SASKATCHEWAN

Water Security Agency

2011 Emergency Flood Damage Reduction Program Review

Saskatchewan Water Security Agency
Integrated Water Services Division

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Executive Summary

Heavy rain falls in 2010 and unusually high snowpack through winter 2010-11 led the former Saskatchewan Watershed Authority (Authority) to project that widespread flooding would occur across southern Saskatchewan in spring 2011 (although the Authority was reorganized into the newly formed Water Security Agency in October 2012, throughout this report it is referred to as the Authority as that was the agency when the work was done). In February 22, 2011, the Government of Saskatchewan announced the Emergency Flood Damage Reduction Program (EFDRP) which the Authority, along with the former Corrections, Public Safety and Policing (CPSP) and now known as Government Relations, immediately began to implement.

This report provides a review of the successes and shortcomings, as well as a cost-benefit analysis of EFDRP. It aims to offer insight into the 2011 flood event by reflecting on the program and problems encountered by individuals and communities coping with flooding in Saskatchewan. It also outlines key lessons related to the successful development of programs that effectively and efficiently reduce human hardship and costs associated with flooding in the future.

It was initially projected that the program would assist approximately 600 clients. However, demand for the program was much higher than originally expected. When the program wrapped up in early 2012, 1,237 individuals, communities, rural municipalities and First Nations had requested assistance. These numbers do not include the countless individuals and municipalities who sought technical assistance for flood mitigation, without participating in the program.

Participants were generally very satisfied with the process and outcomes of the program. Each proponent who participated in the program was interviewed at the end of their experience to rate their experience. Overall, proponent satisfaction with the program was high and the vast majority of participants (91 per cent) were able to effectively avert flood damages.

A cost-benefit analysis of the potential financial losses that were prevented because of program activities suggests that the program was highly cost effective. For every dollar spent in flood prevention efforts on individual yard sites, $23 was saved in property replacement costs. For every dollar spent in flood prevention efforts in communities and RMs, $30 was saved in terms of the expected costs for rebuilding, cleaning and repairs.

Lessons learned from the 2011 program include the importance of rapid program roll-out to effective flood emergency response, clear communication with clients, provision of mitigation guidelines, effective database development, links with other related programs and regulatory processes as well as the ability to adapt to the unexpected. The Authority did have a public relations plan in place, which among other things included the creation of the saskflood.ca website, providing an environment for sharing EFDRP and flood event information.

Through the time and dedication of Authority employees in our regional offices, the staff recruited to work on the program, consulting engineers, and engineering technologists, the program was able to provide timely and effective flood prevention support, both financial and technical. Not only did this program have an impact on the flood of 2011, the structures built and advice given will have a positive effect into the future.

1.0 Introduction

Heavy rainfall in 2010 and an unusually high snowpack through winter 2010-11 led the Authority to anticipate widespread flooding across southern Saskatchewan for the spring 2011. This forecast prompted the development of a program to mitigate flooding and assist residents in at-risk areas.

On February 22, 2011, the Government of Saskatchewan announced the Emergency Flood Damage Reduction Program (EFDRP) aimed at providing grants for flood prevention work to communities, RMs and businesses as well as to rural homeowners. The Authority worked together with Corrections, Public Safety and Policing (CPSP), who administered the Provincial Disaster Assistance Program (PDAP), to fill a gap in flood response by providing a program that offered immediate flood prevention assistance. Grants were to be provided as a cost-sharing regime between the proponents and the Authority. The scope of the activities supported included engineering and technical assistance for implementation of permanent and temporary flood prevention work and financial assistance for flood mitigation measures.

The Authority provided grants to communities and rural municipalities (RMs) of 100 per cent for all engineering and technical assistance, 75 per cent for permanent work completed and 50 per cent for temporary work. For individuals and businesses, the cost-sharing was 100 per cent for engineering and technical assistance and 85 per cent for permanent and temporary works completed. The Authority began to implement the program in late February with the initial projection of approximately 600 participants.

Permanent flood prevention work includes any permanent berms, dykes, ditches, culvert installations and trenching. Temporary flood prevention work includes sandbagging, pumping water and temporary ditching or trenching.

Requests for assistance quickly expanded past the original projection of 600 proponents and more than doubled by the end of 2011. This was due to excessive precipitation and widespread flooding across the province into late spring and early summer. In the fall, the Authority requested additional funding from the provincial government to meet the influx of applications. At the same time, the federal government announced it would reimburse the province for 50 per cent of its funding toward permanent works, and that it would provide 100 per cent of the funding for all flood prevention works completed in First Nations communities.

At the end of the program, a review was conducted to determine the effectiveness of the mitigation works. The information and data for this review was gathered from questionnaires completed by the proponents who participated in the program. Two separate questionnaires were administered – one at the end of their participation with the program and another as a follow up several months afterward. Together, these questionnaires gathered quantitative information regarding the success, satisfaction, and proponent's dependence on the program, as well as the quantitative information necessary to conduct a cost-benefit analysis of the program.

2.0 Background

2.1 Unique Water Issues in Saskatchewan

The hydrology of Saskatchewan differs between winter and summer. Pomeroy *et al.* (2005) describe the prairie winter hydrology as primarily snowfall and snow redistribution by blowing snow storms. Sublimation, when snow crystals transform directly to the gas phase without first becoming a liquid, also occurs. The melting of snow and resulting runoff that occurs during spring melt is extremely important to the water systems of the prairies.

On the other hand, the summer hydrology is characterized by rainfall, evaporation, runoff and infiltration. During the summer months, water availability is heavily dependent on precipitation events that recharge groundwater and replenish the water in lakes, rivers, sloughs and wetlands.

The movement of water throughout the summer season is determined by the major drainage basins in the area. Drainage basins are defined as an area where all the surface water shares the same drainage outlet including all the water found in creeks, streams, and major river systems. In Saskatchewan, there are three major drainage basins – Hudson Bay, Gulf of Mexico and Arctic Ocean (see Figure 1).

The Atlas of Canada (Natural Resources Canada) states that the Hudson Bay drainage area in Saskatchewan accounts for approximately 30 per cent of the total Canadian runoff. The Gulf of Mexico drainage basin first drains into the Mississippi system in the southern United States and eventually makes its way to the Gulf of Mexico.

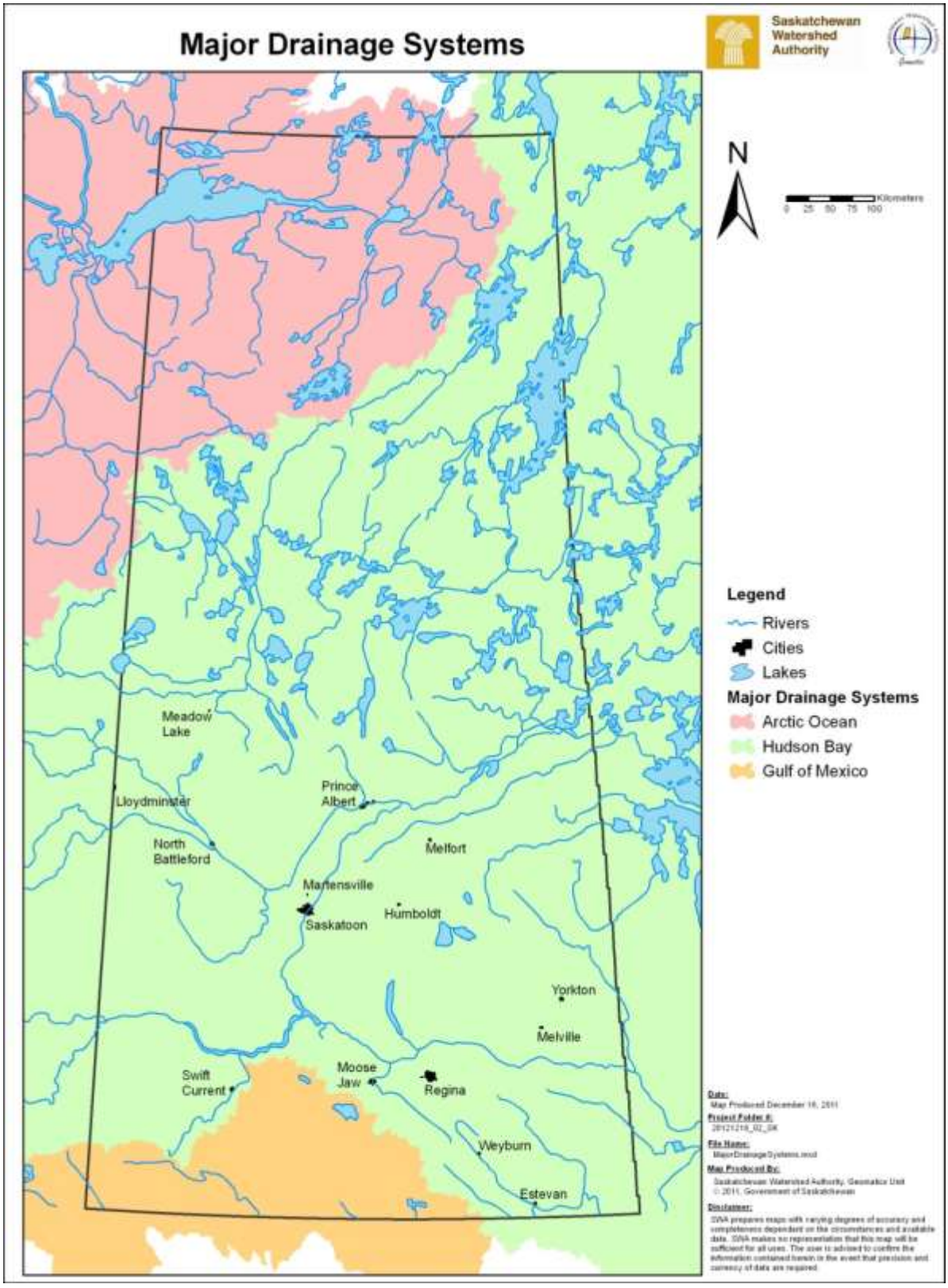

Figure 1: The major drainage areas of Saskatchewan
(Saskatchewan Watershed Authority Geomatics Unit)

There are also areas of our prairie landscape that do not drain into these drainage basins and simply drain into internal bodies of water. These are internal, or non-contributing, drainage areas, defined by Hydrology and Water Resources of Saskatchewan (2005) as areas that do not drain into an ocean or a sea but into local lakes, sloughs or wetlands. The non-contributing drainage areas in Saskatchewan are located primarily in the southern portion of the province, including areas such as the Quill Lakes and Old Wives Lake drainage basins (see Figure 2).

