.ca

Puzyreva, M., Zhao, J., Simoes, J., & Rawluk, A. (2022). *The value of water retention beneficial management practices to farmers and landowners in the Seine Rat Roseau Watershed District.* International Institute for Sustainable Development. https://www.iisd.org/system/files/2022-12/water-retention-practices-seine-rat-roseau-watershed-district.pdf

Roy, D., & Grosshans, R. (2017). *How to best manage water retention sites to protect Manitoba's environment.* https://www.iisd.org/system/files/publications/best-manage-water-retention-manitoba.pdf

Sauchyn, D., Davidson, D., & Johnston, M. (2020). Prairie provinces. Chapter 4 in F. J. Warren, N. Lulham, & D. S. Lemmen (Eds.), *Canada in a changing climate: Regional perspectives report.* Government of Canada. https://www.nrcan.gc.ca/sites/nrcan/files/earthsciences/Prairie Provinces Chapter – Regional Perspectives Report.pdf

Simoes, J., Grosshans, R., & Rawluk, A. (2022). *Summary of the 2022 International Institute for Sustainable Development Canadian Prairie Water Retention Monitoring and Modelling Workshop.* https://www.iisd.org/publications/report/canadian-prairie-water-retention-workshop

Simoes, J., Vanrobaeys, J., Morissette, R. (2023, in press). *Guidelines and practical applications for BMP spatial targeting in Canadian Prairie watersheds to maximize water quality benefits.*

Simonovic, S., & Juliano, K. (2001). The role of wetlands during low frequency flooding events in the Red River Basin. *Canadian Water Resources Journal, 26*(3), 377–397. https://doi.org/10.4296/cwrj2603377

Sustainable Canadian Agricultural Partnership. (n.d.). *Sustainable Agriculture Manitoba: Water Management: Program guide*. https://www.manitoba.ca/asset_library/en/scap/documents/scap-sam-water-programguide.pdf

Thiere, G., Milenkovski, S., Lindgren, P. E., Sahlén, G., Berglund, O., & Weisner, S. E. B. (2009) Wetland creation in agricultural landscapes: biodiversity benefits on local and regional scales. *Biological Conservation, 142*(5), 964–973. https://www.sciencedirect.com/science/article/abs/pii/S0006320709000329

Tiessen, K. H. D., Elliott, J. A., Stainton, M., Yarotski, J., Flaten, D. N., & Lobb, D. A. (2011). The effectiveness of small-scale headwater storage dams and reservoirs on stream water quality and quantity in the Canadian Prairies. *Journal of Soil and Water Conservation, 66*(3), 158–171. https://www.manitoba.ca/sd/water/watershed/iwmp/boyne/documentation/small_scale_headwater_dams.pdf

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