MANITOBA DEPARTMENT OF CONSERVATION AND WATER STEWARDSHIP

Manitoba

Provincial Planning on Adaptation for **Excessive Moisture in the Manitoba Interlake Region**

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EXECUTIVE SUMMARY

The Manitoba Government commissioned a study for Provincial Planning on Adaptation to Excessive Moisture in the Interlake Region of Manitoba. Previous studies (Swanson et al., 2007; Swanson et al., 2009) on the effects and adaptive capability of the agriculture industry in Manitoba have identified the Interlake Region as having the lowest adaptive capacity rates to climate change in Manitoba. Low adaptive capacity puts the agricultural industry in the Interlake Region at risk of not being able to respond adequately to flooding and other water related issues such as drought.

This study aims to make recommendations for the development of a provincial-level strategy to increase the adaptive capacity of the agricultural sector, in the context of reducing risk and vulnerability to excessive moisture. Three components of the study informed the final recommendations:

- Background research, identifying the state of agriculture in Manitoba, as well as existing programs and policies aimed at agricultural producers.
- Hydrological modeling, using a sub-watershed case study to determine the possible impact of climate change on streamflow events.
- Stakeholder consultation (including agricultural producers, environmental NGOs, municipal councilors, etc.), to understand the situation on the ground.

By addressing the issues of the region with the lowest adaptive capacity, the hope is that we generate strategies and techniques that could address the needs of other areas within the Province.

Final recommendations of the study include recommendations for short-, medium- and long-term implementation. The recommendations focus on:

- Promoting the use of particular farm-based practices (for water management and crop diversification).
- Development of programs, policies and legislation that are both flexible and supportive of farmers' needs.
- The development of province-led strategies and plans, in coordination with municipalities and conservation authorities.

The recommendations include:

- Improved maintenance schedule to better manage the existing drainage system. The maintenance schedule should be part of a rolling multi-year plan by provincial and municipal governments.
- The Province should consider reviewing the *Conservation District Act* to ensure that it is still meeting its intended purpose.
- A review of all legislation dealing with water management should be undertaken to ensure the framework is up-to-date and effective.
- Municipalities should be required to develop five-year water management plans, as part of longer-term planning.
- The Province should create a high-level integrated provincial drainage strategy.

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1.0 INTRODUCTION

The Climate Change Branch of the Department of Manitoba Conservation (now Conservation and Water Stewardship) commissioned a study for "Provincial Planning on Adaptation for Excessive Moisture in the Interlake Region of Manitoba". The Prairies Regional Adaptation Collaborative (PRAC) supports the need for policy and planning to deal with increasingly frequent and more severe periods of excess moisture, generally resulting from the effects of extreme weather, likely tied to climate change. In Manitoba, the agricultural industry has been affected by excessive moisture, particularly in the Interlake Region, where adaptive capacity is low. The Government of Manitoba recognized that the development of a provincial strategy to address the management of excess moisture was needed, and that the most effective provincial strategy would address areas with the lowest adaptive capacity. To that end, a case study approach based on the needs of the agricultural community was determined to be the best approach for developing recommendations for a provincial strategy This Report is the result of the combined efforts of the project Steering Committee (composed of members representing various provincial departments), and the consultant team from MMM Group Limited, hired to develop recommendations towards the creation of a provincial strategy.

The project Steering Committee chose the Interlake Region because of its lower adaptive capacity. More specifically, the Icelandic River watershed was chosen to conduct the watershed modeling, as it is representative general agricultural activities and land use composition in the Interlake. Weather conditions that are the primary stress to the agricultural industry in this region (and generally Manitoba as a province) are drought and excessive moisture. Excessive moisture results in increased recurrence of flooding and higher volumes of runoff. These events are projected to increase in frequency under current climate change scenarios.

The intent of this study is to provide recommendations for the development of a provincial-level strategy to increase the adaptive capacity of the agricultural sector in Manitoba, in the context of reducing risk and vulnerability to extremes of moisture.

1.1 Need for a Provincial Strategy

In Manitoba the most significant water-related stressors on the agricultural industry are drought and excessive moisture (often the result of extreme weather events). These are projected to increase under climate change scenarios. The result will likely be increased regularity and recurrence of flooding, as area watercourses and constructed drainage systems are unable to convey the increased runoff volumes from extreme weather events.

1.2 Components of the Study

To generate recommendations for a provincial-led strategy to increase the adaptive capacity to deal with excess moisture, four main components were identified as necessary:

- Literature Review – to understand the context and identify best practices, particularly in the fields of agriculture policy and practices, climate change policy and adaptation practices, and water management policy and practices.

- Hydrological Modeling – to generate a range of potential hydrological scenarios, based on climate change modeling. This quantifies both the range and timing of possible excessive moisture scenarios.

- Stakeholder Engagement – to understand the issues and problems that are currently being faced on the ground, and to understand the needs and implications for those who will be bound by or will implement the recommended provincial strategy.

- Recommendations for a Provincial Strategy - Analysis and Synthesis of the previous findings to understand how the findings of each of the three components (above) may influence each other and inform the development of a provincial strategy.

1.3 Study Partners

1.3.1 Prairies Regional Adaptation Collaborative (PRAC)

This Study was initiated by the Government of Manitoba, which is involved in the Prairies Regional Adaptation Collaborative (PRAC), one of a series of Adaptation Collaboratives (RACs) operating across Canada and led by the Climate Change section of Natural Resources Canada.

The purpose of PRAC is to enhance capacity to integrate climate change adaptation into water resources management, drought and excessive moisture planning, and terrestrial ecosystem management decision-making. To fulfill this purpose, the organization's goal is to catalyze coordinated and sustained climate change adaptation decision-making and action.

1.3.2 Steering Committee

For this study, a Steering Committee was formed that included representatives from several Manitoba government departments, led by the consulting team consisting of planners, consultation specialists, water resources engineers and climate experts from MMM Group Limited. The Steering Committee met several times during the study, providing guidance, feedback and direction throughout. Members of the Steering Committee are presented in Table 1.1.

Table 1.1: Steering Committee Members

Organization	Name	Position
Manitoba Agriculture, Food and Rural Initiatives	Tony Szumigalski	Project Manager, Policy Analyst
Manitoba Conservation – Climate and Green Initiatives*	Randall Shymko	Policy Analyst
Manitoba Water Stewardship*	Jason Senyk	Senior Policy Analyst
Manitoba Agriculture, Food and Rural Initiatives	Maurice Bouvier	Executive Director, Special Projects
Manitoba Agriculture, Food and Rural Initiatives	Laura Grzenda	Landscape Stewardship Specialist
Manitoba Local Government	Katy Walsh	Policy Planner
Manitoba Water Stewardship	Abul Kashem	Water Supply and Drought Management Engineer
MMM Group Limited	Michael Sullivan*	Project Manager
	David Jopling*	Senior Planner
	Brent Shistowski*	Water Resources Engineer
Tyrchniewicz Consulting	Allen Tyrchniewicz*	Agricultural policy specialist

* Now Manitoba Conservation and Water Stewardship

Some Steering Committee members were also members of the project management and study team (marked with an asterisk*). In addition to the Steering Committee members, several additional staff proved invaluable in support of this project and are presented in Table 1.2.

Table 1.2: Study Team Members

Organization	Name	Role
MMM Group	Leah Carson	Planner
MMM Group	Misty Carson	Workshop Facilitator
MMM Group	Natalie Ducharme	Consultation Specialist
MMM Group	Lauren Lange	Consultation Specialist

All study team members provided valuable input to these recommendations. It was a true team effort throughout this project.

1.4 Definitions

1.4.1 Excess Moisture

For the purposes of this study, a definition of excess moisture has been developed based on background research sources.

Excess moisture is a result of the moisture condition in the soil layer directly responsible for agricultural production, when it is greater than would be expected for sustained agricultural production. Excessive moisture occurs in the form of liquid water at the soil surface, filling in the surface depression, as well as saturating the soil below for extended periods of time. Factors that contribute to excess moisture include: weather (large amounts of precipitation), topography (hilly/mountainous areas vs. relatively flat areas), soil types (some have less capacity for infiltration), depth of the water table (soils with higher water tables have less capacity for absorbing additional water), and land use/ground cover (a lack of vegetation reduces interception from high volume events, etc).

A sample of causes and effects of excess moisture is presented in Table 1.3.

Table 1.3: Excess Moisture – Causes and Effects

Causes of Excess Moisture	Effects of Excess Moisture
• Increased intensity of precipitation events • Greater extremes • Reduced permeability • Sloping topography • High water tables • Soil types (with limited capacity to store water) • Land Use/ground cover	• Property damage • Reduced crop yield • Loss of top soil • Increased health and safety risks

The Interlake area experiences excess moisture in these general ways:

1. Intense precipitation (snow, rain, sleet).

2. Extended ponding / prolonged soil saturation.

Excess moisture is generally a local or regional phenomenon, based both on the regional scale of precipitation events and the prevailing soils, topography, drainage and geological conditions.

While this study focuses on excess moisture, we cannot consider it in isolation; drought is also a factor that has significant implications on the agricultural industry in the Prairies. While we do not go into detail analyzing drought, it was not ignored, given that a successful strategy to deal with excess moisture should not exacerbate the ability to deal with severe drought. Drought is being considered more fully by the Province in other studies.

1.4.2 Excess Moisture and Climate Change

Climate change science is indicating that the prevalence of excess moisture from extreme weather events in the prairies will continue to increase in frequency. Given that the purpose of the present study is to plan for future conditions, this poses additional challenges in program and policy development.

At the basis of this study is the assumption and acceptance that climate change is occurring, and may represent real threats to the agriculture community. The authors of this study have taken a proactive approach, assessing the potential impacts of climate change, in order to develop recommendations that can be used and applied for a range of possible climate outcomes. This will ensure that the need to address excess moisture events through both adaptation and mitigation measures can be met. Regions with low adaptive capacity, such as the Manitoba Interlake Region, need to address weaknesses in order to be prepared to respond to future events.

For the purpose of this study, we adopted the commonly accepted definition of climate change from the United Nations Framework Convention on Climate Change (United Nations, 1992):

"…a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." [1]

1.4.3 Adaptive Capacity

Adaptive capacity is the ability/capacity of an area to adapt if the area's environment is changing. Improving adaptive capacity includes work on provincial strategies. Adaptation focuses on the ability of an area to change in the short-term, while mitigation takes a longer-term perspective and focuses on correcting or reducing the problem.

The Interlake Region scored lower in adaptive capacity than other regions based on the following metrics (Swanson et al., 2007):

- Low economic resources.
- Lack of technology, or less technologically advanced.
- Lack of informed, skilled and trained personnel.
- Low variety of infrastructure.
- Lack of well-developed social institutions and networks.
- Either inequitable distribution of resources and/or low availability of and entitlement to resources.

1.4.4 Water Management

Water management includes all activities and infrastructure related to diverting, storing, and releasing water through natural or built means. For example, these include drainage (rivers, pipes, gutters etc.), and water retention (wetlands, stormwater ponds, etc.) infrastructure.

1.5 Geographical Focus and Study Area

Agriculture plays key role in the livelihood of Manitoba residents and in the provincial and national economy. The number of farms in Manitoba peaked at 58,024 farms in 1941 (Honey and Oleson, 2006). By 2001, this number was reduced to approximately 21,071 farms, averaging 905 acres in size primarily as a result of farm consolidation that started during WWII (Honey and Oleson, 2006). Today,

[1] Intergovermental Panel on Climate Change (2007). "Fourth Assessment Protocol Report".

Manitoba has18.8 million acres of farm land, with 13.5 million acres suitable for annual crops. The Province is the largest dry bean, faba bean, sunflower seed, and buckwheat producer in Canada, and is Canada's second largest potato-producing province. Canola and wheat are Manitoba's most valuable crops (Honey and Oleson, 2006). Manitoba is also Canada's largest pig producer with a value of $713 million in 2009 (~45% of total value of agricultural livestock and products) and is Canada's largest pig exporter (MAFRI Industry Intelligence, 2010). From 2006-2008, total agricultural-related employment represented approximately 6.9% of Manitoba's employed labour force, and about 1 in 14 jobs were the result of agricultural production (Manitoba Bureau of Statistics, 2009).

1.5.1 The Interlake Region

Manitoba's Interlake Region was chosen as the study area to begin examining some of the implications of excessive moisture on agricultural activities. Geographically, the Interlake Region is located in south-central Manitoba, between Lakes Winnipeg and Manitoba, north of the City of Winnipeg (Figure 1). The Interlake Region comprises 14 rural municipalities, one city (Selkirk), six towns (Arborg, Gimli, Riverton, Stonewall, Teulon and Winnipeg Beach) and one village (Dunnottar). The largest population centre is in the region Selkirk. The second largest is the town of Stonewall. The region is divided into three of Statistics Canada's census divisions of Canada: Manitoba Census Divisions No. 13, No. 14, and No. 18, which together had a population of 88,854 as of the 2011 census. The total land area of the region is 15,837.39 km^2. The Interlake Region is poorly drained for a variety of reasons:

- The topography of the watershed is highest in the west, and generally slopes down toward Lake Winnipeg in the east.
- The major topographic features are the presence of Lake Manitoba to the West, and Lake Winnipeg to the North and East.
- The watershed contains soils that naturally drain poorly. Drains have been constructed to improve drainage.
- Bedrock outcrops are common in the north-central part of the watershed, and bedrock remains fairly shallow through much of the rest of the area (except at the clay deposits around Arborg and at the south-east and south-west corners). This reduces the capacity of the soil to absorb infiltration.
- Proximity to both Lake Winnipeg and Lake Manitoba was a key factor contributing to previous extreme moisture events, which resulted in increased volumes of precipitation being conveyed into both lakes. Large precipitation events convey greater volumes of sediment, fertilizers and pesticides used by the agricultural industry, all of which negatively affects water quality of receiving bodies.
- Area drainage infrastructure has been designed to accommodate normal water volumes. Extreme moisture threatens to exceed current design volumes, resulting in local and regional flooding due to overflowing.

Manitoba's Interlake region is shown in Figure 1.1.

Figure 1.1: Interlake Region Study Area

1.5.2 Choice of Icelandic Watershed

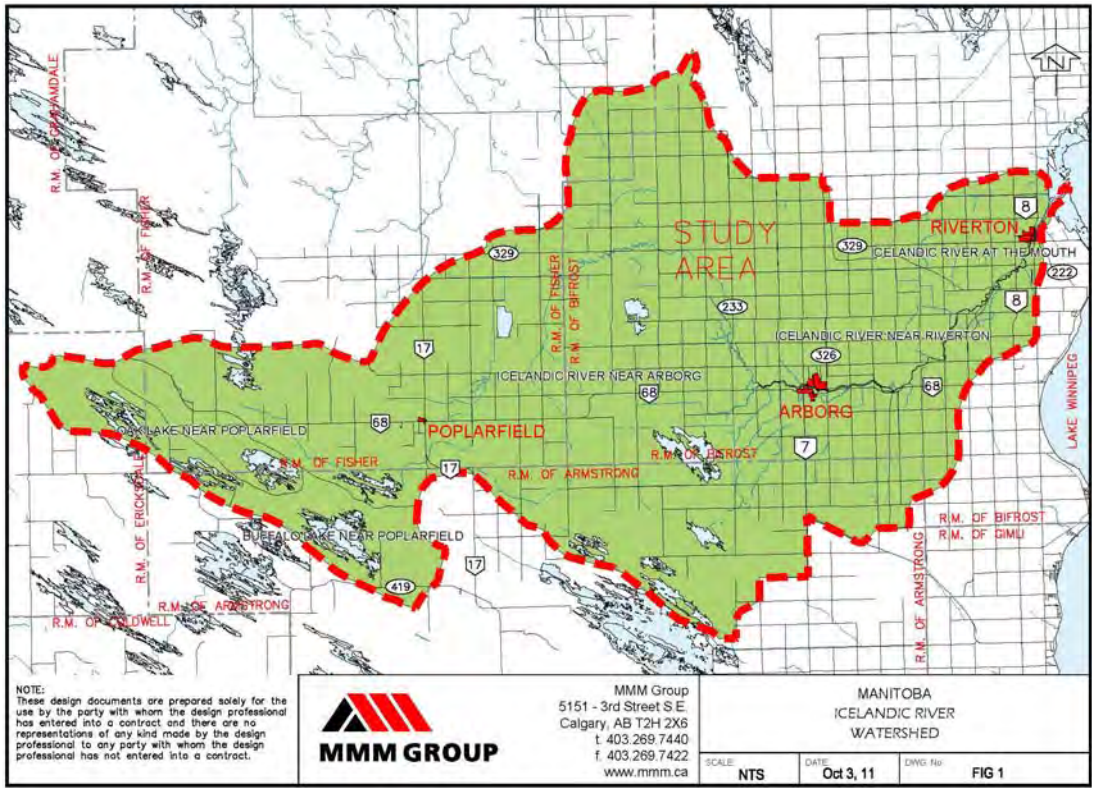
The Icelandic River Watershed was chosen as the study watershed within the Interlake Region for conducting the hydrological modeling. The Icelandic River watershed is located in Manitoba Agricultural Region 12, Division 18, which includes nine rural municipalities (RM), including Bifrost, Armstrong, Fisher and Eriksdale and two unorganized regions. The Towns of Arborg and Riverton are also located in the study area. A quick scan of the study area indicates that of the 736,000 hectares of farmland, 30% involves pastures for livestock; approximately 30% of the land is cropped with a large percentage (40%) in some form of forages.

The Icelandic River watershed is part of a larger watershed called the Icelandic River/Washow Bay Creek (IRWBC) watershed. This larger watershed is one of the four watersheds within East Interlake Conservation District (EICD) boundaries. The Icelandic Watershed is located on the west side of the south basin of Lake Winnipeg. The larger IRWBC watershed covers an area of approximately 2,640 km^2, while the Icelandic watershed alone covers approximately 1,336 km^2 at its mouth (where it drains into Lake Winnipeg) and an area of 1,240 km^2 is captured by the hydrometric station near Riverton.

Municipal land area contained within the watershed includes the municipalities of Armstrong, Bifrost, Fisher, and Eriksdale. Rural communities include the Town of Arborg and the Village of Riverton. The main industries and land uses within the district include agriculture, tourism, and mining of aggregate and peat.

Meteorological data (precipitation and temperature) from the Environment Canada station at Arborg (50°56'00.000" N, 97°05'00.000" W) were used for the hydrological modeling. These were supplemented with solar radiation and wind speed values from Gimli station (50°38'00.000" N, 97°01'00.000" W). Hydrological data from hydrometric station 05SC002, located near Riverton (50°57'53" N, 97°2'14" W) was used for the hydrological modeling and calibration. Figure 1.2 illustrates the Icelandic River Watershed.

Figure 1.2: Icelandic River Watershed



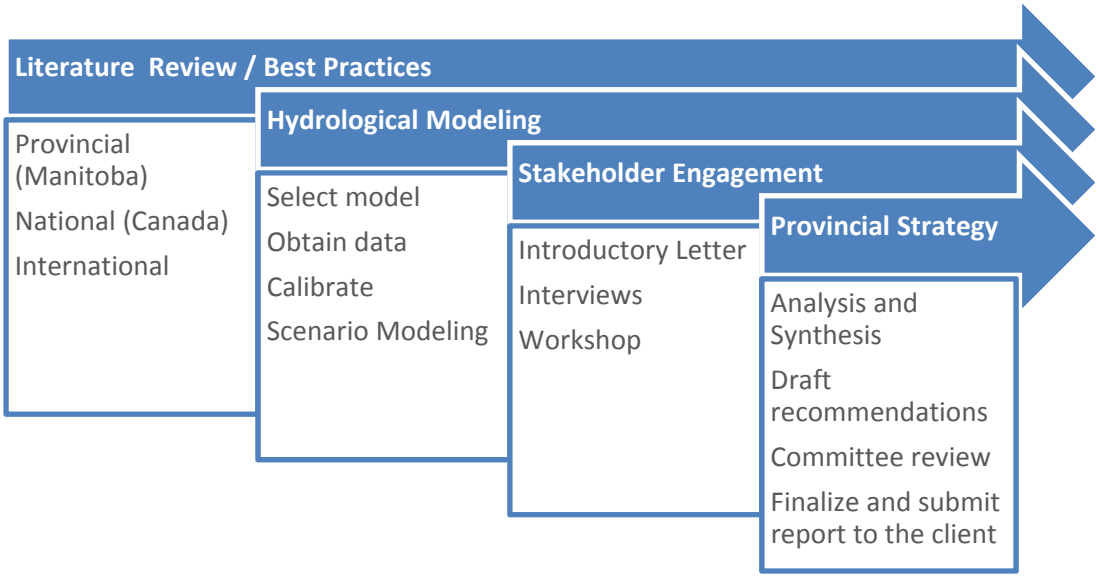
Considerable discussion occurred within the Steering Committee on the appropriate study area for the hydrological modeling informing the development of this strategy. The intent of this strategy was to use a case study approach that focussed on an area within the Interlake Region, which included both sufficient and high quality data, as well as broadly recognized and measurable indicators from within the agricultural industry (such as crop variety, moisture levels, cash crops, forage, livestock and fallow).

Through a review of the data requirements and availability, it was determined that the Icelandic River Watershed offered the best combination of factors, making it the choice for data supporting hydrologic modeling as the basis for this strategy.

2.0 METHOD

In developing recommendations to inform development of provincial strategy on the management of excess moisture, the Steering Committee supported the following method. Each portion of the method is described in some detail below and is graphically presented in Figure 2.1.

Figure 2.1: Study Methodology



2.1 Literature Review

As a first step, to set the stage to move forward and start developing policy and strategy alternatives, a literature review and environmental scan was conducted. The key areas reviewed included:

- Manitoba Agriculture Context
- Climate Change Studies
- Adaptive Capacity and Adaptation Strategies

Within the literature review, several options were identified to facilitate adaptation to the longer-term presence of excess moisture conditions. These adaptation options were considered to identify current and emerging practices for the agricultural industry. These key areas are not mutually exclusive, and therefore information pertaining to one key area was used to inform findings of another key area. The findings of the literature review are organized according to these key areas and jurisdictional review.

The findings of the Literature Review, which are summarized in section 3, informed the development of the workshop materials and ultimately the recommendations of this study.

2.2 Hydrological Modeling

The method for conducting the hydrological modeling involved the following steps:

1. Selection of Hydrological Model – The hydrological model selected needed to meet the following criteria:
    a. Could provide event-based or continuous-time modeling.
    b. Could simulate streamflow throughout the year, including through a winter (i.e., needed to be able to simulate the effects of a snowpack).
    c. Could provide the timing and magnitude of the high and low-flow events.
2. Obtain Data – Input data required to run the model needed to be located and collected. Generally, it can be expected that this would need both meteorological data for input (precipitation, temperature, wind speed and direction, radiation) as well as observed hydrological data (streamflow) to calibrate the model.
3. Calibrate the Model – The model needed to be calibrated to ensure that the model is accurately representing observed responses to meteorological inputs.
4. Apply Climate Change Scenarios to Meteorological Data (Delta Method) – The meteorological data needed to be adjusted to represent future climate change scenarios. This was done using the delta method with the climate change modeling provided by the Government of Manitoba.
5. Scenario Projections – Using the calibrated model and the meteorological data adjusted to represent climate change scenarios, the hydrological response was modeled.
6. Flood Frequency Analysis – Based on the hydrological response from the scenario projections, a flood frequency analysis was conducted to understand potential implications, given the climate change scenarios.

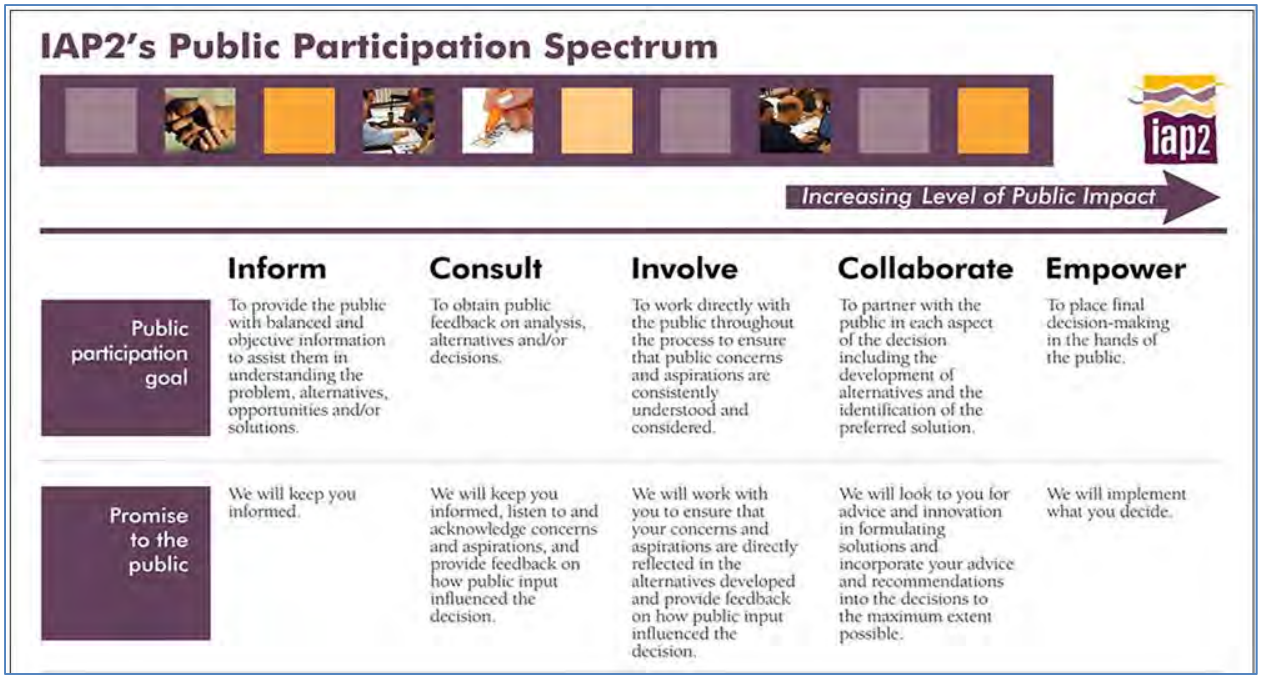
2.3 Stakeholder Engagement

Seeking input from affected stakeholders was fundamental to the success of this study. Our work plan took a broad based approach to the initial consultation activities, with the goal of advancing participation towards engagement.

To address and develop provincial strategies regarding excessive moisture it was necessary and appropriate to collaborate with those stakeholders who will be directly affected by, or expected to, implement recommendations of the provincial strategy. To stay consistent with the goals of the Prairies Regional Adaptation Collaborative (PRAC), the consultation program attempted to examine past policy and program failings and successes, while also promoting uptake of future direction and strategies by participating in the process.

A graphic representation of the spectrum of public participation is presented below, which should assist in providing context for the activities discussed below.

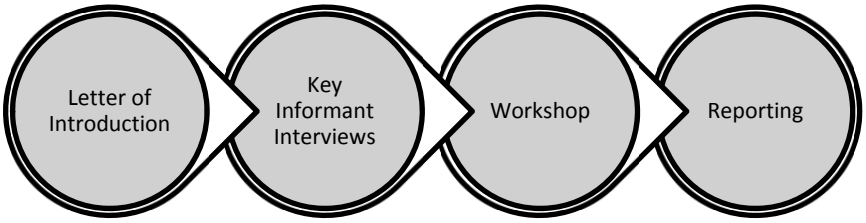
Figure 2.2: Spectrum of Public Participation (IAP2, 2007)



The intent of the public participation component of this study was to involve and seek collaboration in developing recommendations to manage excess moisture in Manitoba. Through the use of the following participation methods, we can demonstrate that affected stakeholders were involved, and that those who wished to collaborate through consensus building efforts were encouraged to do so.

The team developed a customized consultation approach for this study which is presented in Figure 2.3. The graphic depicts the accumulation of knowledge and progression of understanding of the issues throughout the project. Letters of introduction were used to introduce the issues being examined and purpose of the study to stakeholders, with key informant interviews providing the first opportunity for input from specific groups or from individuals. The workshop brought most stakeholders together to share ideas in a group setting. Consultation findings are documented in section 5.

Figure 2.3: Public Participation Methods



By using a variety of participation methods, combined with a solid literature review, and hydrological modeling, an understanding of the issues from many perspectives was gained. This helps achieve the goal of developing a series of recommendations towards establishing a provincial policy on the management of excess moisture.

2.4 Recommendations for a Provincial Strategy

Through the identification of best practices from across Canada and internationally, identifying potential hydrological response to various excess moisture scenarios, vetting our findings and receiving feedback through the local knowledge of stakeholders, and finally analyzing and synthesizing the major issues and findings, this study identifies options for increasing adaptive capacity to excess moisture. These recommendations were developed using short, medium and long-term approaches. Monitoring and evaluation of the implemented recommendations will be required to ultimately determine the level of uptake and success of the recommendations.

3.0 LITERATURE REVIEW

As a first step, to provide a solid foundation to move forward and develop policy and strategy recommendations, a literature review was conducted. The key areas reviewed included:

- Manitoba Agriculture and Regulatory Context
- Climate Change Studies
- Adaptive Capacity and Adaptation Options

The review of adaptation options was conducted to consider current and emerging practices for adjusting to the effects of climate change. These three key areas are not mutually exclusive, and therefore information pertaining to one key area was used to inform findings of another key area. The findings of the literature review are organized according to these key areas and jurisdictional review.

The following summarizes the findings of the literature review.

3.1 Manitoba Agricultural Context

Agriculture is among the most vulnerable sectors to the risks and impacts of global climate change (Parry and Carter, 1989, Reilly, 1995), and historical data show that large numbers of farmers may leave the industry following catastrophic events (such as the severe drought year of 1988, when an estimated 10% of farmers and farm workers left the sector (Phillips, 1990)). Fortunately farmers leaving the sector tended to be replaced by the remaining farmers who expanded their operations. Climate change in itself does pose a significant risk to the food supply. Needless to say, adapting to climate change is not an option; it is a necessity to maintain both the economic health of the province and of its agricultural producers.

Two key policy areas are relevant for agricultural adaptation to climate change: Business Risk Management (BRM) programs, including insurance (AgriInsurance), income stabilization (AgriStability) and disaster relief (AgriRecovery); and farm management practices. The purpose of the BRM programs and farm management practices review is to determine the type of farming practices in the region and the use of agricultural programming to assist with adaptations to existing conditions. The farm management practices, also known as Beneficial Management Practices (BMPs)[2], as well as the BRM practices stem from the Agricultural Policy Framework (APF). The Framework is revised and updated every five years. Reporting on the current APF, known as *Growing Forward* (Government of Manitoba,

[2] **Beneficial Management Practices** (BMP) is a term used in the agriculture sector for farming practices that have environmental benefits. In many cases they relate to water quality as well as climate change from an emissions standpoint.

2007), was underway during the development of this report. As a result, uptake information of the current BRM programs and BMPs was unavailable during the timeframe of this project. However, uptake of the previous APF BMPs is reported under section 3.1.6.

3.1.1 Adaptation in the Interlake Region

Excessive moisture in the Interlake has been detrimental to agricultural production. Recently, the Manitoba agricultural industry focus has shifted from policies which were designed to reacting to extreme moisture events (i.e. longer periods of flooding and drought) towards the development of new technologies and the promotion of beneficial management practices to address changing climatic conditions.

To address the issue of adaptation and other concerns to agriculture, the Federal and Provincial governments develop Agricultural Policy Framework agreements that outline their roles and commitment to the issues. The current agreement is called *Growing Forward* and is the foundation for coordinated federal-provincial-territorial government action over a five year period to help the agriculture and agri-food sectors become more profitable, competitive and innovative. *Growing Forward* is focused on achieving results, reflects input from across the sector, and is delivering programs that are simpler, more effective and tailored to local needs. AgriInvest, AgriStability, AgriRecovery and AgriInsurance are the risk management programs available under *Growing Forward*.

Provincial government agencies such as Manitoba Agriculture, Food and Rural Initiatives (MAFRI) and the Manitoba Agricultural Services Corporation (MASC) have been involved in developing and promoting proactive approaches and financial assistance programs to aid agricultural producers dealing with excessive moisture issues. Examples include the Manitoba Management Plus Program, an interactive, web-based mapping and query program that takes information collected by MASC including yield and management information and allows users to view historical data for areas to aid them in crop related decision making; and, the Excess Moisture Insurance program that provides producers with protection against the inability to seed a crop due to continuous excess moisture from precipitation or flooding.

3.1.2 AgriInsurance

The following information was retrieved from Manitoba Agricultural Services Corporation (2012).

Crop insurance is available for all of the municipalities within Manitoba. Production guarantees are based on a crop's designated risk area, the field's soil type, and the Individual Productivity Index (IPI) of the farmer. The IPI is a 10-year rolling average that compares the farmer’s historical crop yields within a specified Risk Area to other producers growing the same crop in the same Risk Area. If, on average, the farmer’s production is higher than the area's average, the farmer’s IPI is greater than 1. If, on average, the farmer’s production is lower than the average in the area, the farmer’s IPI is lower than 1. There are two key limitations to crop insurance data; information is only available about farms that use crop insurance, and if fewer than 3 farms are reporting in an RM then the information is not given.

Division 18 is part of Manitoba Crop Insurance's Risk Area 15, which is classified as soils that are dominated by loams and coarse loams, with some low-lying marshes scattered throughout. The climate provides an abundance of moisture due to the proximity of both major lakes; a flat terrain and lack of soil drainage only adds to the moisture problem. A lack of heat units (especially in the north) limits the potential for certain crops, with a large amount of forages grown in the area. Crop insurance reports that the common crops are: canola, wheat, barley, native hay, and alfalfa. Although there is forage crop insurance, most forage producers do not use it unless it is for an export market. Over 80% of Manitoba's forage production is for domestic use. The common risks in the Risk Area are excess moisture, frost, and poor germination.

In 2000, Excess Moisture Insurance (EMI) was introduced to compensate producers who could not seed their crops before June 20th due to excessively wet conditions. EMI is now a basic component of the AgriInsurance program. EMI has a basic deductible of 5% of the total acres available for seeding. The deductible will be adjusted according to the farmer's recent EMI claim history. A Zero Deductible Option is available that allows the farmer to buy-down their deductible. The Higher Dollar Value option of the EMI program allows the farmer to buy-up coverage from the basic $50 per acre to $65 per acre. All acres that are normally available for spring seeding (lands cultivated for spring seeding of annual crops) are eligible. Acreage under sod, pasture or perennial forage is eligible for EMI, provided such acreage is destroyed by June 10th and is ready for spring seeding.

A deductible is applied to all eligible acres. The number of acres affected by excessive moisture must exceed the deductible before a claim is in effect.

Ineligible Land

All acreage available for crop seeding is eligible for EMI, except:

- Acreage under bush, brush, fall rye or winter wheat, unless it was destroyed the previous year.
- Acreage under sod, pasture or perennial forage unless it is destroyed by June 10th.
- Acreage not seeded in the previous year due to excess moisture that could have been prepared for seeding, but was not.
- Acreage declared by Manitoba Agricultural Services Corporation (MASC) as being uninsurable.

3.1.3 AgriInvest

The following information was retrieved from Agriculture and Agri-Food Canada (2011a).

AgriInvest is a self-managed farmer-government savings account that allows farmers to set money aside which can be used to recover from small income shortfalls, or to make investments to reduce on-farm risks. The program is designed to assist with small income declines, and provides support for investments to mitigate risks or improve market income. The farmers's AgriInvest account builds as they make annual deposits based on a percentage of their Allowable Net Sales (ANS) and receive matching contributions from federal, provincial, and territorial governments.

Deposits are made to an AgriInvest account held at a participating financial institution. The financial institution notifies Agriculture and Agri-Food Canada once the farmer has made a deposit and the matching government contributions will be credited to their account. Farmers have the flexibility to withdraw funds at any time throughout the year.

AgriInvest is cost shared on a 60/40 basis between the federal and provincial or territorial governments.

3.1.4 AgriStability

The following information was retrieved from Agriculture and Agri-Food Canada (2011b).

AgriStability provides support when the farmer experiences a large margin decline in income. The farmer may be able to receive an AgriStability payment when their current year program margin falls below 85% of their reference margin.

AgriStability program is based on margins:

- Program margin - the farmer's allowable income minus their allowable expenses in a given year, with adjustments for changes in receivables, payables and inventory. These adjustments are made based on information the farmer submits on the AgriStability harmonized form.
- Reference margin - The farmer's average program margin for three of the past five years (the lowest and highest margins are dropped from the calculation).
- Should the farmer's production margin fall below 85% of their reference margin in a given year, the farmer will receive a program payment.

Each year, the farmer is required to actively decide if they want to participate in the AgriStability program and pay an annual program fee. Similar to AgriInsurance, this decision must be made in advance of their program year, before eligibility for a payment has been determined. The fee is calculated based on 85% of the farmer's contribution reference margin being covered and is $4.50 for every $1,000 of reference margin protected. This reflects that AgriInvest will replace coverage for the top 15% of a producer's reference margin and AgriStability is in place to cover margin declines of more than 15%.

In Manitoba, AgriStability is delivered by the Federal government.

3.1.5 AgriRecovery

The following information was retrieved from Agriculture and Agri-Food Canada (2012).

AgriRecovery is a framework that allows the Federal and Provincial governments to work together on a case-by-case basis to assess disasters (e.g., extreme weather, disease, pests, etc.) affecting Manitoban farmers and respond with targeted, disaster-specific programming when assistance is needed beyond existing programs (AgriStability, AgriInvest, AgriInsurance, etc.). The funding of initiatives implemented under AgriRecovery is cost-shared on a 60/40 basis between the Federal and Provincial governments.

The aim of AgriRecovery is to provide affected farmers with assistance to help them take action to mitigate the impacts of the disaster and/or resume business operations as quickly as possible following a disaster event.

When a regional disaster strikes, Manitoba may request an AgriRecovery assessment of the situation/event. The assessment is conducted jointly by the Federal and Provincial governments to determine if assistance is needed through AgriRecovery.

The assessment process includes:

- Evaluating the consistency of the event with federal-provincial-territorial disaster criteria under the Framework.
- Undertaking the work (including meeting with impacted producers and farm organizations) to determine the impacts of the disaster and the needs of producers related to recovering from the disaster.
- Evaluating how existing programs (BRM and others) can help producers deal with the impacts and recover following a disaster.

Based on this assessment, governments decide whether further assistance is warranted under AgriRecovery to help affected producers mitigate the impacts of the disaster and resume business operations as quickly as possible. If further assistance is warranted, they work together to develop and implement an AgriRecovery initiative which is targeted to the specific situation. Implementation includes an announcement of the details of the initiative, including, where applicable, how affected producers can apply.

3.1.6 Environmental Farm Plan (EFP) and Beneficial Management Practices

This program has the farmer complete an assessment of their land based on criteria outlined by the program. Once the assessment is completed, the farmer can apply for funds which are used to offset some of the costs to implement “beneficial management practices”. These practices are designed to provide farming options or techniques to assist farmers to adapt their practices due to such things as changes in weather patterns, for example.

The Environmental Farm Program (EFP) is part of the Growing Forward initiative offered by the Federal and Provincial governments. The program is designed to improve the environmental performance and sustainability of agricultural operations.

The EFAP provides cost-shared funding to producers to implement eligible beneficial management practices (BMPs) identified in their action plans, under such categories as:

- Increased Manure Storage Capacity
- Improved Manure Storage and Handling

- Solid-Liquid Separation of Manure
- Composting of Manure
- Farmyard Runoff Control
- Relocation of Livestock Confinement Facilities
- Wintering Site Management
- Riparian Area Management
- Improved Crop Residue Management
- Precision Agriculture Applications
- Nutrient Management Planning

Additional BMP categories have been available to Manitoba producers through the Manitoba Sustainable Agriculture Practices Program (MSAPP).

- Reduced Greenhouse Gas (GHG) Emissions from Manure Storage
- Manure Land Application
- Reduced Tillage
- Spring Fertilizer Application
- Perennial Cover for Sensitive Land
- Cover Crops
- Improved Pasture and Forage Quality
- Increased Perennial Legumes in Annual Crop Rotation
- Grazing and Pasture Management Planning

Although not all of these practices relate to water management, the use of these programs provides an opportunity for the farming community to get involved in government agri-environmental assistance programs. Figures 3.1 and 3.2 provide a sampling assessment of the uptake of Environmental Farm Plans (information consolidated in 2007) as well as the implementation of BMPs. These maps and programs encouraging BMPs were the result of the previous Agriculture Policy Framework. Additional BMP figures are provided in **Appendix B**.