Because they lack external drainage routes, these areas are more vulnerable to prolonged flooding. In years with higher than average precipitation, the storage within the internal drainage areas reaches full capacity and any additional precipitation begins to overtop the storage and become overland flow. The flow ends up in a terminal lake, causing it to rise above its shoreline, flooding adjacent lands.

Early development was often situated in the flood plains because of the availability of water and because the soil in these areas was the most fertile and best suited for agriculture. When agricultural farmsteads, towns and communities are placed in these flood-prone areas significant flooding issues can arise.

Extreme weather events are common in Saskatchewan – there can be a drought one year and flooding the next. Or sometimes, as in 2010, there can be both drought and flooding in the same year (SaskAdapt 2012). By nature, flooding is a cyclical event in Saskatchewan and being prepared, and having plans and permanent structures in place to cope with these events are important to public safety and the protection of property.

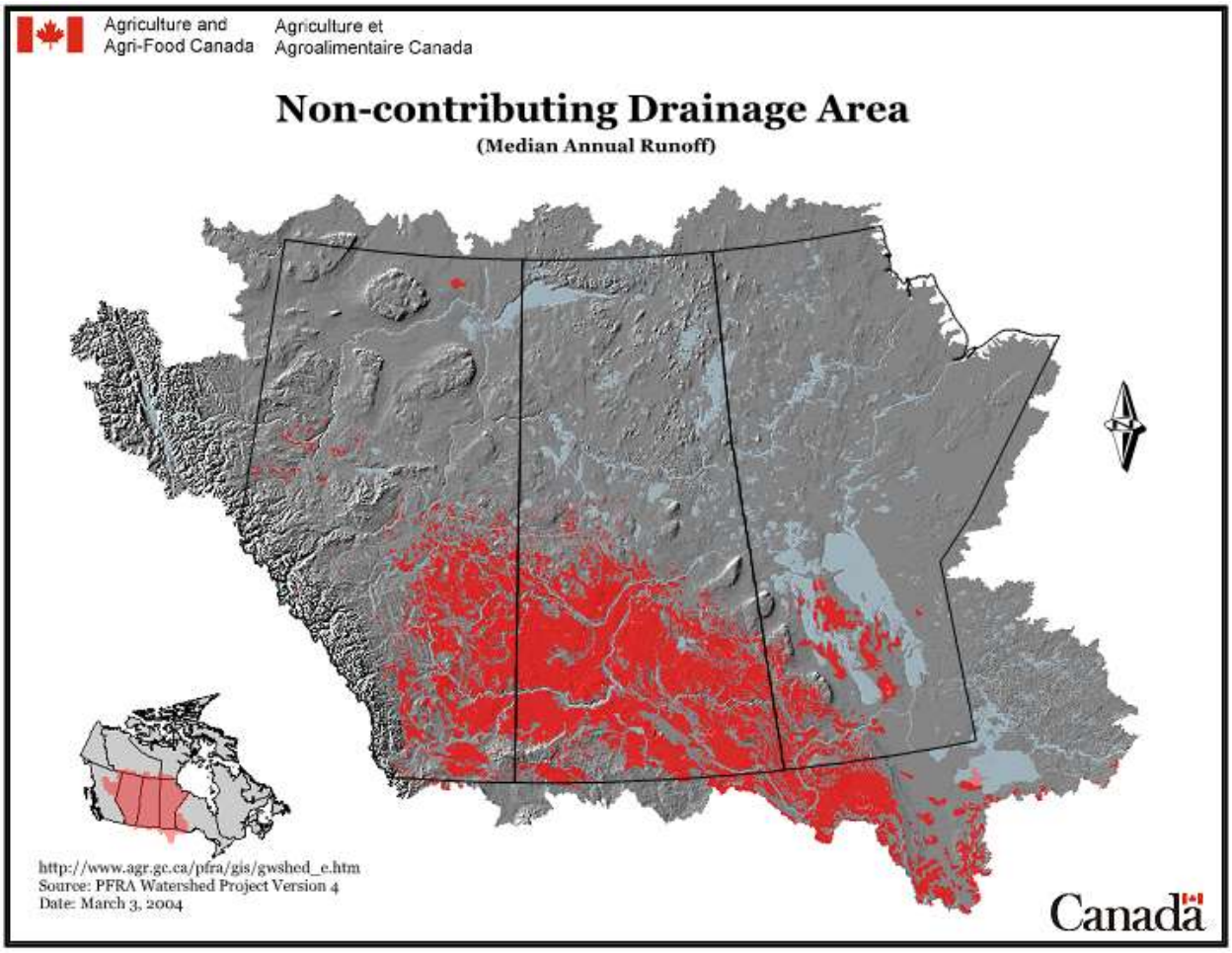

Figure 2: Non-contributing drainage areas of Saskatchewan
(DEM - GTopo30, USGS; Base map - Natural Resources Canada; Watershed Data - Agriculture and Agri-Food Canada)

2.2 Factors contributing to 2011 flooding

The flood event of 2011 stems back to heavy rainfall recorded throughout the province in the spring and summer of 2010. From April until late October of 2010, southern Saskatchewan experienced precipitation far above the historical normal – ranging from 90th percentile to record setting rainfall across almost all of the southern half of the province (see Figure 4).

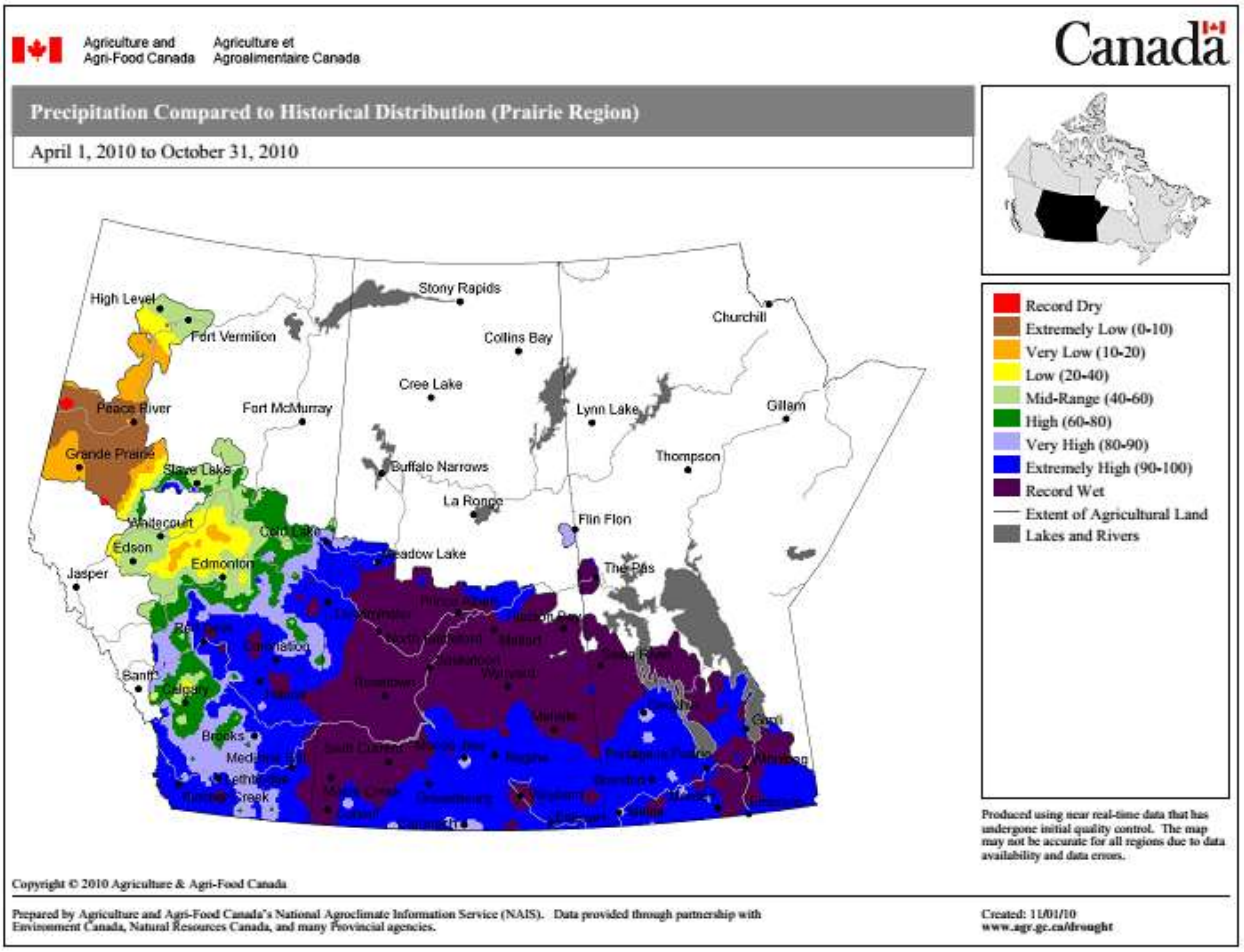

Figure 3: Precipitation Compared to Historical Distribution in the Prairie Region of Canada from April 1 to October 31, 2010
(Agriculture and Agri-Food Canada)

Some areas in southern Saskatchewan experienced devastating flooding through the summer and fall of 2010. Maple Creek and Yorkton both experienced destructive flooding that washed away roads, houses, businesses and affected many lives. The highway between Maple Creek and the Alberta border was closed for some time during the summer for repairs and all traffic was rerouted. PDAP experienced an influx of over 6,000 claims during this 2010 flood event.

In late 2010, the shallow water table levels throughout southern Saskatchewan were extremely high and wetlands and sloughs were full. Areas with internal drainage had reached their capacity and many rivers were still flowing at record rates heading into freeze up.

Through the months of November and December of 2010, the province experienced unusually high snow pack. Figure 5 presents the precipitation in November compared to this historical data. The majority of southern Saskatchewan experienced from mid-range to extremely high precipitation. As a result, the Authority predicted widespread flooding throughout the agricultural region of the province of Saskatchewan. At this point, the provincial government, CPSP and the Authority began early discussions of a possible program to help mitigate flooding in the 2011 year so as to avoid detrimental flooding throughout a majority of the province.

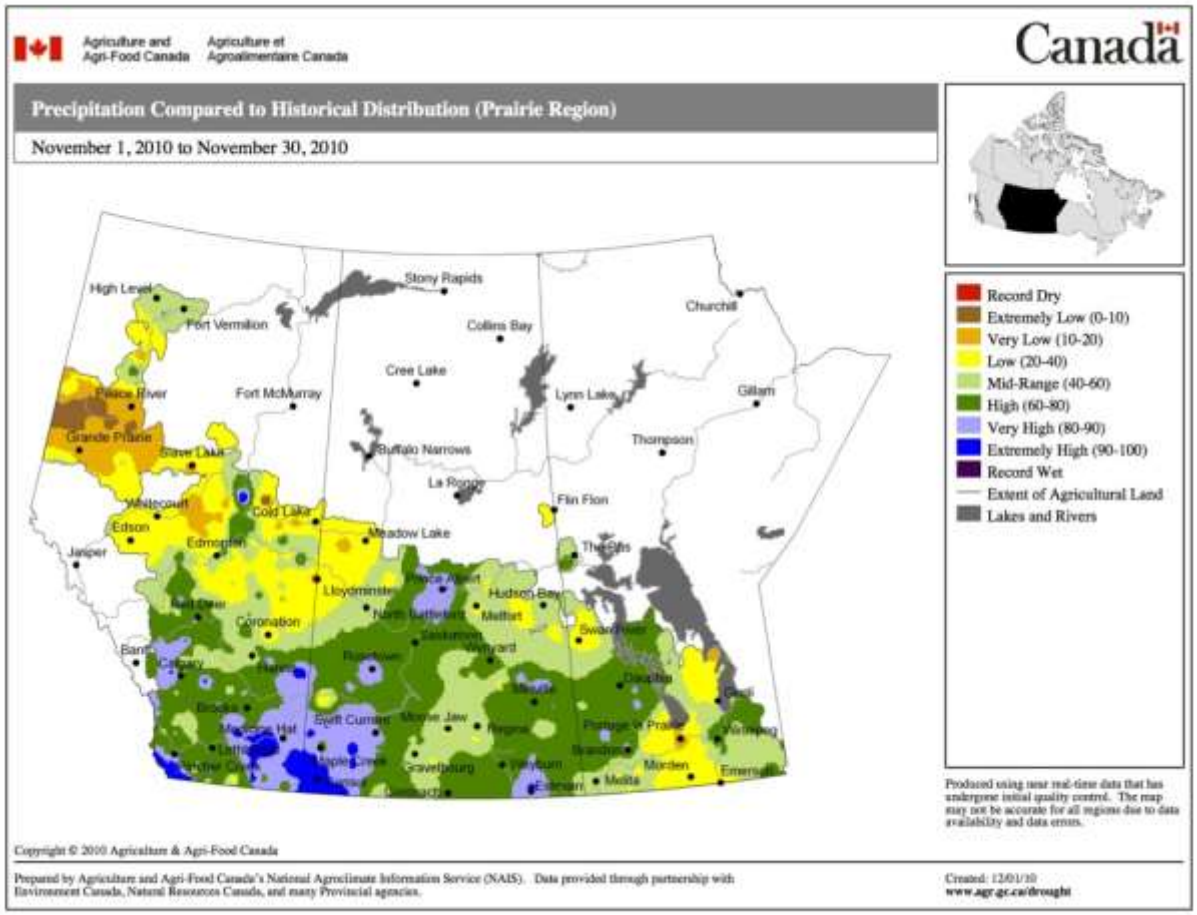

Figure 4: Precipitation Compared to Historical Distribution in the Prairie Region of Canada in November 2010
(Agriculture and Agri-Food Canada)

2.3 2011 Runoff Events

In 2011, in many southern areas of the province, there was a spring runoff peak, followed by a second flood peak caused by rains in May and June. Figure 6 shows the accumulated precipitation from May 22 to June 20, 2011. Some of the areas in the province received in excess of 200 mm of precipitation over the 30-day period.

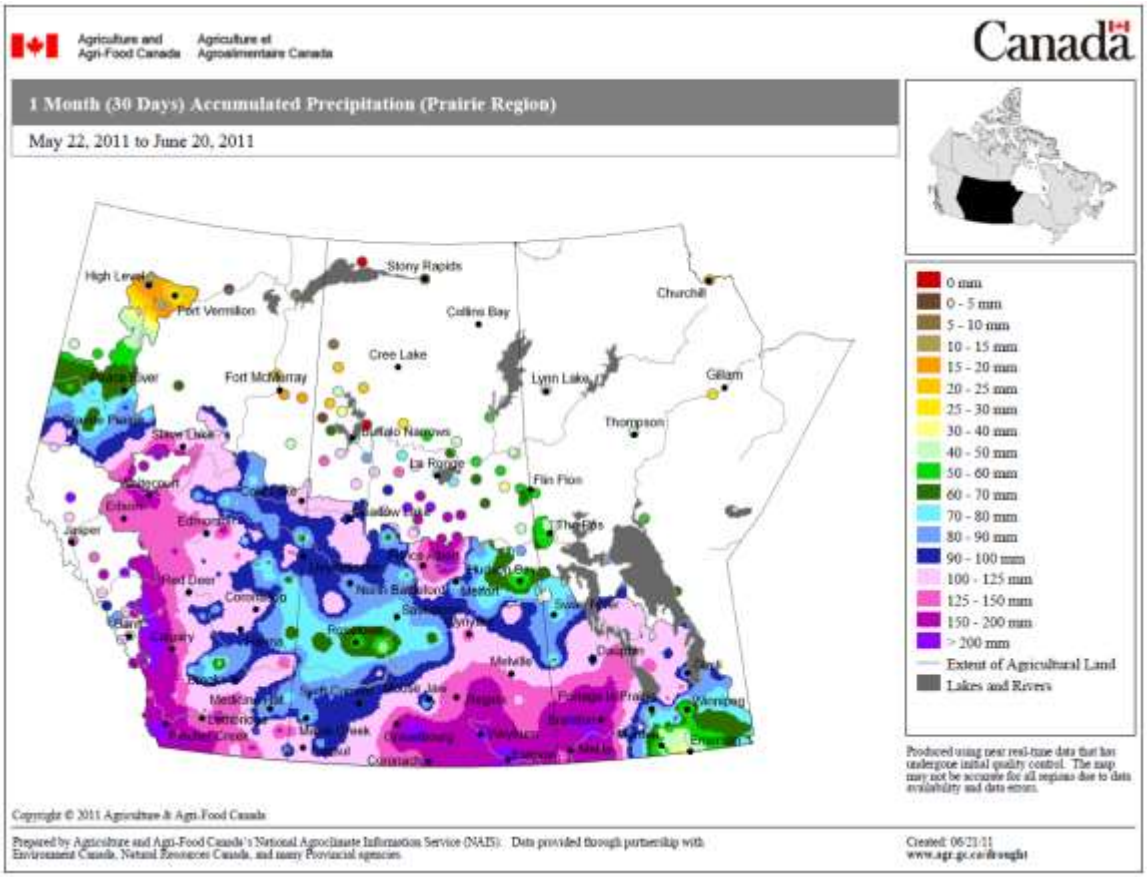

Figure 5: 30-Day Accumulated Precipitation May 22 to June 20, 2011
(Agriculture and Agri-Food Canada)

The per cent of normal precipitation for this 30-day period is shown in Figure 7. Based on the earlier spring runoff and the later June runoff, a runoff frequency map was prepared for the southern part of the province, as shown in Figure 8. Runoff varied from an estimated 1 in 5 year events to 1 in 500 year events.