Figure 3.1: Uptake of Improved Cropping System BMPs in Manitoba through the Canada-Manitoba Farm Stewardship Program (2003-2007)

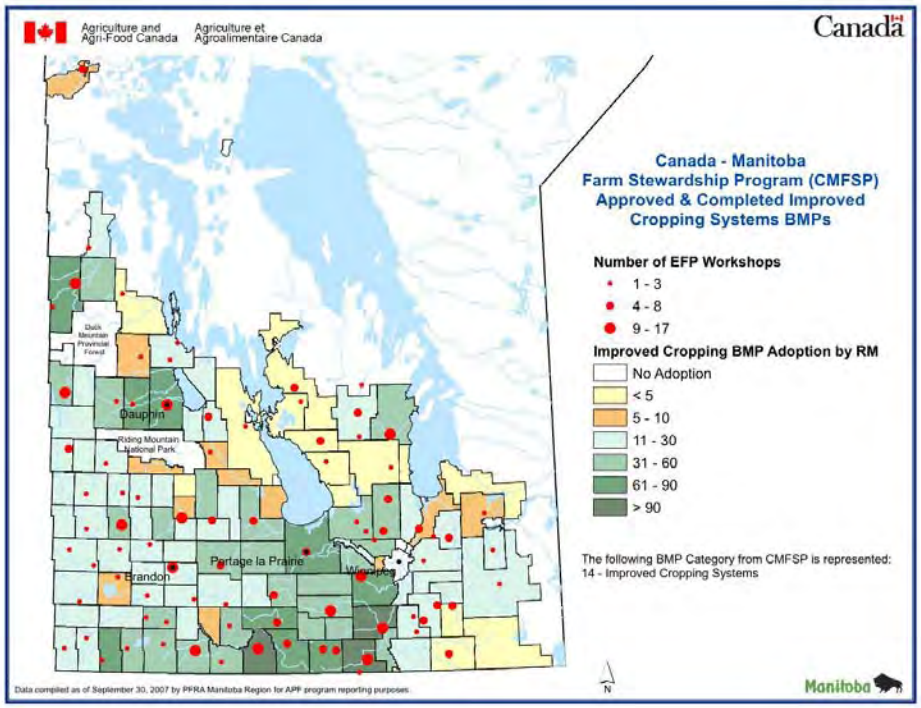
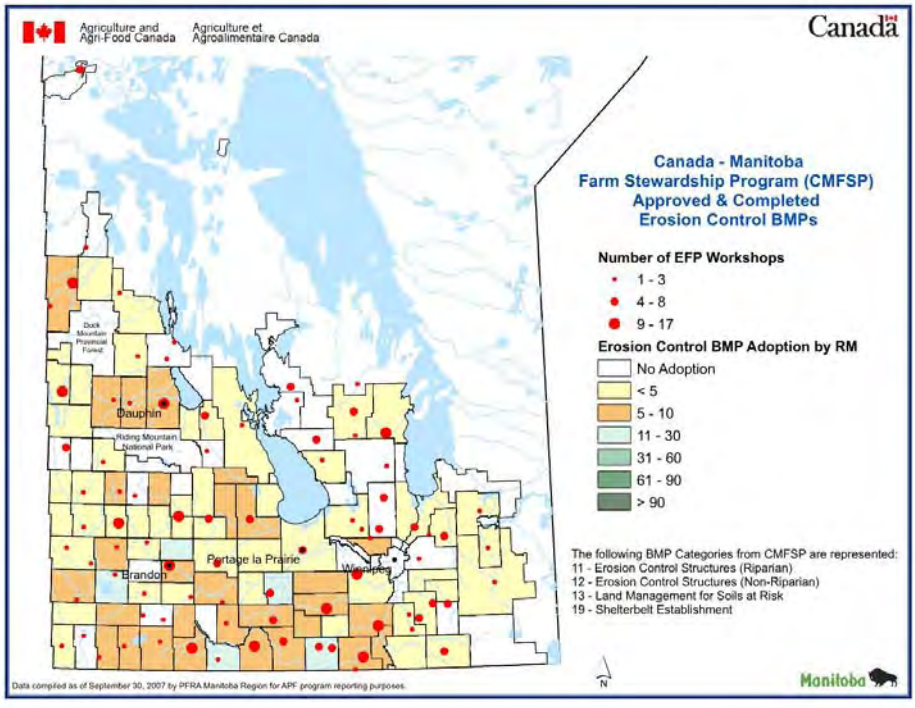


Figure 3.2: Uptake of Erosion Control BMPs in Manitoba through the Canada-Manitoba Farm Stewardship Program (2003-2007)



3.1.7 Conservation Programs

Several conservation organizations offer programs to farmers to modify their land use practices for the benefit of wildlife and its habitat. Ducks Unlimited Canada, Manitoba Habitat Heritage Corporation and Nature Conservancy Canada are three examples of organizations with this type of programming. Most of their programming is about the protection of existing wetlands, but some also involves rehabilitating previous wetlands and establishing new wetlands. Land owners are usually paid based on the number of acres of land that is protected or restored. Where protection or restoration is involved, land ownership may change, or an easement may be put in place. The level of commitment is determined by the Conservation District or related organization on a case by case basis. Depending on the type of land, the farmer might still have the option to use the land for pasture or other permanent cover activities. How much land the conservation organizations would want to protect for wildlife habitat is dependent on the how critical the region is for wildlife production and the budget availability.

3.1.8 Conservation Districts

A Conservation District (CD) is a group of neighboring rural municipalities (RMs), towns and villages working in partnership with the Province of Manitoba to develop programs to effectively manage the natural resources of their area. Conservation Districts are established under the authority of *The Conservation Districts Act.* Currently, there are 18 CDs in Manitoba covering over 60% of Agro-Manitoba. Individual District boundaries may vary, however they are usually based on the drainage basin or watershed of the major river in the area.

The CDs are divided into sub-districts along watershed boundaries. Each of the RMs within a sub-district appoints members to the sub-district board. The former Department of Water Stewardship (now Conservation and Water Stewardship) was responsible for the CD Program. The Conservation Districts Commission (CDC), reporting to the Minister of Conservation and Water Stewardship, is responsible for the Program.

The East Interlake Conservation District (EICD), established in 2005, is the CD operating in the study area. Since then, the District has grown and now consists of all or parts of the RMs of Armstrong, Bifrost, Fisher, Gimli, Rockwood, Rosser, West St. Paul, Woodlands, City of Selkirk, Towns of Arborg, Stonewall, Teulon and Winnipeg Beach, Village of Riverton and Dunnottar. The EICD covers approximately 7,113 km^2 (4,420 $miles^2$) and is home to more than 54,950 residents. The EICD offers a wide range of programs, such as Riparian Area Management, Sealing of Abandoned Wells, Well Inventory, Benthic Invertebrate Monitoring, Culvert Assessment and Inventory, and Surface Water Quality Monitoring.

The EICD, with the assistance of Manitoba Water Stewardship, has completed two Integrated Watershed Management Plans (IWMPs): the Icelandic River and Washow Bay Creek IWMP (East Interlake Conservation District, 2008), and the Netley-Grassmere IWMP (East Interlake Conservation District, 2010). They are in the process of conducting two more.

3.1.9 Integrated Watershed Management Plan

The “Icelandic River and Washow Bay Creek Integrated Watershed Management Plan” (2008) was developed as a partnership between the East Interlake Conservation District, the Province of Manitoba and community stakeholders. It was developed to provide an outline of tasks for residents, government agencies and others that work towards protecting, conserving or restoring land, water and aquatic ecosystems and drinking water sources in the watershed (EICD, 2008). This Plan is based on the following four principles:

- Ensure safe drinking water for the health and prosperity of the community.
- Protect the Agricultural community by reducing the impact of flood events that occur during the summer growing season (June to August).
- Protect and restore the quality and integrity of wetlands and natural waterways to maintain a healthy aquatic ecosystem.
- Build watershed health awareness throughout the community, government and other stakeholder groups.

Actions are linked to each of the above-noted principles. In addition, successful implementations of the actions are also quantified.

3.1.10 Drainage Planning in Manitoba

The following information was retrieved from Manitoba Water Stewardship (unknown).

The existing drainage system was designed to maximize the potential of agricultural land production, given the rich quality of the soils in Manitoba. In the late 50’s and early 60’s, the province took on the role of water management and began developing one of the most comprehensive, intense and well-developed drainage systems in Canada. The Government of Manitoba developed a drain design formula that recognizes the type and value of the land being serviced. This involved creating four drainage standards, each capable of removing a pre-determined size rainfall event within a given timeframe, corresponding to specialty crop needs (e.g., 36 hours for canola and wheat, 4 days for hay). The timeline criteria, in conjunction with soil type, existing topography (slope of land) and a cost benefit formula using the potential crop value, were combined with other design elements to dictate drain size and type.

The need for greater drainage system capacity has been increasing over time due to greater planting levels in specialty crops, improved on-farm infrastructure and urban development into agricultural areas. A general increase in farm size and landowners’ abilities to alter runoff has also aggravated the situation.

As part of a proactive approach, The Government of Manitoba has been preparing 5-year Capital and Minor Infrastructure plans, which include the required drainage infrastructure improvements. The plans necessarily include non-drainage-related infrastructure as highest priority, but include drainage project

priorities as determined within the regions. Maintenance and construction of drainage transportation crossings currently involves up to 50 percent of the provincial drainage budgets. Planning land drainage projects such as this generally require multiyear scheduling for surveys, design, environmental approvals, land acquisition and construction of the works.

3.1.11 Development Plans

Development Plans (and their implementing zoning by-laws, along with building by-laws) provide the basic land development "rules" by which municipalities, developers and the public operate in Manitoba. Development Plans are adopted as by-laws by municipalities and planning districts under *The Planning Act* in all of Manitoba except the City of Winnipeg. Authority for these Development Plans is via *The Planning Act*, specifically the Provincial Land Use Policies section, which is implemented through the Provincial Planning Regulation. This framework identifies the provincial interest policies that a community needs to incorporate into their land use Development Plans. The City's Development Plan (Our Winnipeg) is adopted under *The City of Winnipeg Charter Act*. The adoption processes for the City and the other jurisdictions in Manitoba are similar but not identical.

All municipalities are required to have a Development Plan, but they rarely write their own - normally a consultant is hired and will work with the Province throughout the process. Although written by municipalities or planning districts, all Development Plans must be approved by the Minister of Local Government. For example, all 16 municipalities in the Capital Region, including the City of Winnipeg, have Development Plans in place. Under current legislation, all Development Plans are subject to review every five years, or as specified in the development plan. Local authorities also amend their Development Plans from time to time, and all such amendments also require provincial approval.

Development Plans are intended to set the medium to long-term land development goals and policies for municipalities. While their policies can be quite specific and in some cases quite detailed, for the most part they are far more general than the rules adopted by a municipality under its Zoning By-law. Development Plans include maps which designate areas for basic types of development (or prohibiting development), such as "Residential" or "Neighbourhood" or "Commercial", or "Agricultural", etc. (Government of Manitoba, 2012).

3.2 Climate Change Studies

3.2.1 Canadian National Context

Climate Change Impacts and Adaptation (Lemmen and Warren, 2004) concludes that as a high-latitude country, warming in Canada will likely be more pronounced. The North and the southern and central Prairies are expected to warm more than other areas. Warming will be asymmetrical, being greater in the winter than in other seasons and greater over nights than during days. While this asymmetric warming reduces crop water loss from evapotranspiration and improves water use efficiency, not all of the anticipated effects are positive. Changes of concern for the Prairies include (but are not limited to):

- Increased likelihood of severe drought.

- Changes in increasing aridity in semiarid zones land use.
- Increased precipitation.
- Higher probability of severe flooding.
- Uneven rates of groundwater decline in parts of the Red River basin, which would affect flow in the aquifer and possibly shift the saline/freshwater boundary beneath the Red River valley.
- Decreased summer flows in Prairie rivers, from reduced water supply from snowmelt and glacier runoff. Accompanying decreases in shallow groundwater resources could further compound water shortages.

These changes translate to uncertain impacts on farm sector incomes, water availability, groundwater, streamflow, water quality and irrigation demand. Temperature is generally considered to be the most important bioclimatic factor for livestock. This could translate to challenges during the summer when heat waves hit. Heat can kill animals, and heat stress can also adversely affect milk production, meat quality and dairy cow reproduction. In addition, warmer summer temperatures have been shown to suppress appetites in livestock and hence reduce weight gain (Adams et al., 1999).

While these general changes are anticipated, understanding local effects of climate change is complicated by many unknown factors and feedbacks, including (Lemmen and Warren, 2004):

- Enhanced atmospheric CO_2 concentrations generally increase crop production, with certain types of plants, such as legumes, benefitting more than others.
- Enhanced CO_2 concentration may increase weed growth.
- Livestock pests and pathogens may migrate north as the frost line shifts northward.
- The probability of year-to-year virus survival may increase.
- Warmer winters may increase the range and severity of insect and disease infestations.
- Longer and warmer summers may cause more frequent outbreaks of pests, such as the Colorado potato beetle.
- Pathogen development rate and host resistance may change.
- Geographic distribution of plant diseases may change.
- Competitive interactions between weeds and crops may be affected.

While there do exist many unknowns, it is anticipated that the most vulnerable areas will be those that are already facing water quality and quantity issues, such as the Palliser Triangle (where drought and severe annual soil moisture deficits are recurrent problems).

To better understand the effects of climate change on the agricultural sector, climate change models have been used. However, these do not always appear to report consistent conclusions. In *Assessment of Climate Change and Impacts on Soil Moisture and Drought on the Prairies* (McGinn, Shepherd and Akinremi, unknown), used climate data from the Canadian Center for Climate Modeling

and Analysis (CCCma) to generate five climate change scenarios, spanning best and worst-cases. They evaluated the regional (45 km grid) modeled effects of air temperature and precipitation on soil moisture (as it would affect agriculture). According to their models, they found that soil moisture in the top 120 cm of soil would be the same or higher than current conditions, and that the growing season would not become any more restrictive for crop production under climate change. They suggested adopting earlier seeding dates with conventional short season crops (which results in water savings), as an adaptive strategy that would be particularly effective in regions where summer rainfall is expected to decline. In contrast, Lemmen and Warren (2004) reported on the findings of Nyirfa and Harron (2002), which used the CCCma General Circulation Model (CGCM1), to find that moisture limitations would be significantly higher over much of the Prairies' agricultural regions by 2040–2069, despite increased precipitation. They concluded that this is the result of relatively higher moisture losses from warmer temperatures and from increased rates of evapotranspiration (Lemmen and Warren, 2004).

3.3 Summary of Adaptation Options

Table 3.1 presents a summary of different adaptation options by type.

Table 3.1: Summary of Adaptation Options

Approach	Form of Adaptation	Comments	Source
Technology	Better definitions of critical climate thresholds for agriculture		Lemmen and Warren, 2004
	Advances in centre-pivot systems, including irrigation of field corners and low-pressure application devices	Improved the efficiency and effectiveness of irrigation	Sauchyn and Kulshreshtha, 2008
	Involves crop breeding, or genetic engineering, to develop moisture-tolerant crops.	Involves ethical discussion surrounding the use genetically engineered crops.	Belliveau et al., 2006 Fernandez-Cornejo et al., 2000
Government Programs and Insurance	Development of policies and practices to increase the flexibility of agricultural systems		
	Municipal infrastructure and water conservation programs		Lemmen and Warren, 2004
	Emergency Fire Plan	Extreme drought and moisture have both contributed to a loss of vegetation and soil cover, reducing natural water storage locally, resulting in a higher incidence of fires.	Sauchyn and Kulshreshtha, 2008
	Soil and water conservation plans/programs	For example, the Prairie Farm Rehabilitation Administration	Sauchyn and Kulshreshtha, 2008
	Institutional Initiatives to reduce soil degradation	Agricultural Green Plan*, National Soil Conservation Program (NSCP)*, National Farm Stewardship Program*, Environmental Farm Plan Green cover Canada Program*	Sauchyn and Kulshreshtha, 2008
Farm Production	Water conservation measures	Update operating rules of water resource	Lemmen and

Approach	Form of Adaptation	Comments	Source
Practices		systems. Review need for changes, including timing of irrigation before / after sunset	Warren, 2004
	Adjustment of planting and harvesting dates	Could play a critical role in reducing the losses associated with future moisture conditions	Lemmen and Warren, 2004
	Introduction of new species and hybrids, for example, those that are more resistant to drought and heat	Vegetation that is the most in tune with the evolving climate will require least degree human intervention, and vice versa	Lemmen and Warren, 2004
	Minimum tillage		Sauchyn and Kulshreshtha, 2008
	Crop diversification		Sauchyn and Kulshreshtha, 2008
	Increased storage (for droughts) and diversion (for water surplus)	Involves negative environmental effects including loss of good agricultural lands and natural features (i.e. wetlands)	
	Rainwater Collection systems	For more efficient use of agricultural water resources	Sauchyn and Kulshreshtha, 2008
	Integrated pest management		Belliveau et al., 2006
	Choosing appropriate location to plant	Which side of a hill to avoid frost, or to minimize erosion	
	Greater micromanagement of vineyard	For example: lighten the crop load to divide limited energy among fewer plants, adjust canopy cover as necessary	Belliveau et al., 2006
Farm Financial Management	Budget planning to permit sufficient flexibility to deal with extreme weather / climatic events		Wittrock, 2001
	Drought management plans	AgriInsurance, Rural Water Development Program, National Water Supply Expansion Program*, AgriStability, AgriInvest, Tax Deferral Program (to offset socio economic impacts). Assistance includes helping producers access new water sources, offsetting the costs of producing crops and deferring tax income from culling herd	Sauchyn and Kulshreshtha, 2008 Belliveau et al., 2006
	Re-invest financial gains after a good year, or put money away for a bad year	Income stabilization	Belliveau et al., 2006

* Note that items marked with an asterisk * are programs which no longer exist, but serve as examples.

4.0 HYDROLOGIC MODELING

The main objectives of the hydrological analysis were to identify the timing, frequency, and causes of moisture extreme cycles, and examine the influence of climate change on the magnitude and duration of these cycles, as well as the corresponding change in water balance within the watershed. To do this, a flood frequency curve was developed based on historical data, and four events, representing a range of flood frequencies, were modeled. The modeling exercise involved building and calibrating a Hydrologic Engineering Centre Hydrologic Modeling System (HEC-HMS) water balance model to study the Icelandic River Watershed, based on historical climate and hydrometric data. The primary output of the model focuses on moisture extremes in the upper and lower soil storage zones, and display duration of flooding, magnitude of flooding, and flooding statistical return periods.

4.1 Rationale for Model(s) Chosen

Hydrologic Simulation Program-Fortran (HSPF), was initially selected for the study, but was rejected due to the extremely large data requirements and time required to accurately calibrate the model. For this reason the more user friendly Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) was selected to complete the modeling exercise. It should be noted that HSPF can better represent the spring snow melt runoff events by limiting soil infiltration when the ambient temperature is below freezing, and melt rates can vary monthly; however similar results can be achieved with HEC-HMS by manually adjusting the snow-melt curves directly in the model to match the observed flow at the gauging station. This approach provided sufficient accuracy for a planning level assessment (which, as indicated previously, was to identify the timing, frequency, and causes of moisture extreme cycles).

4.1.1 Description of HEC-HMS

The HEC-HMS model was developed by the United States Army Corps of Engineers. Formerly HEC-1, the HEC-HMS model draws on over 30 years of experience, and is a complex hydrological model with many user-definable options. An overview of continuous modeling using HEC-HMS provided in the HEC-HMS User's manual (2006) is described here.

A basin model is used to represent the physical watershed, within which a dendritic network connects hydrologic elements including: sub basins, reaches, junctions, reservoirs, diversions, sources and sinks. Snow melt is modeled using a temperature index method. HEC-HMS simulates loss rates using either a one-layer deficit constant for simple modeling or the five-layer soil moisture accounting method for simulating complex soil moisture and evapotranspiration interactions. Seven transform methods for converting precipitation excess into surface run-off are available including: unit hydrograph techniques (the Clark tc and R, Snyder, SCS UH, user-input UH ordinates and S-graph ordinates), a linear quasi-distributed UH method (the modified Clark method), and the kinematic wave method with multiple planes and channels. Baseflow can be calculated using one of five methods, two of which (bounded baseflow recession - an exponential decay function, and a constant monthly function) are intended for continuous-time modeling. Six hydrologic routing methods are available for routing flow through open channels.

HEC-HMS features include parameter estimation and optimization by comparing computed hydrographs with observed hydrographs. Initial parameter values are estimated by the user. Parameter estimation takes place either using the univariate gradient method, where the model varies one parameter holding all others constant, or the Nelder and Mead method, which changes the values of all parameters simultaneously at each iteration using a downhill simplex. Goodness-of-fit is evaluated using peak-weighted root mean squared (RMS) error, sum of squared residuals, sum of absolute values, or percent error in peak flow.

4.2 Data Requirements

4.2.1 Base Model Data

Historical data was required to run and calibrate the base HEC-HMS hydrological model. This data was compiled from Environment Canada hydrological and hydrometric gauging stations within the watershed. Collected data included:

- Daily Precipitation
- Daily Icelandic River Historical Discharge
- Daily Temperature Data
- Daily Radiation Intensities
- Daily Wind Speed Readings
- Crop Coefficient Data

Meteorological data (precipitation and temperature) were obtained from historical records from the station at Arborg (50°56'00.000" N, 97°05'00.000" W). These data were supplemented with solar radiation and wind speed values from the Gimli station (50°38'00.000" N, 97°01'00.000" W). Historical hydrological data obtained from hydrometric station 05SC002, located near Riverton (50°57'53" N, 97°2'14" W), was used for the hydrological modeling and calibration. Other modeling input information such as the moisture holding capacity of the soil, crop canopy storage, and infiltration were estimated, and adjusted during the calibration process.

Four historical years, 1974, 1979, 1986 and 1989, were modeled, and calibrated to represent a 1 in 2, 1 in 15, 1 in 33, and 1 in 85 year return period, respectively. The precipitation and temperature data files for these years were then used as the base-line: climate change scenarios used the data from these years to project precipitation and temperature data for future years.

4.2.2 Data Quality

The meteorological and hydrological data used for this study were provided by Environment Canada. Overall, the quality of the meteorological (temperature and precipitation) data was very good. Less than 0.7% of the values for precipitation values were missing or estimated, and similarly, less than 0.5% of

the values for temperature were missing. Where precipitation values were missing, they were assumed to be zero. Where temperature values were missing they were estimated from nearby gauges. There were substantially more missing values from the hydrological data used for calibration. Out of 1648 daily observed values that were used for the modeling, 668, or 41% of them were missing. However, this includes values during the winter. Assuming that the river is frozen in the winter (from December 1 to February 28), we can assume that the streamflow values during this period are equal to or near zero. This is further evidenced by the very low streamflow values at the end of October and the beginning of February (which average between 0.287 and 0.169 for the years modeled, respectively). Assuming that an assumption of zero streamflow between December 1 and February 28 is a reasonable approximation, only 11% of the streamflow values were missing (i.e., values that were missing between March 1 and November 30). Streamflow values that were missing were assumed to be zero. Based on the hydrographs showing the observed (and modeled) records presented in Figures 4.8 through 4.11, we can assume that most of the additional missing values were also in the late fall or early spring, as there are no discontinuities in the streamflow record caused by an assumed value of zero.

4.2.3 Climate Change Scenarios and Data

To simulate various climate change scenarios, this study obtained climate scenario data from the Government of Manitoba under license agreement for three future scenarios: averages for 2010-2039 (referred to as the 2020 scenario), averages for 2040-2069 (referred to as the 2050 scenario) and averages for 2071-2099 (referred to as the 2080 scenario), which allowed us to understand how the climate may change and evolve over time. The data provided projected changes in climate based on the baseline averages from the years 1970 to 2000. In this way, the projected changes could be applied to the historic data (provided it was observed between 1971 and 2000) using the delta method (Wood et al., 1997; Music, 2011) to generate future weather conditions under each of the climate scenarios. The data provided was generated from the CRCM4.2.3 model, using the SRES A2 future greenhouse gas emissions scenario. Three different runs were generated, named “AET”, “AEV”, and “AGX”, in order to simulate natural climate variability (i.e., different initial conditions). We therefore examined three different climate change scenarios (AET, AEV, AGX), at three different points in time (“snapshots” of 2020, 2050, 2080) over the next seventy years:

- 2020 (AET, AEV and AGX)
- 2050 (AET, AEV and AGX)
- 2080 (AET, AEV and AGX)

These climate change scenario “snapshots” were then applied to each of the four years selected to model representative events (1974, 1979, 1986 and 1989). A total of 36 model runs were therefore completed to fully assess the range of possible scenarios in the future, as shown in Table 4.1.

Table 4.1: Model Scenario Runs

Projection Year \ Event Frequency	1 in 2 year (1989)	1 in 15 year (1986)	1 in 33 year (1979)	1 in 85 year (1974)
2020	AET AEV AGX	AET AEV AGX	AET AEV AGX	AET AEV AGX
2050	AET AEV AGX	AET AEV AGX	AET AEV AGX	AET AEV AGX
2080	AET AEV AGX	AET AEV AGX	AET AEV AGX	AET AEV AGX

To identify each of the model runs, they were named according to the year of their associated frequency, the projection year they were simulating, and the climate change scenario used. For example, the model that was run to simulate the 1 in 2 year event (based on the 1 in 2 year event that occurred in 1989) in 2050, using the AGX scenario was called “1989-2050-AGX”. In this way, we were able to distinguish between the results of the model runs.

It should be noted that it has often correctly been pointed out that we cannot rely on past frequency curves to predict the magnitude of future events, since the climate system is changing. The method described above accounts for this by identifying how the magnitudes associated with flood frequencies will shift. This is explained in further detail in section 4.4.

The data representing the climate change scenarios was provided in terms of change in precipitation and temperature between the baseline climate (1971-2000) and the three future time horizons (2020, 2050 and 2080). This allowed us to apply the changes to the observed precipitation and temperature records to generate data inputs for the hydrological model under each of the climate scenarios. Figures 4.1 to 4.6 show how the climate scenarios data varies from the actual observed records. These figures show that average annual temperature increases fairly continuously from the observed year, all the way through to 2080. We also see a trend of increasing precipitation; however the trends in precipitation contain slightly more variability. This is in part due to the dependence of the future scenarios on the observed historical records (since mathematically, they represent modified versions of the historical records, and the absence of precipitation in the baseline year means that a corresponding absence of precipitation will occur in the projection year, despite climate change model results projecting an increase in precipitation).

Figure 4.1: Yearly Average Temperatures for the Icelandic River Watershed under the AET Climate Change Scenario (Source: Government of Manitoba) (Note: the 1979 curve falls under the 1989 curve)

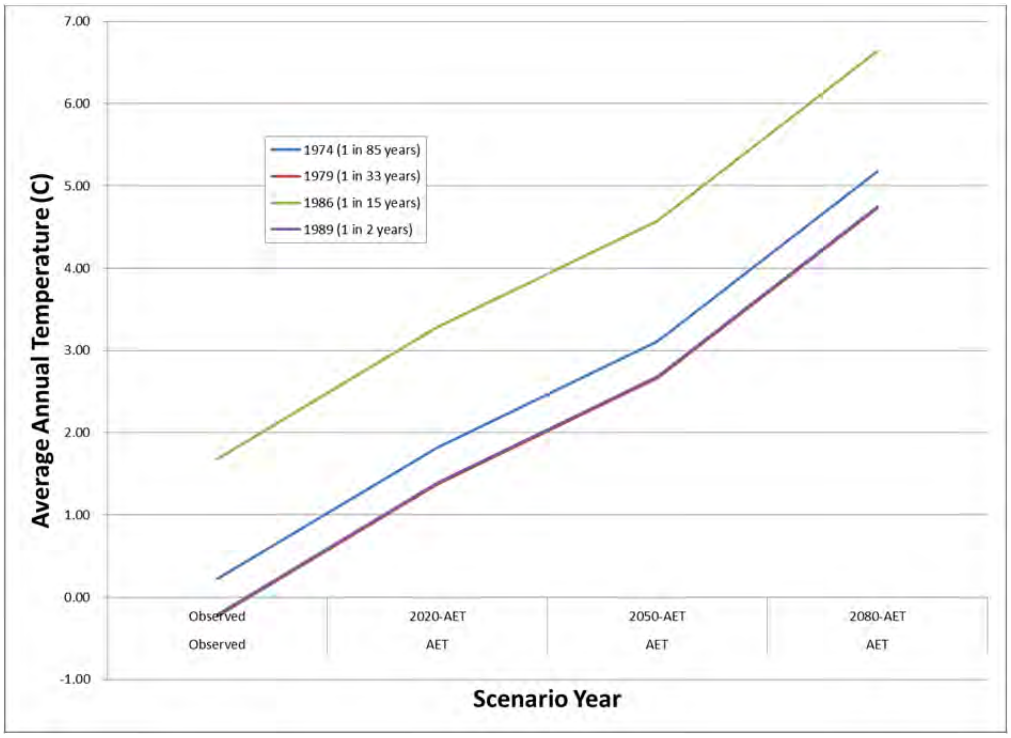


Figure 4.2: Yearly Average Temperatures for the Icelandic River Watershed under the AEV Climate Change Scenario (Source: Government of Manitoba) (Note: the 1979 curve falls under the 1989 curve)

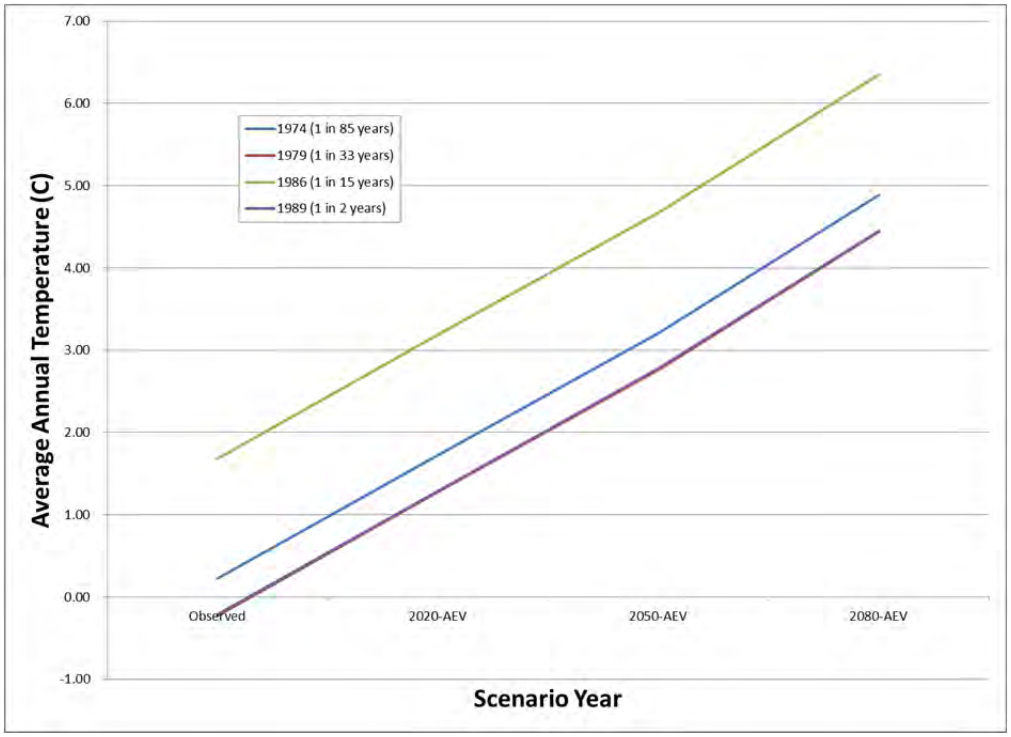


Figure 4.3: Yearly Average Temperatures for the Icelandic River Watershed under the AGX Climate Change Scenario (Source: Government of Manitoba) (Note: the 1979 curve falls under the 1989 curve)

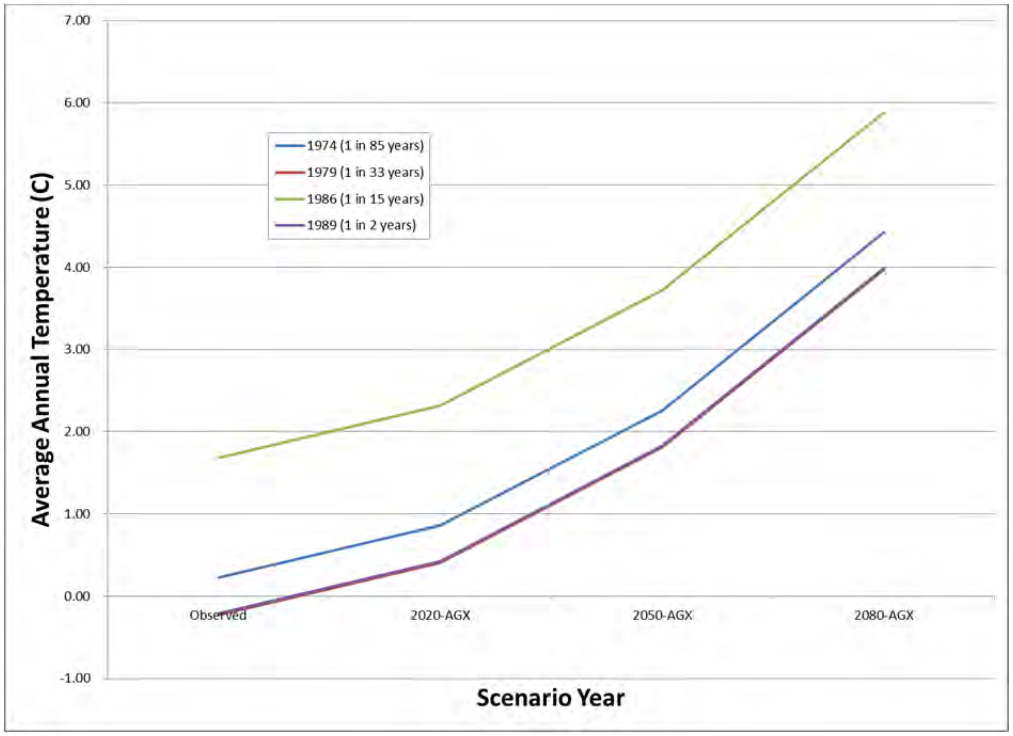


Figure 4.4: Yearly Total Precipitation for the Icelandic River Watershed under the AET Climate Change Scenario (Source: Government of Manitoba)

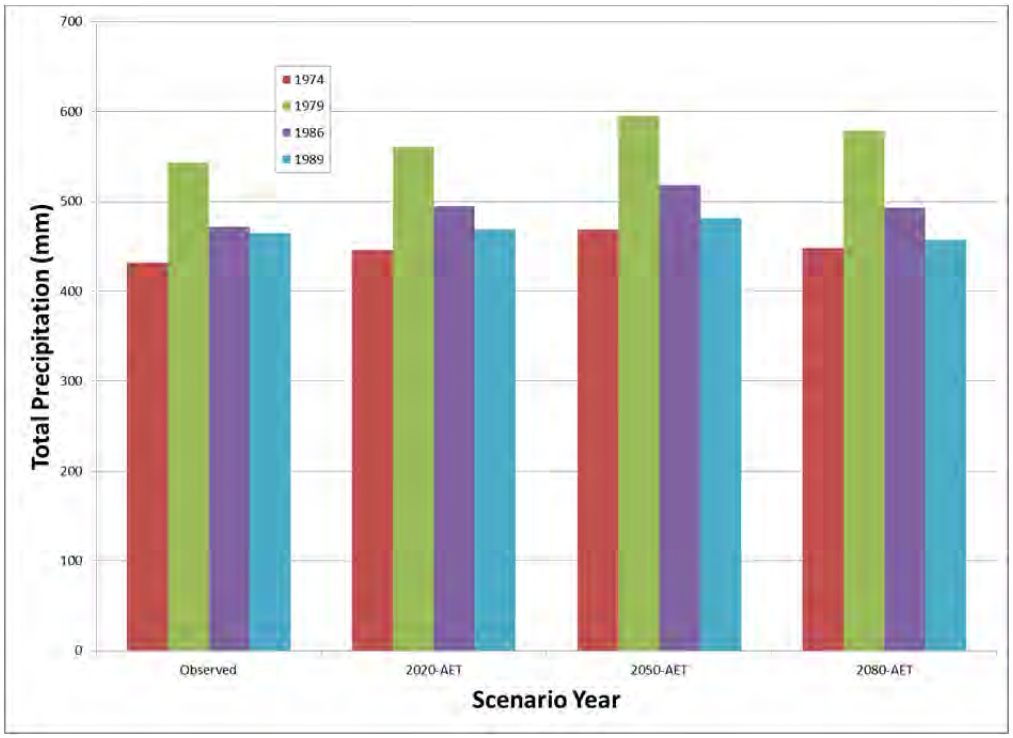


Figure 4.5: Yearly Total Precipitation for the Icelandic River Watershed under the AEV Climate Change Scenario (Source: Government of Manitoba)

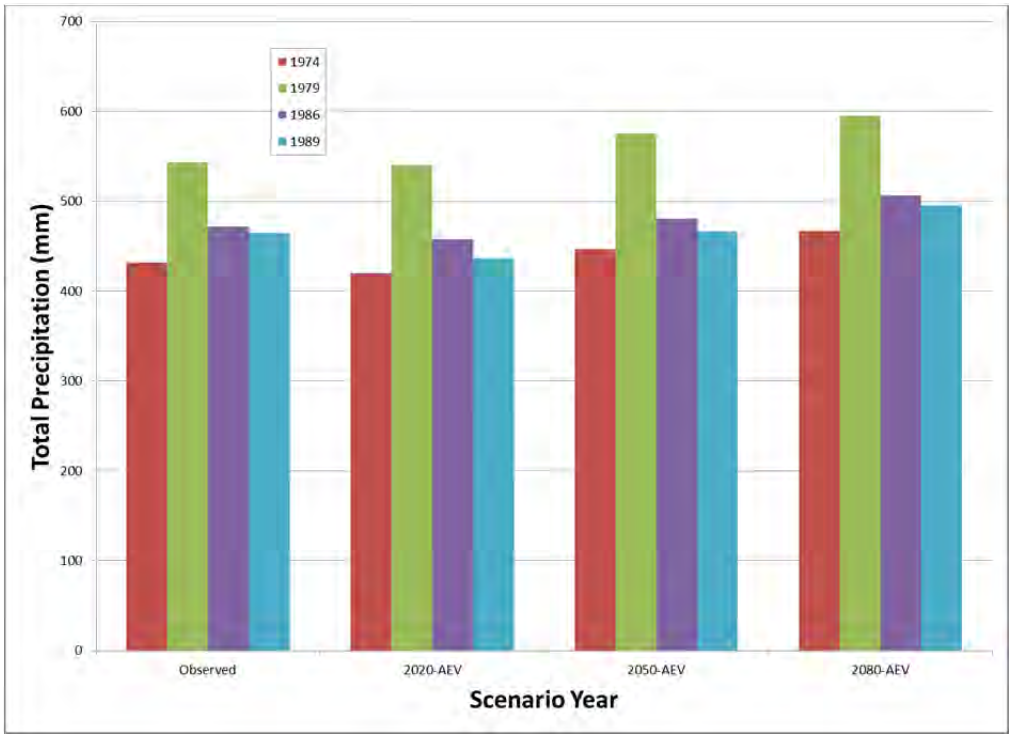
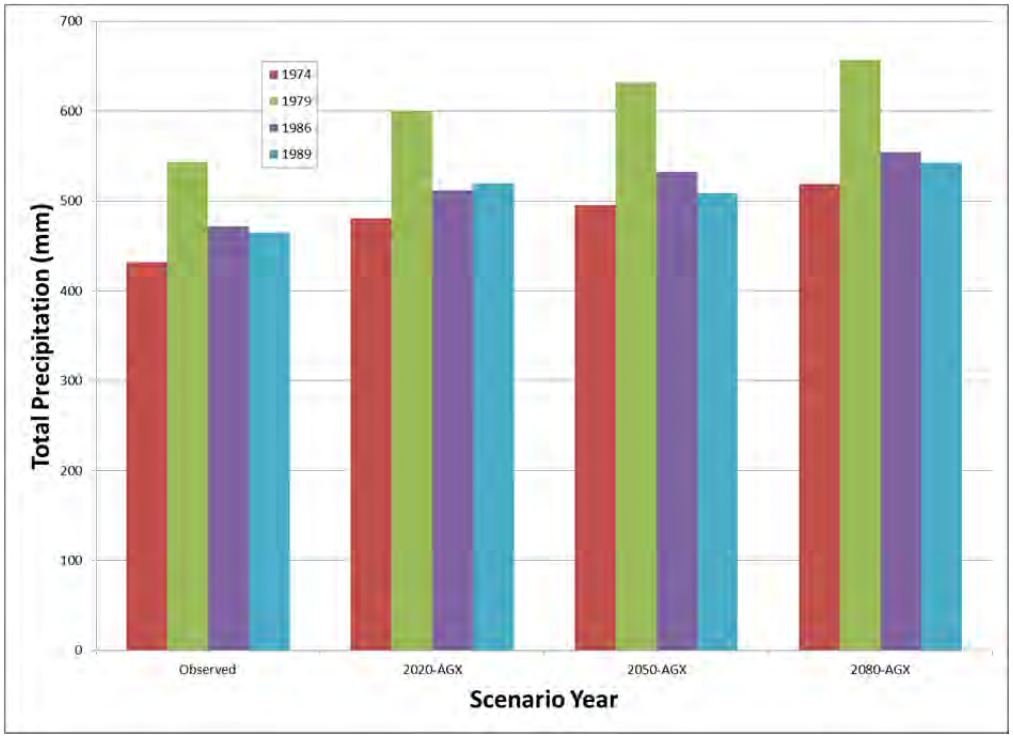


Figure 4.6: Yearly Total Precipitation for the Icelandic River Watershed under the AGX Climate Change Scenario (Source: Government of Manitoba)



4.3 Model Calibration

Historically, the Icelandic River experiences annual flooding during April snow melt events. Peak surface flow rates from spring snow melt events are over 3 times that of runoff generated from summer rainfall events. The Icelandic River Watershed receives the majority of is its annual surface water during the spring runoff; for this reason our analysis focuses on the spring snow melt events, and the accumulation of snow from the previous year.

Assessment of the climate change data presented in Figures 4.2 to 4.7 shows a general trend towards an increase in winter snow fall, and average winter temperatures. An increase in snow fall would generally increase the winter snow pack, and subsequently increase spring runoff rates and flow volumes. However, an increase in winter temperatures may also melt accumulated snow much earlier, and more gradually, depleting the snow pack when the spring snow melt occurs, possibly reducing runoff rates, discharge volumes, and spring soil moisture.

Historical flow records of the Icelandic River indicate that the magnitude of summer runoff events have never exceeded 0.5 L/s/ha (142 acres/cusec) for the watershed. Local flooding due to undersized and non-maintained drains has occurred during summer storm events; however the low average summer runoff rates and the small amount of potential increase in summer rainfall for each climate change scenario would show little change in water balance and peak runoff rates. For this reason, assessment of summer rainfall events was not undertaken, and the calibration and modeling effort was focused on spring melt events.

The hydrologic model was calibrated to simulate events associated with a range of historical flood frequencies. Based on historical data, events were chosen representing the:

- 1 in 2 year flood
- 1 in 15 year flood
- 1 in 33 year flood
- 1 in 85 year flood (there was no 1 in 100 year flood event in the historical record, and so choosing this flood return period was not possible)

The years corresponding to these events were: 1989, 1986, 1979 and 1974, respectively.

The model was run from November 15th of the previous year to December 31st of the year of the respective flood event. While the focus of the calibration was to match the event, the model was run for an extended period of time in order to: a) remove the necessity of having exact initial conditions to properly model the given event, and b) to ensure that the streamflow during the rest of the year was reasonably approximated. This helped ensure a more reliable calibration. Hydrographs of the four, calibrated, base-line years are provided in Figures 4.7, 4.8, 4.9, and 4.10, below.