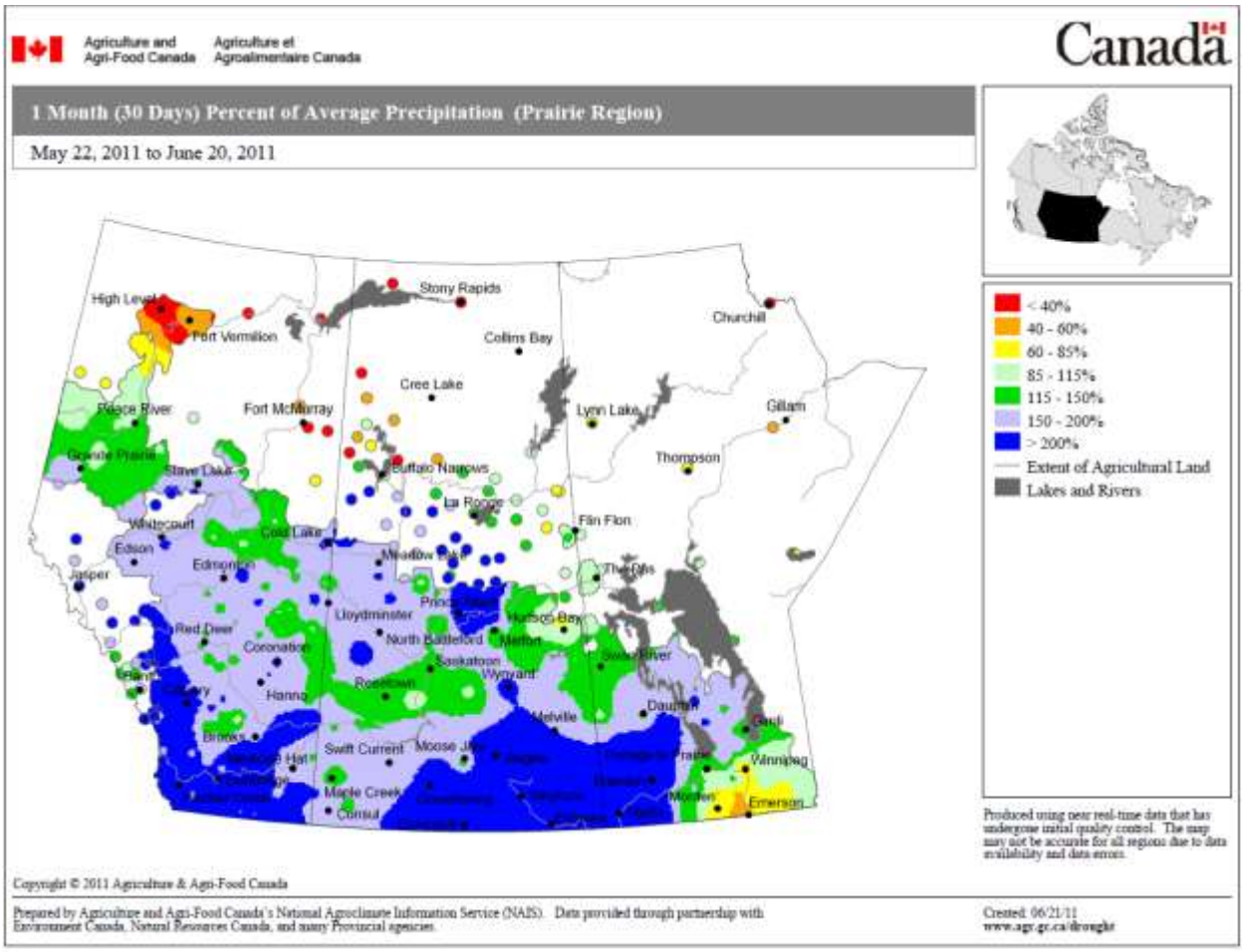

Figure 6: 30-Day Per cent of Normal Precipitation May 22 to June 20, 2011
(Agriculture and Agri-Food Canada)

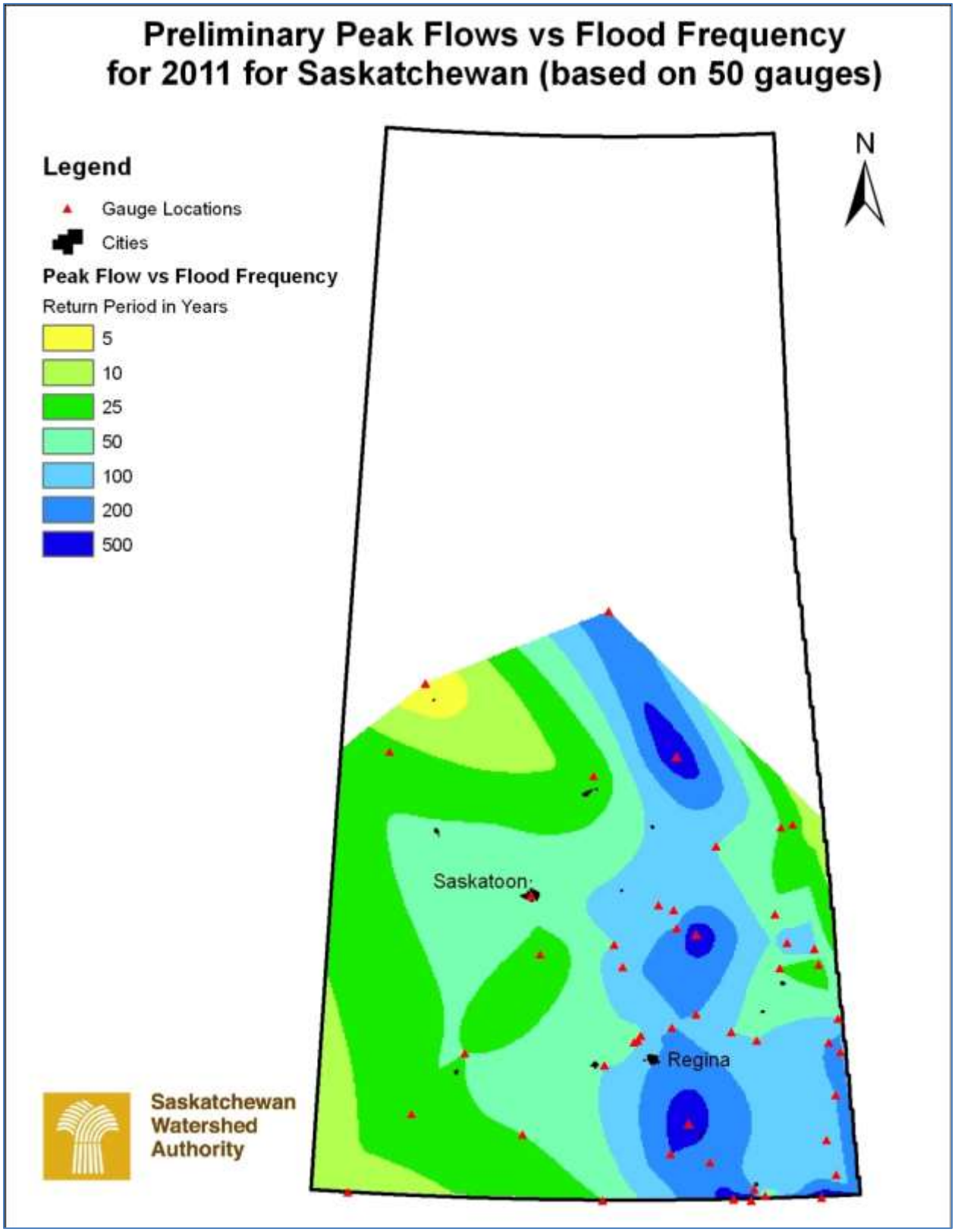

Figure 7: Estimate Flood Peak Flows and Frequency

3.0 Program Development

In January 2011, the Authority proposed that a program be developed to prevent flooding in the areas of the province that were at highest flood risk for the spring of 2011. By February 22, 2011, the Government of Saskatchewan announced EFDRP at the Saskatchewan Association of Rural Municipalities convention. This program was to be headed by the Authority and CPSP and funded by the provincial government. It was aimed at the implementation of emergency flood damage reduction or prevention measures for communities, RMs and individual farm and country residences for spring 2011. The detailed program profile is contained in Appendix 1.

The Authority kept Cabinet informed of the potential for flooding starting in the fall of 2010. By mid-winter it was determined that unless a major change in the weather occurred, the province was poised for a major flood.

The program was set to commence immediately and end in mid June 2011 with the expectation of approximately 600 community and individual participants. The original grant from the provincial government was for $21,365,000, with plans to pursue cost-sharing with the federal government. Two million dollars of this original grant was dedicated to CPSP to rent and purchase equipment and supplies for the program.

The Authority immediately recruited a consulting engineering firm, Water Resource Consultants (WRC), to assist in delivery of the EFDRP. The firm's president, Ray Pentland, P.Eng., worked with the Authority to develop program details. The WRC also coordinated meetings between the Authority and the Consulting Engineers of Saskatchewan, whose members would assist in the delivery of technical support across the province. The WRC also provided additional experienced water resources staff to assist in delivery and review of projects.

Near the end of February 2011, Authority regional office staff began contacting communities and RMs in the areas of greatest flood risk. Shortly thereafter, senior Authority technicians as well as consulting engineers and engineering technologists contracted by the Authority, were sent out to the field to assess sites and help those who had a high flood risk on their property and an interest in participating in EFDRP.

A map created by the Authority predicted the Potential Spring Runoff for 2011 and identified the areas at greatest flood risk (Appendix 2). The map displayed the many communities that were at high risk of flooding and identified which communities should be contacted first about the program.

As the snow melted in early spring, interest in the program increased and the number of applicants surpassed the original estimate of 600 participants. The Authority requested a program extension from the provincial government and the program was extended from the original end date of June 15 to Dec. 31, 2011.

As heavy rains fell throughout the summer of 2011, a need for even more flood damage protection arose. Government approved an additional $12,835,000 of funding for the program to cover additional costs. A preliminary agreement with the federal government was struck to reimburse the province for 50 per cent of its grants for permanent works, as well as to cover 100 per cent of the cost of works completed in First Nations communities. Table 1 provides a cost distribution beginning with the original estimated costs and grants, which also includes the revised estimated costs after the additional funding was granted.

Table 1: Increased costs and estimated cost breakdown as stated in the August 30, 2011 request for additional funding

Activity	Original Estimated Cost	Revised Estimated Cost
Construction of works	$16,385,000	$24,000,000
Consulting and temporary staff	$3,980,000	$3,000,000
First Nations works	$0	$4,000,000
CPSP emergency supplies	$2,000,000	$4,200,000
Total	**$22,365,000**	**$35,200,000**

The program was completed in early 2012 with a final cost of $32,194,436 million. Program staff were contacted by 1,237 proponents, including 330 communities and RMs, 15 First Nations, 881 individual yard sites and 11 other proponents. The vast majority of contacts led to Authority technical assistance and grant funding for flood mitigation works. These 1,237 proponents, however, do not fully reflect the number of people impacted by the program. Behind every community and RM proponent there were hundreds of people who benefitted from the work completed. For each individual proponent, there was often the home of an entire family saved. The impact of EFDRP reached far past the numbers represented in program reports.

4.0 Program Implementation

4.1 Response to requests for assistance

A total of 1,237 individuals, businesses, municipalities and First Nations requested assistance over the course of the 2011 flood year. Three distinct processes were used to manage requests. Appendix 3 contains the various forms used throughout the process.

4.1.1 Applicant Database

In the early stages of the program, a single database, ("applicant database") was constructed to manage information associated with each applicant and track the status of all of the applications for flood damage protection under the program.
The first step in responding to these requests was to carry out an engineering or technical assessment of the flood threat and provide advice as to what could be done to effectively reduce flooding on the proponent's property in the short and long term. Every client was

provided with a consulting report outlining flooding issues and recommendations. A copy of the report was also kept by the Authority (Appendix 3a).