Figure 4.7: Output from Calibrated Model for 1974 (1 in 85 year event) Based on Observed Streamflow

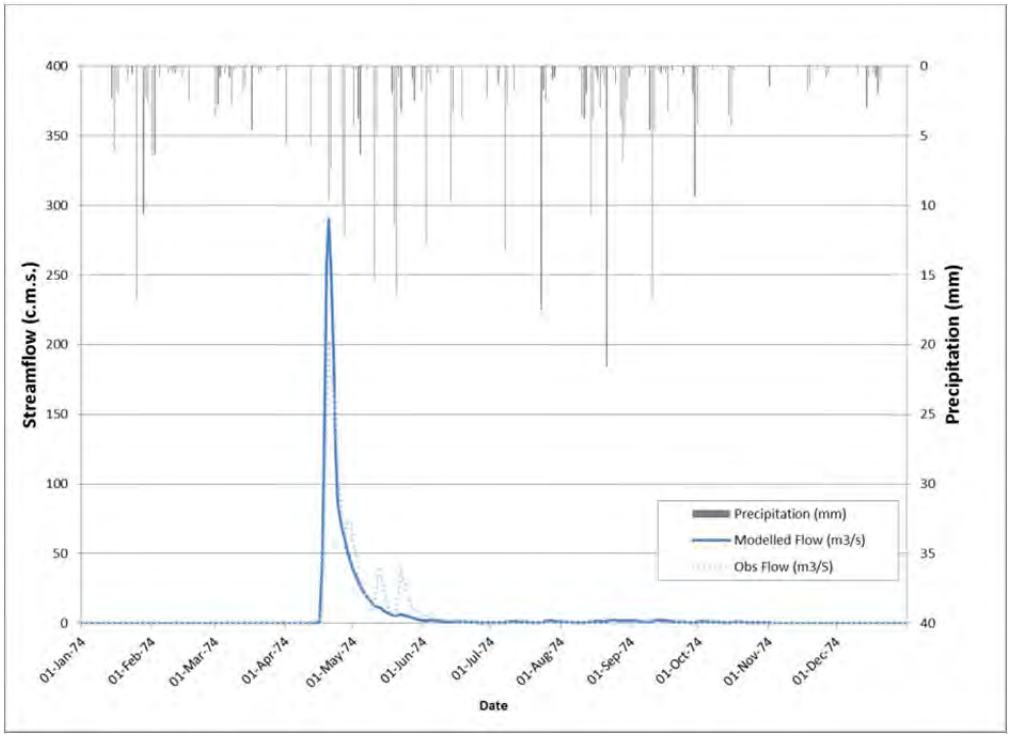


Figure 4.8: Output from Calibrated Model for 1979 (1 in 33 year event) Based on Observed Streamflow

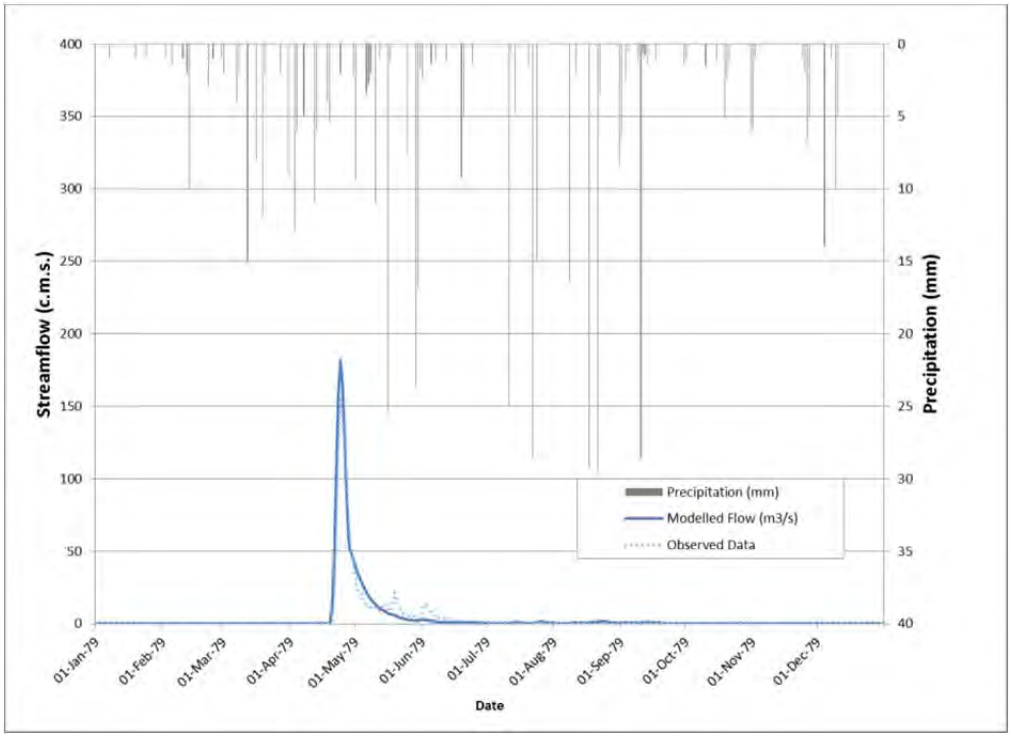


Figure 4.9: Output from Calibrated Model for 1986 (1 in 15 year event) Based on Observed Streamflow

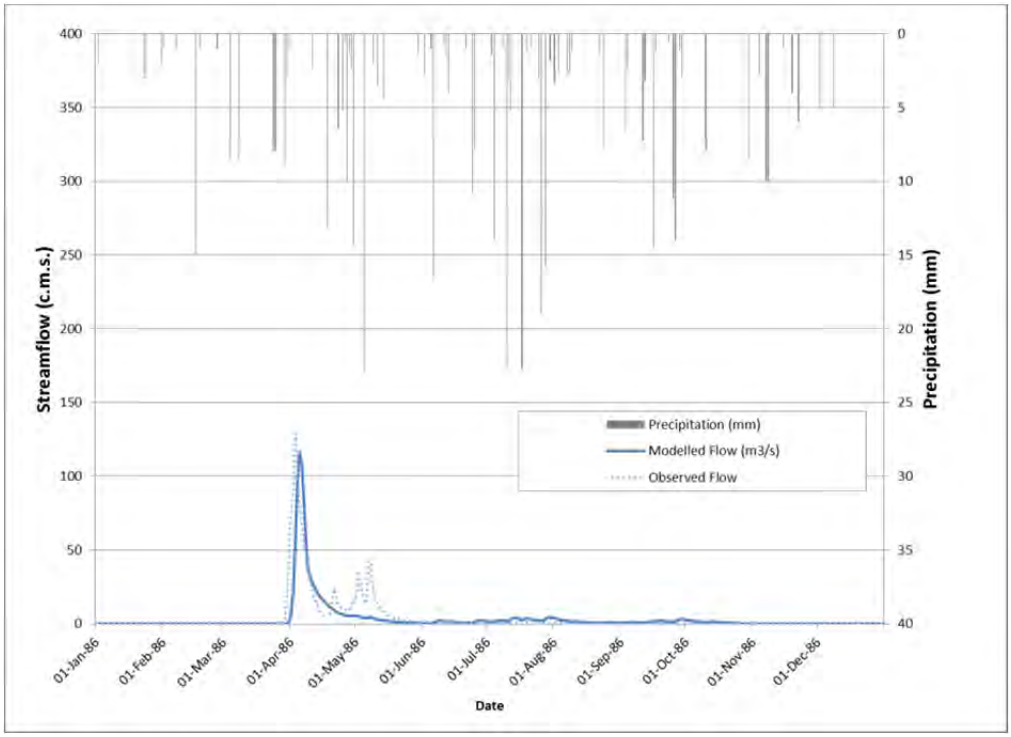
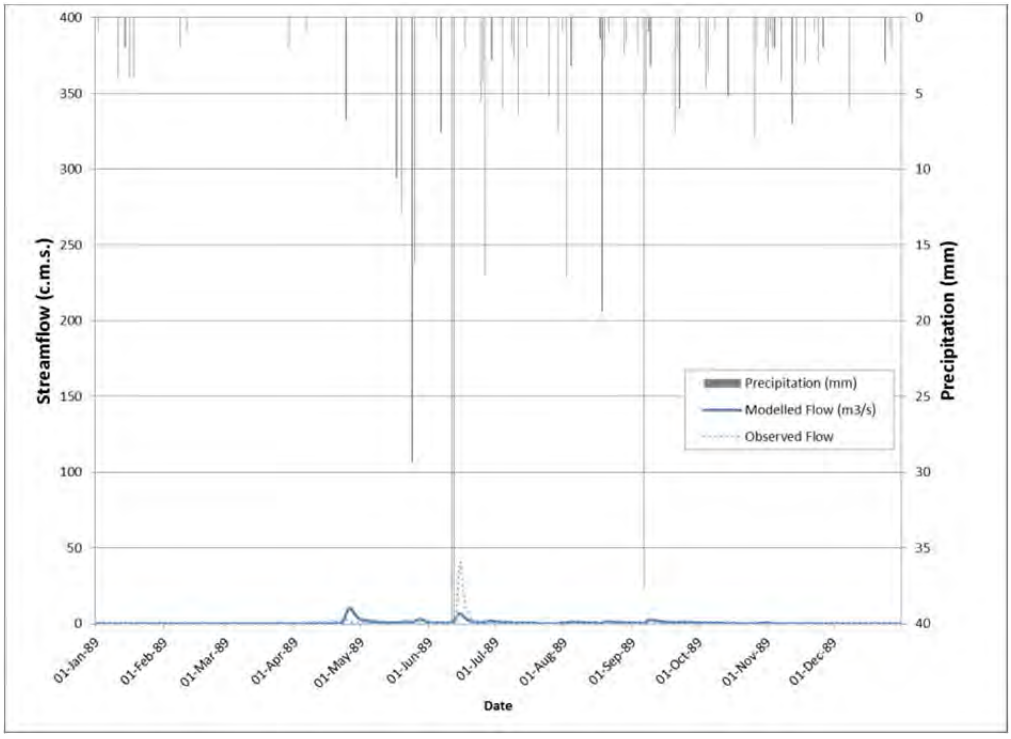


Figure 4.10: Output from Calibrated Model for 1989 (1 in 2 year event) Based on Observed Streamflow



4.4 Analysis of Results

By simple examination of the calibrated hydrographs for the observed record, versus the hydrographs generated using data manipulated to represent the climate change scenarios, it can be seen that the hydrologic response for each of the snow melt events for the 1 in 2-year, 1 in 15-year, 1 in 33-year and 1 in 85-year period is mimicked in each of the scenarios, with the primary variable being the peak amplitude of the annual maximum instantaneous streamflows. These hydrographs are provided in Appendix D.

Based on these results, we generated modified flood frequency curves for each of the scenarios for each of the three future time periods:

- 2020 (AET, AEV, AGX)
- 2050 (AET, AEV, AGX)
- 2080 (AET, AEV, AGX)

To do this, we assumed that the years chosen for each of the event frequencies (1 in 2-year, 1 in 15-year, 1 in 33-year and 1 in 85-year flood) would continue to represent these same frequencies in the future, but that the modified climate change data would drive the magnitude of hydrograph response associated with each of the future scenario years. The result was then a frequency curve that was shifted “up” or “down” on the vertical axis (annual maximum instantaneous streamflow) for each of the nine modeled scenario-time point cases (noted above). In other words, while the frequency and probability of the events would not change, the magnitude of these events would. Figure 4.11, 4.12 and 4.13 show the frequency curves from the lowest and highest maximum streamflow events for 2020, 2050 and 2080, respectively. Figure 4.14 shows the frequency curve from the scenario resulting in the lowest annual instantaneous maximum streamflow (corresponding to model run 1974-2080-AGX), and the frequency curve from the scenario with the highest annual instantaneous maximum streamflow (corresponding to model run 1989-2020-AET) of all of the model runs. These curves show that based on the climate change scenario adopted, the hydrologic response may vary significantly. In one extreme, the 100-year flood event hovers around 35-45 c.m.s, and in the other extreme the 100-flood event approaches 2,000 c.m.s. (approximately 50 times greater). While both may cause flooding, the potential for damage incurred by the latter vastly exceeds the potential for damage of the former flood event. Trends of increased or decreased hydrological response over time (i.e., moving from the 2020 snapshot to the 2080 snapshot) vary depending upon the base year used and the scenario (AET, AEV or AGX) applied. Conclusive results with respect to expected hydrological trends can therefore not be drawn. However, it is interesting to note that the scenarios examined imply that either option (a decrease or an increase) in hydrological peak may occur. This is likely partially due to the fact that increases or decreases in precipitation are projected by month, and therefore the moisture levels of the base year months also affects the modeled moisture levels (i.e., projected increases in precipitation may not significantly impact moisture levels in months that are very dry because they are projected as percent increases. On the other hand, base year months with high accumulated moisture levels will result in larger absolute changes in precipitation for the simulated years).

Figure 4.11: Shifted Flood Frequency Curves from Modeled Output Based on 2020 Climate Change Scenarios (Source: Government of Manitoba)

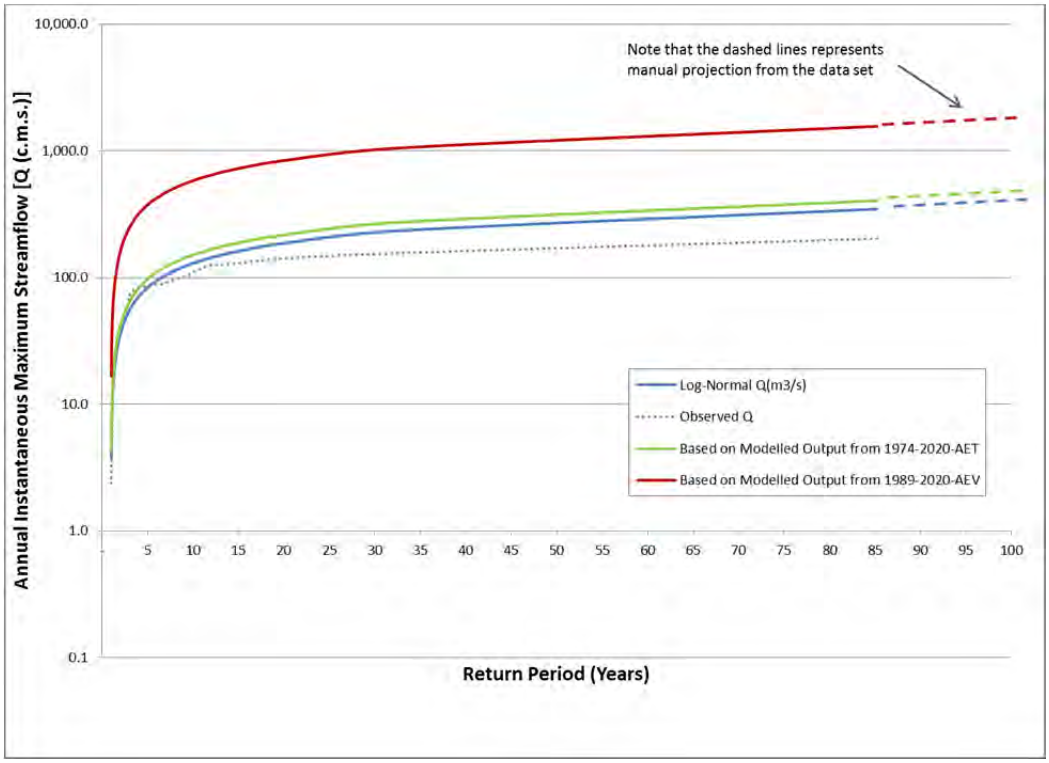


Figure 4.12: Shifted Flood Frequency Curves from Modeled Output Based on 2050 Climate Change Scenarios (Source: Government of Manitoba)

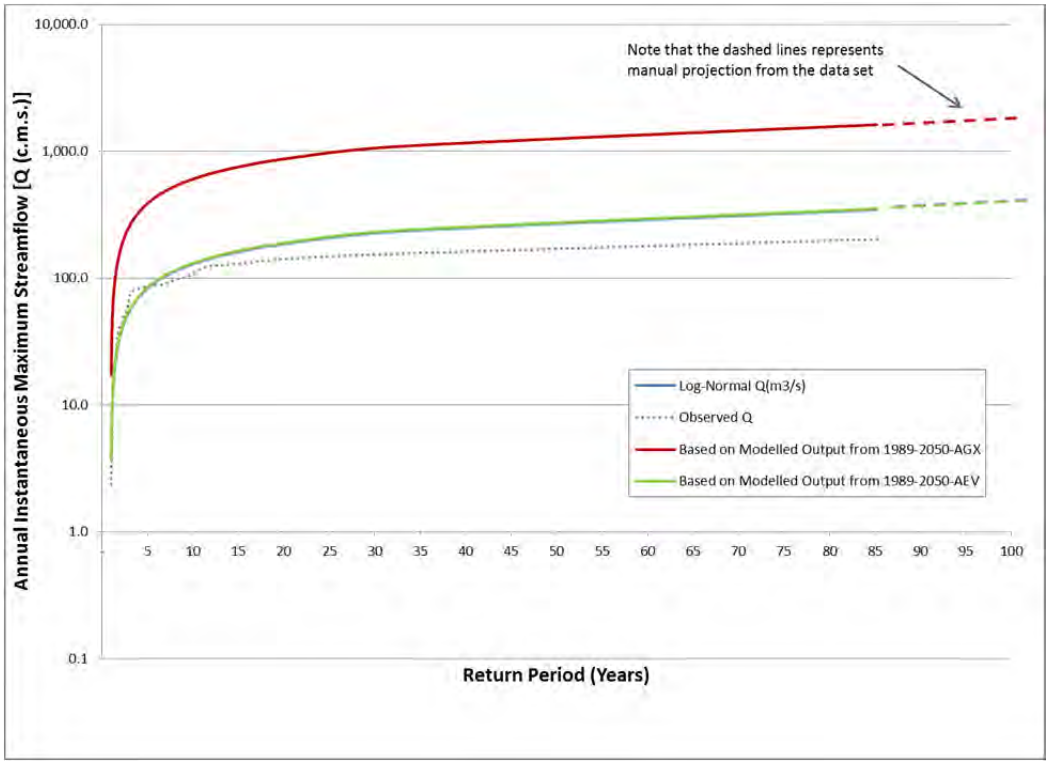


Figure 4.13: Shifted Flood Frequency Curves from Modeled Output Based on 2080 Climate Change Scenarios (Source: Government of Manitoba)

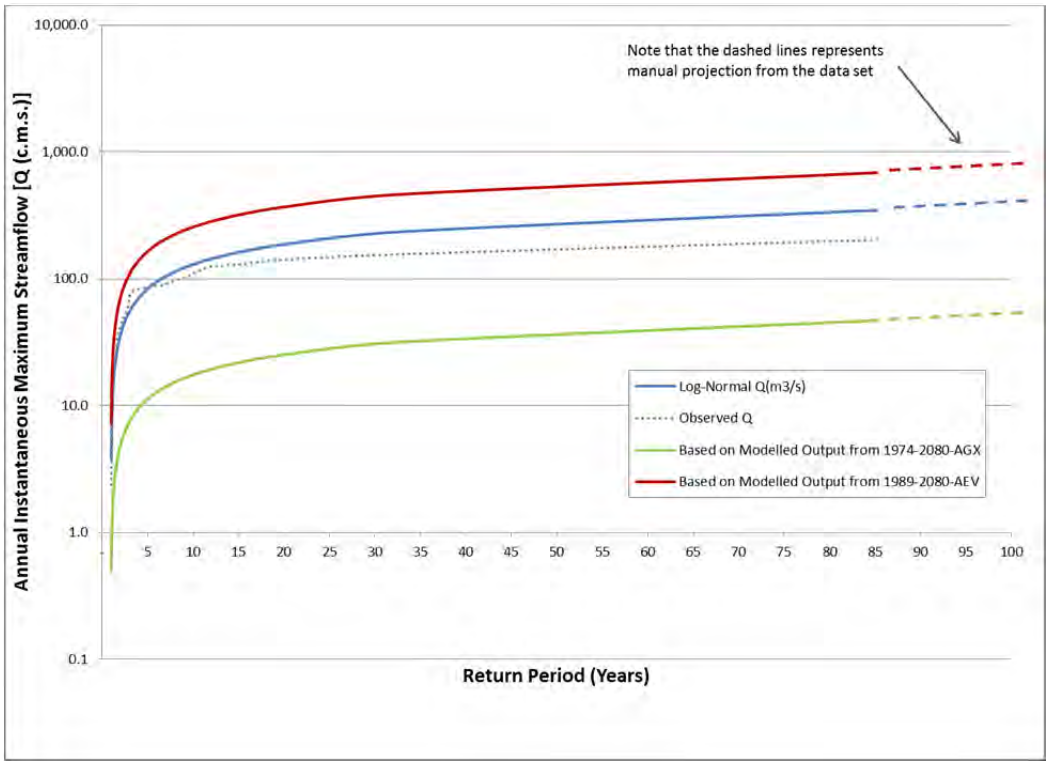
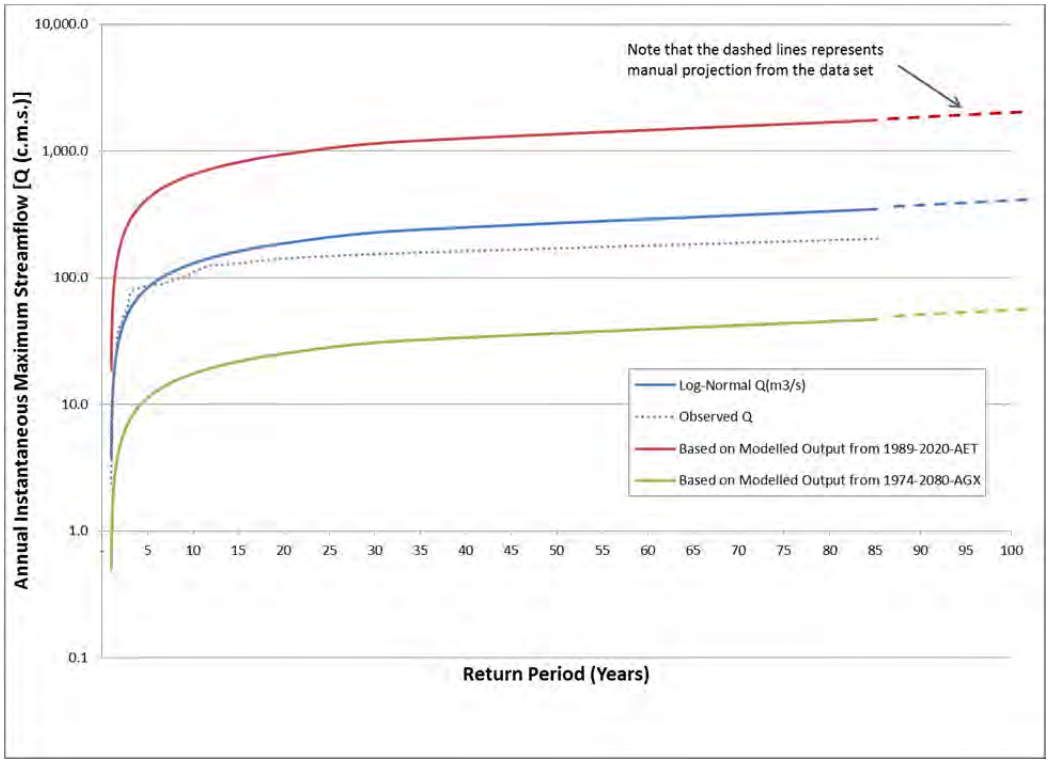


Figure 4.14: Shifted Flood Frequency Curves from Modeled Output Based on All Climate Change Scenarios (Source: Government of Manitoba)



4.5 Summary

According to the modeled results, the highest magnitude floods under the climate change scenarios follow some of the general trends of hydrographs currently observed for the Icelandic Watershed. Stream flow peak coincides with spring melt of the snow pack, releasing a large quantity of stored water in a very short period of time. This saturates the soil to the point that little water can infiltrate the soil, and the water that does infiltrate does so at a reduced rate, which is slower than the rate of snow melt. At the same time, temperatures at this time of year are not high enough to compensate for the lack of storage capacity in the soil through evaporation. The result is a large volume of water at the ground surface, which will eventually flow downstream to the Icelandic River.

Review of the historical stream flow records indicate that there are very few instantaneous stream flow peaks other than the spring snow melt peak. An excess moisture strategy will largely depend on the ability to deal with spring melt. Conversely, should the characteristics of the snow-pack change substantially (e.g., volume of stored water is significantly reduced or increased as a result of seasonal changes in temperature and in precipitation) the stream flow peak will change substantially and may necessitate the need to revise the adaptation strategies. In addition, as noted previously, the range of potential hydrologic responses varies greatly (as shown in Figure 4.11). Any adaptation strategy will need to be flexible enough to deal with the potential minimum and maximum stream flow events.

Beyond considering spring melt, past experience also teaches us, that while not the largest annual events, flooding during the summer growing months can cause real problems for agricultural producers, as saturated soils lose the ability to dry out quickly. In fact, during the key informant interviews, we were told anecdotally, that provided a producer can drain their field within 2 days, there is a good chance of being able to save crops. When water is left on the fields for longer periods, the ability to preserve the crops is drastically reduced.

4.6 Model Limitations

The above hydrological modeling, analysis and summary provide real quantitative findings for various climate change scenarios. However, despite the fact that real, quantitative numbers were used for the modeling, output and analysis, the reader is cautioned against taking these numbers at face value or out of context. It is cautionary to provide the reader with a brief reminder that while the science is precise, one must evaluate the accuracy of the results in the context of the model limitations and climate change uncertainties.

4.6.1 Hydrological Model Limitations

There are various limitations associated with hydrological modeling in general and with the HEC-HMS model specifically.

- Modeling the physical world (be it climate, hydrology or other) always involves certain assumptions and approximations:

- The modeling assumed no land cover/land use change between historical events and future projections. This may not be accurate.
- The modeling assumed that the same factors (including drainage and storage practices) that governed the hydrological response historically will be the same factors governing hydrological response in the future.

- While the model did a relatively good job of modeling the spring melt events associated with each of the return periods, it was not as successful at modeling some of the smaller flood events occurring throughout the growing season. These events represent real challenges, as evidenced by excess moisture events in recent years, which are a result of the cumulative effects of multiple excess moisture events. This has reduced the ability of saturated soils to dry out or be drained, and the municipal and provincial drainage systems have not been able to handle additional run-off due to poor maintenance, and in some cases, design issues. This has resulted in lower crop harvests for producers.

4.6.2 Climate Change Uncertainty

In addition to the model limitations described above, there also exist many uncertainties related to climate change:

- While climate science is closing the gap on the source of climate change, there still exists uncertainty with respect to feedbacks within the natural system that could enhance or reduce the magnitude of current climate change projections.
- Policies, programs and legislation changes could significantly affect societal response to climate change, both in preparing (or not preparing) sufficient adaptation plans, and in mitigating (or exacerbating) climate change.
- The climate change data acquired provided possible changes in temperature and precipitation, however, because these changes were applied to existing weather patterns, the weather data for the climate scenarios would only account for changes in temperature and precipitation magnitude. The data provides no insight on changes in the frequency of extreme events (including those contributing to excess moisture). We suggest that one could expect an increase in the frequency of extreme events, based on findings from other climate change studies. And, perhaps most importantly.
- The climate change data was based on scenarios, projecting what could happen in the future. These are not predictions; rather, they establish likely outcomes given various trajectories taken (which are affected not only by the natural world but also by political will, technological development and economics).

The hydrological modeling results provided were used to assess the potential range of hydrological responses to excess moisture based on various scenarios. The hydrological modeling work we have completed does not predict hydrological outcomes, it assess the possible range of responses we may see in the future. For this reason, no significance should be given to any individual streamflow response

magnitude; they must be analyzed together, in the context of developing policy and recommendations for a provincial strategy.

5.0 STAKEHOLDER ENGAGEMENT

The stakeholder engagement plan for this Study involved local stakeholders and selected agriculture producers to review the local issues and identify potential recommendations to help address the challenges. Engagement techniques used were introduced in Section 2.3.

5.1 Letter of Introduction

An initial list of stakeholders was provided by MAFRI as the basis for circulating a letter of introduction. This list was circulated within the Steering Committee with additions and revisions being made to ensure that a cross-section of, producers, NGOs, Rural Municipalities, politicians and government agencies were well reflected.

Two different letters of introduction were sent. The first was used to introduce the project to stakeholders and to invite them to attend the consultation workshop. This was sent to 28 stakeholders. The second was to introduce stakeholders to the project, and to ask them to consider a list of questions for a follow-up Key Informant Interview (described in section 5.2) related to excess moisture and agriculture. This letter was sent to 10 stakeholders.

5.2 Key Informant Interviews

As a follow-up to the letters of introduction, MMM staff conducted telephone interviews with selected agriculture producers as well as municipal, First Nations and NGO representatives. The interviews were conducted with the following participants:

- Four NGO representatives
- Three Agricultural Producers
- One First Nations representative
- Two Conservation District Representatives
- Two Elected Officials
- One Provincial Crown Corporation
- Three Provincial staff members

A series of questions was posed to each interviewee during the exchange and was used to inform the discussions at the upcoming workshop that was planned:

Questions that were posed to Agricultural Producers; Answers will be used to inform the workshop:

1. Have you noticed any changes in weather patterns or climate in your area over the past years that have impacted crop yield or quality?
    a. Yes
    b. No
    c. How/What:
2. What farm management practices have changed as a result of recent changes in the weather patterns? If so, how?
3. What are the top 3 concerns to Agricultural producers in the Icelandic Watershed currently?
4. What types of programs or policies have been offered in the past to deal with weather pattern or climate change events effects by the government of other agencies? What would you like to see in the future?

A summary of the results of these interviews is presented in Table 5.1. The full details of interview responses are provided in Appendix B.

Table 5.1: Summary of Key Informant Surveys

	Response	Number of Responses	Comments
1. Changes in weather	Yes	16	• It is much wetter. • Spring is cooler and fall is warmer. Some mixed feedback about the growing season being longer. • Crop yields are lower. • There have been some implications to development (in some areas more development applications, and in others, fewer applications).
	No	-	
2. Changes in farm practices due to weather changes	Yes	14	• Equipment used is changing to front wheel tractors • Overall expenses and maintenance costs have increased over time • Drainage infrastructure has been built and wetland restoration programs improve drainage • Financial aid is provided to flood prone areas, to raise houses to protect them from future flooding • More seeding is required for the same yields • Different crop types are planted, such as soya beans, wheat, oats and clover
	No	1	

	Response	Number of Responses	Comments
3. Top 3 concerns to Producers	Drainage, Flooding, River Health and Water Management	8	Other responses included: • Lack of long-term planning and solutions • The need for programs to address credit, debt and insurance • Effects on other industries • Loss of Tax Base • Jurisdictional management of drainage infrastructure
	Crop Production	6	
	Livelihood (Loss of income, houses, employment)	7	
4. Types of programs/policies	-Forage Restoration -Feed Shortage Program -Crop Insurance -AgriStability -Safety net programs -Acreage Payment for flooded areas		Other programs that were noted as being needed or improved included: • Emergency programs • Wetland maintenance and restoration programs • Long-term solutions • Agri-flex programs
5. Most viable options for future excess moisture	Change Crops	7	Viable crops include: soya beans, wheat, barley, corn, canola, forage, oats, flax, hemp, feed grains.
	Improve Drainage	2	Through maintaining and restoring wetlands, using dykes and using more drainage infrastructure.
	Implement Policies and Programs	2	Policies and programs need to be implemented to retain and restore wetlands including: 1) Incentive-based policies, 2) Regulatory policies and 3) Education and Awareness programs.
6. Are wetland / retention ponds, drainage systems useful?	Yes	15	Ten of the respondents also indicated that while the landscape elements (such as wetlands, retention ponds, drainage systems) are useful, the existing supply is inadequate to deal with excessive moisture seen in recent years. Other comments included the fact that while landscape features are useful, there is a problem with asking farmers to store water on their land, replacing the use of prime agricultural land with water storing capacity. Because Agriculture is a means of living, this is asking producers to give up a potentially significant portion of their income.
	No	1	

5.3 Workshop

A key component of the Manitoba Interlake Excessive Moisture Study was a stakeholder workshop. The workshop was hosted and facilitated jointly by Manitoba Agriculture, Food and Rural Initiatives (MARFRI), Manitoba Conservation (now Manitoba Conservation and Water Stewardship) and MMM Group (the project team) on Wednesday, November 16, 2011, at the Bifrost-Arborg Community Centre in Arborg, MB from 10:00 am to 2:00 pm. The goal of the workshop was to better understand how excess moisture impacts the agricultural community (particularly agricultural producers, land stewards and municipal government), and how existing public policy might be modified to better serve the agricultural community in order to adapt and respond to highly variable moisture conditions. Participants invited included agricultural producers, local government officials, NGO staff (for example,

from Ducks Unlimited), and provincial staff. Details of the Workshop, including the participant list, presentation and findings are located in **Appendix C**.

Project information boards were displayed throughout the room and study area maps were provided for discussion.

A total of 23 participants attended the workshop. Upon arrival, workshop participants were asked to sign in. They were then divided into four discussion groups and were asked to discuss topics that corresponded to three stages of problem solving, as follows:

- Identifying Issues and Challenges
- Determining Typical Solutions to Excess Moisture
- Recognizing Future Opportunities

Representatives from MMM, MAFRI and Manitoba Conservation (now Manitoba Conservation and Water Stewardship) were available to answer questions raised by those in attendance throughout the course of the workshop. Each discussion group discussed each of the topics and reported back to the entire workshop group after each exercise was completed to share the highlights of the discussions.

Based on the exit survey, completed by 22 of the workshop participants, respondents indicated that they felt that the workshop was useful and/or educational, and that they hoped the workshop comments would be incorporated into policy and strategy recommendations.

The summary that follows provides an overview of the responses.

5.3.1 Summary of Group Discussions

5.3.1.1 Discussion Topic A: Issues and Challenges

The first discussion topic aimed to identify issues and challenges surrounding excess moisture in the agricultural sector. Three questions were posed to do this:

1. What are the primary issues and challenges from weather changes that are impacting agricultural producers (cropping, livestock, specialized agriculture, etc.) in the Icelandic Watershed? Explain the impact it/they has/have had.
2. Rate the impacts most significant with dots (i.e., dot voting technique).
3. Are these similar to issues generally across the Interlake area? Or across the province in other agricultural areas in Manitoba?

Based on the issues identified and the subsequent dot voting to rate the significance of each of the issues, Table 5.2 shows the results. The results are listed from most to least significant for each associated theme. Due to time constraints, question three was not discussed in detail.

In each case, the same questions were asked of each of the four focus groups. At the end of the idea generating phase, participants were asked to 'vote' on their top three priorities. Each participant was given 3 'dots' which they then placed beside their priority choices. The resulting 'votes' were counted and the top 3 choices for each group were identified as priorities (i.e. ❶, ❷, ❸). The number of priorities identified by each group was not a constant three, but rather varied depending on the group position. Hence there may be more than twelve priorities identified (4 groups x 3 priorities each = 12). This is normal and quite acceptable in the practice of dot voting.

Table 5.2: Workshop – Topic A: Significant Issues and Challenges to Adaptation

Theme	Stakeholder Comments	Identified as a Priority
Policy	• Co-operative policy and planning between all parties involved to develop effective policy	❶❷
	• Water management strategy is needed	❷❷
	• Monitoring and evaluation of existing policies to determine gaps.	
	• Implementation of effective policy is required to address the issues	
	• Preservation of wetlands should have incentives for agricultural producers	
	• Provincial policies need to reflect the need for producers to be able to adapt and diversify	
	• *Conservation District Act* requires significant revisions (originally written in the 1970s)	
Economics	• Lack of drainage plan and maintenance (currently underway, but needs to be more extensive)	❶
	• When rain events are repeated over many years, it becomes more difficult to recover after many years	❷
	• Recent lack of revenue (economic impacts) due to excess moisture on farmers and the businesses that support farmers.	❸❷
	• Programs are not designed for multiple year losses. o For example, the AgriStability program is based on 5 year margins, and crop insurance is based on longer time averages.	❸
Farming Operations	• Saturated soils increase net crop loss. o Storing water in the soil is good. o Loss of permeability results in increased runoff from flash floods • Soil compaction results	❶❸❶
	• Spring and summer excess moisture and saturated soil makes it difficult to seed	
	• Producers cannot properly access their land for seeding, harvesting, or grazing	
Natural Heritage Protection	• Nutrient loading in Lake Winnipeg	❷
	• Society as a whole needs to help protect wetlands and better understand their function	❸
	• There are spin off effects from economic hardship (lack of revenue and inconsistency of revenue) on farmers.	

Priority topics identified under Topic A (Issues and Challenges):

- Water saturated soil becomes compacted and increases net crop loss:
    - Excess moisture results in water being stored in soils, which then results in increased crop loss, as well as increased runoff from flash floods.
- Co-operative policy and planning between all parties involved to develop effective policy:
    - Policy and planning appears to be created on a reactionary, rather than responsive basis, suggesting a lack of coordination and communications. This lessens its effectiveness.
- Water management strategy is needed:
    - Water management is perceived as being conducted on an ad-hoc, regional basis with little overall provincial coordination.
- Lack of drainage plan and maintenance (currently underway, but needs to be more extensive):
    - Drainage infrastructure design is based on antiquated and obsolete standards, which needs to be reviewed and updated.
    - Maintenance schedules need to be made more frequent and funded accordingly.
- When rain events are repeated over many years, it becomes more difficult to recover:
    - Financial aid programs seem to be reactive, so based on an emergency or isolated event. Aid is not considered on the basis of multi-year losses.

5.3.1.2 Discussion Topic B: Typical Solutions to Excess Moisture

The second discussion topic centered on determining the typical solutions used for adapting to excess moisture conditions. Questions used to generate discussion included:

1. What has been the typical way that excess moisture has been addressed in the past by:
- Farmers/Producers
- Agencies
- Municipal Government
- Provincial Government
- Federal Government

2. Are these methods appropriate or should they be altered?

Based on the discussion and responses received, Table 5.3 outlines the typical solutions used and whether or not they are appropriate solutions.

Table 5.3: Workshop – Topic B: Typical Solutions for Responding to Excess Moisture

Method	Party					Priority?
	Farmers / Producers	Agencies	Provincial Government	Rural Municipalities	Federal Government	
Draining farmlands and/or wetlands	X					
Techniques and policies required to improve holding/storing moisture on the land	X					
Crop diversification based on excess moisture conditions	X					1 3
Retool business risk management programs to better reflect multi-year disasters		X	X			
Implementation of effective policy that would assist producers when necessary	X	X	X	X		3 1
Province should develop a program that would maintain wetlands*		X		X		2
Provincial property insurance for excess moisture	X		X	X		3
Creating crop insurance programs that are more diverse and/or are related to production of the crop	X	X	X	X		
Manage drainage system better (brush/trees) – improved maintenance schedule	X		X	X		3
Cooperative policy and planning between all parties involved^	X	X	X	X	X	
Lack of a collective strategy between federal government, provincial government and producers	X	X	X	X	X	1
Best Management Practices needed including integrated watershed planning	X	X		X		2 2
Need innovations in planning approach to policy and practices that accepts regular flooding in some areas regardless of insurance/funding programs	X	X	X	X		2 1

* Wetlands alone were noted to be part of the solution, but had volume and time of year limitations.

^ Reflected in all policy-related points.

Note that some of the priorities identified by the workshop participants were duplicated under Topic A or C, while others did not represent a solution. The priorities identified below are focused on typical solutions, which address the question being asked. Other priorities listed in Table 5.3 are also important, and may be of use to the Government of Manitoba for related matters.

Priority topics identified under Topic B (Typical Solutions):

- Crop diversification based on excess moisture conditions:
    - Farmers and producers have historically adjusted their crop varieties based on moisture levels.
    - Soy beans and other moisture-tolerant crops have emerged in place of less tolerant crops such as grains and corn.
- Implementation of effective policy that would assist producers when necessary:
    - Historically, federal and provincial support to help farmers manage risk has been reactive (i.e., AgriInsurance and AgriStability). While helpful, these programs are not effective for producers in periods of continual extreme weather.
- Provincial property insurance for excess moisture:
    - Property insurance is again used on a reactive basis, as a result of an emergency event.
- Best Management Practices needed including integrated watershed planning:
    - Practices need to be updated based on the successes of those across the province.
    - This would be best achieved through integrated watershed planning.

5.3.1.3 Discussion Topic C: Future Opportunities

The third discussion topic was focused on recognizing future opportunities to better respond to excess moisture conditions. Questions posed to generate discussion included:

- What are some examples (techniques, programs, strategies, etc.) that you are familiar with that may be explored to assist farmers to address impacts from extreme weather events? Would there be any other implications from the implementation of these?
- What can farmers do to better protect themselves from the challenges resulting from extreme weather events (flooding, erosion, etc.)?
- Do you have any policy recommendations to help address these issues?

Table 5.4: Workshop – Topic C: Future Opportunities

Topic	Comments	Identified as a Priority?
Techniques / Programs / Strategies	Create a high-level integrated approach to drainage • all levels of government are involved in continuous collaboration and communication Goal is to create a provincial drainage strategy	1 3
	Amend drainage standards to reflect crop technologies across the province	
	Direct funding to drainage rather than crop insurance	
	Encourage MASC to provide water management feedback and play a more significant role in planning for drainage	
	Encourage municipalities to use direct taxation (proportioning) for drainage projects	
	Streamline regulations to ensure the system can change in a timely manner, particularly under extreme events	2 2
	Create an on-going infrastructure program while simultaneously illustrating that drainage is an important issue in Manitoba	
	Soil classes need to be more accurately mapped to guide land use decision making	
	Long-term conservation programs are needed which would pay farmers to leave (i.e. not farm) the land	
	Municipal long-term water management strategy with provincial conservation districts	2
	Approaches should accept that flooding may be a regular, rather than sporadic event	1
Farmer Protection	Improve and enhance crop practices through encouraging farmers towards crop diversification	
	Direct watershed reserve areas to specific (i.e. designated) land parcels throughout the Icelandic Watershed	
	Financial compensation is required for farmers giving their lands up for water storage purposes (designated or emergency purposes).	3
	Cost sharing of drainage systems between government and producers (ex. Cook's Creek drainage which was a coordinated approach)	1
	Education of farmers and producers is required to better understand water storage in wetland areas	
Policy Recommendations	Revising and re-writing the *Conservation District Act* is required through an effective public consultation process	
	Apply bio-economic processes to create new markets and adjust to what the land produces on a year-to-year basis	
	New policies could include a return that is based on the cost of production for compensation	2
	Maintenance of infrastructure needs to be sustainable and this should be regulated municipally or provincially	1
	Better research into the natural drainage patterns should be incorporated into decision making	3

Priority topics identified under Topic C (Future Opportunities):

- Create a high-level (Provincial) integrated approach to drainage:
    - Involving all levels of government.
    - Streamline regulations to ensure the system can change in a timely manner, particularly under extreme events.
    - Accept that flooding may be a regular, rather than sporadic, event.
- Costs and compensation should reflect actual costs on the ground:
    - Financial compensation is required for farmers giving their lands up for water storage purposes (designated or emergency purposes).
    - New policies could include a return that is based on the cost of production for compensation.
    - Cost sharing of drainage systems between government and producers (ex. Cook's Creek drainage which was a coordinated approach).
- Improve existing infrastructure:
    - Maintenance of infrastructure needs to be sustainable and this should be regulated municipally or provincially.
    - Better research into the natural drainage patterns should be incorporated into decision making.

5.3.1.4 Summary of Workshop

In summary, while participants agreed that continual excessive moisture of recent years has not been characteristic of the region, it is a phenomenon that has significantly impacted livelihood and agricultural production. Overall, the participants felt there was a gap between provincial policy and local initiatives available to farmers, producers and Rural Municipalities. Policy and programs have historically been developed by the Province in response to emergencies, resulting in an *ad hoc* approach. Improved coordination is required in policy development, including a comprehensive review/evaluation of all water and watershed policies to determine their effectiveness. Current provincial agricultural policies, potentially including the *Conservation District Act*, would need to be reviewed and updated, as required. On-going monitoring and evaluation of policies is also needed to measure and demonstrate success.

Farmers and local agricultural producers are supportive of water storage and distribution requirements that would have them remove land from active production, provided there is some form of financial incentive to help compensate for lost income, either on a temporary or permanent basis.

An underlying issue for the region is the lack of maintenance of the existing drainage infrastructure as well as the need to improve programs to maintain and create new drainage infrastructure. Drainage

standards need to be reviewed and revised across the Province to reflect current cropping technologies and address compensation for farmers whose lands are identified to address local/regional needs.