The proponent then entered into an agreement that outlined the work required and the estimated costs (Appendix 3b). The Authority provided guidelines for costs based on Ministry of Agriculture guidelines or industry standards (Appendix 4). From there, the proponents completed the work with their own resources, or with the help of a contracting company. The proponent owned these works and was responsible for any issues such as land control or regulatory permits. Interim requests for payment could be submitted to the Authority (Appendix 3c/d). It should be noted that all proponents working in the program were working on tight timelines in order to prevent flood damage.

At the completion of the work, a final inspection and report were completed by a consultant or Authority staff member. As part of this step, basic information related to proponent satisfaction was gathered (Appendix 3e). The proponent was then required to submit a Request for Final Payment form, accompanied by original invoices for all work claimed (Appendix 3f/g). The submitted request and related files was then reviewed by the inspector, who completed a Final Payment Sheet recommending full payment (or not) (Appendix 3h). The complete package was also reviewed by Authority management and sent for payment, at which time a cheque would be issued.

As the final cutoff date for submission of request for payment drew near, there were cases of proponents who had not submitted their final request for payment and/or had not included all invoices for claimed work. In these situations, the Authority sent proponents a letter reminding them of the cutoff date and their responsibilities, if they desired compensation (Appendix 5).

4.1.2 Walk Up Database

The “walk up database” was created for those proponents whose request for assistance came at a critical time, *i.e.* when flooding was imminent or in progress. Many proponents did not have time to apply for the program and wait for someone to come out and assess their property as the flood water was encroaching on their homes. In these cases, the Authority provided limited technical advice by telephone and over the internet and informed the proponent on what qualifies under EFDRP. The Authority’s ultimate goal was to provide flood protection in a timely fashion but at the same time provide adequate technical assistance. Engineering consultants were dispatched in only the most severe cases.

Upon the completion of the work, the proponent signed an amended Flood Damage Assistance Agreement (Appendix 3i), herein complying with the rules and guidelines of the program. From this point, the Authority proceeded as above, sending an inspector out to view the completed work and sent the file off for payment.

4.1.3 First Nations Applicants

First Nations were not included in the program until the middle of April 2011. At that time, runoff was well underway across the southern part of the province. Initial flood response activities focused on dealing with real-time emergency situations to protect property and maintain road access for critical health and safety services. The first requests for assistance came through CPSP, who worked with bands along the Qu'Appelle system. At the request of Cowessess, Sakimay, Muscowpetung, Piapot and Ochapowace First Nations, consultants were assigned to provide assistance. Requests from other bands followed shortly afterward.

Funding for the First Nations was provided by the federal government and applied to 100 per cent of the costs for both permanent and temporary flood damage protection work. Most of the First Nations communities had an initial assessment completed by a consultant who identified what temporary and permanent work was necessary to provide short and long term flood protection.

After the first contact was made between EFDRP and the First Nations, an application to the program was made. A primary inspection was undertaken (if possible) of the proposed work to be completed as well as the work that had already begun. When the work was completed, all bills, invoices and receipts were submitted to the Authority. A meeting was scheduled to discuss what expenses were eligible under EFDRP and to review the information that had been compiled. The agreement was reviewed and draft wording for a Band Council Resolution, required to enable the Band to enter into an Agreement, was developed. A follow-up inspection of all work completed was also done at this time, if feasible. It should be noted that the EFDRP guidelines were not modified for use in First Nation communities.

Once all bills and invoices were received, the information was reviewed and entered into a spreadsheet and the portions that were eligible under EFDRP were highlighted. Prior to payment however, the information was reviewed by Aboriginal Affairs and Northern Development Canada (AANDC) to verify that the work had not already been funded. Payment for these portions at 100 per cent were then issued to the First Nation. The spreadsheet was sent to PDAP for review to ensure that those expenses paid under EFDRP were not included under PDAP and to evaluate any expenses not eligible under EFDRP to determine if they were eligible under PDAP. Lastly, AANDC reviewed those expenses that were not eligible either under the EFDRP or PDAP programs to determine if they could be funded under their ongoing program.

4.2 Role of Regional Offices

The Regional Offices were generally the first line of contact between the Authority and the proponents applying to EFDRP. The offices were the administrative base for the field inspectors and provided proponents with information about the program. They documented the flood threat, worked with the proponent to identify possible remedial actions and prepared the client profile that was sent to the head office for follow-up.

4.3 Consultants and Temporary Staffing

On behalf of the Authority, WRC hired engineers with experience in hydrology and the nature of flooding. These engineers made up the staff working behind the scenes, directing field investigations of flood threats and mitigation by assigning consultants and technical staff to priority areas, providing assistance to proponents over the phone, approving and disallowing flood prevention work and processing claims. They helped establish the program, coordinated activities with Authority regional staff and with the Consulting Engineers of Saskatchewan. They also entered into discussions with the US Army Corps of Engineers and determined the standards of the flood prevention work that would be covered through EFDRP. These experienced engineers ensured adherence to the program and strived to maintain the standards of the flood prevention measures.

The Authority hired 22 engineering firms to aid with the field assessment of properties and to provide recommendations to proponents through EFDRP. These engineers played an extremely important role in the program, as they were on the front lines interacting with proponents on behalf of the Authority. This was a large task to which the firms devoted a significant amount of time and effort to complete. In the cost-sharing regime, the Authority funded all engineering and technical assistance at 100 per cent. This included all technical advice and consultations completed through EFDRP.

The Authority also hired engineering technologists to provide technical services in the field. They carried out initial assessments and recommended actions for over 300 applicants. Later in the program, they performed inspections of the work being completed through the program and ensured that all work held up to the engineering standards. They ensured the safety and integrity of the work and provided advice on the completion and future upkeep of the mitigation measures to ensure their effectiveness into the future.

The engineers and engineering technologists provided advice in a timely manner and also produced over 600 reports outlining flood threats and proposed solutions in less than three months. Without the support of the engineers and engineering technologists, the program could not have run as efficiently and effectively as it did. The work they completed was invaluable not only to the Authority, but to the countless proponents who, by following their advice and guidance, successfully protected their property from flooding in the short term, and quite often, the long term.

5.0 Program Evaluation

5.1 Methods

EFDRP was evaluated in order to determine if the outcome of the program upheld the original goal of the program – to provide financial and technical flood damage prevention assistance in a timely and effective manner during the 2011 flood in Saskatchewan. The program was originally evaluated using results of the Final Inspection Reports, wherein proponents assessed

different aspects of the program and rated their satisfaction. As it was also important to understand how the program affected the lives of the proponents, the Authority developed a follow-up questionnaire to determine what property might have been lost, what impact the program had on the proponent's stress levels and the suggestions the proponents had for future programming.

The Authority hired a professional insurance adjusting company to overview the data gathered from these questionnaires and produced an accurate financial cost-benefit analysis of the program. The Authority assigned Scrivener Claims with the task of conducting a review of the financial assets of municipalities and individuals that were protected by flood protection measures implemented as a part of EFDRP.

Scrivener was provided an estimate of the cash value of the assets protected by the program, derived from questionnaires filled out by program participants. Scrivener also conducted field inspections of the flood damage reduction work at 77 yard sites and in 39 RMs and communities. These field visit sites were chosen, at random, from a larger group of 439 proponents who had participated in the program and had received their payment as of Sept. 27, 2011 (see Figure 6).

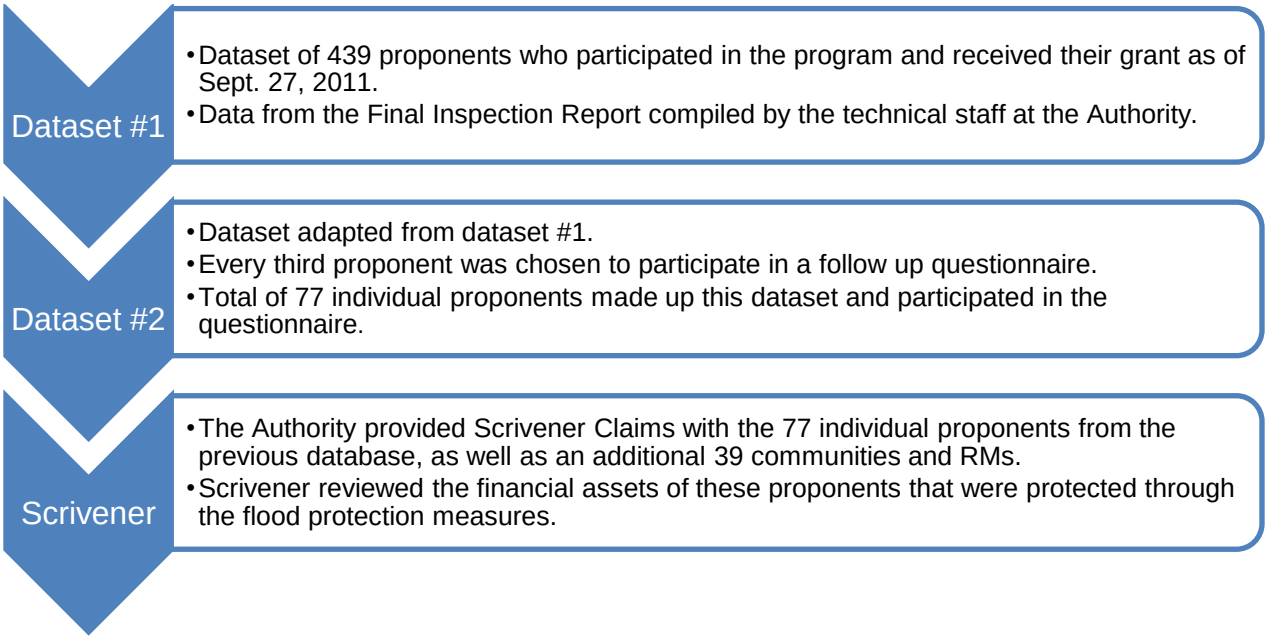

Figure 8: Schematic diagram depicting the dataset selection for the EFDRP review.

5.1.1 Individual Yard Sites

The Authority provided property information to Scrivener for the individual yard sites. The information included the age of property, the square footage, upgrades to the property, number of people living on the property and their estimated value of the property. The information was gathered by the Authority during a telephone interview (Appendix 7).