New business opportunities should be considered that reflect bio-economy standards to identify potential new markets where excess moisture cannot effectively or sustainably be managed. Also, Rural Municipalities need to be financially empowered to address issues at the local level.

5.4 Summary of Stakeholder Engagement Activities

Stakeholder engagement resulted in the identification and exploration of several ideas that could be used to help inform the development of a provincial strategy. This section summarizes all consultation activities into topics that can be converted into priorities for action. Table 5.5 provides a summary of stakeholder recommendations. The Steering Committee determined that further study and analysis needs to occur, including the need to review legislation and planning documents.

Table 5.5: Summary of Stakeholder Recommendations

Topic	Recommendations
Agency Coordination	Province should partner with NGO's to identify priority projects for funding
	Improved maintenance schedule to manage the existing drainage system
	Maintenance of drainage infrastructure needs to be sustainable and this should be regulated municipally or provincially
Watershed Management	Best Management Practices are needed including watershed management planning that is better integrated in the decision-making process.
	Create a high-level integrated provincial drainage strategy that would: manage wetlands; require a multi-jurisdictional approach; identify a response and implementable management framework
	Streamline the current regulatory framework to ensure the system can change in a timely manner, particularly under extreme events
	Develop a long-term water management strategy with the Province, Conservation Districts and the Rural Municipalities
	Review the *Conservation District Act* to determine if updates are required, including using a consultation program focusing on producers.
Effective Policy	Need innovations in planning policy and practices that accepts regular flooding in some areas regardless of insurance/funding programs
	Implementation of effective policy that would assist producers when necessary on a more consistent basis rather than reactive basis
	Approaches should accept that flooding may be a regular, rather than sporadic basis, and programs therefore need to understand how this may affect compensation over multiple years

Topic	Recommendations
	New policies could include a return that is based on the cost of production for compensation
	Review and evaluation of existing policies. Delete duplication/redundancy, strengthen successes. Implement monitoring and evaluation system to address future issues.
Producer / Farmer	Crop diversification choices should be made based on excess moisture conditions
Financial	Cost sharing of drainage systems between government and producers (ex. Cook's Creek drainage which was a coordinated approach)
	Direct funding to address drainage issues at the Rural Municipality and producer levels rather than crop insurance, which would provide short-term mitigation
	Need consistent, responsive funding. Downloading to Rural Municipalities is not sustainable.
	Provide for flexibility in funding to support regular and extreme weather events. This would require a change from reactive to responsive funding.

The priorities that were identified as applicable to this Study were brought forward for inclusion in Section 6, as recommendations for a provincial strategy.

6.0 RECOMMENDATIONS FOR A PROVINCIAL STRATEGY

Recommendations were developed based on observations made and conclusions drawn from the literature review, input from the Steering Committee and results of stakeholder engagement activities. This section documents the input of members of the Steering Committee and members of the project team, which identifies priority areas identified, then makes best efforts to categorize these priority areas into implementable and actionable items.

6.1 Priority Areas

Identification of priority areas for implementation required a principled-approach to addressing the problem statement, which defined this project from the outset, being management of excess moisture. The development of these recommendations also needs to be consistent with the principles established in existing policy and planning documents (i.e., including but not limited to *The Planning Act* and the Provincial Planning Regulation, *The Water Protection Act,* the Icelandic River and Washow Creek Integrated Water Management Plan (as well as other Integrated Water Management Plans), *The Conservation District Act*, *The Save Lake Winnipeg Act* etc.).

In developing recommendations for a provincial strategy, two general yet recurring themes were communicated, which are consistent with the approach identified by the Steering Committee. They are:

1. Open and consistent communications within all levels of government are required.
2. Review and evaluation of existing policies towards reducing duplication. Implement monitoring and evaluation system to identify and promote success and learn from mistakes.

This study makes several recommendations, which can be divided into two distinct themes: government and agricultural industry. The distinction is made to highlight the practical needs of the industry and the medium to long-term approach addressed by government policy and regulation. Our approach with the recommendations is to provide the overall objective being recommended, supported by a more detailed explanation including sub-topics, as warranted. The study recommendations are provided in Table 6.1, below.

Table 6.1: Summary of Recommendations

Priority	Objective	Explanation / Sub-Topics	Time Frame for Implementation		
			Short-Term (< 2 years)	Medium-Term	Long-Term (6+ years)
GOVERNMENT					
Regulatory Framework	Require Conservation Districts to issue drainage permits for land use changes.	Explanation: Encourage Municipal Councilors and Conservation Districts to work together to ensure that any land use changes approved locally require a permit or drainage impact study as part of its approval process to better understand the impacts of land use change on the drainage system.	X		
	Province should undertake a drainage study to define water quality and drainage objectives in a balanced way.	Explanation: Balance the need for good drainage and the need to improve water quality before it outlets into Lake Winnipeg in the provincial strategy.	X		
	Province should encourage planning authorities to use best available data to clearly designate land so that development is guided away from higher-risk areas.	Explanation: Identifying hazardous areas using current G.I.S. data to avoid decisions where agricultural uses such as cropping are sometimes directed to low lying lands. Perhaps with the increase of flooding events, the use of these low lying lands for cropping should not be encouraged, unless there are BMPs that can address the shortened growing periods.	X		
	Coordinate excess moisture management under the *Provincial Planning Regulation* policies and Development Plans to ensure lands subject to regular flooding are not considered for development.	Explanation: Coordinate excess moisture management with land use planning in accordance with *The Provincial Planning Regulation* to develop policies within Development Plans that ensure lands that are subject to continuous flooding are left in a natural state as much as possible. Much of the province is in a floodplain, and much of that land has already been developed, which complicates the issue.	X		

Priority	Objective	Explanation / Sub-Topics	Time Frame for Implementation		
			Short-Term (< 2 years)	Medium-Term	Long-Term (6+ years)
	Survey producers, agricultural organizations and supporting agencies to determine the effectiveness of the *Conservation District Act*, other relevant legislation and implementing regulations.	Explanation: The Province, in conjunction with Conservation Districts, should survey producers, agricultural organizations and supporting agencies to determine the effectiveness of the *Conservation District Act* and the *Water Protection Act* and its implementing regulations. This should be done with a focus on determining if additional power and required funding should be afforded to Conservation Districts to ensure a more coordinated and consistent approach to water management within individual watersheds.		X	
	The Province should undertake a study to ensure that drainage practices on private land are consistent with provincial strategy and policy, and how to align drainage practices on private property with the provincial strategy.	Explanation: Undertake a study to determine how the Province can work with private land owners to ensure that drainage practices on private land support (rather than vitiate) the provincial strategy. Methods to achieve this should be explored under the scope of this study, including compensation for preserving wetlands, as well as setting aside public land with appropriate policies limiting development.		X	
	The Province should create a high-level integrated provincial drainage strategy.	This proposed drainage strategy would: 1. Manage wetlands; 2. Require a coordinated, multi-jurisdictional approach; 3. Set policies for drainage practices on private property; 4. Use drains to both move water off of land as well as replenish moisture levels in certain areas, during periods of drought; 5. Identify a realistic and sustainable response; and 6. Implement a long-term management framework. 7. Streamline regulations implementing the Integrated Plan to eliminate redundancy (which can adversely affect response to excess moisture and other extreme weather events). 8. Consider the risks and strategies for dealing with high volume spring melt events, as well as for dealing with the compounding effect of excess moisture events in the summer on waterlogged soil.		X	

Priority	Objective	Explanation / Sub-Topics	Time Frame for Implementation		
			Short-Term (< 2 years)	Medium-Term	Long-Term (6+ years)
	Municipalities should be required to develop a five-year water management plan, as part of longer-term planning.	This should be done in conjunction and with input from the Conservation Districts.		X	
	The Province should initiate a review of policies, programs and initiatives supporting the agricultural industry and used in reaction to historical extreme events, including excess moisture.	Explanation: Historical practice suggests an ad hoc approach to policies. A comprehensive policy review should be undertaken to consolidate, update and simplify the existing regulatory framework. The goal is to clarify the policy context for improved understanding by the general population. The review should address the following areas: • Policy development framework for future extreme events. • Inventory current policies, regulations and programs developed for the agricultural and water resources industries • Evaluate the relative success of each initiative. • Identify obsolete policies, regulations and programs that no longer apply to current issues and recommend they be discontinued. • Identify conflicting policies/priorities between departments and between levels of government. • Consolidate relevant policies, regulations and programs, where possible to simplify and clarify the regulatory framework. • Implement a monitoring and evaluation system to develop a sustainable and responsive		X	
	The Province, in conjunction with Conservation Districts and municipalities, should monitor selected elements and update the Strategy as needed.	The following are the selected elements suggested for monitoring: • Adaptive Capacity • Uptake of programs and implementation of policy recommendations • Technical data, including: Climate change projections, hydrological trends and land use changes (to update projections in hydrologic response to excess moisture events).			X

Priority	Objective	Explanation / Sub-Topics	Time Frame for Implementation		
			Short-Term (< 2 years)	Medium-Term	Long-Term (6+ years)
	The Province needs to be innovative in planning policy and practices that accepts regular flooding in some areas regardless of insurance/funding programs.	Explanation: The current business as usual approach to the management of excess moisture is not sustainable. The Province needs to develop some non-traditional approaches to deal with flooding as a regular occurrence. Insurance / funding criteria for flooding should not remain as the determining factor. This could include a broader policy that recognizes infrastructure and property damage. It is important that policies and programs work with the strengths (and within the confines of) natural systems rather than against them.			X
	The Province should undertake a review of water-related legislation, policy and regulations to develop consistency and determine if changes are required.	Explanation: Stakeholders identified the need to strengthen and clarify water-related legislation and related regulatory framework (i.e. *Water Protection Act*, *Conservation Districts Act*, etc.)/ The Province should also consider shifting responsibility of implementation to a joint effort by the Province and the Rural Municipalities with input from Conservation Districts. Municipal implementation could be accomplished through a Provincial Watershed Management Plan.			X
Coordination	Improve shared (province, municipalities, land owners) understanding of water flows in the region.	Explanation: Improved sharing of information would include AgriInsurance loss information due to excess moisture, to both municipal and provincial stakeholders, to improve planning.	X		
	Accept that flooding may be a regular event, rather than sporadic or occasional events and have budgets and protocols for policy and insurance programs set on this basis.	Explanation: Provincial policies and regulations need to accept flooding as a regular, long-term occurrence and set aside appropriate budgets to address it annually. Emergency-based approach to funding is not sustainable. Further work should be coordinated with land use planning exercise to develop policies that ensure lands that are subject to continuous flooding are left in a natural state as much as possible. Business Risk Management programs should also be reviewed and revised as necessary, to better respond to the impacts of multi-year extreme events.	X		

Priority	Objective	Explanation / Sub-Topics	Time Frame for Implementation		
			Short-Term (< 2 years)	Medium-Term	Long-Term (6+ years)
	Consider options for engaging private land owners in water management practices that are aligned with approved water management practices.	Explanation: The Province, in conjunction with municipalities and Conservation Districts, should consider options for engaging private land owners in water management practices that are aligned with water management practices of Conservation Authorities and Integrated Watershed Management Plans.		X	
	Improve communication of weather pattern information to farmers to assist in applying BMPs.	Explanation: The Province should consider methods for communicating weather pattern information to farmers in certain micro climates that help them apply BMPs to better adapt to changing weather patterns and trends. This should include consideration of current and potential future drainage practices on private land.			
Infrastructure Development	Improve maintenance schedule to better manage the existing drainage system.	Explanation: The maintenance schedule should be part of a rolling multi-year plan by provincial and municipal governments	X		
	The Province should partner with municipal governments and NGO's to identify water management and drainage priority projects for funding.	Explanation: Working with partners will provide the Province with improved access to local issues, including identifying specific drainage priorities and connecting these projects with available funding.		X	
	Ensure that maintenance of municipal and provincial drainage infrastructure is sustainable and regulated on a watershed basis.	Explanation: The Province and municipalities need to ensure that maintenance of municipal drainage infrastructure (i.e., road side ditches, culverts, etc.) and provincial drainage infrastructure (i.e., provincial waterways and highway drainage) is sustainable and should be regulated on a watershed basis. This should be regulated by a responsible party, likely either by: an agency representing collaborating municipalities (part of the same watershed), conservation districts (that will need to be granted the power to do this), or by the province. In addition, the province should undertake an initiative to improve the coordination of drainage standards between municipal and provincial drains.		X	

Priority	Objective	Explanation / Sub-Topics	Time Frame for Implementation		
			Short-Term (< 2 years)	Medium-Term	Long-Term (6+ years)
AGRICULTURAL INDUSTRY					
Funding	Provide for flexible funding to support regular and extreme weather events.	Explanation: The Province, the federal government, municipalities and other institutions need to provide for flexibility in funding to support regular and extreme weather events, by taking into account the probability of repeated extreme events in consecutive years.			X
Coordination	Encourage crop diversification choices based on long-term excess moisture trends in the context of fixed physiographic conditions.	Explanation: Crop choices require current technical data on weather patterns to be available to the agricultural industry on a timely basis. This requires a degree of trust and clarification of expectations between government and producers.	X		
Infrastructure Development	Explore cost-sharing models for drainage systems to ensure the financial burden is not solely with the producer.	Explanation: Explore models to encourage cost sharing of drainage systems between Municipal government and producers such that producers are not required to front-end the capital costs, then wait for repayment to occur (e.g. Cook's Creek drainage which was a coordinated approach).		X	

In addition to these recommendation, we have also provided a compilation of general beneficial practices (or BMPs) available to producers in Table 6.2.

Table 6.2: Summary of Adaptation Options and BMPs for Producers

Approach	Form of Adaptation	Comments	Source
Farm Production Practices	Water conservation measures	Update operating rules of water resource systems. Review need for changes, including timing of irrigation before / after sunset	Lemmen and Warren, 2004
	Adjustment of planting and harvesting dates	Could play a critical role in reducing the losses associated with future moisture conditions	Lemmen and Warren, 2004
	Introduction of new species and hybrids, for example, those that are more resistant to drought and heat	Vegetation that is the most in tune with the evolving climate will require least degree human intervention, and vice versa	Lemmen and Warren, 2004
	Minimum tillage		Sauchyn and Kulshreshtha, 2008
	Crop diversification		Sauchyn and Kulshreshtha, 2008
	Increased storage (for droughts) and diversion (for water surplus)	Involves negative environmental effects including loss of good agricultural lands and natural features (i.e. wetlands)	
	Rainwater Collection systems	For more efficient use of agricultural water resources	Sauchyn and Kulshreshtha, 2008
	Integrated pest management		Belliveau et al., 2006
	Choosing appropriate location to plant	Which side of a hill to avoid frost, or to minimize erosion	
	Greater micromanagement of vineyard	For example: lighten the crop load to divide limited energy among fewer plants, adjust canopy cover as necessary	Belliveau et al., 2006
Farm Financial Management	Budget planning to permit sufficient flexibility to deal with extreme weather / climatic events		Wittrock, 2001
	Drought management plans		Sauchyn and Kulshreshtha, 2008 Belliveau et al., 2006
	Re-invest financial gains after a good year, or put money away for a bad year	Income stabilization	Belliveau et al., 2006

6.2 Implementation

Recommendations are only useful and effective if they are implemented. For these recommendations to be of assistance to the Government of Manitoba and its partner stakeholders the following needs will need to be met:

1. Continuous sustainable **funding** for the maintenance of drainage infrastructure and farm operations. This should be provided both during periods of excess moisture and during times of drought to maintain functionality.

2. A **lead Department or agency** identified and charged with implementation.

3. **Monitoring** changes occurs on a regular and consistent basis through hydrological modeling and review of policy.

4. Changes are **evaluated and modifications made** based on relative success.

7.0 CONCLUSIONS

Excess moisture is affecting the agricultural industry in the Interlake Region of Manitoba. The issues include overwhelming current drainage infrastructure, inadequate maintenance on existing infrastructure, and lack of financial and policy support for producers on a multi-year basis. Using the Icelandic River Watershed as the base for hydrologic modeling and incorporating climate change models, projections indicate that the highest magnitude floods under the climate change scenarios follow some of the general trends of hydrographs currently observed for the Icelandic Watershed. Provided temperatures are low enough for a substantial snowpack to accumulate over the winter, a lack of storage capacity in the soil will result in a large volume of water at the ground surface (i.e. ponding), which will eventually flow downstream to the Icelandic River. This saturated state may persist, exacerbating the effects of precipitation events later in the growing season. Review of the historical stream flow records indicate that there are very few other instantaneous stream flow peaks other than the spring snow melt peak. An excess moisture strategy will largely depend on the ability to deal with spring melt. Should these conditions change, strategies would need to be adapted to the new conditions. The concentration of peak flows at the spring snow melt provides for some effort to be focused at this time of year, as opposed to spreading the effort over a longer period. Focusing on the spring snow melt should result in a more efficient and effective use of resources, but still have to be mindful of cumulative extreme precipitation events in the summer.

Managing the effects of excess moisture within the Province of Manitoba will require a coordinated and multi-year approach, including evaluating policy effectiveness, reviewing funding programs for consistency and sustainability, obtaining government acknowledgement that excess moisture events will pose significant problems for the agricultural sector in the future. Stakeholder feedback has identified the need for a shift from reactive policies and programs, created on an event-basis, to responsive ones, where producers are consulted regularly by policy-makers in order to understand current conditions.

Implementation is the key to the success of this initiative. This study provides a strong basis for the creation of a Strategy to Manage Excess Moisture, including literature review of best practices, and key information provided by stakeholders most directly affected by this issue. Moving forward, this study has identified several short, medium and long-term priorities which provide guidance to policy-makers to make positive changes to the Province's policy and financial framework that should seek to improve the current environment to one of responsiveness. To achieve this in a successful way, regular evaluation of policies and programs followed by monitoring of any changes into the future, through hydrological modeling and policy review, will remain key tasks.

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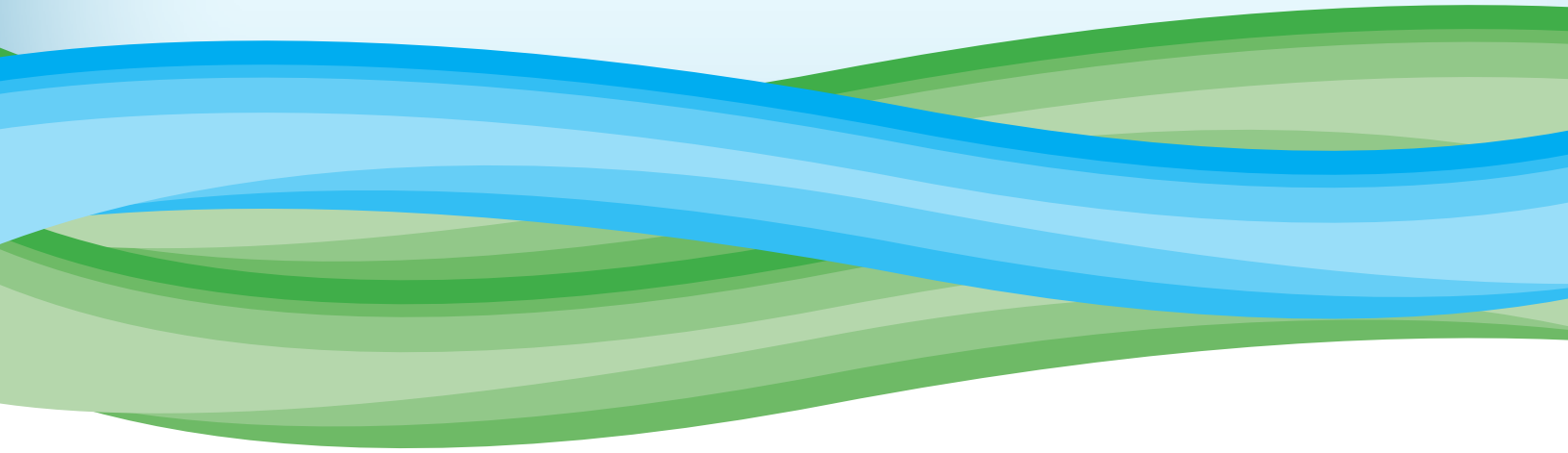
Appendix **A**

Stakeholder List and Introductory Letter

D14-012-012



D14-012-012

Manitoba Interlake Moisture Study									
Stakeholder List									
Title	First Name	Last Name	Group	Email	Phone	Address	Town	Postal Code	Watershed
Municipality/Town Village									
Reeve	Garry	Wasylowski	RM of Armstrong	rmofarmstrong@highspeedcrow.ca	204-278-3377	Box 69	Inwood, MB	R0C 1P0	Icelandic/Willow Creek/West Interlake/Netley-Grassmere
Reeve	Harold	Foster	RM of Bifrost	bifrost@mts.net	204-376-2391	Box 70	Arborg, MB	R0C 0A0	Icelandic
Reeve	Richard	Hyde	RM of Fisher	rmoffisher@mts.net	204-372-6393	Box 280	Fisher Branch, MB	R0C 0Z0	Icelandic
Mayor	Randy	Sigurdson	Town of Arborg	townofarborg@mts.net	204-376-2647	Box 159	Arborg, MB	R0C 0A0	Icelandic
Mayor	Colin	Bjarnasson	Village of Riverton	vilofriv@mts.net	204-378-2281	Box 250	Riverton, MB	R0C 2R0	Icelandic
Reeve	Arne	Lindell	RM of Eriksdale	admin@eriksdale.com	204-739-2666	Box 10	Eriksdale, MB	R0C 0W0	Icelandic
Planning Districts									
Mr.	Don	Rybachuk	Fisher Armstrong Planning District	rmofarmstrong@highspeedcrow.ca	204-372-6393	Box 280	Fisher Branch, MB	R0C 0Z0	Icelandic/Willow Creek
Ms.	Nancy	Thom	Eastern Interlake Planning District	eipd@mts.net	204-642-5478	Box 1758	Gimli, MB	R0C 1B0	Icelandic/Willow Creek
First Nations									
Mr.	Alfred	Anderson	Manitoba Metis Federation (Interlake)	info@ima.ca	204-646-2706	Box 390	St. Laurent, MB	R0C 2S0	All Interlake Watersheds
Stakeholders									
Mr.	Doug	Chorney	Keystone Agricultural Producers	kap@kap.mb.ca	204-697-1140	#203 – 1700 Ellice Avenue	Winnipeg, MB	R3H 0B1	N/A
Mr.	Harold	Foster	East Interlake Conservation District		204-642-7578	Box 1740	Gimli, MB	R0C 1B0	N/A
Mr.	Doug	Oliver	West Interlake Watershed Conservation District		204-383-5887	Box 732	Lundar, MB	R0C 1Y0	N/A
Mr.	Greg	Bruce	Ducks Unlimited (Provincial Office)	g_bruce@ducks.ca	204-467-3301	P.O. Box 1160	Stonewall, MB	R0C 2Z0	N/A
Mr.	Scott	Beaton	Manitoba Habitat Heritage - Interlake Region	mhhc@mhhc.mb.ca	204-471-9663	Box 13 GRP 220 RR2	Winnipeg, MB	R3C 2E6	N/A
Ms.	Sheri	Grift	MAFRI - Land Use Specialist	sheri.grift@gov.mb.ca	204-745-7209	446 Main St.	Selkirk, MB	R1A 1V7	N/A
Mr.	Duane	Guignion	Manitoba Beef Producers	mcpa@mts.net	204-772-4542	154 Paramount Rd.	Winnipeg, MB	R2X 2W3	N/A
Mr.	John	Plohman	Manitoba Agircultural Services Corporation - Chair	mailbox@masc.mb.ca	204-239-2346	400-50-24th St. NW	Portage la Prairie, MB	R1N 3V9	Insurance division address
Ms.	Heather	McBey	Manitoba Forage Seed Association	hmcbey@forageseed.net	204-376-3309	Box 2000	Arborg, MB	R0C 0A0	N/A
Mr.	Brent	McCannell	Manitoba Forage Council		204-726-9393	125 Patterson Cres.	Brandon, MB	R7A 6T7	N/A
Mr.	Bob	Penner	Arborg GO Team Manager		204-641-4910	Box 2000, 317 River Road West	Arborg, MB	R0C 0A0	N/A
Mr.	Dean	Stoyanowski	Farm Production Advisor. North Interlake GO Team		204-641-1588	Box 2000, 317 River Road West	Arborg, MB	R0C 0A0	N/A
Mr.	Eric	Fridfinnson	Bifrost Agricultural Sustainability Initiative Committee	Efridfin@lakenet.ca	204-642-2074	Box 877	Arborg, MB	R0C 0A0	Icelandic/Washow Bay Creek
Dr.	Selena	Randall	Research Development Coordinator, Watershed Systems Research Program, University of Manitoba			322 Ellis Building, 13 Freedman Cr.	Winnipeg, MB	R3T 2N2	
Mr.	David	Lobb	Senior Research Chair, Watershed Systems Research Program, University of Manitoba		209-474-9319	13 Freedman Cr.	Winnipeg, MB	R3T 2N2	
			Prairies East Sustainable Initiative Inc.	prairies.east@gmail.com		Box 2000	Arborg, MB	R0C 0A0	
			Interlake Development Corporation	info@interlakedevelopment.com	204-641-1171	Box 689	Arborg, MB	R0C 0A0	N/A
Dr.	Danny	Blair	Prairie Adaptation Research Collaborative	manitoba@parc.ca					N/A
Mr.	Kyle	Foster		kyle.foster@lakenet.ca	204-364-2417	Box 691	Arborg, MB	R0C 0A0	
Mr.	Len	Loewen		loewenlen@gmail.com	204-378-2771	Box 254	Riverton, MB	R0C 2R0	
Mr.	Brian	Johnson		bjohnson@johnsonseeds.com	204-376-5228	Box 205	Arborg, MB	R0C 0A0	
Mr.	David	Schettler		bschettl@mts.net	204-378-2830	Box 2000	Arborg, MB	R0C 0A0	

Indicated an Agricultural Producer

MMM Group Limited
Suite 111-93 Lombard Avenue
Winnipeg, MB R3B 3B1
t: 204.943.3178 | f: 204.943.4948

www.mmm.ca

November 1, 2011 Ref. No. 14.11225.001

Dear Sir/Madam,

Re: Manitoba Interlake Excessive Moisture Study

Manitoba Conservation and Manitoba Agriculture, Food and Rural Initiatives (MAFRI) have retained MMM Group Limited (MMM) to consider the potential effects of moisture from extreme weather (i.e. precipitation, rapid snow melt, etc.) on agricultural productivity in the Interlake Region. The focus of the study is on periods of excessive moisture or drought. MMM is modeling various scenarios based on anticipated changes in the Icelandic Watershed and would like to get your thoughts and experiences about the agricultural community through a key stakeholder workshop.

MMM is focusing its efforts on the Icelandic Watershed; looking at drainage and agricultural practices found within its boundaries (see attached Figure). The goal of the key stakeholder workshop is to share information with you, to discuss current attitudes, techniques and past experiences that have affected the agricultural industry in the region. MMM will use the feedback from this workshop to inform the development of a provincial strategy to help address the effects of excess moisture on agriculture. This will provide Manitoba Conservation with an initial understanding of best practices to deal with future extreme moisture or drought scenarios. Those invited to this workshop represent interest groups, local municipal governments and technical specialists.

What: Manitoba Interlake Excessive Moisture Study – please RSVP by November 12, 2011

When: Wednesday, November 16, 2011 from 10:00 a.m.-2:00 p.m. – Lunch will be provided

Where: Arborg Bifrost Community Centre - 409 Recreation Centre, Arborg, Manitoba

RSVP: Laura Dainard at (204) 943-3178 or dainardl@mmm.ca by November 12, 2011

If you have any additional questions, please feel free to contact David Jopling directly at (204) 272 2032. If you are unable to attend please advise if there is an alternate contact who could come in your place. We look forward to having you participate in this process.

Yours very truly,
MMM Group Limited

Michael Sullivan, M.Pl., MCIP
Senior Environmental Planner

Enclosure

cc. Tony Szumigalski, Manitoba Conservation
Natalie Ducharme, MMM Group

Monday, October 03, 2011 4:10:21 PM
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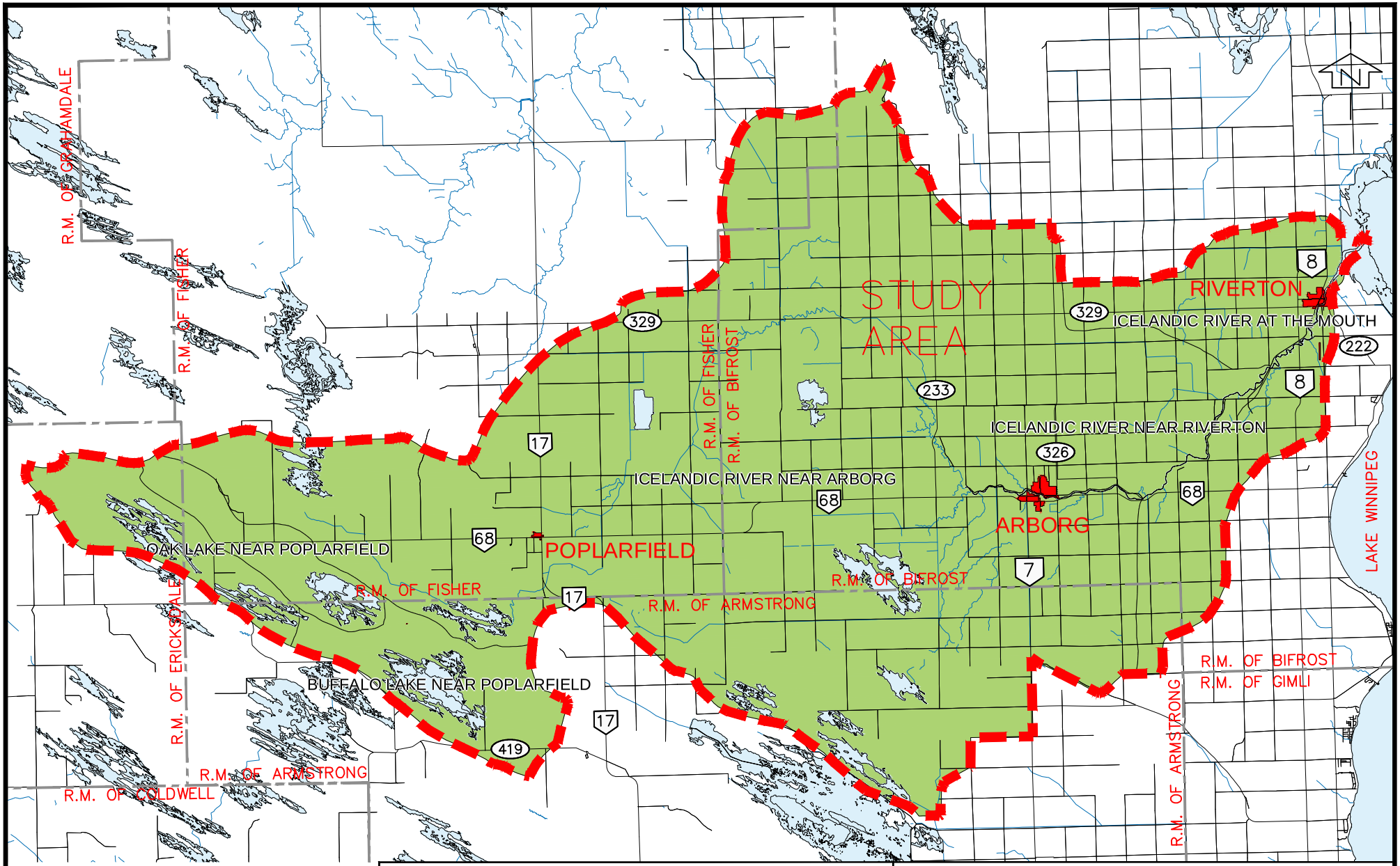


NOTE:
These design documents are prepared solely for the use by the party with whom the design professional has entered into a contract and there are no representations of any kind made by the design professional to any party with whom the design professional has not entered into a contract.

MMM GROUP

MMM Group
5151 - 3rd Street S.E.
Calgary, AB T2H 2X6
t. 403.269.7440
f. 403.269.7422
www.mmm.ca

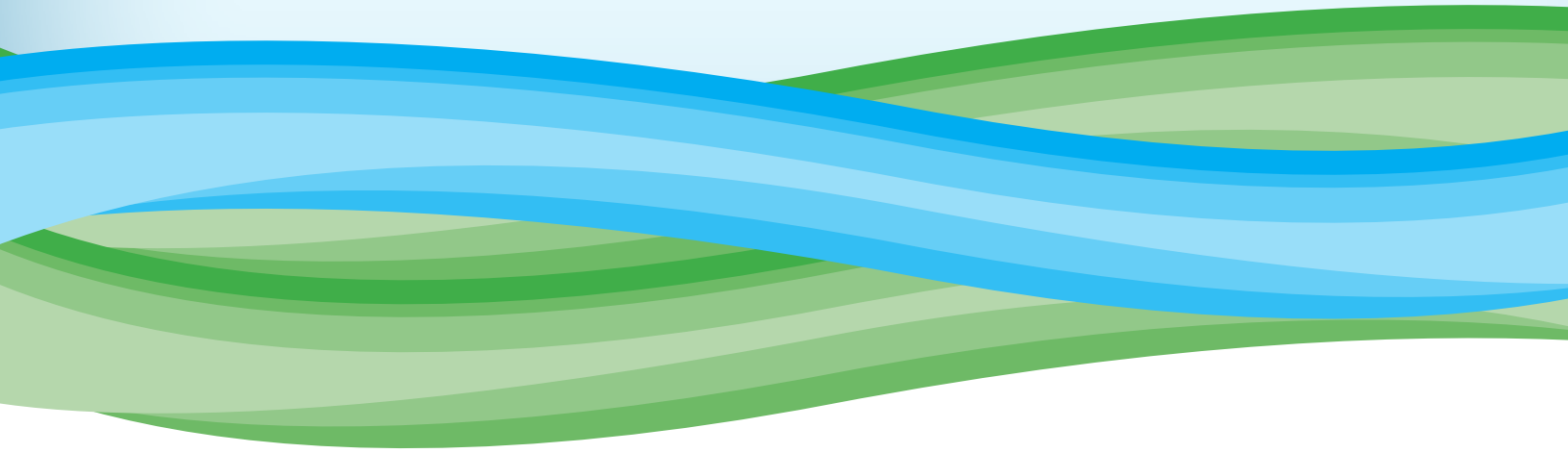
MANITOBA ICELANDIC RIVER WATERSHED

SCALE:	DATE:	DWG. No.
NTS	Oct 3, 11	FIG 1

Appendix **B**

Stakeholder Survey

D14-012-012



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Icelandic Watershed Moisture – Questionnaire

Questions to be posed to Agricultural Producers; Answers will be used to inform the workshop:

1. Have you noticed any changes in weather patterns or climate in your area over the past years that have impacted crop yield or quality?
    a. Yes
    b. No
    c. How/What:

2. What farm management practices have changed as a result of recent changes in the weather patterns? If so, how?

3. What are the top 3 or 4 concerns to Agricultural producers in the Icelandic Watershed currently?

4. What types of programs or policies have been offered in the past to deal with weather pattern or climate change events effects by the government of other agencies? What would you like to see in the future?

5. Which crops do you believe are the most viable in the Icelandic Watershed? Can you see that changing if there were to be an increase/decrease in moisture?

6. Do you believe wetlands, retention ponds, drainage systems are in adequate “supply” in the Icelandic Watershed?

	Questions										
	1	Yes/no?	1	2		2	3		3	4	
	1a.		1b.	2a.		2b.	3a.		3b.	4a.	
Position/Group	1a. Have you noticed any changes in weather patterns or climate in your area over the past years?		1b. If so, how have these impacted your work/community/crop yield or quality?	2a. What land use or ecosystem management has changed in your community as a result of changes in weather patterns?	change?	2. What farm management practices have changed as a result of recent changes in the weather patterns? If so, how?	3a. What are the top three concerns for the community, as they relate to economic livelihood and vulnerability to weather patterns?	Top 3	3b. What are the top 3 or 4 concerns to Agricultural producers in the Icelandic Watershed currently?	4a. What types of programs or policies have been offered in the past to deal with weather pattern or climate change events effects by the government of other agencies? What would you like to see in the future?	
RM of Armstrong	The past three years have seen an abundance of rain, however since early July 2011 there has been little rain. There are no changes in the season length, although spring is seen as being colder and fall is now warmer. The frequency or rain events and the amount of rainfall has increased during 2008-2010. Before, there was often 1/4"-1/2" of precipitation, but more recently it has been 2"-3" and more frequently. In the winter, livestock is affected when it is colder.	Yes	There has been a negative change in crop quality.		yes	The way livestock is being fed has changed. It is difficult to put up quality hay and in come cases it must be rented from other farms. Sliage grain is not grown for grain. The crop this year that is used for pasture was lost in July. The equipment used has changed to front wheel tractors, and overall expenses and maintenance costs have increased over time.	1. Drainage (maintenance is a major issue, improving the standards) 2. Commodity Prices (low cost of product, but the cost of inputs has increased) 3. Provincial drainage system that the municipalities are expected to take over from the province.	1drainage 2Comoditiy prices 3Change of jurisdiction between provincial drainage system to municipalities		There have been a number of programs announced (Forage Restoration, Flooded Lands, and 2010 Feed Shortage Program). Some of the programs work and others only benefit people who choose not to find alternatives. An example would be the Feed Shortage Program which only supplements if the	*Forage Restoration *Flodded Lands *2010 Feed Shortage Program
RM of Fisher	*yes, very wet, nice and dry this fall, but 6 -7 really wet years	yes	no crops for 5-6 year, they were drowned out	*a lot of drainage has been put in, some problems are coming out. A lot of farm land (farm land farmed for >100 years) is sitting in water, because draining water from other lands. Fisher river runs across native comunities, difficult to clean. Draining lands, but when water gets to river, has no where to go because native reserves don't allow water to be put into the river	yes	*	*We need value added industry to try to offset some of the farming, but that doesn't currently exist. Cleaning out the river would be a top priority if could get fed gov't and native communities to buy in to cleaning river and draining river off	1Cleaning river 2Value added industry to offset farming		*hard to say, he's not a major farmer. Got some land under water for last 10 years. There are a lot of programs out there. Not too sure	
Eastern Interlake Planning District	*excess moisture, flooding, with the exception	yes	*building permits for new construction, decline of applications because of content of moisture, most properties were underwater, would need fill, so too much work. Also likely because of the recession	*special circumstances *finanacial aid to flood prone areas, providing grants to raise houses to protect from future flooding, permits are being issued for these types of projects. Weather is a predictor on how much will occurr - ie. Rushing to get permits before the frost.	yes	*decrease of agricultural production, loss of prime agricultural land	*town of winnipeg beach: mostly a resort town - poor weather = low tourism, low beach goers- they put in a new prov park recently. Same for Gimly - because of harbour and beach, they do have a broader base to draw from. Argeddon bifrost, agricultural based - flooding and drought - inability to use prime land.Riverton - some fishing and some limited farming.	1Loss of tourism 2Inability to use prime agricultural land 3Fishing		*water stewardship has made changes to act to increase elevation of buildings, flooding happens during the high October winds - example: willow island, a causeway that you drive to a higher elevation in the middle of the lake. Higher lake levels = shorter distance to shore, therefore winds can blow these in. Helping municipalities identify these areas, needs to be done to limit development there	*Changes to the act to increase elevation of buildings *Need to help identify flood prone areas - sometimes due to wind
Manitoba Metis Federation (Interlake)	yes - floodout out in St. Vernont	yes	community lost housing, tax base on the beaches, people were displaced - permanent so far, looking for accomodation	no, other than the flooding	no		*homes, tax base loss, trying to create employment to re-build the houses	1Loss of homes 2Loss of tax base 3Create employment			
Keystone Agricultural Producers	*over past immediate 2 years - huge amount of rain, 3 years if you go north. This summer 0 rain	yes	*being a farmer - wrecked everything - first year affected farm was 2010 because had seeded everything, since all expenses	*subsequent years, seeded less - about 3/4. Need two really good years to make up for time. Born on the farm - 93 was a year with 2 week stretch with lots of rain. Going into harvest water - but still able to get crop. Other bad year was 2005 - because really wet in the spring time. 2009-2010 never dried up in the fall to do any harvesting, and in the spring residue left therefore couldn't do any more work	yes	no changes - except lots of drainage work been done, but infrastructure can't handle. Creek back-flowed into field into 2010	*drainage is the biggest thing. With amount of rain in 2010, if creeks could have taken rain away. Hydro controls level of lakes near by - they keep it high because can get more power that way. Lack of water management on hydro's part	1Drainage 2Water management		*only thing have really had is crop insurance. Also Ag Stability, but hasn't seen any money from it.	*crop insurance *Ag stability
West Interlake Watershed Conservation District	*most assuredly - now in the 3rd year of 15 wet cycle - water stewardship told us. Still have flooding. Bone dry the rest of the province	yes		*flood mitigation *as conservation district, improving water quality, sealing abandoned wells, etc. Been proactive for past 3 years. Also riparian fences, to keep cows away	yes	*engaging in restoration projects - hayland that was destroyed. Offering prgorams to pay for forage seed	*increased water - driven economy in toilet, ag. And tourist businesses - all businesses along hwy #6. not a lot of incentive to get things done because no money.	1Water management 2Tourism		*province funds their programs, looking at fish habitat in the waterways so better spawning in the waterways. Need to slow the water down to allow for this to happen - looking at spawning shoals, inverting culvert to slow velocity of water. Downtream impact is that you could flood everyone else, so you have	*Need to slow water down for Fish