Scrivener took this information and, utilizing background analysis from other information sources, established a dataset for properties affected by overland flooding. They separated the 77 properties provided by the Authority into categories by age of property (Table 2).

Table 2: Property Classes as determined by Scrivener Claims.

Class	Year	Dollar per square foot
Class A	1981 – present	$225/ft^2
Class B	1961 – 1980	$200/ft^2
Class C	1941 – 1960	$175/ft^2
Class D	Prior to 1940	$150/ft^2

From here they established the replacement costs of the homes based on the different standards of construction in each age class of home. Due to unique issues found at some locations, the final database consisted of 62 properties.

5.1.2 Rural Municipalities and Communities

Scrivener first conducted phone interviews with the selected RMs and communities to establish in greater detail the scope of the project that had been completed and the stated reason for the work. Scrivener undertook site visits for each RM or community to conduct interviews with the local authority. Inquiries included what property, other than land, was intended to be protected, including both public and private property. The actual property protected had to be within the municipality or community to be considered part of this data.

A worksheet was completed for each RM or community, photos were taken where appropriate, and a representative map was obtained for many that showed the positioning of the project involved and the expected protection area. Scrivener was able to establish two categories of costs that were prevented. One was the expected cost to infrastructure damaged and the second was to individual properties. Within each community claim, two values were derived – the expected costs to repair property and the estimated replacement cost of the property, had it been destroyed.

Scrivener's analysis of financial savings for RMs and communities differed from the individual yard sites, as more detailed investigation allowed for this estimate of the expected repair costs based on the amount of water that would have infiltrated the building. Repair costs include the cost of clean-up and the repairs required to rebuild the community after a flood. Sub-categories for repair costs included consideration of the age of property, finished basements, depth of water expected, tear-out costs, content value, mould removal costs and rebuilding costs. The estimated amount of damage was based on what level the water may have reached, as determined in consultation with the municipality.

In this manner, Scrivener was able to provide, with relative confidence, what the costs would have been for each RM or community. The number representing replacement cost for the properties was consistent with the value for individual claims within this project.

Upon completion of individual claims and RM and community claims, both sets of data were summarized for consideration. Again, Scrivener's work comprised pertinent comparisons and use of insurance modeling software to determine replacement values.

5.1.3 Lumsden Project

Scrivener claims also undertook the task of assessing the town of Lumsden. In 1979, under the old Flood Damage Reduction Program, the government provided the town of Lumsden with funding to construct two dykes that run adjacent to the Qu'Appelle River. Since then, the Authority has shared the costs of maintaining these dykes to ensure that they remain effective into the future. As a result, the town of Lumsden only had a small claim through EFDRP and the town was protected.

Scrivener visited the town of Lumsden and assessed the damage to real property that could have occurred in 2011 had the dykes not be in place or, if they had failed due to inadequate maintenance throughout the years, and the town flooded. Scrivener used the same valuation process as described above to determine an estimated replacement value for residences (Table 2, above). Valuation of non-residential "commercial" buildings was established by detailed field inspection at a number of the buildings.

5.2 Results

5.2.1 Program Successes

The Authority received a total of $35.2 million from the provincial government to fund EFDRP. The majority of proponents did not have to claim flood damages through PDAP because flooding was prevented through work funded by EFDRP. Not only will this have an impact this year, the permanent work will prevent flood damages in the future.

Table 3 outlines the costs and benefits associated with EFDRP. The costs encompass the financial costs of running the program and the maintenance of the permanent work into the future, the social costs, including the safety of some of the work completed, and the environmental costs of preventing flooding and obstructing the natural flow of water. The benefits associated with the program consist of: financial savings in terms of property protected this flood year and, in the case of permanent work, into the future; social benefits, including preventing the mental and physical stress and hardship as a result of flooding; and the environmental benefits, such as the prevention of harmful chemicals entering the system. The costs and benefits associated with the program will be discussed in more detail in the subsequent section.

Table 3: Cost Benefit Analysis Summary Table

	Costs	Benefits
Financial	-$34 million spent on the program -Much of the work was permanent and upkeep will have to be done in order for it to be effective into the future	-Property saved through the program -Very few proponents had to be relocated as a result of the flood -Permanent works completed will provide flood prevention into the future
Social	-Safety risks associated with permanent construction work -Diverting water on to neighbouring property contributed to a number of the drainage complaints received by the Authority (also a financial cost to the Authority) -Illegal ditching and drainage affecting the safety of the community	-Flooding can result in financial and mental stress and mental and physical health problems; this was decreased by the assistance through the program -Water borne illnesses and mould can cause problems when water infiltrates a home, this was greatly decreased through the program
Environmental	-Permanent work can obstruct natural waterways and fragment habitat -Temporary work can result in erosion and sedimentation of streambeds -Flooding is a natural occurrence and replenishes ecosystems; flood prevention removes these benefits	-Farm chemicals, septic systems and other harmful compounds were prevented from washing into water bodies by the prevention of flooding on yard sites and farm businesses

Individual Yard Sites – Approximately 881 homeowners in rural areas across the province participated in the program. For individual yard sites, Scrivener estimated that for every dollar spent on flood prevention by the Authority, $23 was saved in replacement costs for these proponent's homes. Through the program, a total of $8,528,146 was spent on flood prevention on individual yard sites and therefore it was estimated that over $196 million was saved.

Every dollar spent on flood prevention on individual yard sites saved $23 in expected replacement costs.

Replacement costs were used as it was difficult to estimate the amount of water that would have infiltrated these homes. It was believed that the damage would have been quite extensive regardless and would approach the cost of replacing the home completely. In addition, at most individual yard sites there were other structures and outbuildings that would have been damaged, but these were not taken into consideration as the adjusters were not physically at the yard sites and were unable to make a proper estimate. As a result, they are confident that the replacement costs for the home compensate for the buildings that were not taken into account and the numbers, therefore, reflect an accurate cost-benefit analysis.

Communities and RMs – 330 communities and RMs throughout Saskatchewan participated in the program. For communities and RMs it was determined that for every dollar spent on flood prevention through the Authority, $30 were saved. Through EFDRP, the Authority spent a total of $13,595,720 on flood prevention in communities and RM's and avoided over an estimated $407 million in damages. The damage prevented and money saved represents homes, infrastructure,

Every dollar spent on flood prevention in communities and RMs saved $30 in the expected cost of property loss.

businesses, farm buildings, and heritage buildings saved as a result of the preventative measures taken in the 2011 flood year.

First Nations Communities – 15 First Nations Communities in Saskatchewan sought assistance through the program. Not only did the program provide funding to these communities, it provided sound engineering and technical assistance. The engineering advice helped the First Nations communities cope with the flooding this year, as well as properly mitigating flooding into the future. No specific cost-benefit analysis was performed for the First Nation communities.

Lumsden Analysis – In April 2012, Scrivener provided the Authority with a report of their findings regarding damages averted in Lumsden. Scrivener determined that for the 306 dwellings that would have been damaged if flood protection works did not exist, the accumulated cost would have been over $81 million. For the 80 commercial buildings that would have been damaged, the costs would have been close to $60 million (see Table 4).

Table 4: Estimated costs of 2011 flood in Town of Lumsden, with no flood protection

Type of building	Replacement cost ($)
Residential	$ 81,015,175
Non-residential	$ 58,949,000
Total property costs	$139,964,175

In terms of constructing the Lumsden dike system in 2012, it is estimated that the cost would be approximately $10 to 12 million with an annual maintenance budget of $15,000 per year. The total cost of the dike system since 1980 would then be around $14 million or 10 per cent of the estimated loss that would have resulted due to the 2011 flood. This does not include the damage that may have resulted over the past 30 years from other flood events that have occurred however to a lesser degree than what was witnessed in 2011.

5.2.2 Impact on PDAP

Prior to the development of EFDRP, the Saskatchewan government prepared for floods by communicating with municipalities about potential flood risks and providing information and technical assistance for emergency preparedness. During the course of the event, the former CPSP would dispatch staff to regional and municipal Emergency Operations Centres to assist with emergency response. The PDAP was used to assist individuals and communities during the flood event and then to recover the individuals and communities following the event. In 2011, there was an enhanced response with deployment of rapid response teams sent into communities to assist with emergency response. The Saskatchewan government did not have a program to provide assistance for flood mitigation prior to the flood event.

EFDRP was developed to fill this gap and as a complement to PDAP. Officials from PDAP and EFDRP worked together during the 2011 flood year to provide flood mitigation and disaster

assistance in the province. Under EFDRP, after the initial threat had passed, proponents who had completed temporary projects could be funded by EFDRP to make these into permanent flood prevention structures. The objective was to not only prevent flooding during the 2011 flood, but to mitigate flooding into the future.

Works funded under EFDRP prevented over 1,000 potential flood damage claims from individuals as well as hundreds more within communities in 2011 – a 91 per cent success.

Not only did the program divert probable damage to property, it also prevented several claims from entering PDAP. During 2010, PDAP experienced a large influx of claims (over 6,000) from people who experienced flood damage on their property. Nearing the end of 2011, PDAP had over 8,000 claims as a result of extreme flooding throughout the southern portion of Saskatchewan and had spent over $56 million on flood damages on 2,000 of these claims. A survey of individuals who participated in EFDRP; however, determined that only 235 of the 1,237 proponents (19 per cent) who participated in EFDRP had to put a claim through PDAP, *i.e.* over 1,000 individuals did not need to claim for flood damages including numerous homes that would have been affected within the communities.

5.2.3 Applicant Feedback

At the time of the final inspection of property, proponents were asked to rate their satisfaction with the program on a scale from 1-to-5, 1 being not satisfied and 5 being completely satisfied. Although complete flood prevention is unachievable and unsustainable, overall participant satisfaction with the program was very high; 91 per cent of proponents rated their satisfaction as a 4 or higher. On average, the proponents rated their satisfaction with the flood protection through the program as 4.6 out of 5. Satisfaction with the cost-sharing scheme and funding provided through EFDRP was also rated an average of 4.6 out of 5. Satisfaction with the consultants was rated as 4.5 out of 5 and satisfaction with the Authority's response to the request for assistance was rated a 4.7 out of 5 (Figure 7).