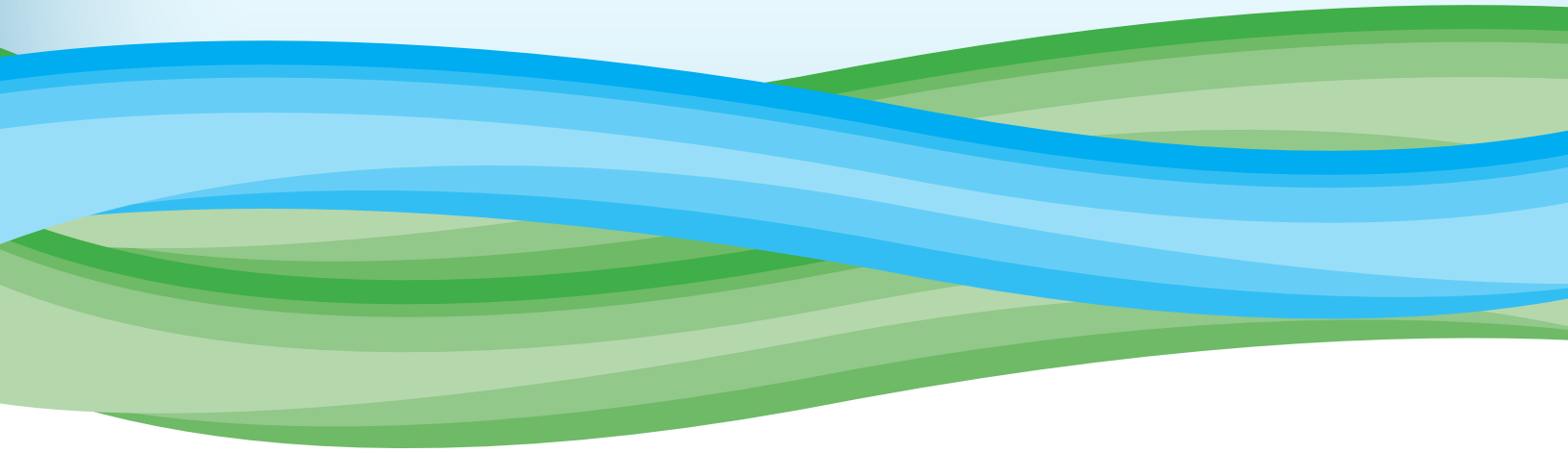
Ducks Unlimited (Provincial Office)	*came from a climate change workshop put on by Manitoba Conservation. *yes - intuitively people are seeing more extremes in weather patterns. Just came out of a flood in the spring	yes	*Planning districts are taking a second look at rules and regulations, individuals and farmers are responding - 90% of wildlife resides on privately owned land. What they are seeing is that farmers are responding naturally - trying to improve drainage infrastructure in their fields. I.e. drainage ditches		n/a		*lost income, lost quality of life (i.e., cottages destroyed because of flooding), significant loss of income (i.e., retirement/savings/quality of life opportunities), fish on lake winnipeg, ice cream vendor (tourism), agricultural producer. Infrastructure - spending $7M to deal with flooding issues - people displaced because of flooding. First nations have been displaced. Tax payers are footing the bill. Takes away from money that could be spent elsewhere.	1Lost income 2Drainage infrastructure 3Displaced homes		*election recently, Oct 4. three of the four parties had platforms on wetlands. Increased awareness of role of wetlands, need for keeping water on the landscape. On climate change side science is grossly unknown. Can become huge emission sources when they are drained. Many of the programs appear to be offset by draining the wetlands. Haven't done much to reduce flood	*wetlands - increase awareness of role. Many programs appear to be offset by draining wetlands
Manitoba Habitat Heritage - Interlake Region	yes	yes		*Yes - has impacted through farming, at Heritage - some programming, wetland restoration and water storage to minimize peak flows - some wetland conservation, more for land maintenance	yes	*starting to grow some covered crops, clover . As a farmer rarely usually "complain" about it as an outlet	*increased flood events and therefore loss of nutrients (leaching), loss of production - restore wetlands - you loose production.	1Flooding 2Loss of production		Going into the future - unsure with what is going on with money for the current program, which is geared towards carbon sequestration - through federal gov't, but not seeing it continue.	
MAFRI - Land Use Specialist	*a lot wetter	yes	*look at thing from agricultural planning perspective (i.e., in terms of land use). Noticed that as a result of wetness, people are applying for more subdivision applications. They can't use the land for agriculture, so try to say they can drain it. Hasn't come up all the time, but in some cases it does come up because of loss of prime agricultural land	*become more difficult for producers to manage their lands, because not just managing for best output but trying to manage from a water perspective.	yes	*have also seen significant impact on crown lands, which are important for cattle producers. They were leased to producers for grazing etc.. Potential long term impacts, i.e., some of the crown lands was re-classified	*first and foremost, people don't want to have to evacuate their residence. Loss of people is a huge concern. Being in emergency mode is exhausting	1Loss of homes 2Loss of people		*Emergency programs that went into effect this year- getting money to farmers or helping to get hay to farmers. IT's been reactive, not proactive. In recent development plans, lots of the (St. andrews, St clement district planning area) land along the water is designated as residential	*emergency programs needs to be proactive
Manitoba Forage Seed Association	Yes, now the weather is much wetter especially in the last 3-5 years. The seasons are later, spring is cooler and because of moisture, some areas have not been farmed in the last 3 years (crops were typically forage seed, wheat and canola with some changed to soya beans). The last draught for the region that was recalled was 8-9 years ago. The area has always been known to be wet and in the past drainage was sufficient, however now things have changed and may be related to climate change.	yes		Soya beans have been added and are now a popular crop. Different seeding practices are used and the type of equipment used. Farmers are returning to tillage from seeding to avoid tracking in the soil and return soil back to better quality for the crops.	yes		1. Adequate drainage systems 2. Maintenance of the existing drains 3. Management systems to be used in wetter conditions 4. Crop rotations, need to be changed for better crops adequate crop safety insurance, because currently as the crop yields decrease, so does the coverage. The agricultural sustainability affects the safety net programs currently in place.	1Drainage 2Crops 3insurance		No specific answer was available, there are ad-hoc programs in place (ex. Forage restoration, safety net programs) but there is no long-term planning that would be of use. The interviewee indicated that all levels of government need to work together to ensure that policies relating to drainage don't contradict each other.	*ad-hoc program in place (forage restoration and saftety net program. No long term planning though
Arborg GO Team Manager, Dept of Agriculture	*yes - flooding, drought	yes	*difficult to get enough hay - lake manitoba flooding, flooded out housing	*programs: helping cow producers buy hay, crop insurance programs for unseeded acres, compensation for farms that are flooded out	yes		*hay production, pasture and cattle feed, inability to get seed into the ground,	1Crop Production 2Livestock feed 3Seed into ground			
Farm Production Advisor. North Interlake GO Team	There has been an above normal number of occurrences of heavy rainfall in the past five growing seasons. The falls are also longer and warmer, but still experience killing frost. The spring season has not seen much change, but in the spring of 2010, water was melting and entering the ditches in March.	yes	In 2005, there was a late crop and harvesting took place in Mid-November . Although there may be warm weather in the early months, frost still prohibits early planting.	Originally, cereal crops were most common (oat/barley), however due to more moisture, soya beans and wheat are now becoming more common in the region. Production has increased tillage in the region. In the 1990's, much of the land was no-till,, but with the change back, producers require new equipment or are using old equipment. The farm equipment used included double disc and offset discs, however newer machinery includes vertical tillage which disturbs the upper layers and does not plug in wet conditions.	yes		1. Excess moisture 2. Infection of cereal crops related to increased moisture and stagnant water (Fusarium is common) 3. Municipal and provincial infrastructure improvements to drainage systems. 4. Crop insurance/agristability changes. Programs that would help more during rough times.	1Flooding 2crop disease 3drainage 4Insurance		There are no known agencies providing programs for the region. The government has given monetary support for farms which had not been seeded or destroyed due to the excess moisture. In 2011, there have been forage restoration and shortfall restoration funding for those affected. In the future, a reliable system that would respond and not require the ad-hoc services would provided more stability to agri-producers in the region.	monetary support/insurance from gov't. forage restoration

Bifrost Agricultural Sustainability Initiative Committee	There is much higher rainfall and it is more frequent. This year, it was wet early in the year with a lack of rain through the summer.	yes	The are more risks in crops with good harvest quality such as wheat. Due to the changes in climate, forage and grass seed (e.g. alfalfa) have almost become obsolete. The current state of municipal and provincial in the area cannot support more extreme weather or climate changes because the lack drainage and were constructed a long time ago. Ongoing maintenance such as clearing, draining and mowing ditches needs to occur. In addition, ditches are now being used for telecommunication towers and gas lines.	Broadcast seeding over past years has resulted in lower crop yields. A lot of work on farm drainage has been done with scrapers and excavation equipment. Cropping patterns have changes, lucrative high risk crops are low yield. Crop mix has changed and now there are many farms with soya beans and oats which are more likely to withstand flooding.	yes		1. Improved water management, especially drainage 2. Programs are needed to provide income stabilization in years where crop production is low. 3. Income needs to become more stable because of the decreased crop production in the area. 4. Credit and debt issues are common and many have severe financial issues because of the industry's troubles. 5. Farm succession (Currently people in their mid 50s may be the youngest people farming in the area)	1Drainage 2Programs 3Lost Income 4Credit and debt 5Farm Succession		Acreage payment for flooded land has been paid. Currently, there is an advance on agri-stability which is deducted from future payments. The agri-stability and crop insurance are reasons why people have stayed in the area. But because people have collected so many times, they are now "empty shelves" that don't offer much support. The average yields for crops have lowered and the crop insurance coverage has also decreased. There have been talks between the Federal and Provincial government to form an Agri-Flex program which would help to solve some of the water management issues in the area; however capital funding is needed to proceed. It was suggested that a strategy should be developed for areas with multi-year cropping difficulties.	Acreage payment for flooded, advance on agri-stability which is deducted from future payments. Crop insurance. Potential Agri-Flex program
	Since approximately 2007, there has been a significant change in the amount of rainfall. There are more rain events over the growing season. The growing season appears to be longer, however because of moisture, they have not gotten on the land any earlier.	yes		Soil requires more 'working' to make it useful. There are next to no inputs into the soil until farmers know that there will be a crop. Seeding now occurs with new tools that can be pulled through the heavily saturated soil. The new equipment is considered an additional expense to farmers.	yes		1. Water management in the region 2. Financial Survival/support 3. Long term plan for seasons where there are no crops in the ground.	1water management 2Income and survivial 3Long term plan for seasons with no crops		There are no programs except the agri-payments and those payments are minimal and hardly cover increased expenses year to year (ex. Rising fuel costs). Potential long term solutions discussed include more reliable and bankable programs for producers, improving drainage, regulating the drainage to ensure it is operational. Potentially consider reducing some restrictions (e.g.. DFO has alot of control over the activities on farms). Many problems associated with drainage in the region have primarily shown up in the last 15 years.	agri-payments. Potential solutions: bankable programs for producers,
	There have been significant changes to the amount of excess moisture in the area. Over the last 10 years, excess moisture from isolated weather events has occurred. The spring and fall have seen a variability in temperature. A positive effect of the changes is that the sub-soil has retained moisture and there is no worry about draughts.	yes	The major impact of the excess moisture is on crop yield and quality.	A major change in farming practices is the need to plant as early as possible in the growing season. As well, there is a shift to new crops. Formerly, peas were grown extensively in the region. Wheat has diminished and there is an increase in soya beans. Higher flotation equipment is required and scrapers are used to minimize losses due to standing water. There is a general realization that there is a lack of drainage infrastructure and water management in the region.	yes		1. Drainage and not being able to handle the water. 2. Collapsing Icelandic River and its increase of water to agricultural land. 3. Because of the lack of infrastructure, rare heavy rainfall (3-4inches at a time), have reduced the ability for water to dissipate of the land. For the past 20 years, these issues have been at the forefront and the culmination of them has resulted in the loss of agricultural land.	1drainage 2collapsing river		The only programs that are of interest are crop insurance and agri-stability. The problem with the programs is that they are only applicable after seeding has occurred. In the future, it needs to be realized that it is not the water that is the problem, but rather that proper drainage is the solution. Solving the issue would benefit farmers and increase the return to taxpayers.	crop insurance and agri-stability
	Since 2006, the weather has changed significantly. The fall season has become longer, but the excess moisture has prevented any late harvesting.	yes	As a result, producer has not been able to seed his land. In 2009-2010, Lake Winnipeg has been a cause for some of the excess moisture due to the high water levels. In the past, crops were on and off the land earlier (harvesting in end of September), but over the last 10-15 years harvesting is occurring in August. Weather patterns have made a difference and plant breeders are looking for earlier varieties to plant.	There is now more tillage in the fall. From approx. 1988-2007, the Ag producer had a certified organic farm. Because of the importance of tillage and growing variety, they did not meet the organic requirements. The equipment has remained the same, however because there are no pesticides used, a new method was adopted. On the pasture land, the pastures are cut earlier and then left for cattle to graze on when it is wet and coll. This is the case on pasture and hay land.	yes		1. Drainage: In the local area, farmers are concerned with RMs not maintaining the drainage. The area is considered a "marginal farming area" because it is bordered by swampland and is five minutes west of Lake Winnipeg. The area is especially concerned with overland flooding because water moves in from the west and south. 2. There is a concern at the Municipal level about overloading the Icelandic River. There are two major drainages that alleviate pressure. They help the Arborg/Riverton area, but north of Riverton there is not as much control.	1Drainage 2Overloading river		Crop Insurance: it works because it keeps up-to-date with weather patterns, however it is not a long term solution. It has been around but only since 2007/2010 has it really become on the forefront. Many farmers would like to see some return on even a minimal amount of their land if only a portion of the land can be seeded. R&D is a potential solution or may aide in a solution. Currently, much of the research is looking at drought tolerant crops. In the Interlake region, crops that are moisture tolerant need to be considered.	crop insurance (but not a long term solution).

Appendix C

Workshop Materials

D14-012-012



D14-012-012

Contact	First Name	Last Name	Group	RSVP	Reason for Not Attending
ND	Garry	Wasylowski	RM of Armstrong	yes	
ND	Harold	Foster	RM of Bifrost	yes	
LC	Richard	Hyde	RM of Fisher	yes	
LC	Randy	Sigurdson	Town of Arborg	yes	
LC	Colin	Bjarnasson	Village of Riverton		
LC	Arne	Lindell	RM of Eriksdale		
LC	John	Livingstone	Fisher Armstrong Planning District	yes	
LC	Nancy	Thom	Eastern Interlake Planning District	Maybe	
LC	Alfred	Anderson	Manitoba Metis Federation (Interlake)	yes	
LC	Doug	Chorney	Keystone Agricultural Producers	no	Prior commitment on that day. Alternate attending.
LC	Harold	Foster	East Interlake Conservation District		
LC	Doug	Oliver	West Interlake Watershed Conservation District	no	unable to attend; the study doesn't include much of their CD
LC	Greg	Bruce	Ducks Unlimited (Provincial Office)	maybe	waiting on confirmation of who is attending/agenda
LC	Scott	Beaton	Manitoba Habitat Heritage - Interlake Region	yes	
LC	Sheri	Grift	MAFRI - Land Use Specialist	yes	
ND	Duane	Guignion	Manitoba Beef Producers		
LC	John	Plohman	Manitoba Agircultural Services Corporation - Chair	no	Representative sent in his place.
ND	Heather	McBey	Manitoba Forage Seed Association	no	Board meeting scheduled for that day.
LC	Brent	McCannell	Manitoba Forage Council		
LC	Bob	Penner	Arborg GO Team Manager	no	Prior commitment on that day.
ND	Dean	Stoyanowski	Bifrost Agricultural Sustainability Initiative Committee	yes	
ND	Eric	Fridfinnson	Research Development Coordinator, Watershed Systems Research Program, University of Manitoba	yes	
LC	Selena	Randall	Senior Research Chair, Watershed Systems Research Program, University of Manitoba	no	Prior commitment on that day.
LC	David	Lobb	Prairies East Sustainable Initiative Inc.	no	Prior commitment on that day.
LC	TBD	TBD	Prairie Adaptation Research Collaborative		
LC	TBD	TBD	Interlake Development Corporation	No	A representative will notify us if this changes.
LC	Danny	Blair		no	Prior commitment on that day.
ND	Kyle	Foster	Producer	no	Prior commitment on that day.
ND	Len	Loewen	Producer	no	out of town
ND	Brian	Johnson	Producer	yes	
ND	David	Schettler	Producer	yes	
Recently Added Participants					
ND	Josh	Brandon	Climate Change Connection/MB Eco-Network	yes	
ND	Anika	Terton	Climate Change Connection/MB Eco-Network	yes	
ND	Sacha	Kopelow	Climate Change Connection/MB Eco-Network	yes	
ND	Paul	Bullock	University of Manitoba	no	Prior commitment on that day.
ND	Curtis	McCrae	Keystone Agricultural Producers	yes	
LD	Brian	Johnson	Manitoba Agircultural Services Corporation	yes	In place of John Plohman
ND	Marvin	Magnusson	RM of Bifrost Ward 1	yes	
ND	Gordon	Klym	RM of Bifrost Ward 2	yes	
ND	Darvin	Firman	RM of Bifrost Ward 3	yes	
ND	David	Shott	RM of Bifrost Ward 4	yes	
ND	Richard	Chomokovski	RM of Bifrost Ward 5	yes	
ND	Donald	Vigfusson	RM of Bifrost Ward 6	yes	

Manitoba Interlake Excessive Moisture Study
November 16, 2011

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Manitoba Interlake Excessive Moisture Study
November 16, 2011

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GINA WASYLOWSICZ	Box 57 FRASERWOOD	643-5390	WASGEM@LAKENET.CA
DAVID SCHEFFER	BOX 672 ARBORG	378-2830	
T. MACONACHIE	BOX 1160 STONEWALL	467-3268	t.maconachie@ducks.ca.

Management of Excessive Moisture in the Manitoba Interlake Region

Workshop

Wednesday, November 16

Arborg Community Centre, Manitoba

MMM GROUP

Workshop Agenda

Time	Item	Details	Length
10:00	1	**Arrival and Coffee**	10 min.
10:10	2	**Introductions**	10 min.
10:20	3	**Presentation**	30 min.
10:50	4	**Workshop Round Table A: Identify Current Issues & Challenges**	30 min.
11:20	5	**Workshop Round Table B: Summarize and Evaluate Past Solutions & Approaches**	40 min.
Noon	6	**Lunch Served**	45 min.
12:45	7	**Workshop Round Table C: Future Opportunities and Challenges**	45 min.
1:30	8	**Summary and Wrap-up**	30 min.

Excess Moisture

What is Excess Moisture?

- The moisture condition in the soil layer directly responsible for agricultural production. Excessive moisture would occur in the form of liquid water at the soil surface, filling in the surface depression, as well as saturating the soil surface below for extended periods of time.

Excess Moisture

Causes:

- Increased intensity
- Greater extremes
- Reduced permeability

Effects:

- Property damage
- Reduced crop yield
- Loss of top soil
- Increased health and safety risks

How do we see it?

- Intense precipitation (snow, rain, sleet)
- Extended ponding / prolonged soil saturation.

NOAA

Climate Change

Working Definition and Understanding:

- *"…a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."*

  - IPCC 4th Report, 2007

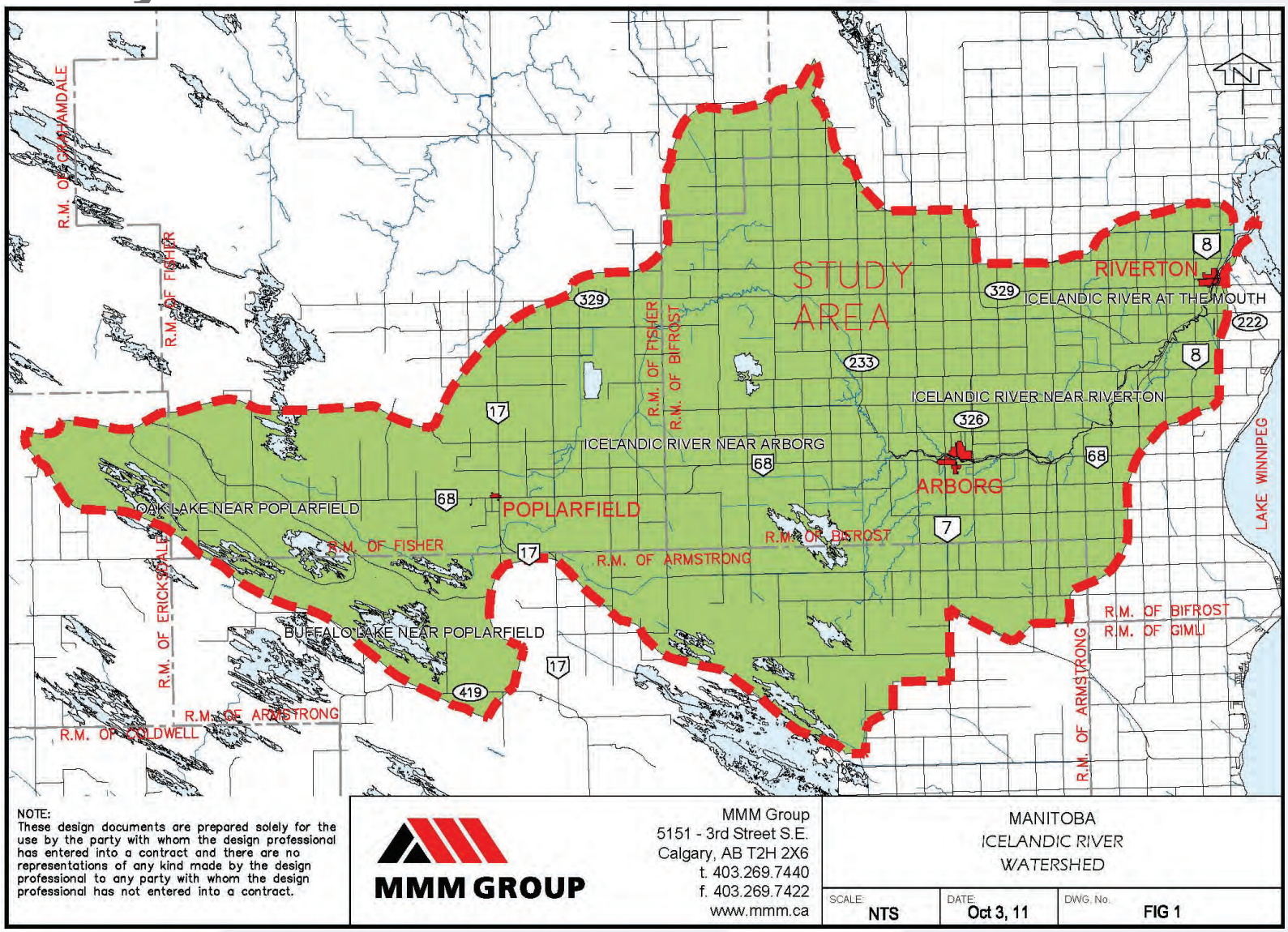
Visible effects in Manitoba:

- Greater warming in the winter than in other seasons
- Less frequent rain events leading to increased likelihood of drought
- Changes in land use in sensitive arid areas
- Decreased summer flows in Prairie Rivers, from reduced water supply from snowmelt and glacier runoff
- Increased per event precipitation
- Higher probability of severe flooding

} Excess Moisture

Manitoba's Interlake Region

Study Area: Icelandic River Watershed



Why the Interlake Region?

Background:

- Represents a wide variety of agricultural industries and practices
- *" Manitoba's Interlake region … exhibits the lowest ranking (53rd) for adaptive capacity [to climate change]…"*
  - Indicators of Adaptive Capacity to Climate Change for Agriculture in the Prairie Region of Canada, 2007
- **Adaptive capacity** is the ability/capacity of an area to adapt if the area's environment is changing.

Key Question:

- How can we improve adaptive capacity?

Answer:

- Through studies like this that involve:
  - Learning from other jurisdictions
  - Identifying local and regional climate patterns using modelling
  - Listening and learning from local communities
  - Applying this combined knowledge to a Strategy

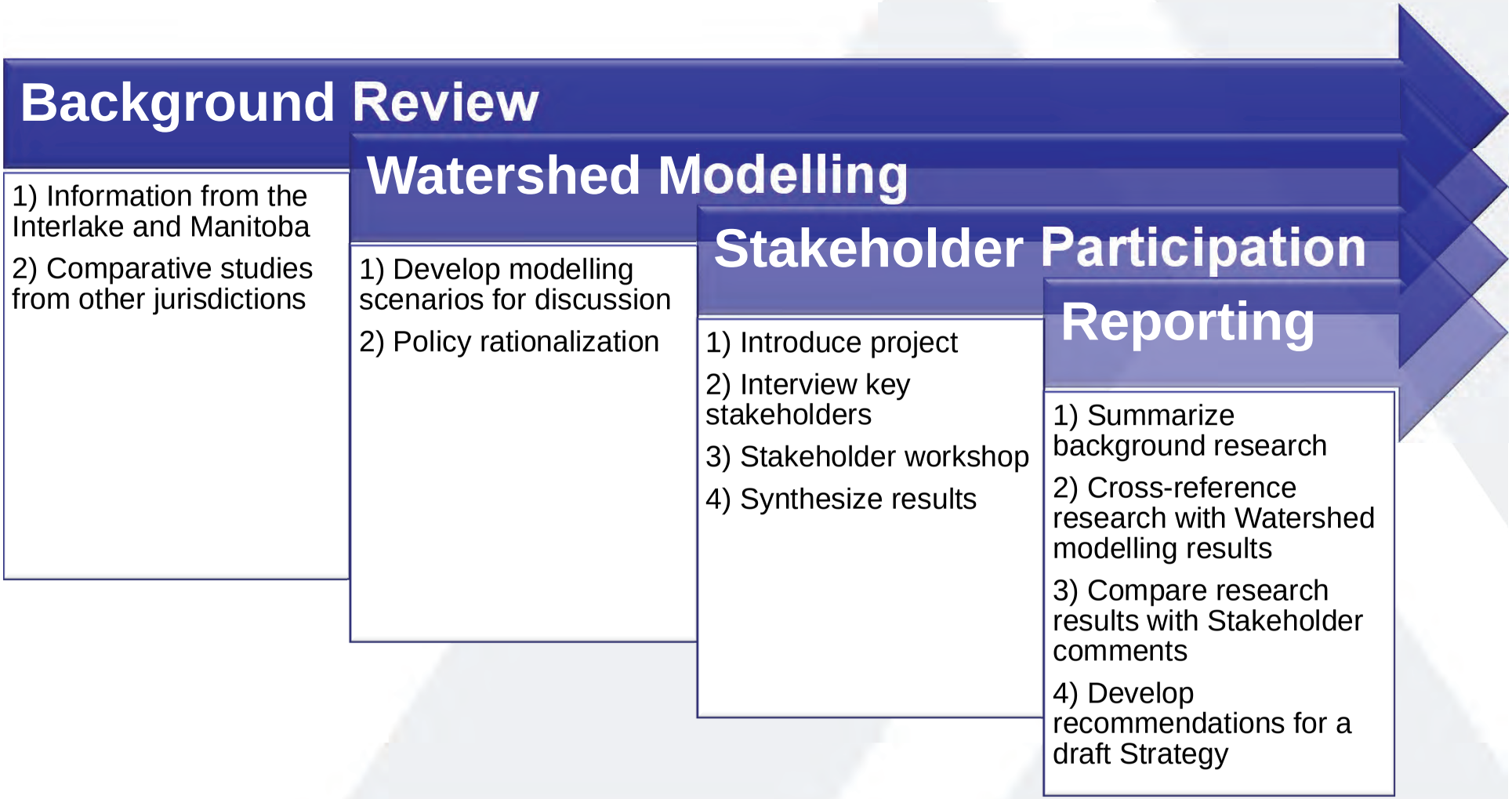
Project Objectives

1. Evaluate Risks from Excess Moisture on Farmlands

2. Identify Potential Effects Associated with Modelling Scenarios

3. Prepare recommendations to assist in development of a Provincial Strategy

Project Work Plan



Relationship to Climate Change

1. Accepts that extreme weather events are occurring and a coordinated strategy is needed to deal with it.
   - *Regardless of the cause of these events*

2. Aims to:
   - recommend adaptive strategies that can be employed in policies to:
     - respond to observations
     - anticipate, prepare and adapt for the events that may be observed

3. Objective:
   - To solve an identified or perceived problem based on local and/or regional observations

Relationship to Climate Change

1. No Regrets approach:
   - *Recommendations that are beneficial regardless of future weather conditions will be favoured over recommendations that depend on specific climate outcomes*

Adaptation strategies do not depend on an understanding of the cause of circumstances. They depend only on recognition of the need for a response.

Watershed Modeling

Purpose:

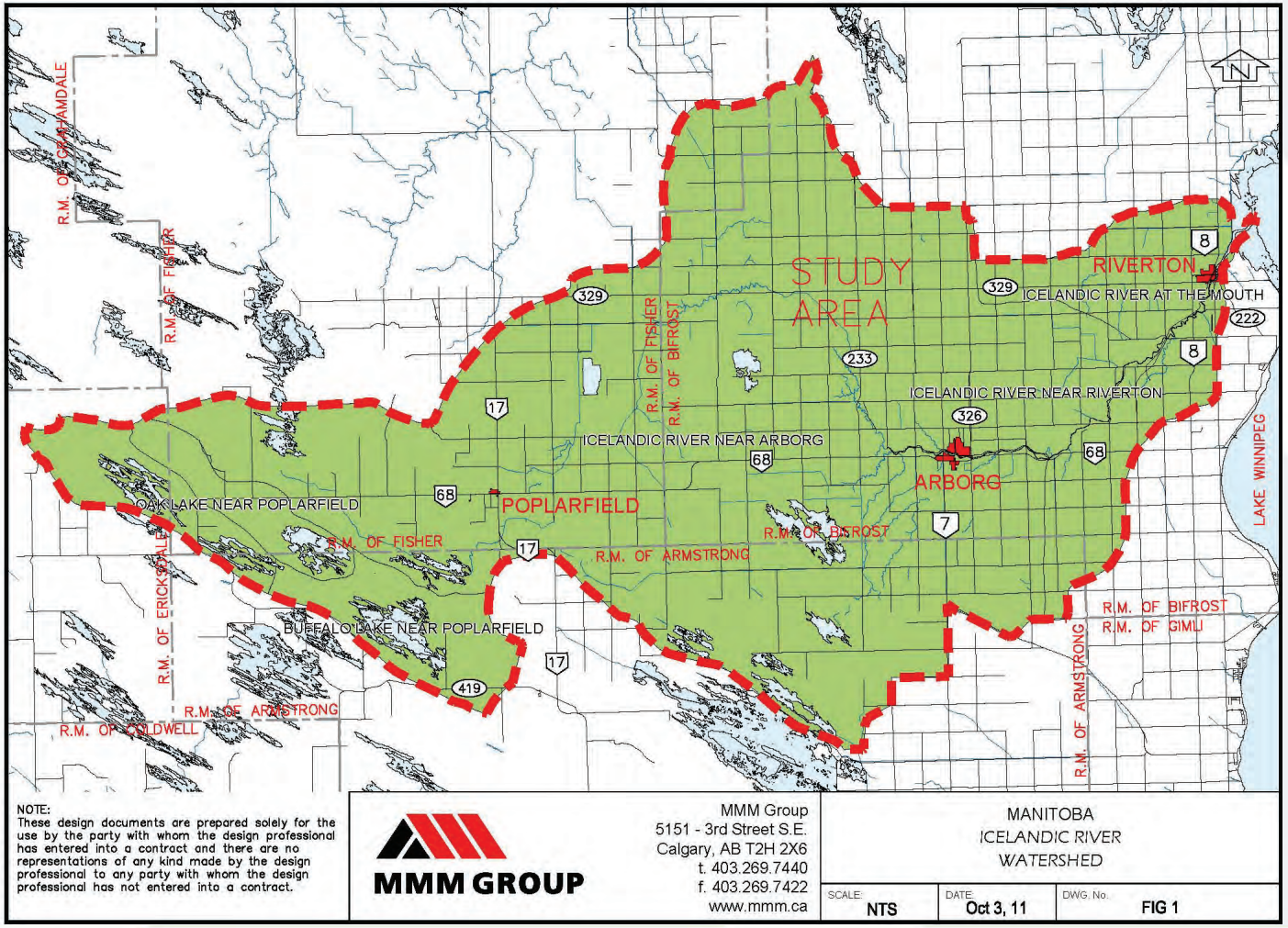
- To rationalize policy recommendations with a projected range of extreme weather scenarios, based on climate change projections.

Steps:

- Calibrate the watershed model using historic data
- Conduct a sensitivity analysis using weather and hydrologic variables (evapotranspiration, precipitation, temperature, and soil moisture) to:
  - determine the watershed`s resilience to projected changes in weather patterns.
- Use projected temperature changes consistent with the IPCC 4th Assessment Report to model future scenarios.

Watershed Modeling

Study Area – Icelandic River Watershed



Consultation Methods

- Environmental scan
  - Learn from successes of other jurisdictions
  - Identify common issues
  - ‘Highlight’ areas requiring further investigation
- Project Steering Committee Meetings
  - Government specialists (MAFRI, MConservation, Water Services, etc.)
  - MMM Consulting team
- Telephone calls and emails with:
  - Agricultural Producers
  - Agency/Associations with an interest/stake
- Stakeholder Workshop
  - Provide a series of discussion questions raised-to-date
  - Engage in a dialogue to gain local and industry knowledge
  - Identify ideas that will lead to practices and policies for the Provincial Strategy.

Consultation Objectives

- Encourage active participation leading to engagement to:
  - Identify and address concerns related to excess moisture
  - Identify issues of local concern
  - Confirm project findings to date
- Provide policy recommendations to:
  - Increase adaptive capacity for drought and excessive moisture
  - Identify issues common to larger areas within the Province
  - Develop a provincial strategy for managing excess moisture
- Gain local community knowledge by:
  - Generating a series of discussion questions
  - Host a workshop to enable discussions

Consultation – Preliminary Findings

Weather Observations:

- Increased Flooding and Droughts
- Higher frequency of heavy rainfall events
- Changes in the length of seasons

Observed Effects:

- Loss of crop production
- Loss of prime agricultural land
- Changes to the types of crops grown
- Displaced wildlife
- Planning Districts re-examining rules and regulations
- Lost housing and property damage, displaced people
- Decreased number of applications for building permits

Consultation – Preliminary Findings

Local Adaptation Strategies

- Flood mitigation
- Water quality protection (sealing abandoned wells)
- Riparian area fencing
- Restoration Projects: hay land, agricultural land, Wetland Restoration Incentive Program

Provincial and Federal Adaptation Strategies

- Financial help:
  - Crop Insurance Programs for unseeded acres
  - Compensation for farms that are flooded out
  - Grants to elevate houses to protect them from future flooding

Summary of Today's Event

- Introduced the project
- Defined excess moisture
- Linked excess moisture to climate change
- Rationale for the study area
  - Interlake Region
  - Icelandic Watershed
- Introduced the Project Work Plan
- Reviewed watershed modelling
- Consultation-to-date
  - Methods used
  - Preliminary findings
- Introduce the Workshop

Project Next Steps

Project Steps	Completion Date
Stakeholder Workshop	November 16, 2011
Workshop Comments and Feedback	December 5, 2011
Draft Strategy Report	January/February 2012
Final Strategy Report	February/March 2012

Interlake Region
Excess Moisture Study
Stakeholder Workshop

Questions?

Workshop Overview

- Work collectively in groups on brainstorming and thinking out side the box
- Listen to each other respectfully
- Learn from others
- Share your ideas
- Law of Two Feet
- The Four Principles:
  - Whoever comes are the right people
  - Whenever it starts is the right time
  - When it's over, it's over
  - Whatever happens is the only thing that could happen
- FOCUS on the High Level Issues don't get lost in Details
- Goal: To create Policy Recommendations

Today's Discussions

Workshop Round Table A:

Issues and Challenges

1. What are the primary issues and challenges from weather changes that are impacting agricultural producers (cropping, livestock, specialized ag., etc.) in the Icelandic Watershed? Explain the impact it has had.

2. Rate the impacts from most significant to least significant (dot voting)

3. Are these similar to issues generally across the Interlake area? Or across the province in other agricultural areas in Manitoba?

Workshop Round Table B:

Typical Solutions or Responses to Excess Moisture

1. What has been the typical way that excess moisture has been addressed in the past by:
   - farmers/producers,
   - agencies,
   - municipal government,
   - provincial government, and
   - Federal government

2. Are these methods appropriate or should they be altered?

Workshop Round Table C:

Future Opportunities

1. What are some examples (techniques, programs, strategies, etc.) that you are familiar with that may be explored to assist farmers to address impacts from extreme weather events?
    1. Would there be any other implications from the implementation of these?

2. What can farmers do to better protect themselves from the challenges resulting from extreme weather events (flooding, erosion, etc.)?

3. Do you have any policy recommendations to help address these issues?

Interlake Region
Excess Moisture Study
Stakeholder Workshop

THANK YOU!!

Don't Forget the Exit Survey

Contact:
Natalie Ducharme
MMM Group, Winnipeg
ducharmen@mmm.ca
204-943-3178

Exit Survey
November 16, 2011

Please take a minute to comment on today's workshop. We appreciate your input.

Did you find the workshop today useful and/or educational?

☑ Yes ☐ No

How did you find out about the workshop?

☑ 1. Direct Invitation – Mail or Email

☐ 2. Referred by Organization, RM, or Town

☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

Have more input from policy makers ~~on~~ so they are able to recieve comment or add comments.

Include some producers who may have input on what may work.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Exit Survey
November 16, 2011

Please take a minute to comment on today's workshop. We appreciate your input.

Did you find the workshop today useful and/or educational?

☑ Yes ☐ No

How did you find out about the workshop?

☐ 1. Direct Invitation – Mail or Email

☑ 2. Referred by Organization, RM, or Town

☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

Studies on Water Controls and
Change to Insurance Policys

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Exit Survey
November 16, 2011

Please take a minute to comment on today's workshop. We appreciate your input.

Did you find the workshop today useful and/or educational?

[X] Yes [ ] No

How did you find out about the workshop?

[ ] 1. Direct Invitation – Mail or Email

[ ] 2. Referred by Organization, RM, or Town

[X] Other: (Please indicate) PRRC project committee member.

Do you have any further comments about the workshop?

Good workshop. Good participation from stakeholders. Diverse ideas presented.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Exit Survey
November 16, 2011

Please take a minute to comment on today's workshop. We appreciate your input.

Did you find the workshop today useful and/or educational?

☑ Yes ☐ No

How did you find out about the workshop?

☑ 1. Direct Invitation – Mail or Email

☐ 2. Referred by Organization, RM, or Town

☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

GOLD SESSION. WE NEED MAJOR POLICY CHANGES TO MAKE WATER MANAGEMENT WORK. MUST THINK OUTSIDE THE BOX.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Exit Survey
November 16, 2011

Please take a minute to comment on today's workshop. We appreciate your input.

Did you find the workshop today useful and/or educational?

[X] Yes (kind of) [ ] No

How did you find out about the workshop?

[ ] 1. Direct Invitation – Mail or Email

[ ] 2. Referred by Organization, RM, or Town

[X] Other: (Please indicate) Referred by Steering Committee member

Do you have any further comments about the workshop?

- Good workshop. good location., good timing
- Report back to participants on outcome of workshop and of the larger strategy/report
- BASIC project with LiDAR data will help determine the best place to store water
- Landowners should recieve compensation to store water
- Need to fit into Provincial strategy for wetland policies, shoreline management or surface water mgt.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Exit Survey
November 16, 2011

Please take a minute to comment on today's workshop. We appreciate your input.

Did you find the workshop today useful and/or educational?

☑ Yes ☐ No

How did you find out about the workshop?

☑ 1. Direct Invitation – Mail or Email

☐ 2. Referred by Organization, RM, or Town

☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

INTERESTING MIX OF PARTICIPANTS WHICH MADE FOR SPIRITED, EDUCATIONAL AND WIDE-RANGING DISCUSSIONS AND IDEAS!

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Exit Survey
November 16, 2011

Please take a minute to comment on today's workshop. We appreciate your input.

Did you find the workshop today useful and/or educational?

☑ Yes ☐ No

How did you find out about the workshop?

☑ 1. Direct Invitation – Mail or Email

☐ 2. Referred by Organization, RM, or Town

☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

- NOW THAT WE'VE ESTABLISHED VARIOUS FOCUS POINTS, A FURTHER WORKSHOP WITH MORE DIRECTED DISCUSSION WOULD BE USEFUL
- DIRECTED DISCUSSION TO COME UP W/ ACTION AREAS TO ACCOMPLISH ACTUAL RESULTS.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Exit Survey
November 16, 2011

Please take a minute to comment on today's workshop. We appreciate your input.

Did you find the workshop today useful and/or educational?

☑ Yes ☐ No

How did you find out about the workshop?

☑ 1. Direct Invitation – Mail or Email

☐ 2. Referred by Organization, RM, or Town

☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

VERY GOOD. WILL HOWEVER BE VERY DIFFICULT TO MAKE DECISIONS / A MODEL BASED ON THIS AREA.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Exit Survey
November 16, 2011

Please take a minute to comment on today's workshop. We appreciate your input.

Did you find the workshop today useful and/or educational?

[X] Yes [ ] No

How did you find out about the workshop?

[X] 1. Direct Invitation – Mail or Email

[ ] 2. Referred by Organization, RM, or Town

[ ] Other: (Please indicate) _____

Do you have any further comments about the workshop?

a bit more time for discussion (I know this is always hard)

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

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November 16, 2011

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☒ Yes ☐ No

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☐ 2. Referred by Organization, RM, or Town

☒ Other: (Please indicate) through another organization

Do you have any further comments about the workshop?

We needed more expertise at the table.

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☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

GOOD DISCUSSION AT MY TABLE. WORKSHOP WAS WELL SET UP AND WELL RUN.

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☑ Other: (Please indicate) Steering Committee Member.

Do you have any further comments about the workshop?

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November 16, 2011

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☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

It was interesting working at the table, and hearing from the other participants
- The introductory remarks were incomplete

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☐ 2. Referred by Organization, RM, or Town

☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

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November 16, 2011

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☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

Interesting day -

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☑ Yes ☐ No

How did you find out about the workshop?

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☐ 2. Referred by Organization, RM, or Town

☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

I thought we were here to talk about water problems for Lanigan. What was Perdue Unlimited doing here. Please remember who is being hurt by this excess water.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

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November 16, 2011

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How did you find out about the workshop?

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☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

- We need annual workshops like this.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

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November 16, 2011

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Did you find the workshop today useful and/or educational?

- [x] Yes
- [ ] No

How did you find out about the workshop?

- [ ] 1. Direct Invitation – Mail or Email
- [x] 2. Referred by Organization, RM, or Town
- [ ] Other: (Please indicate) _____

Do you have any further comments about the workshop?

Good functions – Very open group + lots came forward.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Exit Survey
November 16, 2011

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Did you find the workshop today useful and/or educational?

☑ Yes ☐ No

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☑ 2. Referred by Organization, RM, or Town

☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

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Exit Survey
November 16, 2011

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☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

Hope that cooperation and good decisions can be used to make better water use plans.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Exit Survey
November 16, 2011

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☐ Other: (Please indicate) _____

Do you have any further comments about the workshop?

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How did you find out about the workshop?

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☑ Other: (Please indicate) Steering Committee.

Do you have any further comments about the workshop?

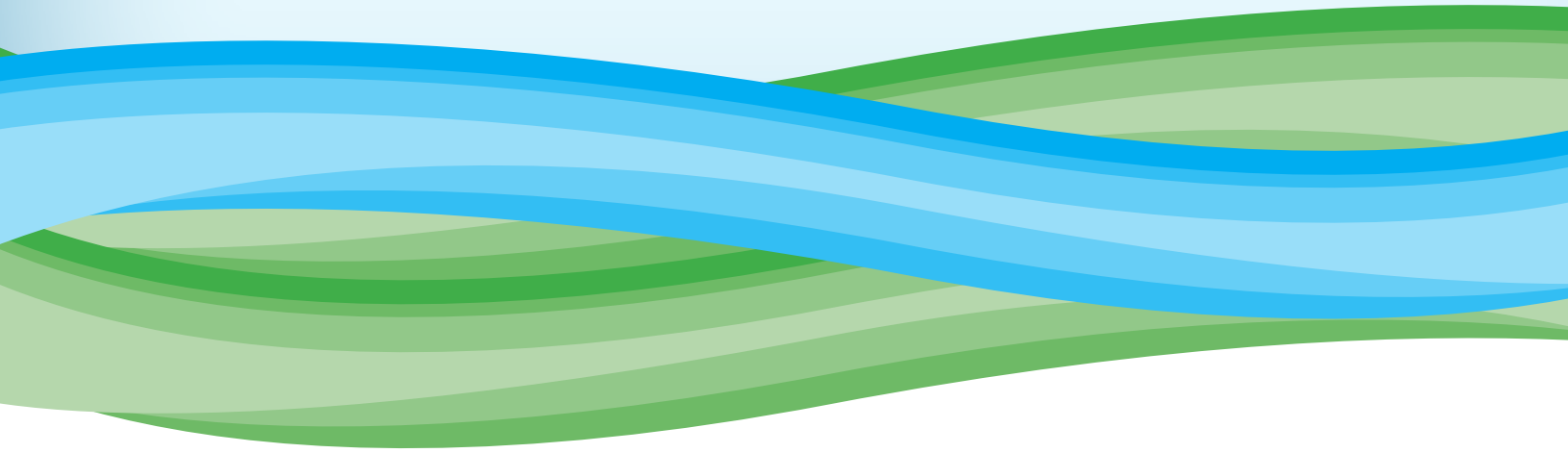
Good job - well organized

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Appendix **D**

Hydrologic Modeling Materials

D14-012-012



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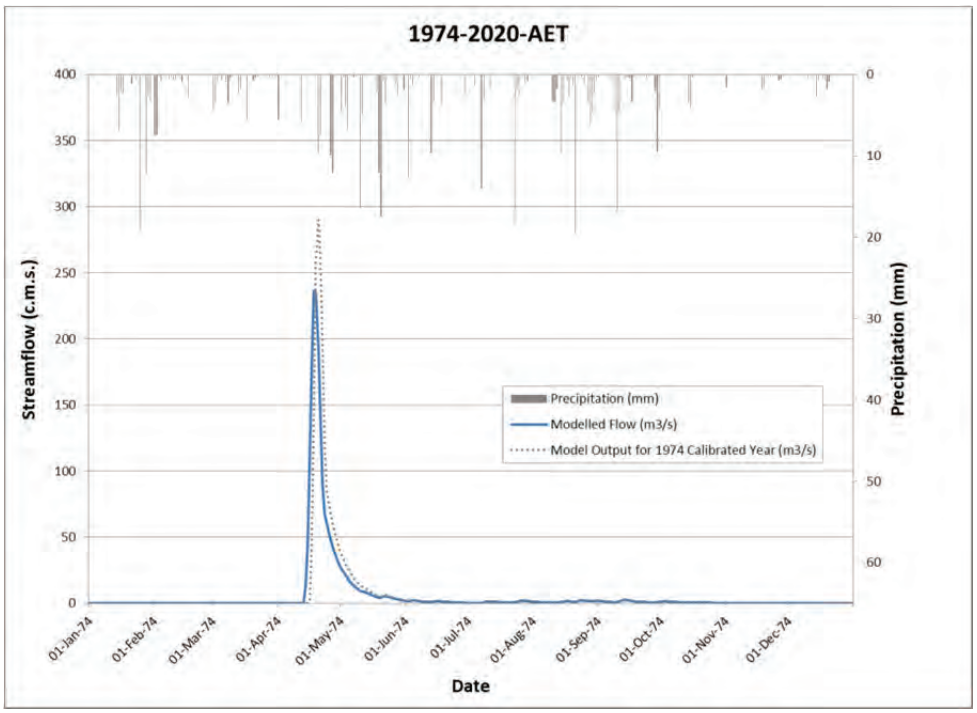
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Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1974 Calibrated Year (m3/s)
0
50
100
150
200
250
300
350
400
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50
60
01-Jan-74
01-Feb-74
01-Mar-74
01-Apr-74
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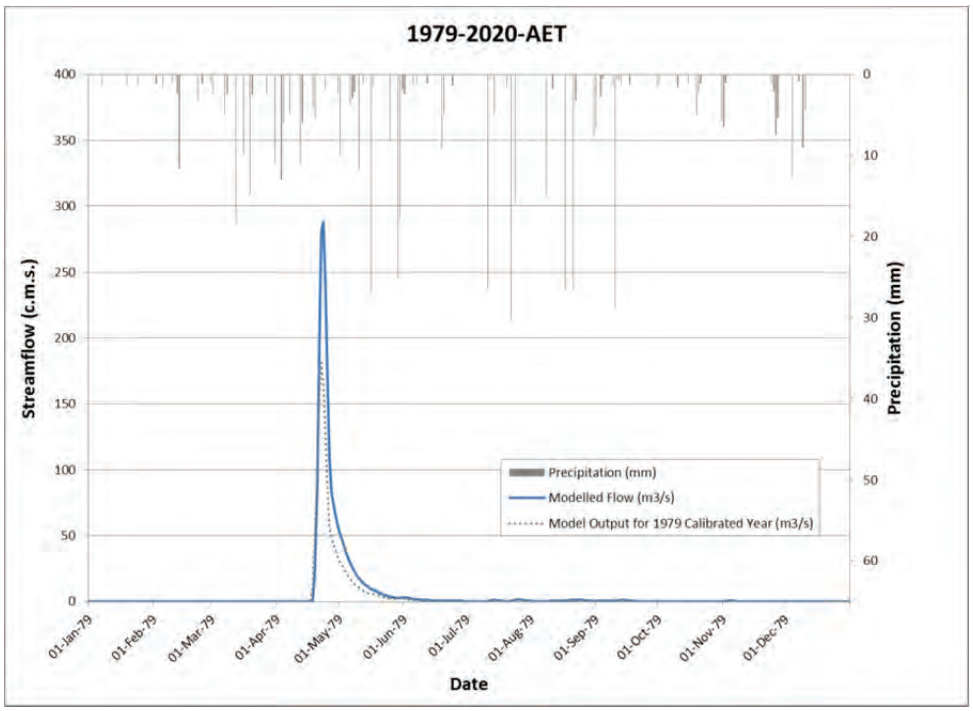
1979-2020-AET
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Date
Precipitation (mm)
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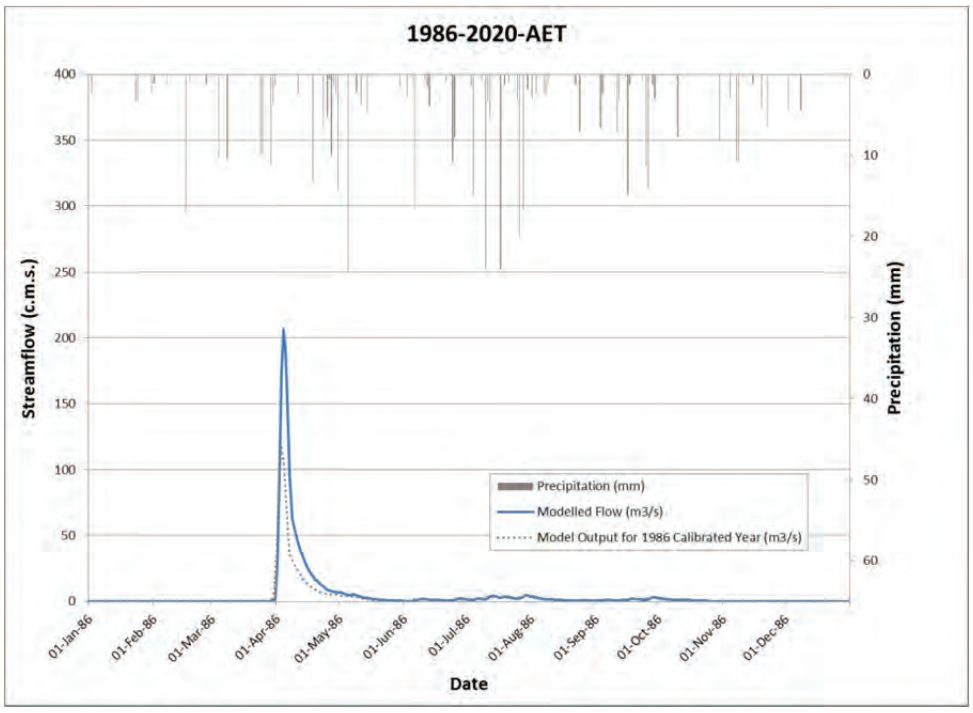
1986-2020-AET
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1986 Calibrated Year (m3/s)
01-Jan-86
01-Feb-86
01-Mar-86
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01-Aug-86
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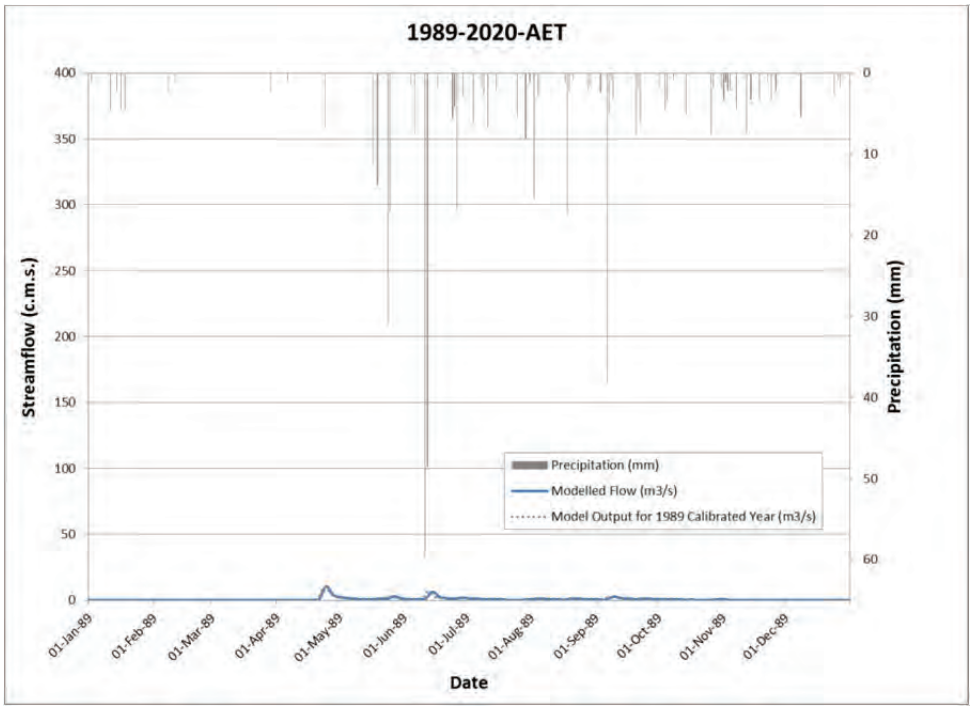
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Precipitation (mm)
Date
Precipitation (mm)
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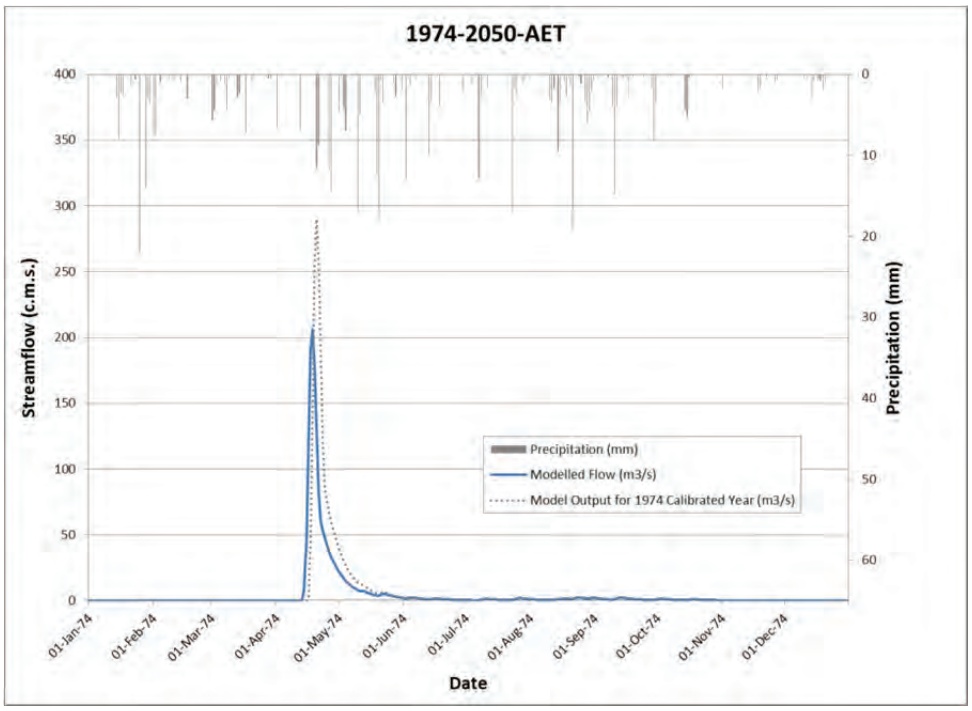
1974-2050-AET
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1974 Calibrated Year (m3/s)
01-Jan-74
01-Feb-74
01-Mar-74
01-Apr-74
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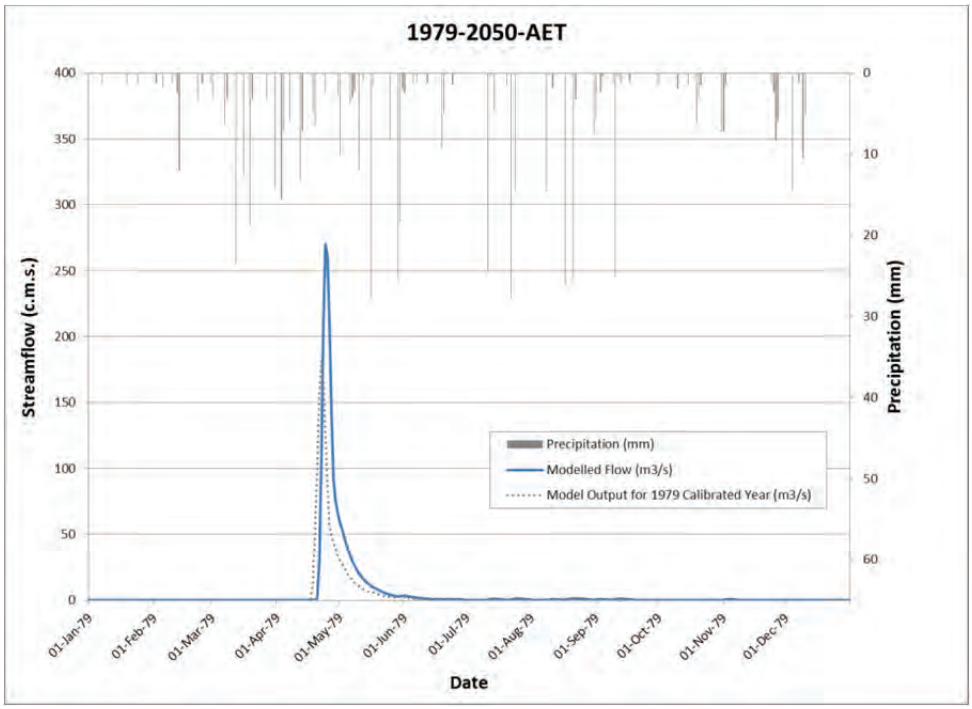
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Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1979 Calibrated Year (m3/s)
01-Jan-79
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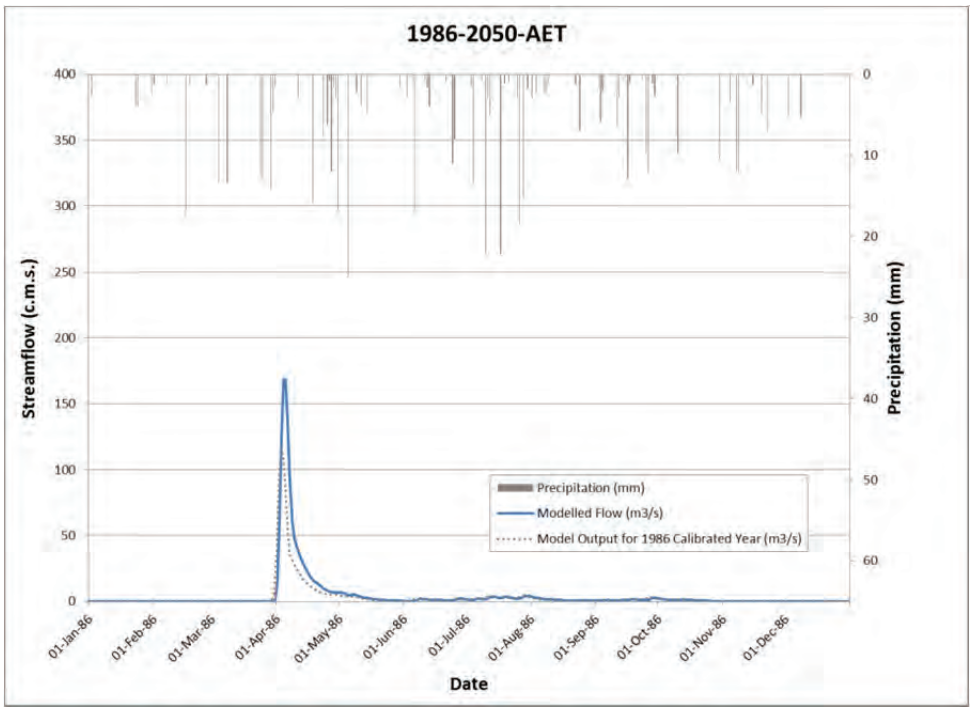
1986-2050-AET
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1986 Calibrated Year (m3/s)
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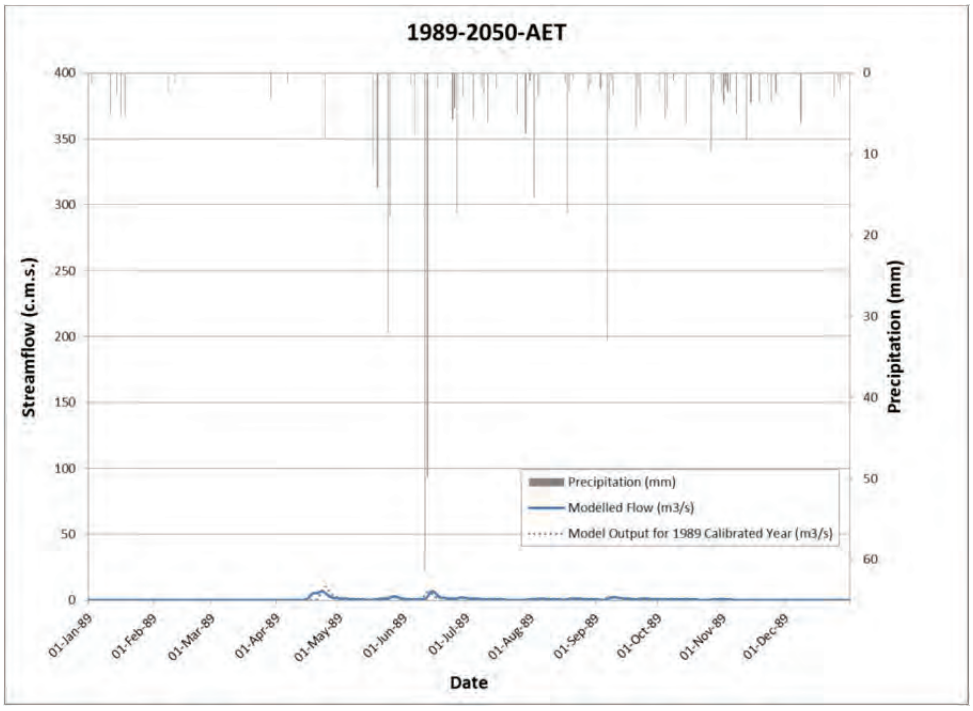
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Precipitation (mm)
Date
Precipitation (mm)
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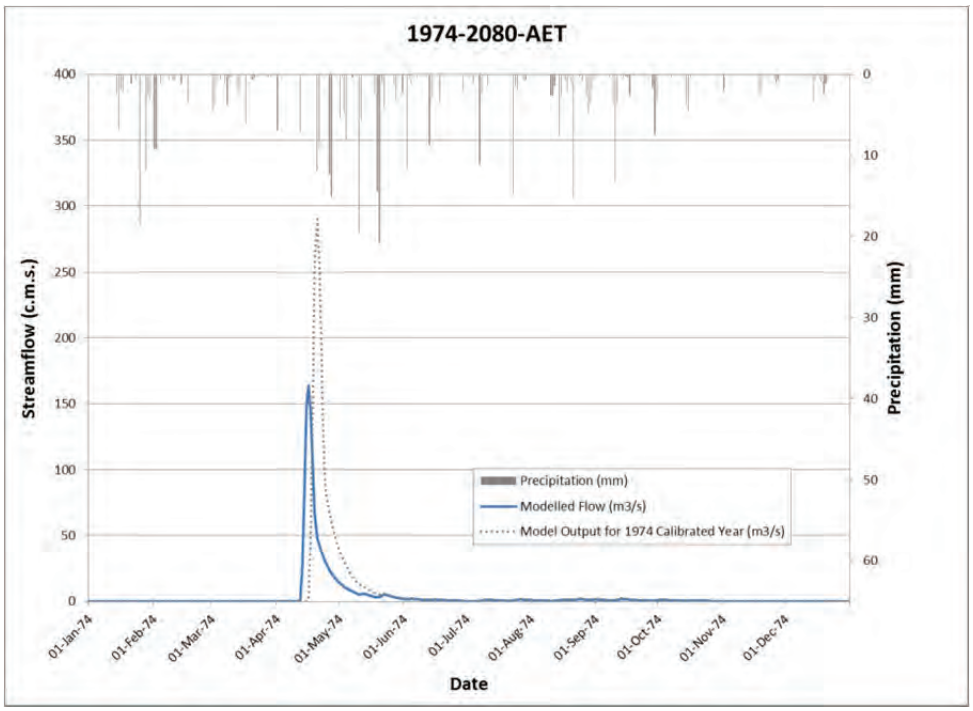
1974-2080-AET
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1974 Calibrated Year (m3/s)
0
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100
150
200
250
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400
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30
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50
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01-Jan-74
01-Feb-74
01-Mar-74
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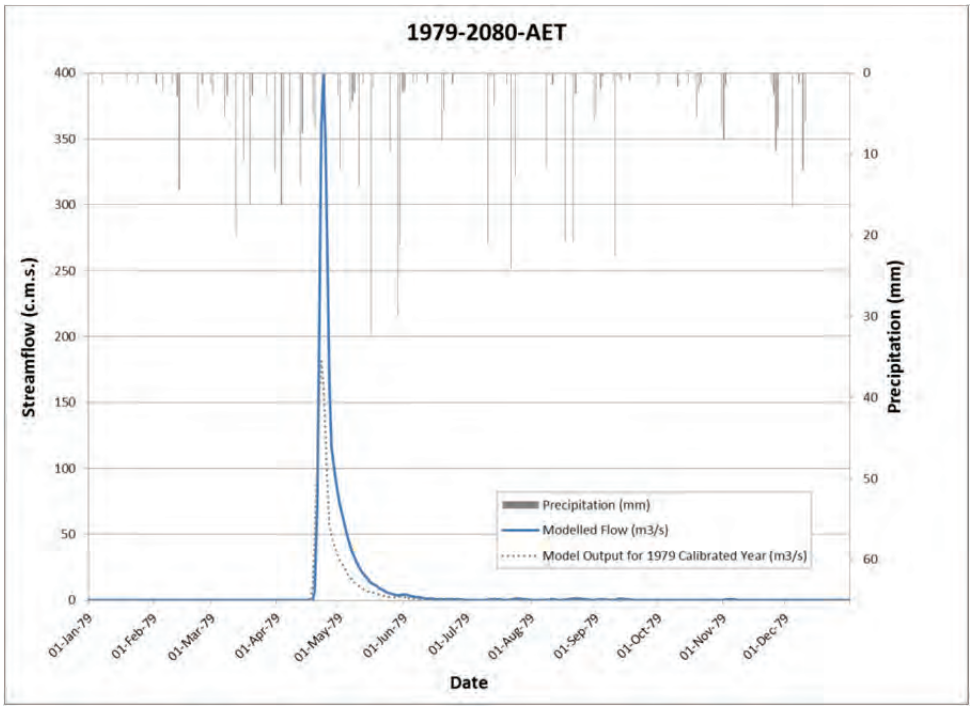
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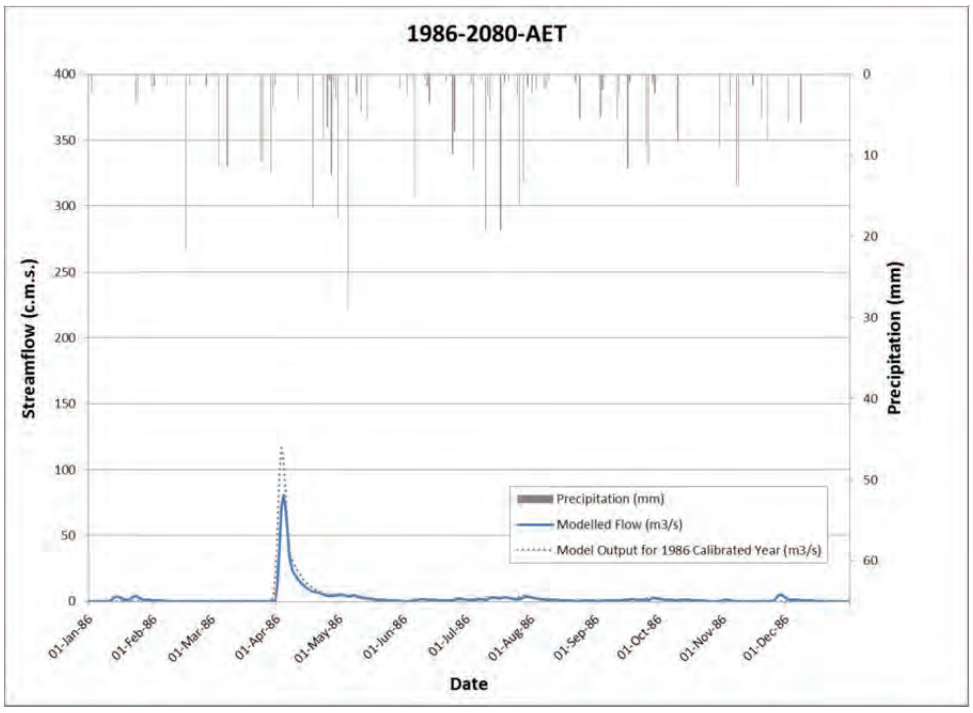
01-Oct-79
01-Nov-79
01-Dec-79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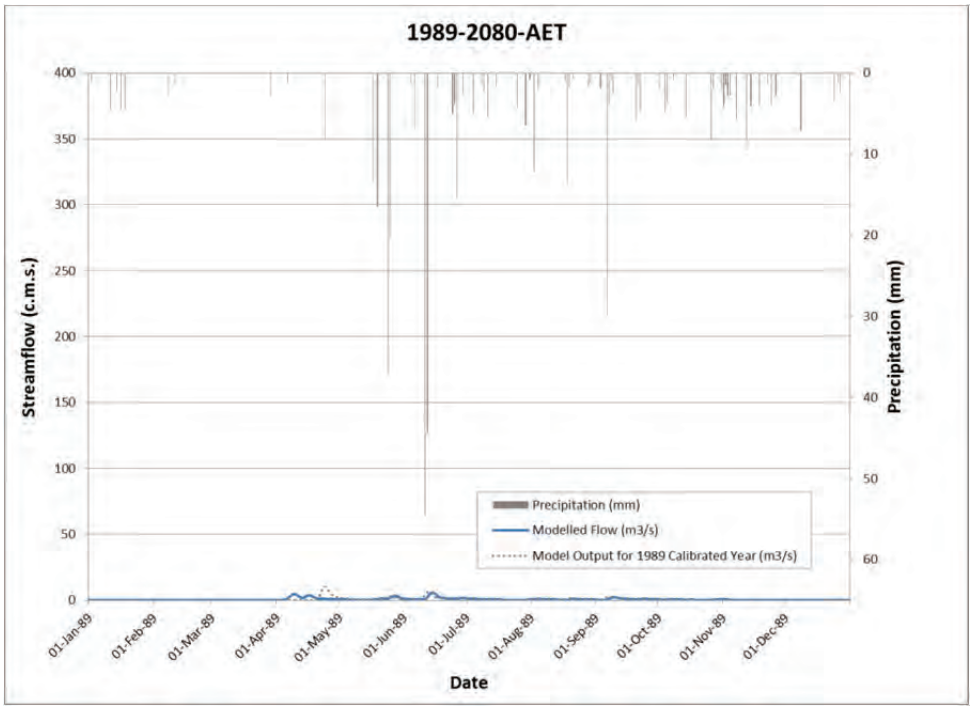
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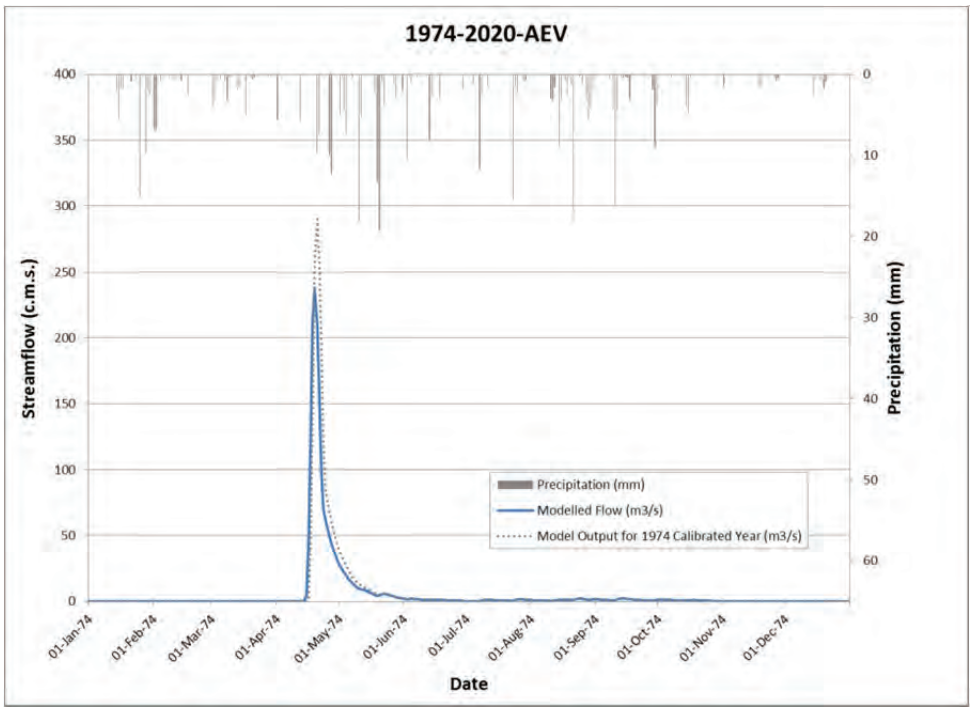
1974-2020-AEV
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1974 Calibrated Year (m3/s)
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01-Feb-74
01-Mar-74
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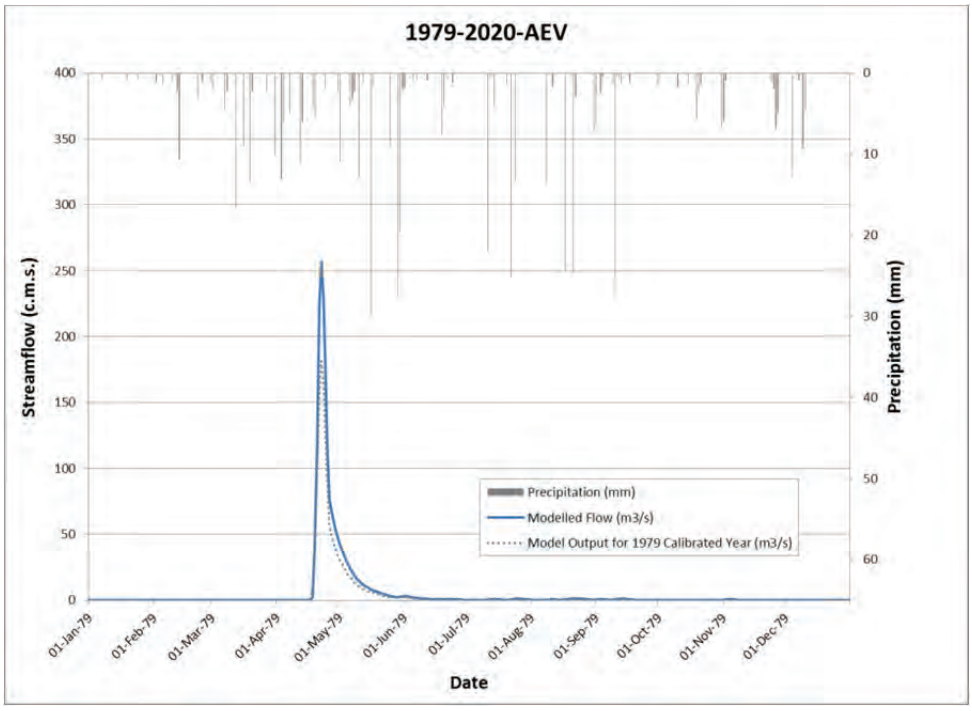
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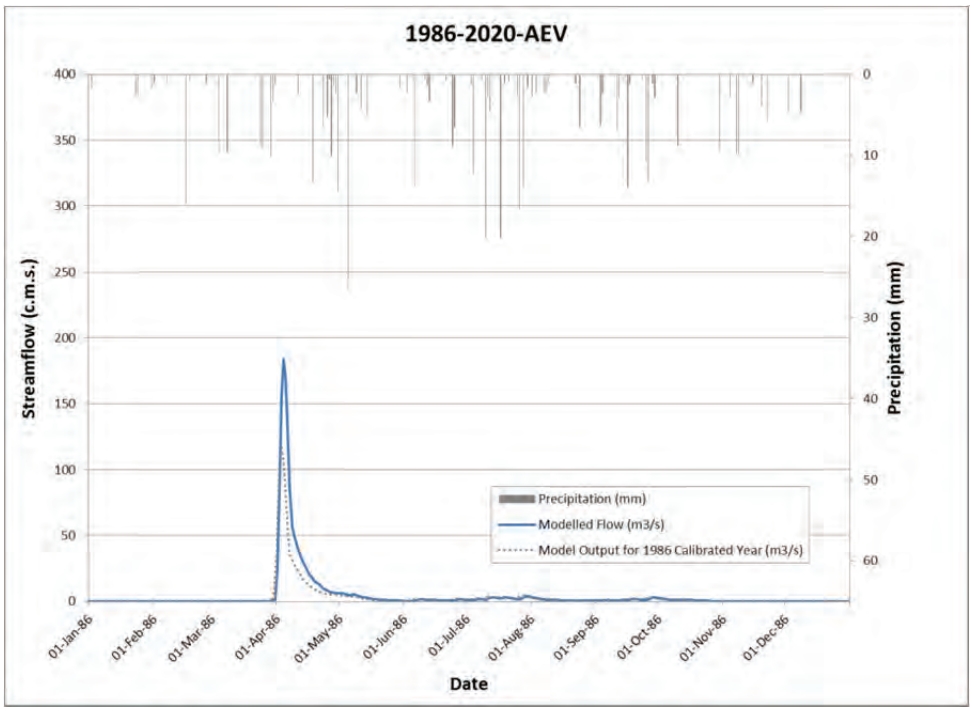
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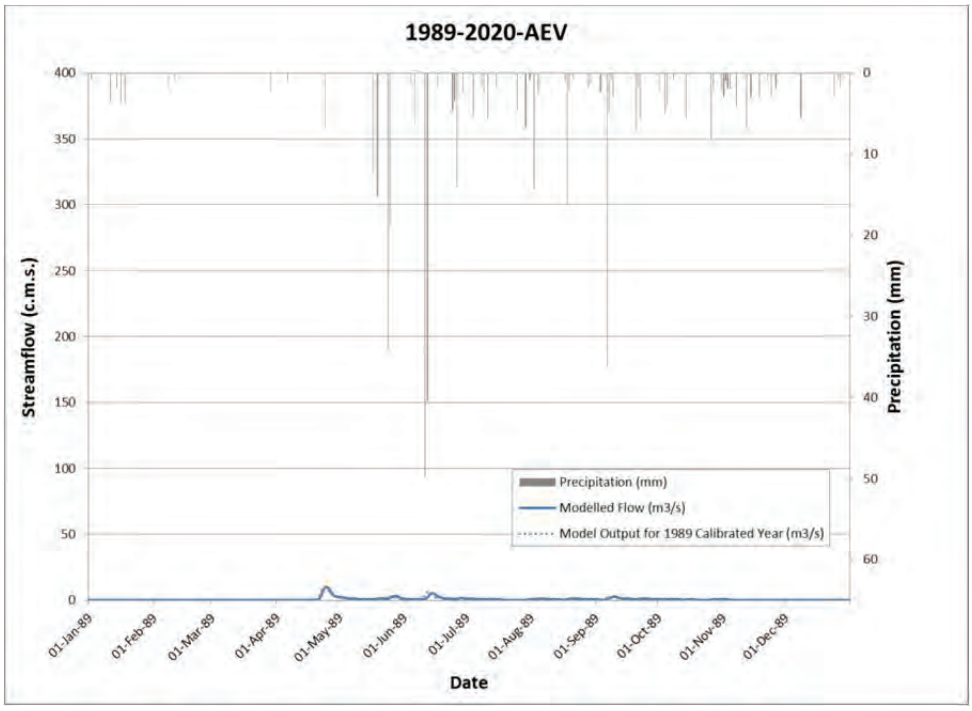
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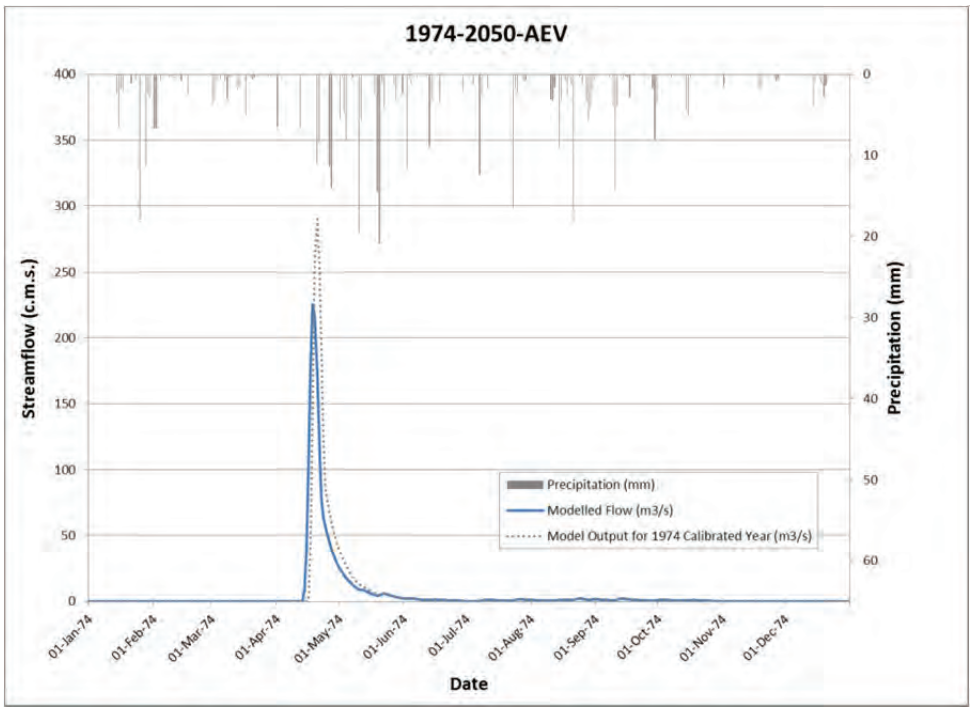
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Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1974 Calibrated Year (m3/s)
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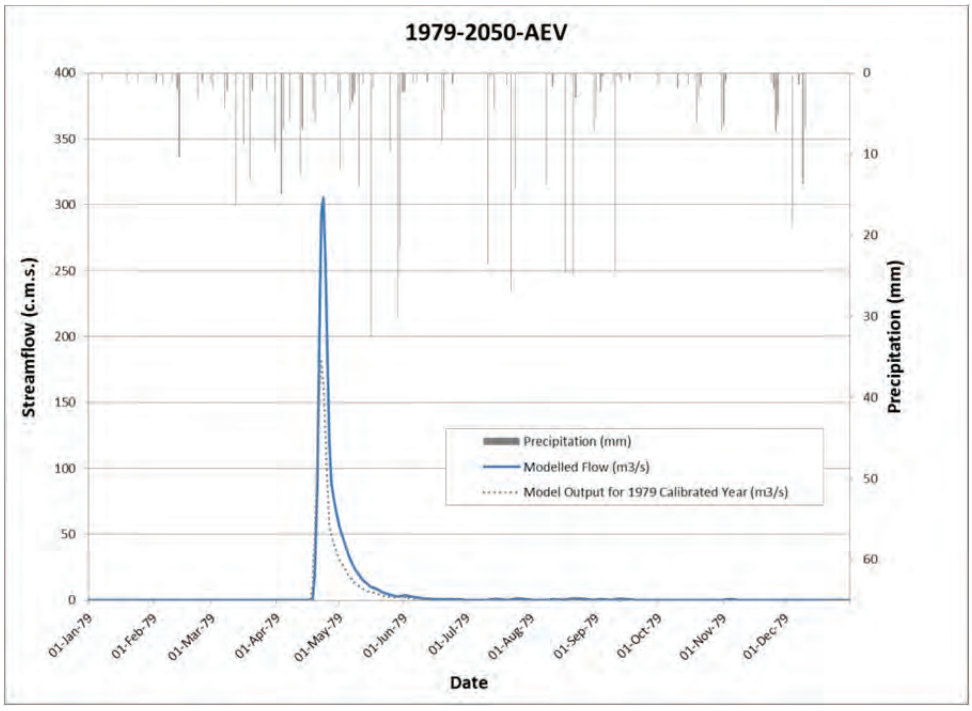
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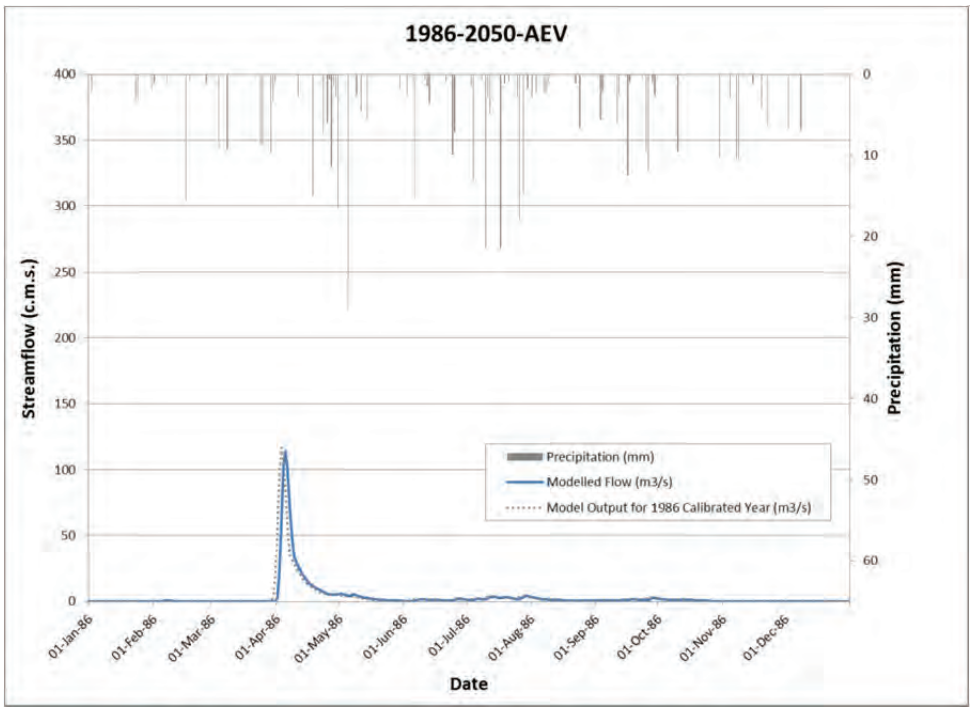
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Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1986 Calibrated Year (m3/s)
01-Jan-86
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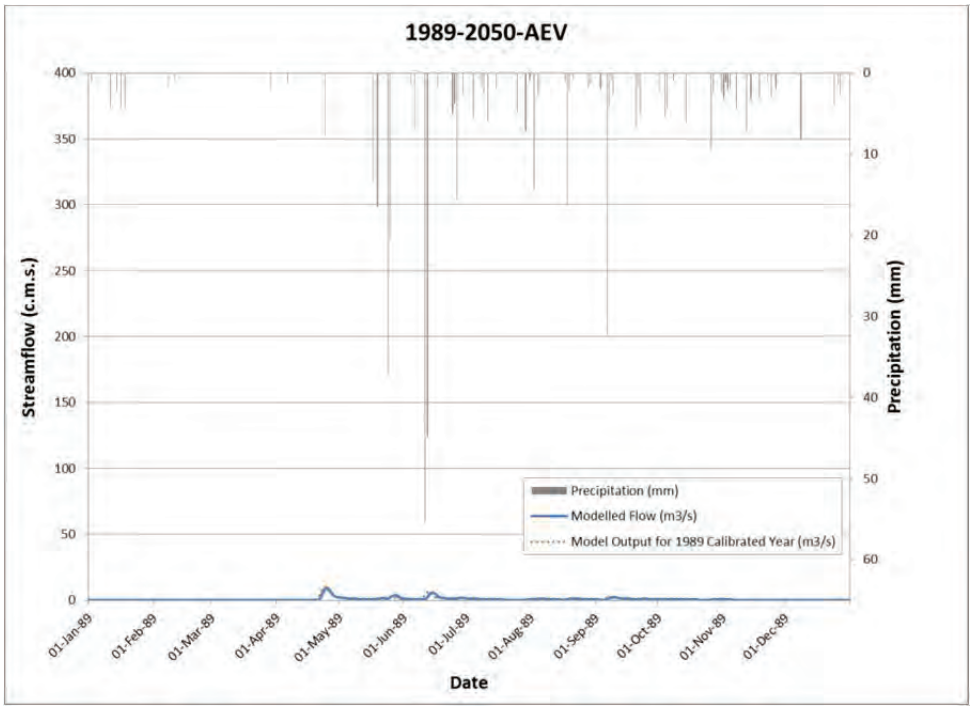
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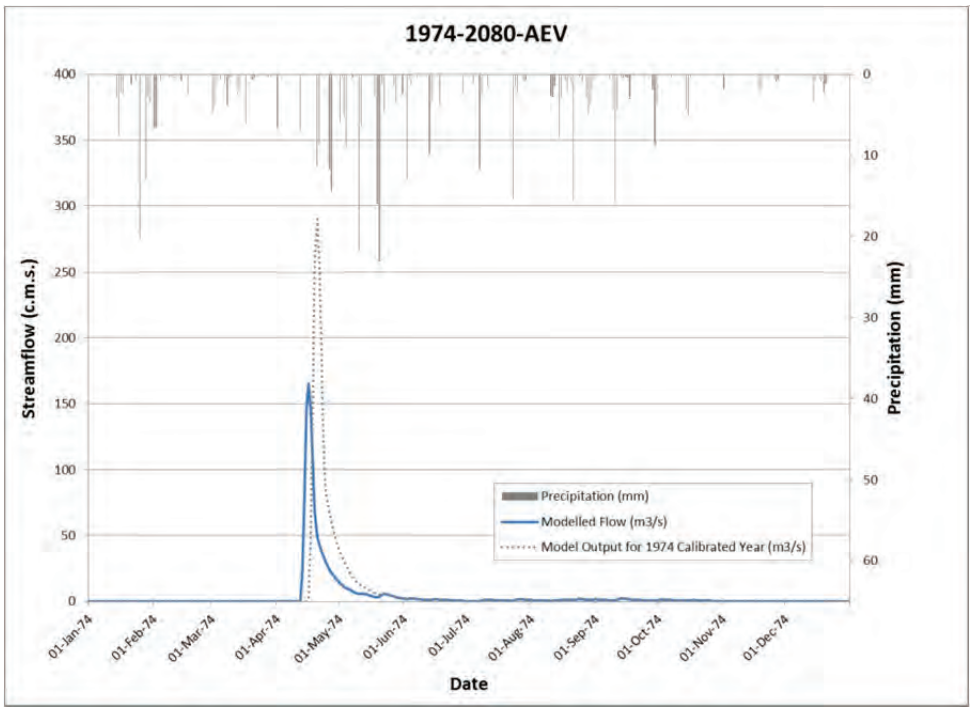
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Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1974 Calibrated Year (m3/s)
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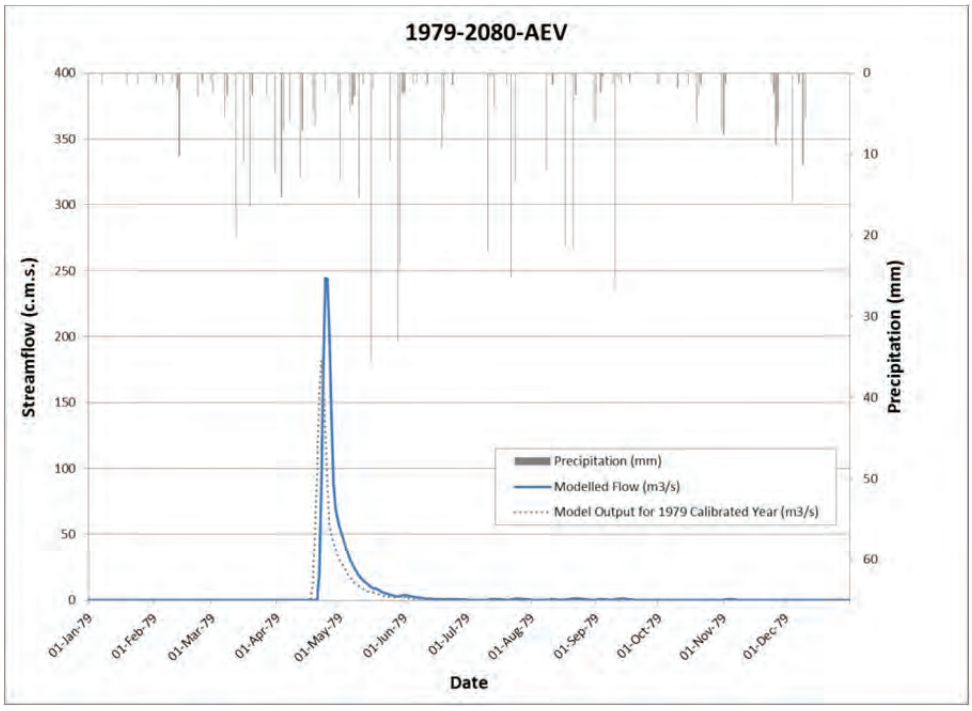
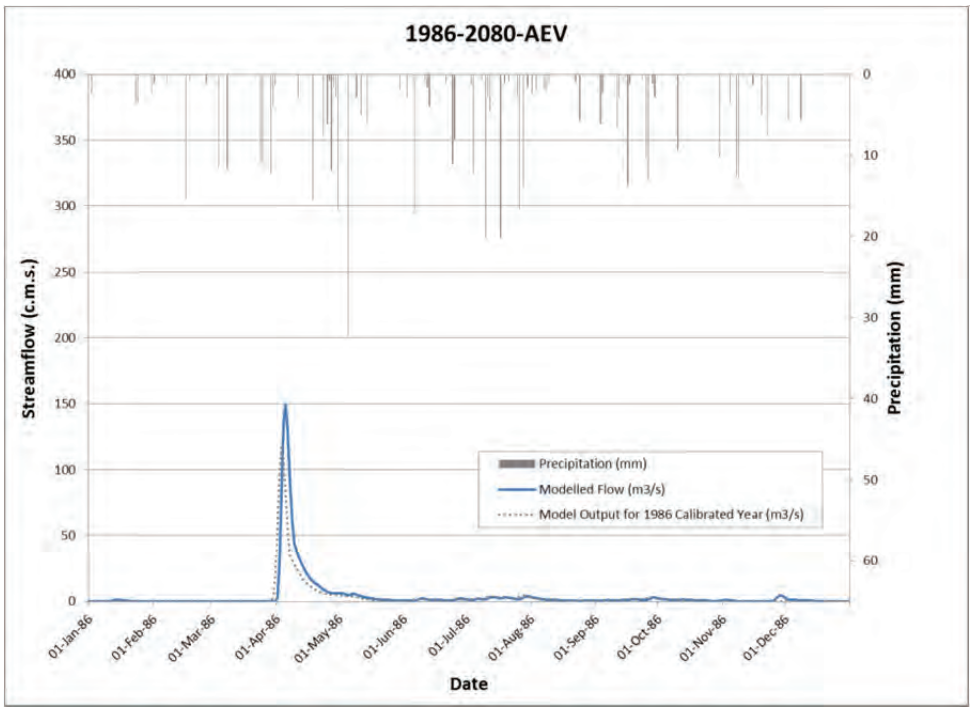
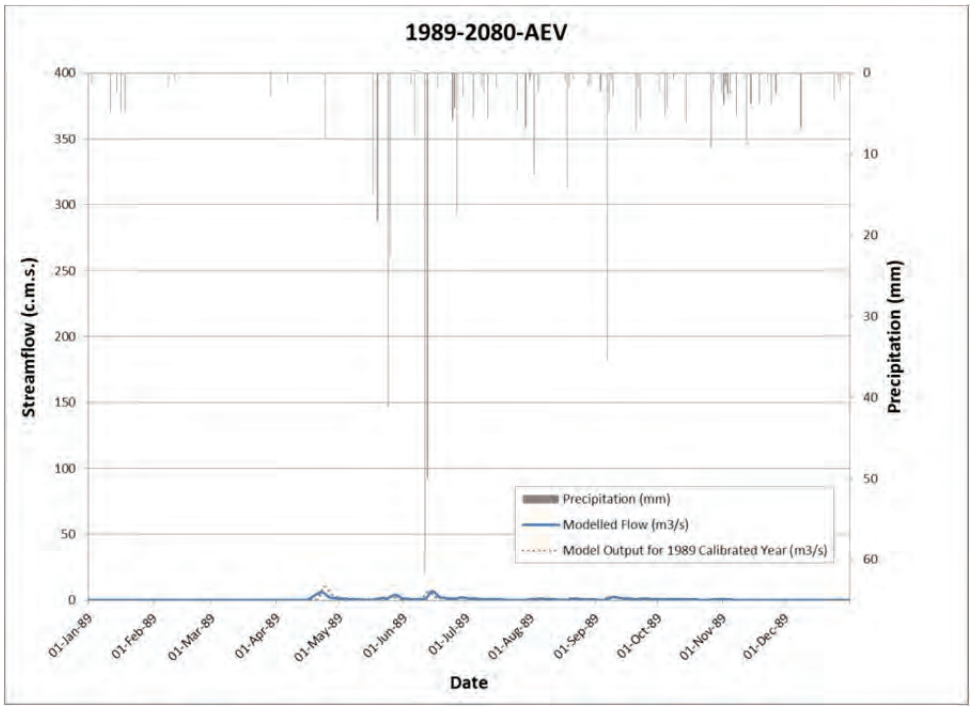
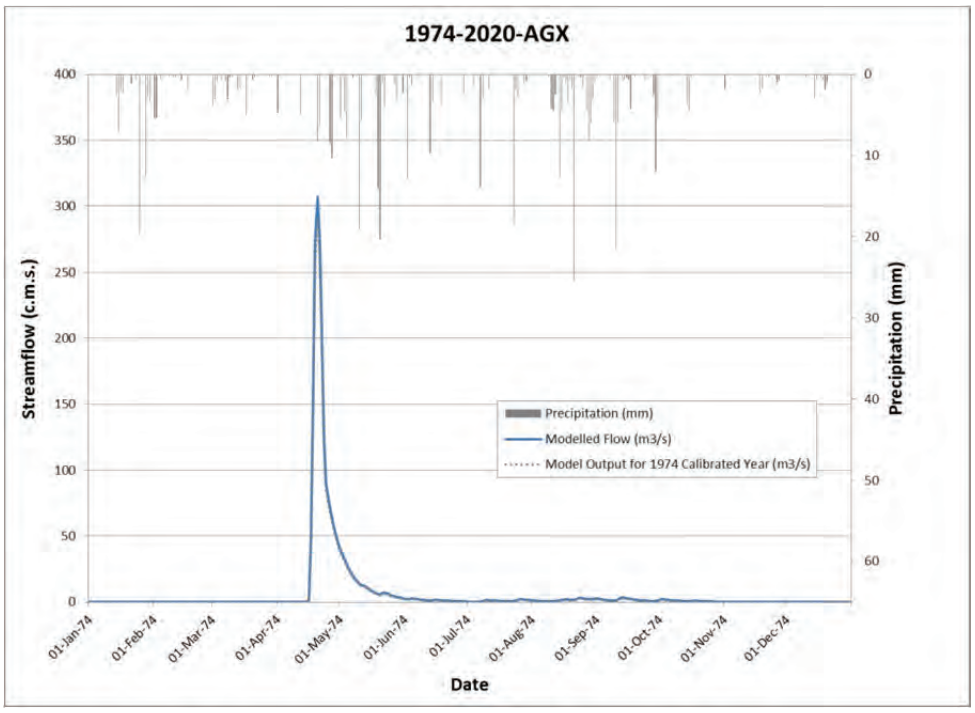
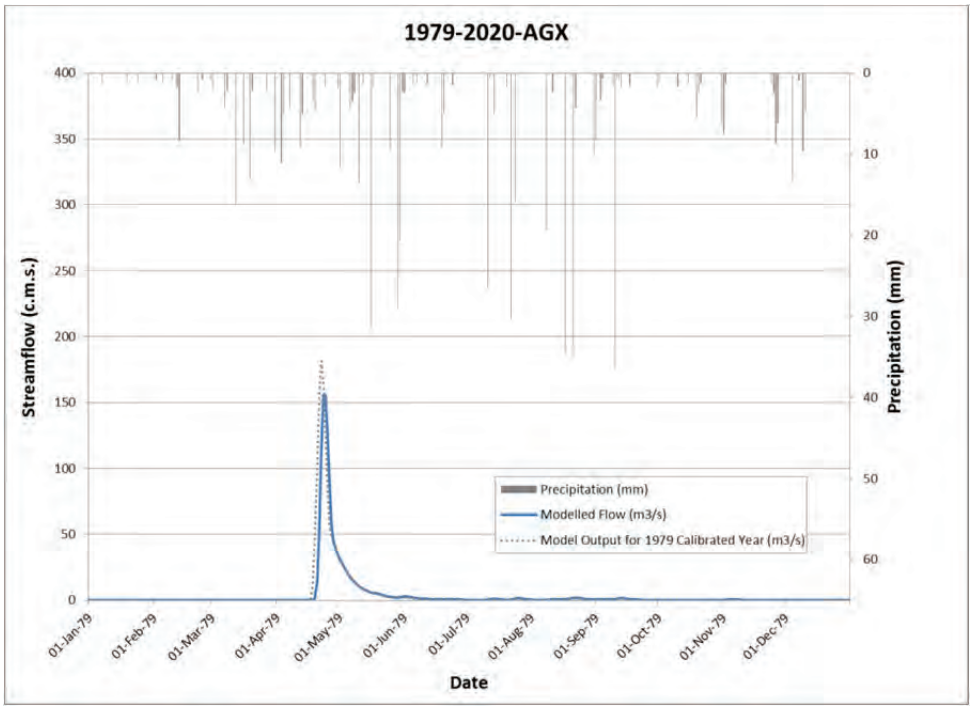
01-Sep-74
01-Oct-74
01-Nov-74
01-Dec-74