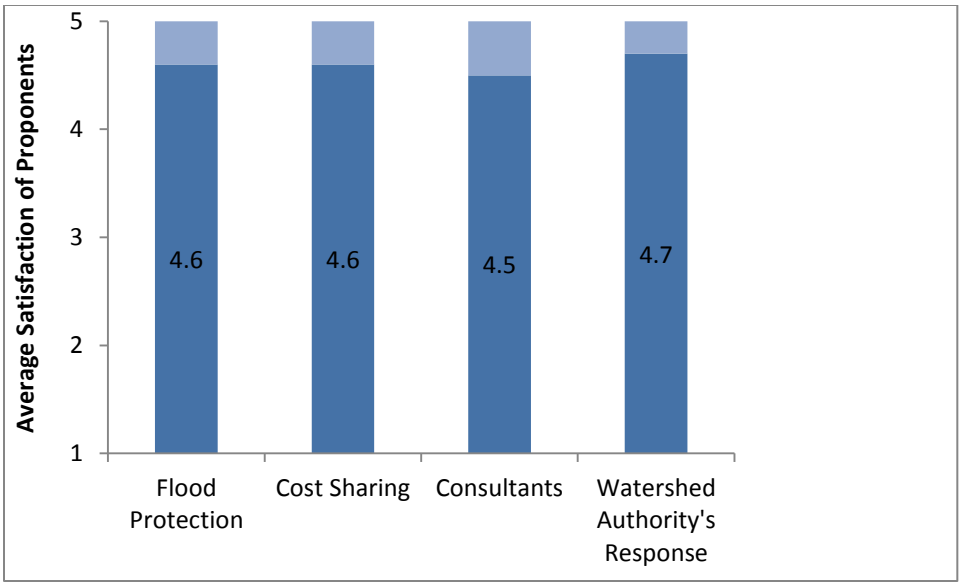

Figure 9: Satisfaction with EFDRP

Overall, 96 per cent suggested that they would participate in a long term program like EFDRP in the future. When asked if they would participate in a program that provided only technical assistance and not financial however, only 85 per cent said yes.

One area that proponents cited for improvement was around communication. While there were numerous media releases and other media activities about the program, 14 per cent requested more advertising was needed. Many felt they could have accomplished more flood protection on their property if they had known about the program at an earlier date. Many proponents had heard about the program later in the spring and often it was already too late for them to accomplish any form of flood protection on their property. This left them dissatisfied with the parameters of the program and the deadlines imposed at its commencement.

Some proponents believed that the cost-sharing with the provincial government was insufficient and could have been closer to 100 per cent funding. These were mostly cases in which the proponent felt that flooding had been caused by the activities of an upstream neighbor or community or the operation of flood control structures. Most proponents however, agreed with the cost-sharing format as well as the coverage they received and believed that, in the future, this same format should be utilized.

Proponents were asked to add any comments they had about the program in an open section in the final inspection report. The most frequent comment, at 18 per cent of proponents, was that EFDRP was good as is. As well, 14 per cent of proponents surveyed believed that this program should continue to become a more permanent program available in years where flooding is a threat.

Through the final inspection report and the countless emails and letters received by the Authority, it was evident that the program was viewed in an extremely positive light. Not only

did it help save several people's property from flood damages it also saved the mental and financial turmoil associated with flood disaster events on individual yard sites, communities and RMs within the province of Saskatchewan.

5.2.4 Program Limitations

EFDRP had some limitations imposed due to program scope and regulatory requirements. In some cases, proponents seeking help through the program had to be turned away because the work they had completed, or were seeking to complete, did not qualify under the parameters of EFDRP. The areas of work that fell outside of program coverage were erosion control work, personal labour, and agricultural flood prevention.

The program's time constraints forced some proponents to be creative and quick-thinking when attempting to prevent flooding on their property. In some cases, unconventional methods were used, and these were often successful in preventing flooding. For example, a couple located north of Sturgis, Saskatchewan, with no material readily available and the flood encroaching on their property, utilized the only material in abundance, snow. They constructed a berm made completely of snow around their property and as a result saved approximately $240,000 worth of property with very little cost.

Many lakefront site owners undertook erosion control in response to wave action on their property and this was not covered. In these cases, the proponents may have had severe problems and had to complete extensive work to spare their property, but as the scope of the program was limited to flood prevention, rather than the impacts of erosion brought on by flooding, they did not qualify for financial assistance.

In addition, personal labour was not covered by the program. The reason for this exclusion was that the Authority expected that the proponents would have attempted to protect their property whether or not they were getting paid to do it. Some proponents however, were upset when they discovered that they would not be reimbursed for the countless hours they spent pumping, ditching, hauling sandbags and building berms.

Flood prevention for agricultural land was also not eligible under the program. Given the volumes of excess water in the province, the limited resources available, and the extent of possible damage to buildings and infrastructure alone, the decision was made to exclude farmland.

Due to the urgency of the situation, many works funded under EFDRP were allowed to go ahead without the formal approvals that would have otherwise been necessary. Some of these could not be approved after the fact, as they did not meet regulatory requirements. For example, some channelization work and ditches had to be filled and some berms removed. EFDRP funding was applied to the remedial work in these cases.

6.0 Cost Benefit Analysis

6.1 Financial Costs and Benefits

6.1.1 Financial Costs

The main financial cost of EFDRP was the $35.2 million that the Government of Saskatchewan supplied to the Authority for the implementation of the program. Within this budget, $22,769,501 or 65 per cent was spent on the construction of flood prevention structures. Within the construction of works, 71 per cent of the funding went to permanent works, while 29 per cent went to the funding of temporary flood prevention works. Funding for consulting and temporary staff, including engineers, engineering technologists and others who worked on the program was $4,630,131, or 13 per cent of the total spent. In addition to the funding directed to the Authority, CPSP received $4,149,171, or 12 per cent of this budget, for emergency supplies and $645,633 or 2 per cent was spent on assisting First Nations. Funds provided to First Nations were reimbursed to the province at 100 per cent.

Table 5: Actual Costs associated with EFDRP

Activity	Actual Cost
Construction of works	$22,769,501
Consultants and Temporary Staff	$4,630,131
CPSP Emergency Supplies	$4,149,171
First Nation Works	$645,633
Total	**$32,194,436**

Another financial cost includes the portion of the cost-sharing that was paid by the proponents themselves. The funding scheme left individuals responsible to cover 15 per cent of all temporary and permanent work completed, and communities and RM's to cover 50 per cent of temporary work and 25 per cent of permanent work. This added up to $1,533,277 spent by individuals and $11,904,028 by communities and RMs.

Although this program was only implemented for the 2011 flood year, some of these costs will extend into the long term. A large portion of the money through the program was dedicated to permanent works, which will require ongoing maintenance. It is estimated that the upkeep of permanent works would be approximately 10 per cent of the original cost of the work each year. Since this program was only designed for one-time funding, maintenance costs fall solely on the individuals, communities and RM's. A long term flood prevention program could aid in the structure maintenance, as well as provide assistance for new work.

The onset of flooding occurred so quickly in some places that proponents did not have the time to plan effectively to have their work completed. The demand greatly outweighed the supply of contractors to undertake the flood damage works. This, as well as an increase in cost of materials and supplies were strained, caused the cost of work to be higher than under normal conditions. The wet conditions also made it difficult for the work to be completed and led to projects taking longer than if conditions were dry, also driving up the price of the construction works. As a result, the costs greatly varied and depended not only on size, location and material, but also the timing of construction.

6.1.2 Financial Benefits

In the short term, the financial benefits of EFDRP revolve around the prevention of flooding in 2011. The financial hardship involved with having to rebuild, repair and clean up the damages as a result of flooding would have been extensive and would have primarily fallen on the shoulders of the proponents as well as PDAP.

The funding also helped many proponents undertake flood prevention works on their property that they might not have been able to construct had the program not been in place. This precise question was posed to the proponents involved in the follow up questionnaire and 57 per cent answered that they would not have been able to go to the same lengths to protect their property had the program not been available. The rest of the proponents, however, stated that they would have had to complete the work whether program was available or not. The flood risk was simply too high. On average, those who said they could not have gone to the same lengths to protect their property without the program spent just over $20,000. Those who would have done the work even without program funding spent an average of approximately $5,600.

EFDRP also reduced the financial burden and costs that would have been associated with proponent evacuation and finding new housing for a large number of people across the province. In many cases, the program saved the proponent's homes and there were no or only minor evacuation requirements. Cumberland House and Cumberland House Cree Nation were evacuated in 2005 after flooding threatened their homes and community. As a result of the program in 2011, the community was able to prevent the water from inundating their community and evacuation was not necessary.

Peripheral financial benefits accrued to consulting and engineering companies and construction contractors who were involved in program implementation. The consulting and engineering companies experienced increased demand for their services. Many contractors were employed in flood prevention work and, in many cases, proponents paid a premium in order to secure a contractor to complete work before the flood overtook their property.

6.2 Social Costs and Benefits

The social impacts of flooding include many non-economic losses, physical and mental health concerns, household disruption and community and neighborhood changes (Walker *et al.* 2005). Floods can have a large negative social impact not only on those directly affected, but also on the greater community or those situated downstream of the flooding.

6.2.1 Social Costs

There were some social costs associated with the implementation of EFDRP. One issue that surfaced several times throughout the course of the program was that of communication

between neighbouring yard sites, communities and RMs. In many cases, water was moved from one piece of land to another, as proponents diverted water from their property by diking, ditching, constructing berms, or replacing culverts. This water, in turn, often ended up on a neighbouring property. This created a domino effect, where by many proponents believed that they would not have had to do any work if not for the work completed by an upstream neighbour. As a result, the Authority received many complaints from landowners and community administrators, adding to the stress and anxiety the proponents were already experiencing.

6.2.2 Social Benefits

Sockone *et al.* (2004) suggest that losing a home, witnessing it being destroyed, being evacuated on short notice and being displaced for an extended period of time causes great anxiety. Flooding also causes economic costs, which in turn creates stress and hardship. The health issues related to slow rising flooding are often longer lasting. These can include mental health issues such as post-traumatic stress disorder, and the moulds and mildew and respiratory concerns resulting from the wet conditions (Square 1997). The goal of EFDRP was to aid in the financial cost, while at the same time prevent distress and hardship as a result of flooding. Because the program was so successful, these potential long term health effects were generally avoided.