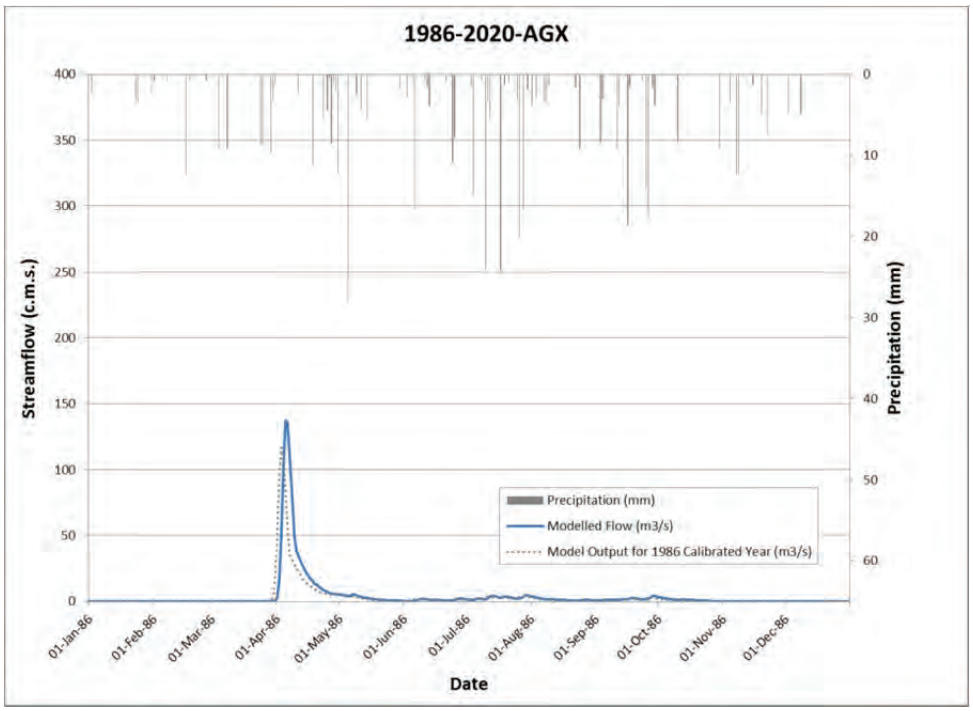

1979-2080-AEV
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1979 Calibrated Year (m3/s)
01-Jan-79
01-Feb-79
01-Mar-79
01-Apr-79
01-May-79
01-Jun-79
01-Jul-79
01-Aug-79
01-Sep-79
01-Oct-79
01-Nov-79
01-Dec-79

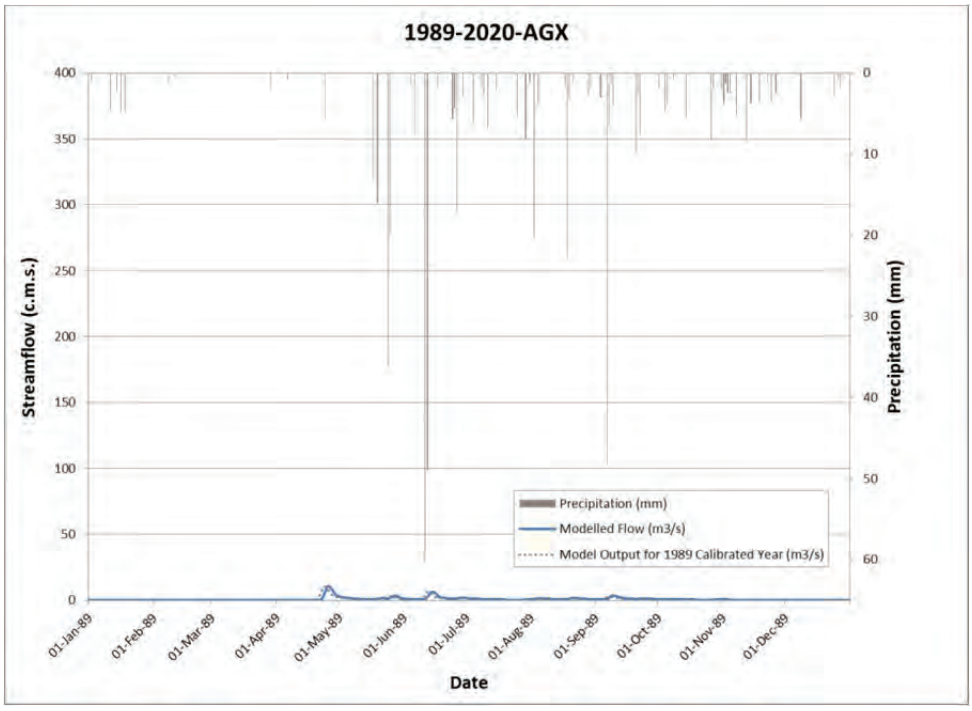

1986-2080-AEV
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1986 Calibrated Year (m3/s)
01-Jan-86
01-Feb-86
01-Mar-86
01-Apr-86
01-May-86
01-Jun-86
01-Jul-86
01-Aug-86
01-Sep-86
01-Oct-86
01-Nov-86
01-Dec-86

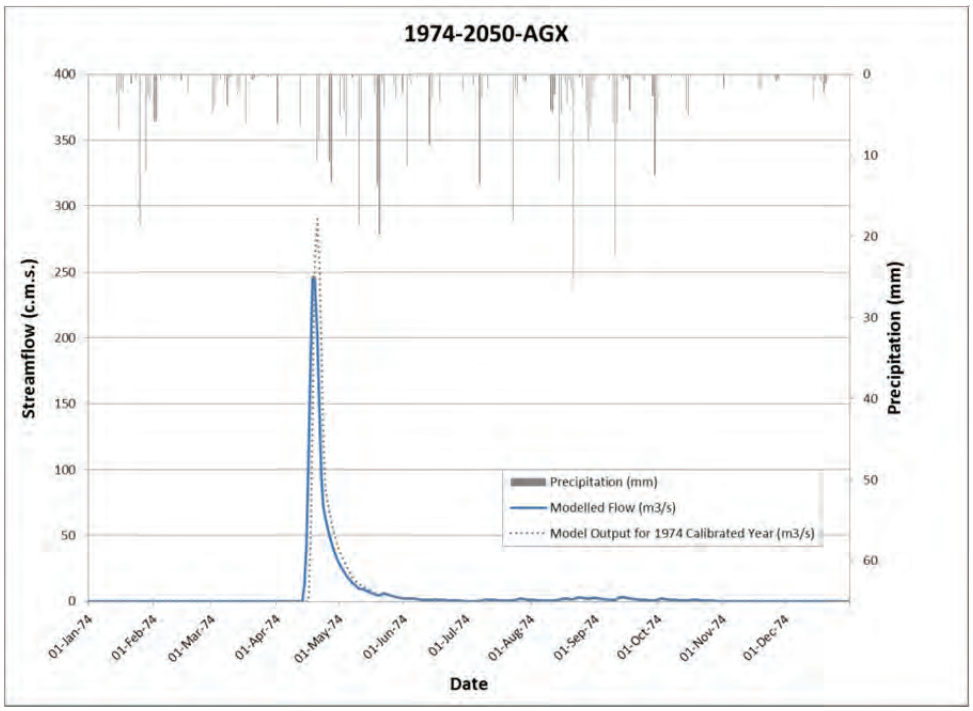

1989-2080-AEV
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1989 Calibrated Year (m3/s)
01-Jan-89
01-Feb-89
01-Mar-89
01-Apr-89
01-May-89
01-Jun-89
01-Jul-89
01-Aug-89
01-Sep-89
01-Oct-89
01-Nov-89
01-Dec-89

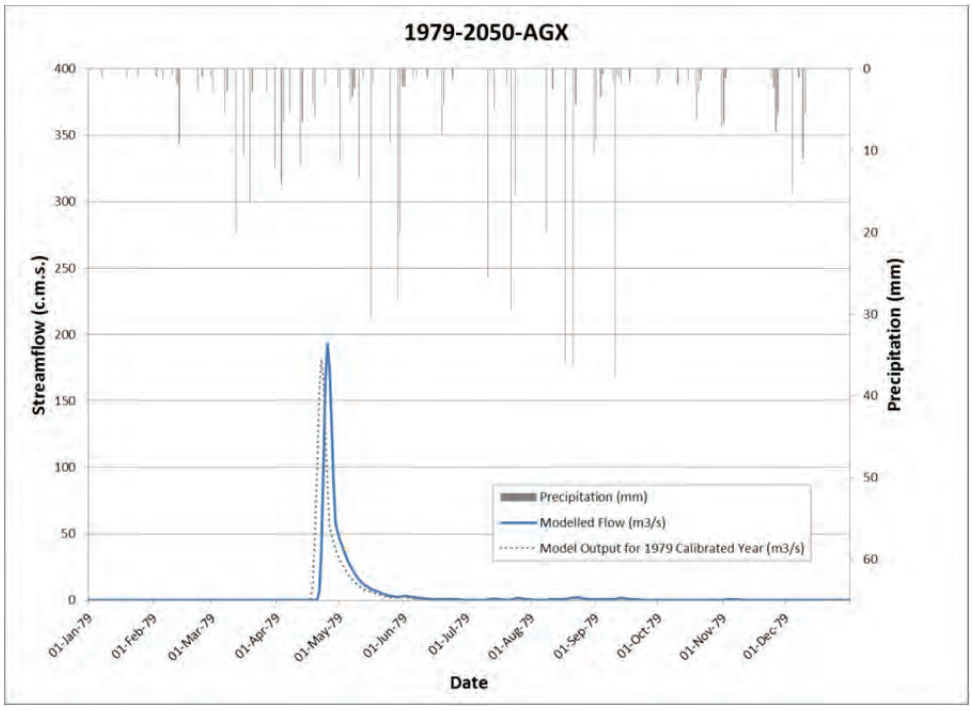

1974-2020-AGX
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1974 Calibrated Year (m3/s)
0
50
100
150
200
250
300
350
400
10
20
30
40
50
60
01-Jan-74
01-Feb-74
01-Mar-74
01-Apr-74
01-May-74
01-Jun-74
01-Jul-74
01-Aug-74
01-Sep-74
01-Oct-74
01-Nov-74
01-Dec-74

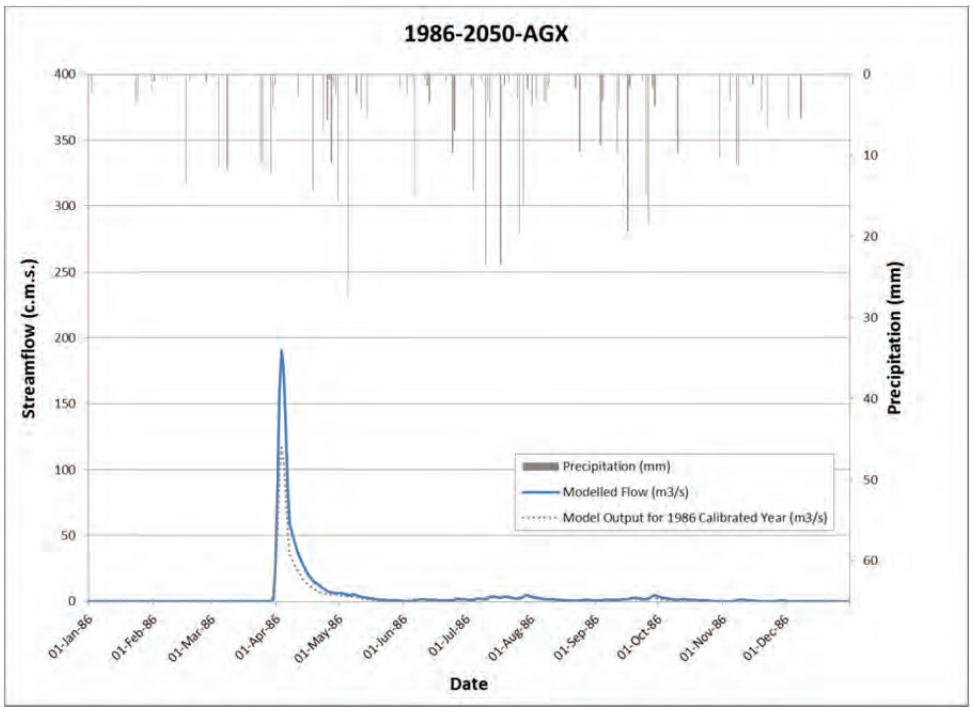

1979-2020-AGX
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1979 Calibrated Year (m3/s)
0
50
100
150
200
250
300
350
400
10
20
30
40
50
60
01-Jan-79
01-Feb-79
01-Mar-79
01-Apr-79
01-May-79
01-Jun-79
01-Jul-79
01-Aug-79
01-Sep-79
01-Oct-79
01-Nov-79
01-Dec-79

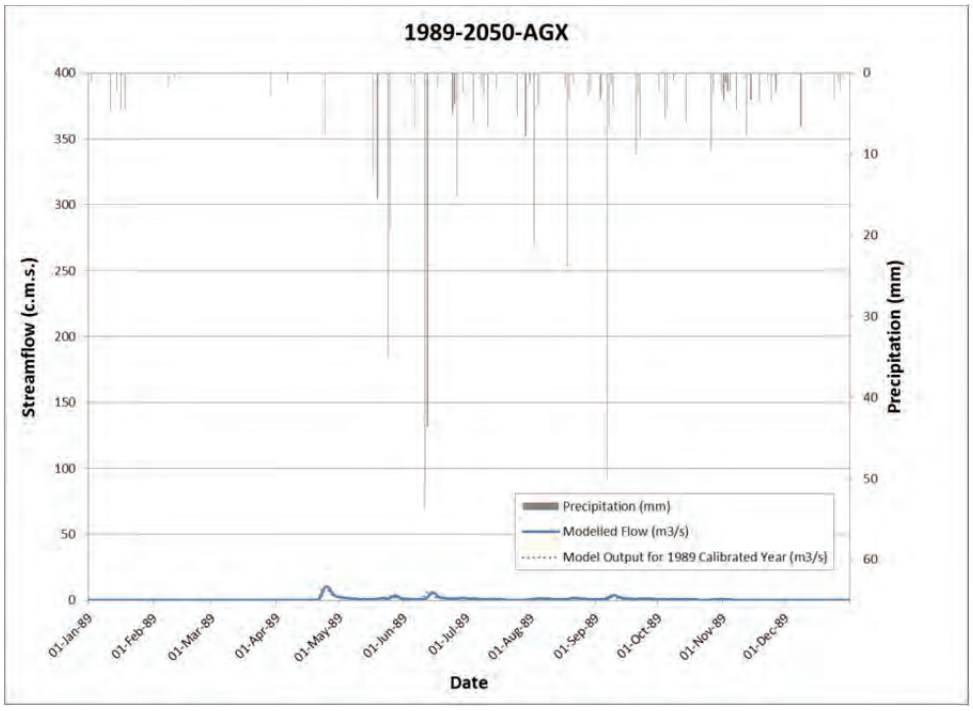

1986-2020-AGX
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1986 Calibrated Year (m3/s)
01-Jan-86
01-Feb-86
01-Mar-86
01-Apr-86
01-May-86
01-Jun-86
01-Jul-86
01-Aug-86
01-Sep-86
01-Oct-86
01-Nov-86
01-Dec-86

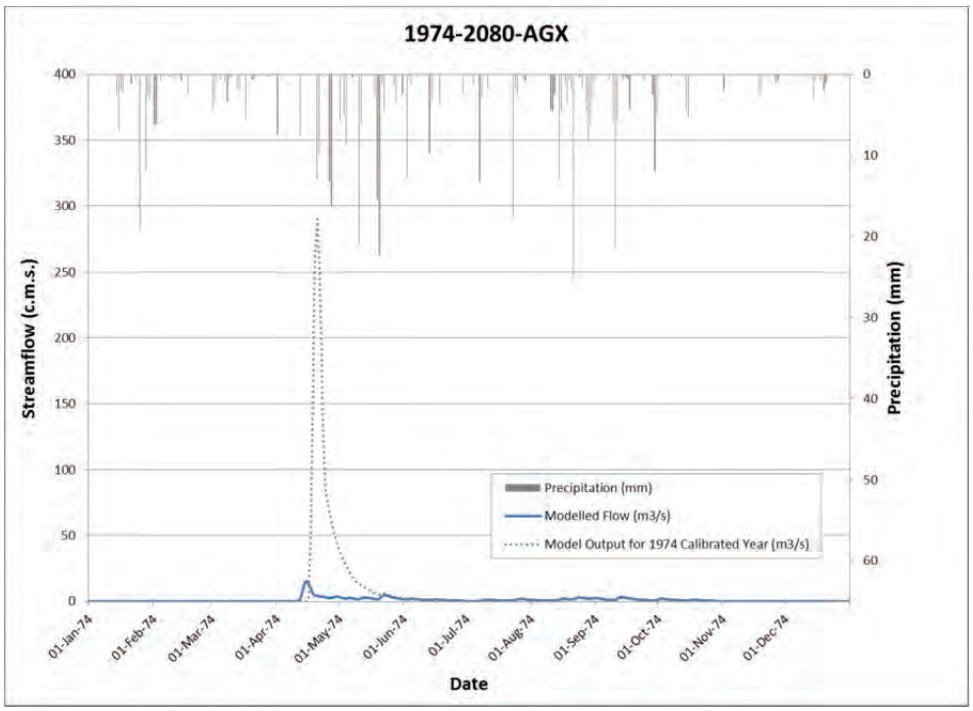

1989-2020-AGX
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1989 Calibrated Year (m3/s)
01-Jan-89
01-Feb-89
01-Mar-89
01-Apr-89
01-May-89
01-Jun-89
01-Jul-89
01-Aug-89
01-Sep-89
01-Oct-89
01-Nov-89
01-Dec-89

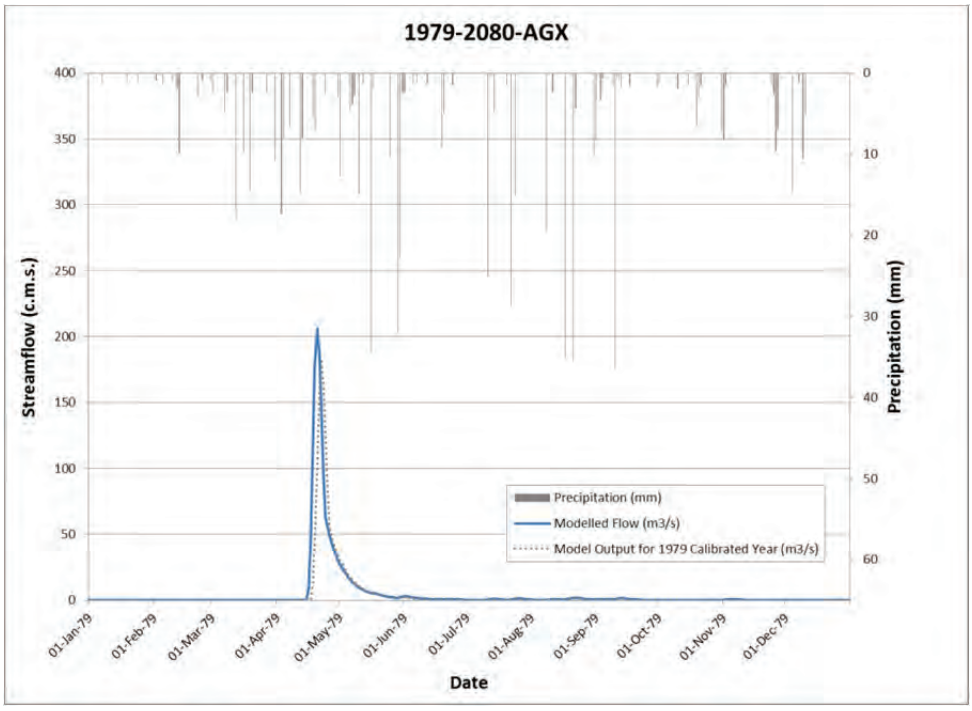

1974-2050-AGX
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1974 Calibrated Year (m3/s)
01-Jan-74
01-Feb-74
01-Mar-74
01-Apr-74
01-May-74
01-Jun-74
01-Jul-74
01-Aug-74
01-Sep-74
01-Oct-74
01-Nov-74
01-Dec-74

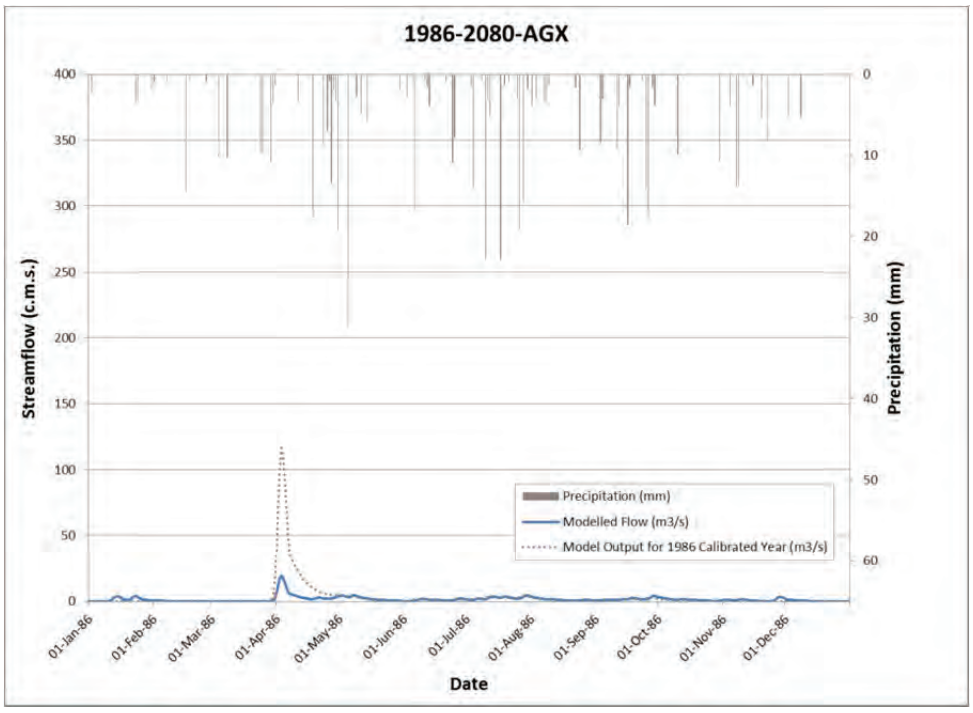

1979-2050-AGX
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1979 Calibrated Year (m3/s)
01-Jan-79
01-Feb-79
01-Mar-79
01-Apr-79
01-May-79
01-Jun-79
01-Jul-79
01-Aug-79
01-Sep-79
01-Oct-79
01-Nov-79
01-Dec-79

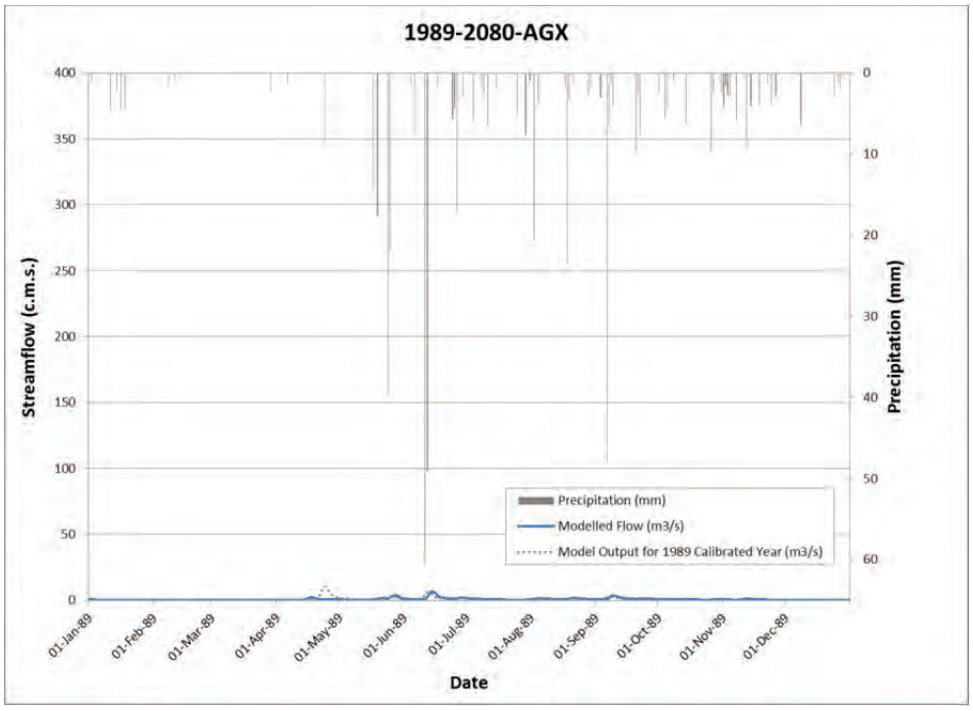

1986-2050-AGX
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1986 Calibrated Year (m3/s)
01-Jan-86
01-Feb-86
01-Mar-86
01-Apr-86
01-May-86
01-Jun-86
01-Jul-86
01-Aug-86
01-Sep-86
01-Oct-86
01-Nov-86
01-Dec-86


1989-2050-AGX
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1989 Calibrated Year (m3/s)
01-Jan-89
01-Feb-89
01-Mar-89
01-Apr-89
01-May-89
01-Jun-89
01-Jul-89
01-Aug-89
01-Sep-89
01-Oct-89
01-Nov-89
01-Dec-89


1974-2080-AGX
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1974 Calibrated Year (m3/s)
01-Jan-74
01-Feb-74
01-Mar-74
01-Apr-74
01-May-74
01-Jun-74
01-Jul-74
01-Aug-74
01-Sep-74
01-Oct-74
01-Nov-74
01-Dec-74


1979-2080-AGX
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1979 Calibrated Year (m3/s)
01-Jan-79
01-Feb-79
01-Mar-79
01-Apr-79
01-May-79
01-Jun-79
01-Jul-79
01-Aug-79
01-Sep-79
01-Oct-79
01-Nov-79
01-Dec-79

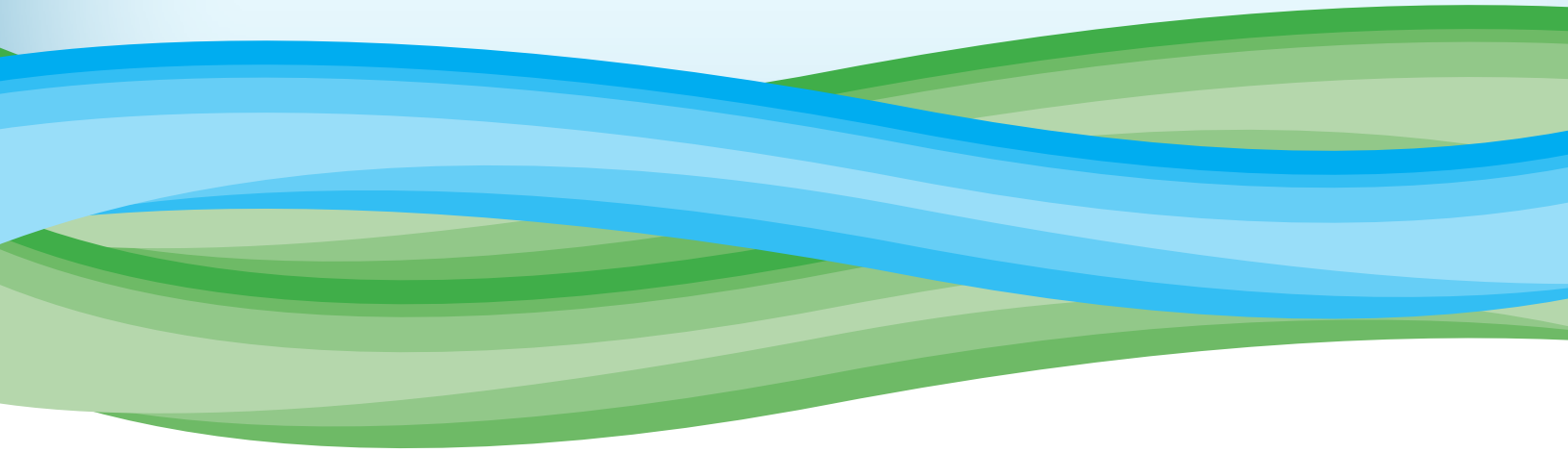

1986-2080-AGX
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1986 Calibrated Year (m3/s)
01-Jan-86
01-Feb-86
01-Mar-86
01-Apr-86
01-May-86
01-Jun-86
01-Jul-86
01-Aug-86
01-Sep-86
01-Oct-86
01-Nov-86
01-Dec-86


1989-2080-AGX
Streamflow (c.m.s.)
Precipitation (mm)
Date
Precipitation (mm)
Modelled Flow (m3/s)
Model Output for 1989 Calibrated Year (m3/s)
01-Jan-89
01-Feb-89
01-Mar-89
01-Apr-89
01-May-89
01-Jun-89
01-Jul-89
01-Aug-89
01-Sep-89
01-Oct-89
01-Nov-89
01-Dec-89

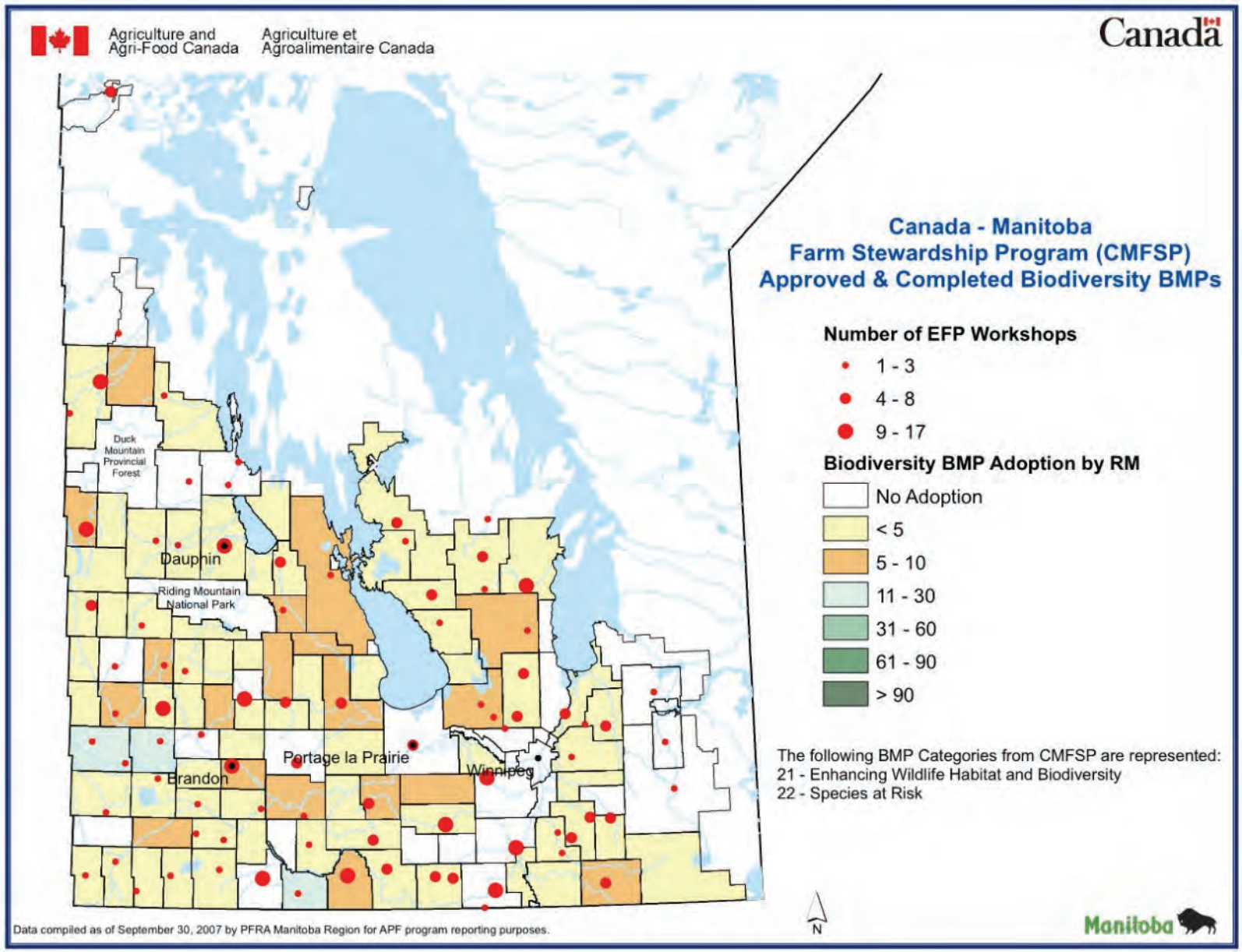
Appendix **E**

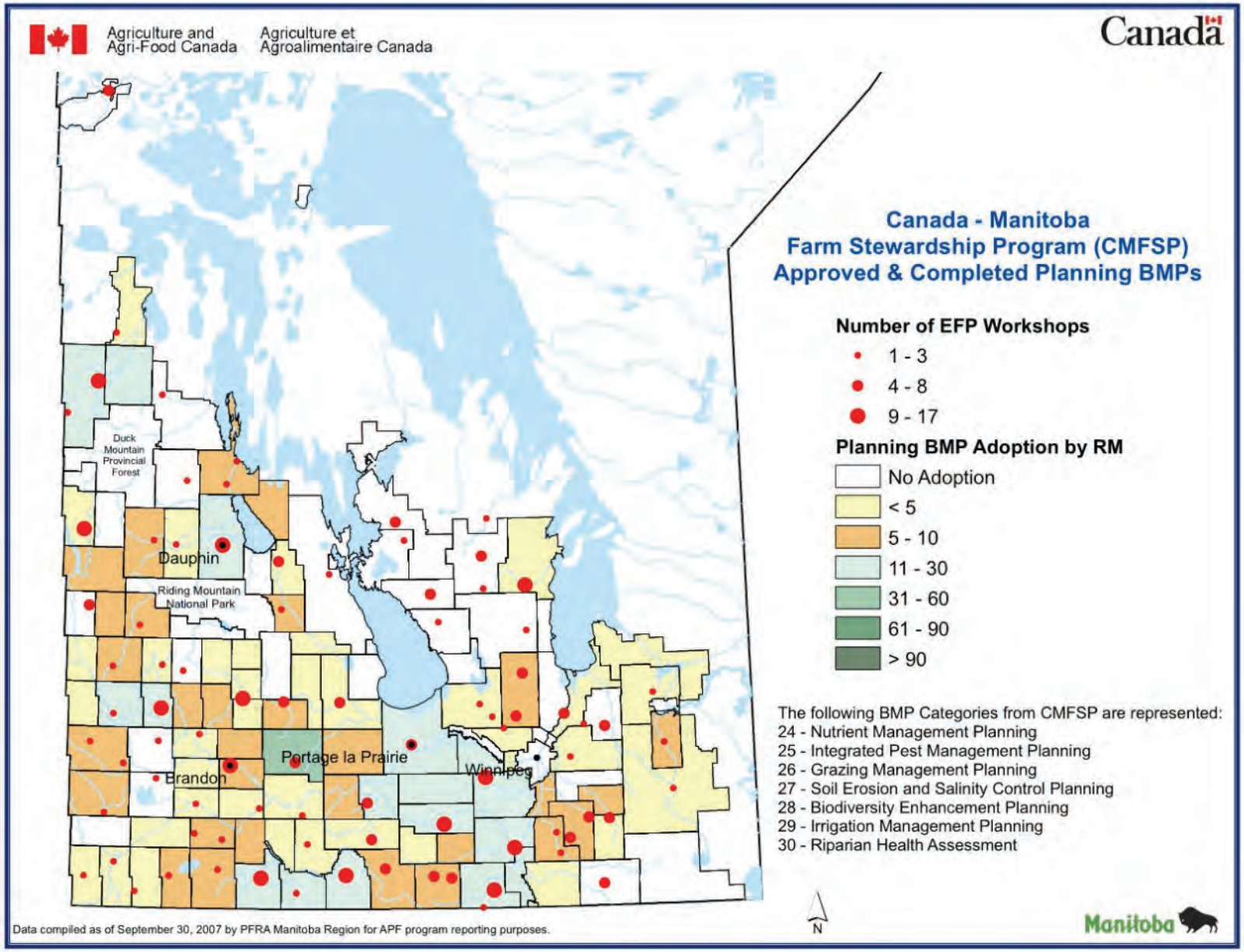
Beneficial Management Practice (BMP) Maps

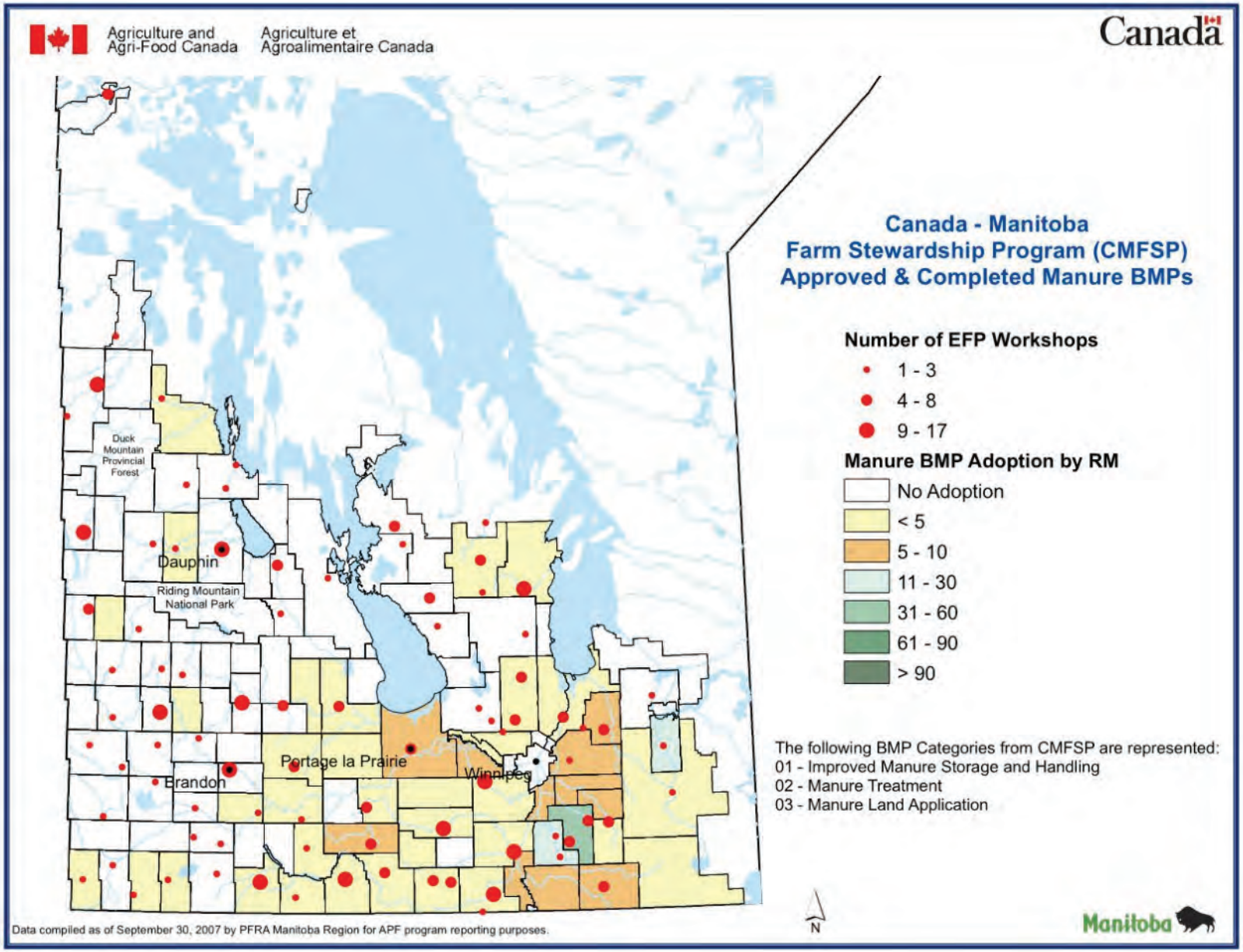
D14-012-012

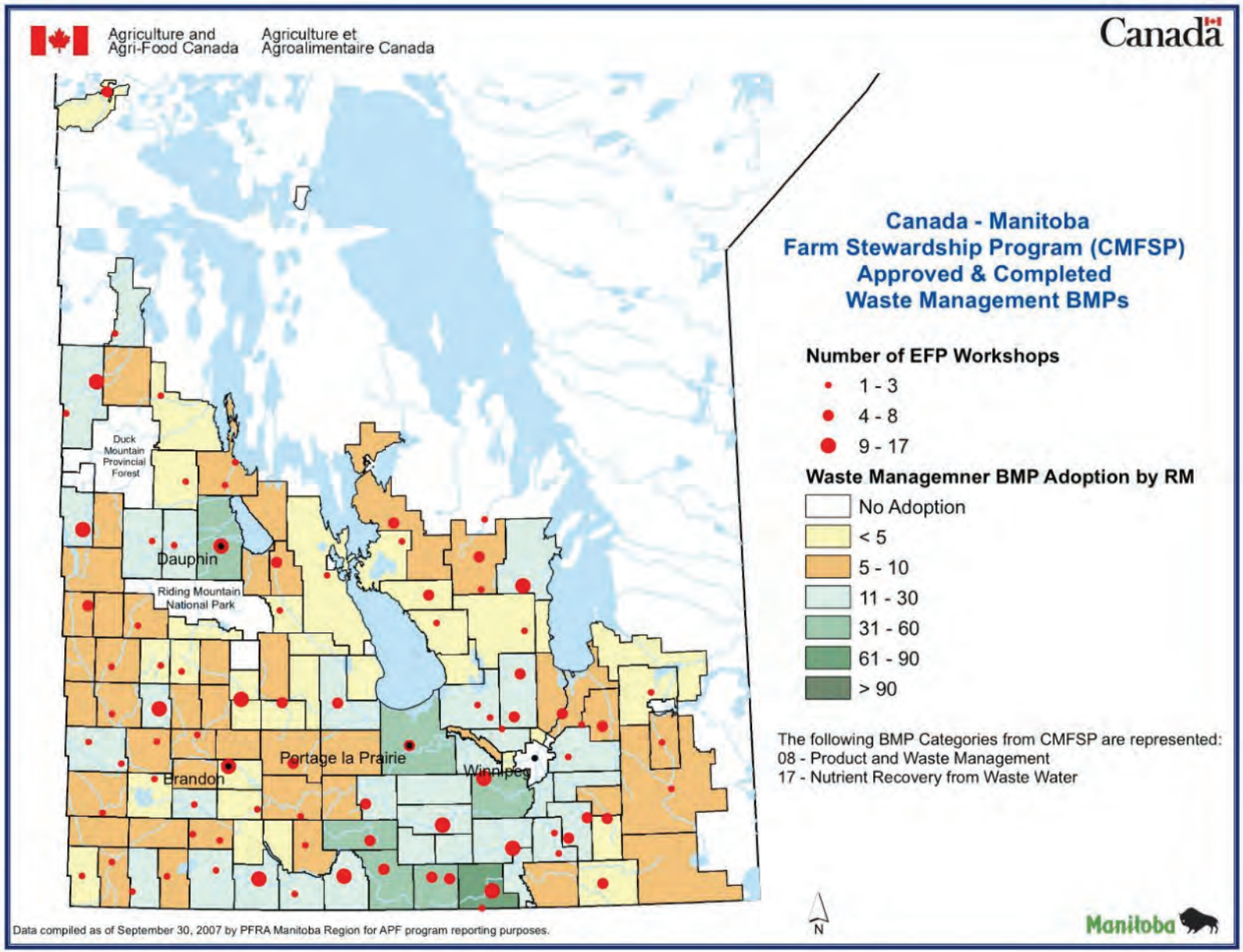


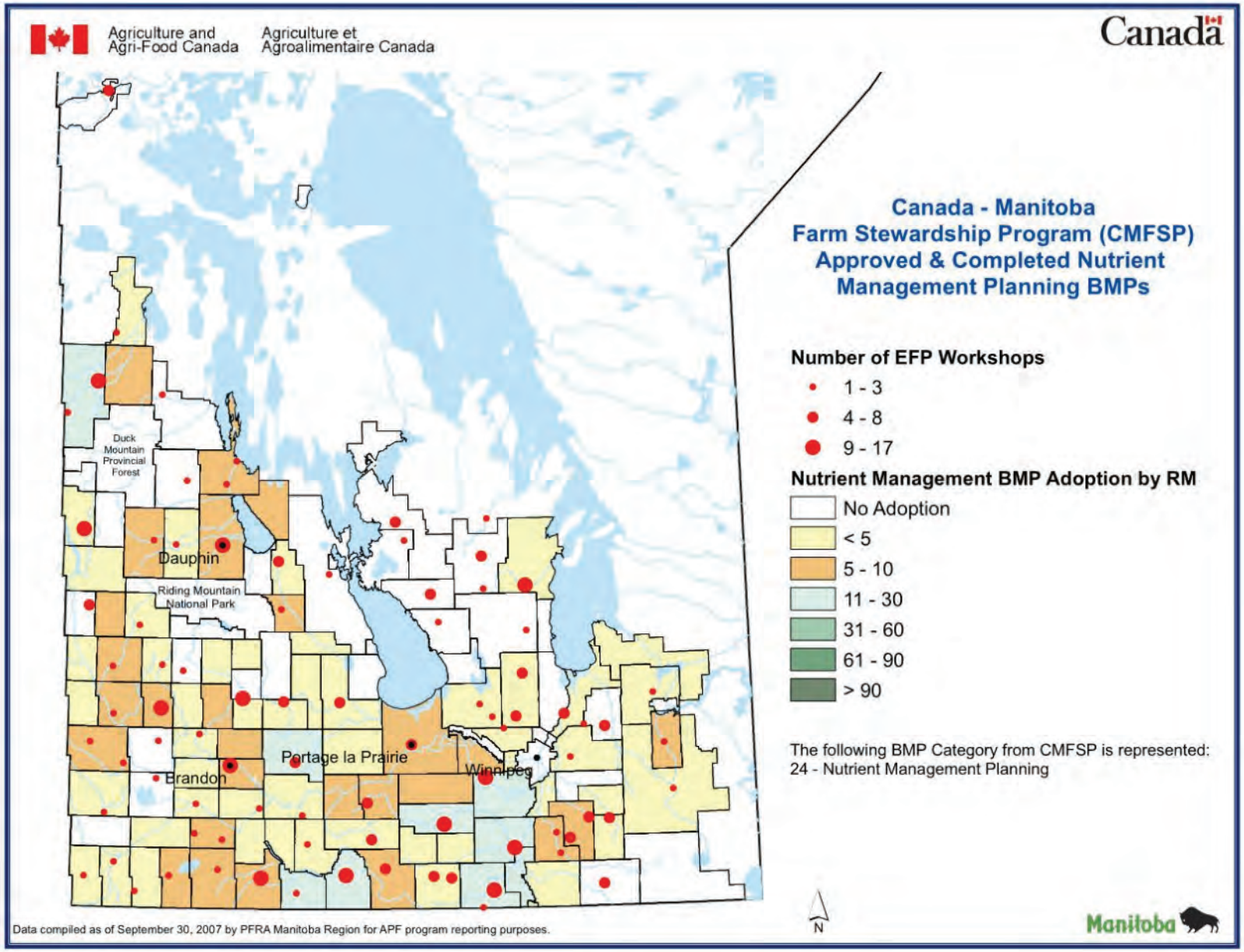
D14-012-012

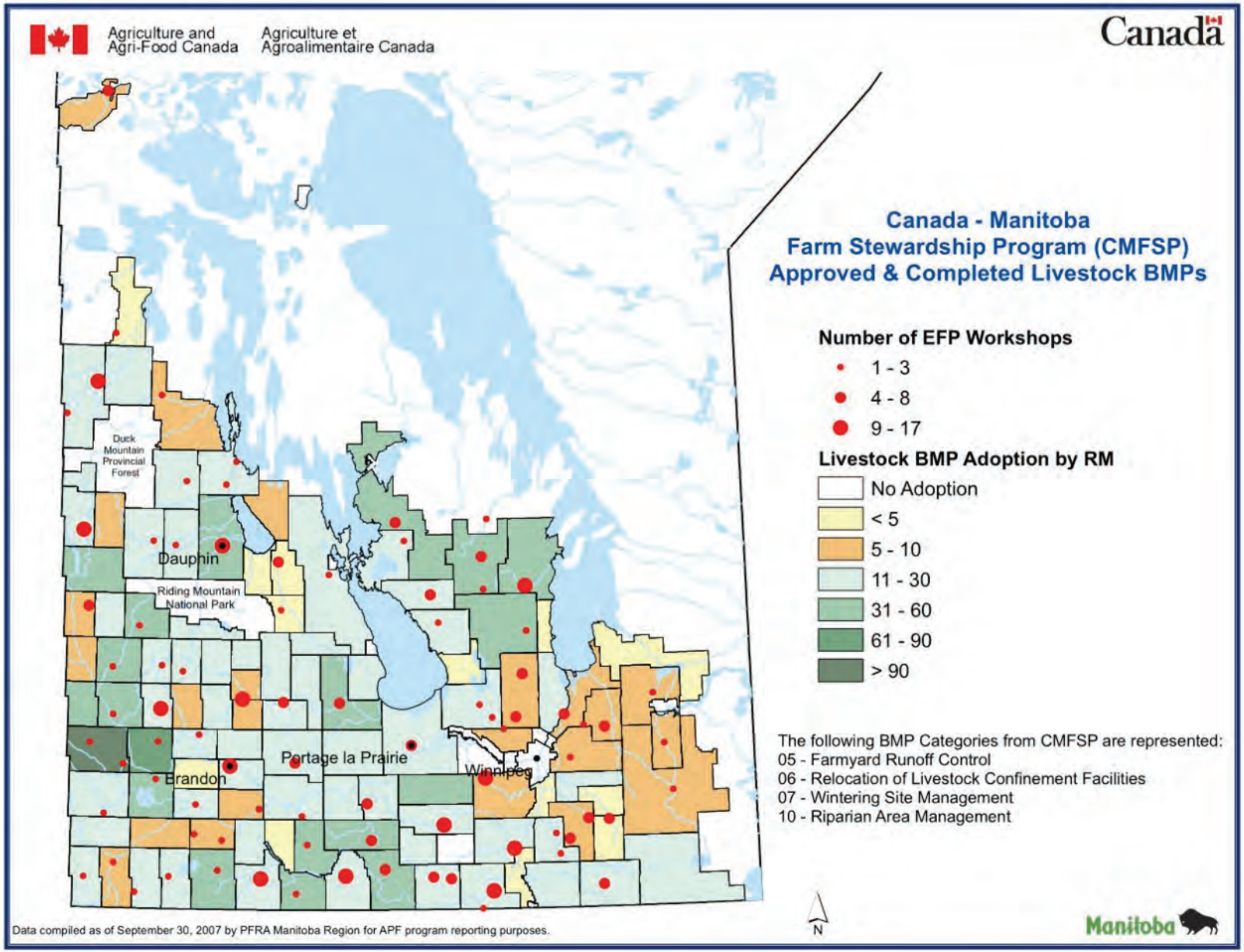

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Canada - Manitoba
Farm Stewardship Program (CMFSP)
Approved & Completed Biodiversity BMPs
Number of EFP Workshops
1 - 3
4 - 8
9 - 17
Biodiversity BMP Adoption by RM
No Adoption
< 5
5 - 10
11 - 30
31 - 60
61 - 90
> 90
Duck Mountain Provincial Forest
Dauphin
Riding Mountain National Park
Portage la Prairie
Brandon
Winnipeg
The following BMP Categories from CMFSP are represented:
21 - Enhancing Wildlife Habitat and Biodiversity
22 - Species at Risk
N
Data compiled as of September 30, 2007 by PFRA Manitoba Region for APF program reporting purposes.
Manitoba

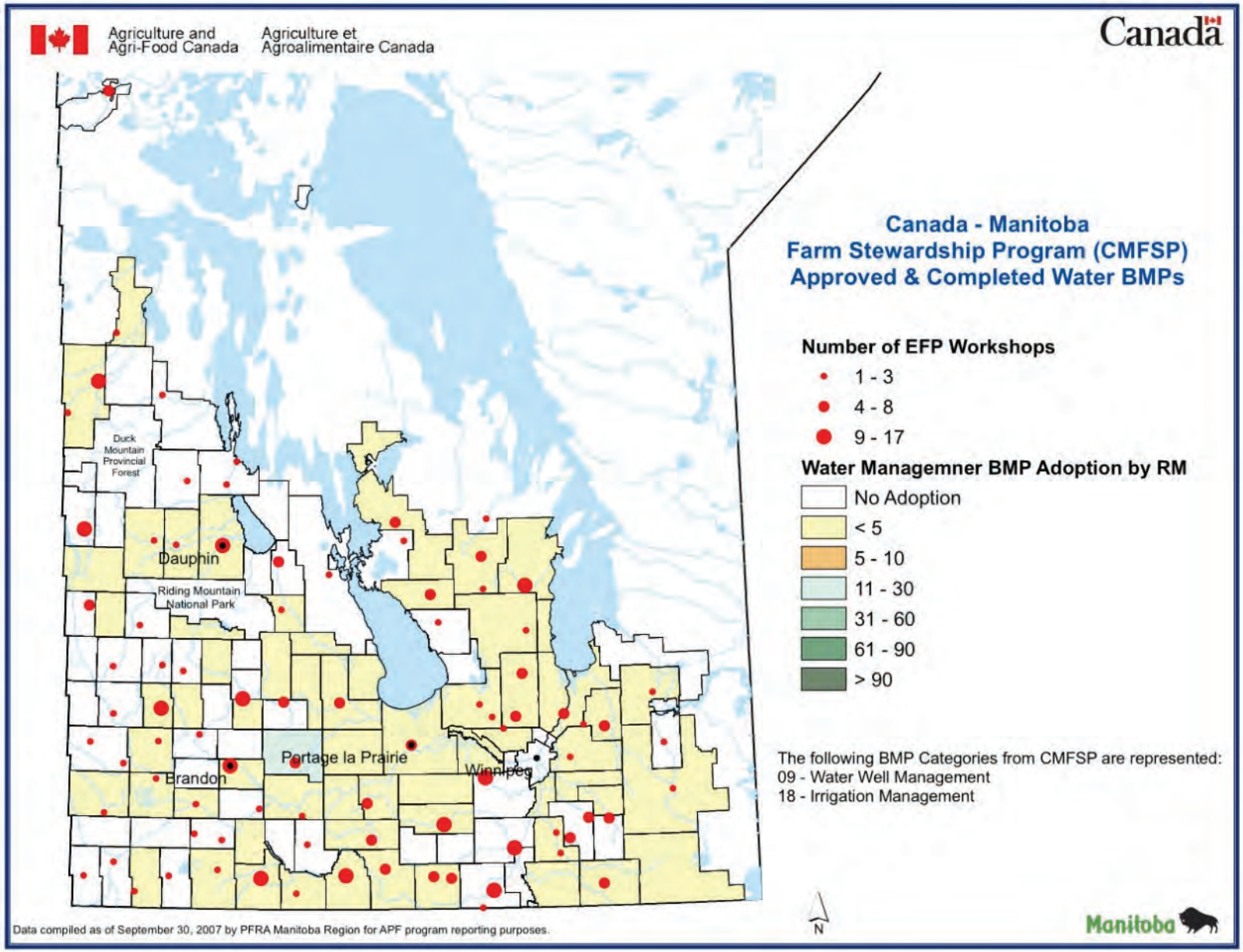

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Canada - Manitoba
Farm Stewardship Program (CMFSP)
Approved & Completed Planning BMPs
Number of EFP Workshops
1 - 3
4 - 8
9 - 17
Planning BMP Adoption by RM
No Adoption
< 5
5 - 10
11 - 30
31 - 60
61 - 90
> 90
Duck Mountain Provincial Forest
Dauphin
Riding Mountain National Park
Portage la Prairie
Brandon
Winnipeg
The following BMP Categories from CMFSP are represented:
24 - Nutrient Management Planning
25 - Integrated Pest Management Planning
26 - Grazing Management Planning
27 - Soil Erosion and Salinity Control Planning
28 - Biodiversity Enhancement Planning
29 - Irrigation Management Planning
30 - Riparian Health Assessment
N
Manitoba
Data compiled as of September 30, 2007 by PFRA Manitoba Region for APF program reporting purposes.

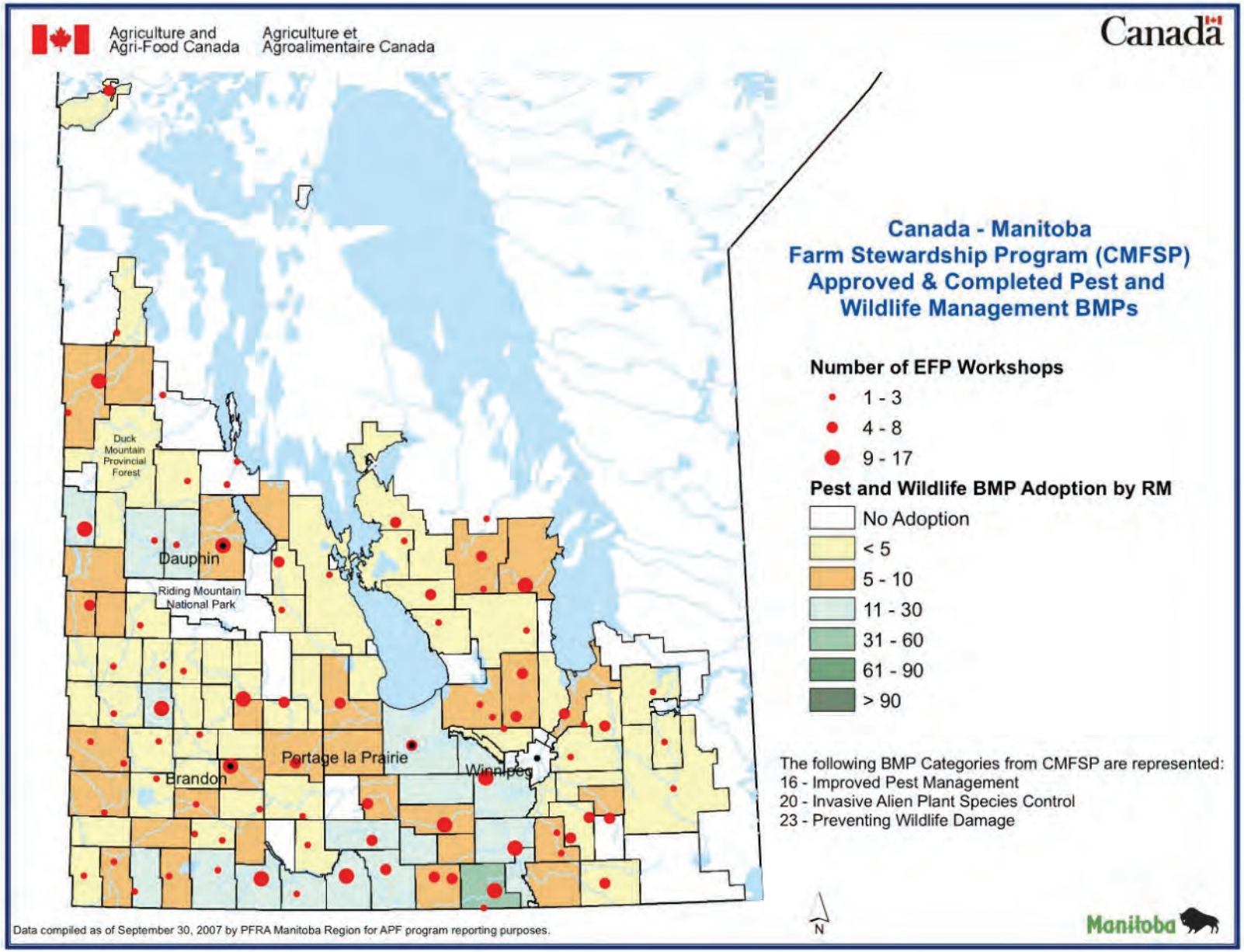

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Canada - Manitoba
Farm Stewardship Program (CMFSP)
Approved & Completed Manure BMPs
Number of EFP Workshops
1 - 3
4 - 8
9 - 17
Manure BMP Adoption by RM
No Adoption
< 5
5 - 10
11 - 30
31 - 60
61 - 90
> 90
Duck Mountain Provincial Forest
Dauphin
Riding Mountain National Park
Portage la Prairie
Brandon
Winnipeg
The following BMP Categories from CMFSP are represented:
01 - Improved Manure Storage and Handling
02 - Manure Treatment
03 - Manure Land Application
N
Manitoba
Data compiled as of September 30, 2007 by PFRA Manitoba Region for APF program reporting purposes.

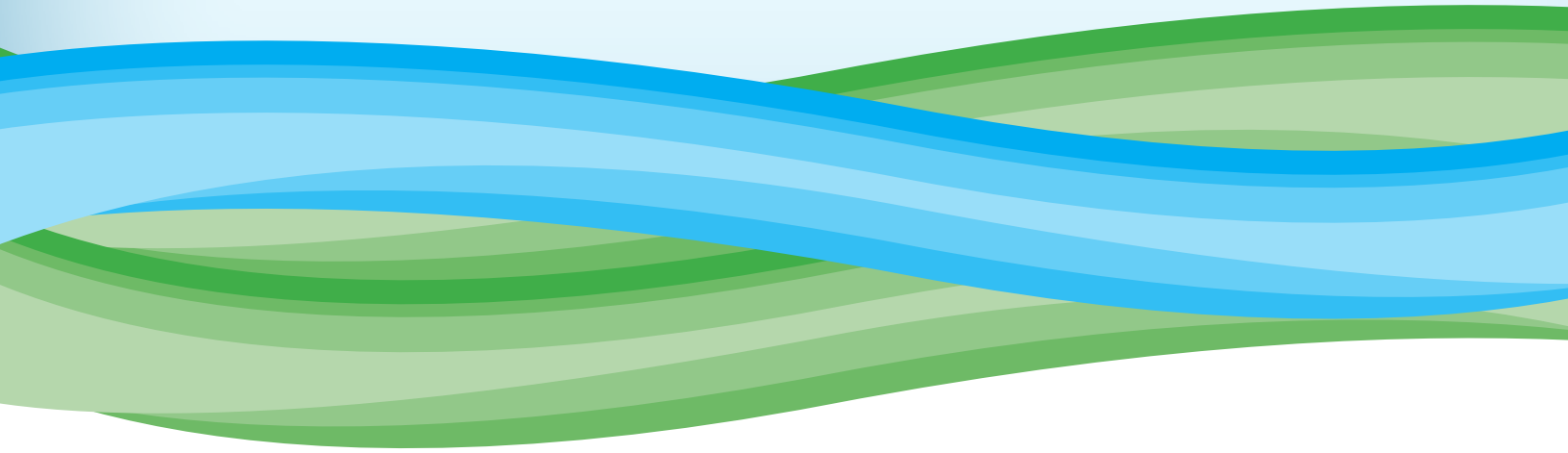

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Duck Mountain Provincial Forest
Dauphin
Riding Mountain National Park
Portage la Prairie
Brandon
Winnipeg
Canada - Manitoba
Farm Stewardship Program (CMFSP)
Approved & Completed
Waste Management BMPs
Number of EFP Workshops
1 - 3
4 - 8
9 - 17
Waste Managemner BMP Adoption by RM
No Adoption
< 5
5 - 10
11 - 30
31 - 60
61 - 90
> 90
The following BMP Categories from CMFSP are represented:
08 - Product and Waste Management
17 - Nutrient Recovery from Waste Water
N
Manitoba
Data compiled as of September 30, 2007 by PFRA Manitoba Region for APF program reporting purposes.


Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Canada - Manitoba
Farm Stewardship Program (CMFSP)
Approved & Completed Nutrient
Management Planning BMPs
Number of EFP Workshops
1 - 3
4 - 8
9 - 17
Nutrient Management BMP Adoption by RM
No Adoption
< 5
5 - 10
11 - 30
31 - 60
61 - 90
> 90
The following BMP Category from CMFSP is represented:
24 - Nutrient Management Planning
Duck Mountain Provincial Forest
Dauphin
Riding Mountain National Park
Portage la Prairie
Winnipeg
Brandon
N
Manitoba
Data compiled as of September 30, 2007 by PFRA Manitoba Region for APF program reporting purposes.


Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Canada - Manitoba
Farm Stewardship Program (CMFSP)
Approved & Completed Livestock BMPs
Number of EFP Workshops
1 - 3
4 - 8
9 - 17
Livestock BMP Adoption by RM
No Adoption
< 5
5 - 10
11 - 30
31 - 60
61 - 90
> 90
Duck Mountain Provincial Forest
Dauphin
Riding Mountain National Park
Portage la Prairie
Brandon
Winnipeg
The following BMP Categories from CMFSP are represented:
05 - Farmyard Runoff Control
06 - Relocation of Livestock Confinement Facilities
07 - Wintering Site Management
10 - Riparian Area Management
N
Manitoba
Data compiled as of September 30, 2007 by PFRA Manitoba Region for APF program reporting purposes.


Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Canada - Manitoba
Farm Stewardship Program (CMFSP)
Approved & Completed Water BMPs
Number of EFP Workshops
1 - 3
4 - 8
9 - 17
Water Managemner BMP Adoption by RM
No Adoption
< 5
5 - 10
11 - 30
31 - 60
61 - 90
> 90
Duck Mountain Provincial Forest
Dauphin
Riding Mountain National Park
Portage la Prairie
Brandon
Winnipeg
The following BMP Categories from CMFSP are represented:
09 - Water Well Management
18 - Irrigation Management
N
Manitoba
Data compiled as of September 30, 2007 by PFRA Manitoba Region for APF program reporting purposes.


Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Canada - Manitoba
Farm Stewardship Program (CMFSP)
Approved & Completed Pest and Wildlife Management BMPs
Number of EFP Workshops
1 - 3
4 - 8
9 - 17
Pest and Wildlife BMP Adoption by RM
No Adoption
< 5
5 - 10
11 - 30
31 - 60
61 - 90
> 90
Duck Mountain Provincial Forest
Dauphin
Riding Mountain National Park
Portage la Prairie
Brandon
Winnipeg
The following BMP Categories from CMFSP are represented:
16 - Improved Pest Management
20 - Invasive Alien Plant Species Control
23 - Preventing Wildlife Damage
N
Manitoba
Data compiled as of September 30, 2007 by PFRA Manitoba Region for APF program reporting purposes.



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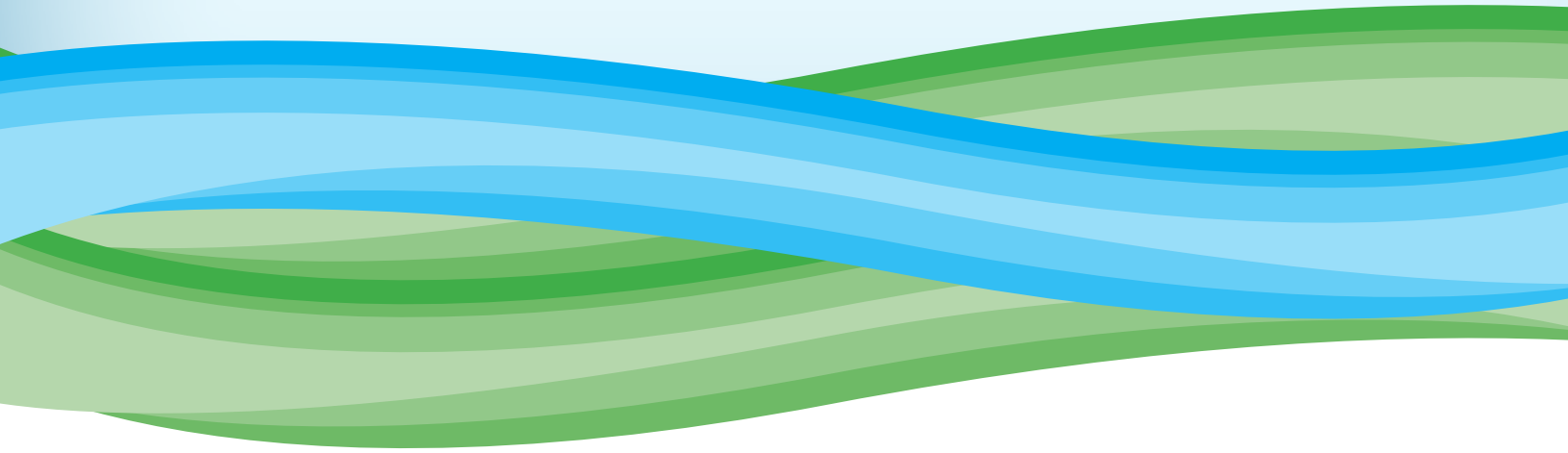

D14-012-012