> *One program participant noted that as the water was rising and threatening their home, a technician from the Authority drove up, informed them of the program, and helped them figure out what needed to be done to protect their home. The homeowner stated that this was the first time in weeks they had a good night sleep as they were not worried about losing everything they owned in the flood.*

Not only did the program prevent these long term health effects, it also reduced the immediate stressors of flooding involved with protecting one's property. A group of proponents surveyed in the follow up questionnaire were asked to rate their stress level on a scale of 1 to 5 (1 being no stress at all and 5 being extremely stressed) before they implemented flood protection measures on their property and after the flood was prevented with the help of EFDRP. The stress level prior to the program, with the threat of flooding looming, was reported as an average of 4.6 out of 5. After the program, with flood prevention measures in place, the reported stress level was, on average, 2.2 out of 5. Figure 8 below depicts the results. It is evident that the program helped reduce the stress and anxiety that these proponents were feeling as a result of the impending flood.

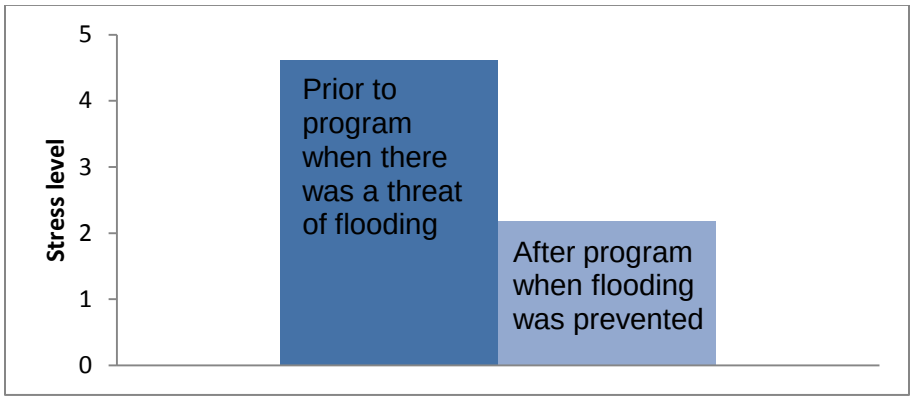

Figure 9: Stress levels before and after EFDRP.

The program also aided in the prevention of standing water on a proponent's property, which could potentially cause a disease outbreak or contamination of a ground water supply. Standing water, as a result of flooding, can lead to the outbreak of many waterborne pathogens, as pathogens from the contaminated flood waters enter the potable water system

and are consumed by humans (Sauchyn *et al.* 2010). Since a majority of the proponents were rural yard sites and many of them use private wells as a drinking water source, the spread of disease was a significant threat. Through the program, many proponents were able to protect their wells and water sources from flood waters and as a result prevented this from occurring. As a precautionary measure, the Authority also provided the proponents with a well water testing program allowing them to test their water after the flood to ensure its safety.

Another social benefit of EFDRP was the prevention of loss of property that may not have any measurable monetary value, but has sentimental or non-economic value to the proponents. This included heritage buildings, such as old farmhouses and the historic buildings, which line the streets of the small towns in Saskatchewan. In one particular case, a proponent was living in the old Katepwa school house. In this case, there would have been a monetary value assigned to their property, but it would not have fully accounted for what the history of the house meant to the proponent.

6.3 Environmental Costs and Benefits

At the commencement of the program, a discussion was held with the federal Department of Fisheries and Oceans (DFO) and Saskatchewan Ministry of Environment (MOE) in order to determine the best method to ensure compliance with regulatory standards. Ordinarily, when dealing with water and structures being built to deflect and divert water, there are permits that are required from both DFO and MOE in order to proceed with the work. In the case of EFDRP, the flood was considered an emergency situation and therefore permit requirements were waived during the emergency phase of the program. The obligation remains with the proponent to obtain proper permits if structural works such as ditches are to be made permanent.

The environmental evaluation of the program differed from the financial and social cost-benefit analysis in that there was no data available to determine the costs and benefits of the program. The following information is based on an evaluation of flood impacts in general and comparison with similar flooding situations in other regions.

6.3.1 Environmental Costs

Flood prevention is positive for human built structures, but for the surrounding ecosystems flood prevention can have harmful effects. In ecosystems, flooding is a natural disturbance. When permanent dykes, ditches and trenches are constructed to prevent flooding and divert the excess water, the natural flow is disrupted. This deprives the system of its natural disturbances and stimulation.

Anthropogenic flood barriers can separate the main channel and the natural floodplain resulting in fragmented habitat for aquatic organisms and plant life. This is evident in fish spawning habitat. Permanent flood prevention infrastructure can act as barriers to fish migration, fragmenting habitat into several small areas rather than maintaining the habitat as a

whole. When permanent structures are in place, the fish have problems migrating to their usual spawning habitats, as well as travelling to new spawning habitats. Habitat fragmentation is one of the leading contributors of listing species on the endangered list.

Furthermore, fish utilize flooding to optimize new, critical spawning habitat. Flooding creates a production boom in fish populations by increasing the diversity of fish species as well as increasing the amount of available aquatic habitat available for spawning. Preventative measures taken for flooding can result in these areas no longer being created and therefore, over time, can have a negative impact on fish populations.

Another common permanent flood prevention strategy is that of replacing smaller culverts with larger ones to allow more water to pass through. This may help with the excess and pooling of water in the short term, but unfortunately can cause several problems downstream. A larger culvert allows more water to pass through, potentially increasing erosion and affecting the sediment regime of rivers and streams.

Temporary works, including culvert clearing, snow removal, pumping, sandbagging, and temporary ditching, can also have a negative effect on the surrounding environment. The accumulation of sand and dirt in temporary berms and ditches is often not secured, unlike in more permanent structures. This means that rainfall events or strong winds can cause erosion and ultimately sedimentation of waterways downstream of these structures.

Sedimentation causes several issues for aquatic systems. It increases the nutrient load in the system, which can lead to eutrophication. It can also negatively impact habitat, including fish spawning habitat, by altering the characteristics of lake and stream beds.

Other forms of temporary works include the removal of debris blocking culverts and river channels. In many cases, the debris blocking these waterways is the result of beaver dams. While beaver dams can cause many problems by obstructing water flows, they also are extremely important to the ecosystem, creating wetland habitat for many other species, including birds, animals, insects and fish. In many cases during the 2011 flood, beaver dams were destroyed and removed because they were blocking culverts and flooding the land upstream.

The addition of nutrients to a system can lead to eutrophication, which is typified by "...excessive growth of algae. As the algae die and decompose, high levels of organic matter and the decomposing organisms deplete the water of available oxygen, causing the death of other organisms, such as fish." (Art 1993).

Generally within EFDRP, there were very limited areas within a river reach or along a shoreline where flood mitigation infrastructure was constructed. With the large increase of flooded lands in 2011, the areas protected, causing loss of habitat and habitat fragmentation would be insignificant in size. As noted, larger culverts in a large flood event may cause some issues. However, in the more frequent, smaller flood events, the larger culverts would improve flow capacity and improve fish passage at the crossing.

6.3.2 Environmental Benefits

Conversely, the environmental benefits of EFDRP are quite extensive and extremely important in terms of conservation and water quality. Anthropogenic alterations to the system, such as cropping, removal of wetlands and application of chemicals to soil, can lead to negative environmental impacts in flood situations. Under these conditions flood waters can leach toxins, added chemicals, salts and nutrients stored in the soil, carrying them downstream to enter lakes and river systems. It is well studied that excess nutrients in surface water, for example, rapidly increase algal growth and ultimately result in the eutrophication of these systems.

The prairies are dominated by agriculture, and seepage of fertilizers and pesticides is inevitable. Generally, a system can handle the small volumes of contaminants that enter it on a regular basis. A flood event however, can cause a large influx in a short period of time. EFDRP reduced this influx.

In many communities, the program prevented the water from reaching the landfills, lagoons and lift stations. On individual properties, septic fields, wells and septic tanks were protected. As a result, the program prevented the organic compounds in these areas from being inundated by flood waters, which could carry the oxidizing bacteria and other contaminants downstream, unbalancing ecosystems, increasing eutrophication, degrading water quality and negatively impacting biodiversity.

7.0 Flood Mitigation: Past and Future

7.1 Past Flood Prevention Solutions

In the past, the federal government, in partnership with the Government of Saskatchewan, offered a Flood Damage Reduction Program (FDRP) that prepared flood risk maps to identify flood hazard areas in urban communities. This information was used by participating Saskatchewan communities to undertake both structural and non-structural flood prevention. Structural methods were generally diking. Non-structural prevention included regulating land use in the floodplain, flood proofing of buildings, purchase of property in the floodplain, relocating buildings and infrastructure, altering upstream land management practices, and establishing and maintaining flood forecasting and warning systems (Environment Canada 1989).

The program was in effect from 1977 to 1997. Although this program was phased out approximately 15 years ago, the impact and work completed through the program greatly aided communities during the flood of 2011. For example, the city of Regina participated in FDRP, but did not designate under the program. However, under FDRP flood risk maps were developed and the city used these maps and the flood lines in preparation of zoning bylaws and development plans. The city has not allowed development in the floodway and in areas

considered susceptible to flooding. Further, while Regina installed temporary measures as a precaution during the 2011 flood, the permanent works constructed in the 1970s and rehabilitated in the 1990s held and no damage was done to private property.

The town of Lumsden is another example of the previous FDRP still providing benefits to this day. Lumsden is located at the bottom of the Qu'Appelle Valley next to the Qu'Appelle River. In 1979, after major flooding events that occurred in Saskatchewan in the early 1970s, the program funded the building of two dykes along either side of the river to protect the town of Lumsden. During the 2011 flood event, it was estimated that the water would have been three to four meters high at the bottom of the valley if these dykes had not been in place to prevent the water from spilling over the banks. It was determined that, without the dykes in place, close to $140 million in property damage would have been incurred in 2011. With the flood protection works, the town of Lumsden's claim was minimal.

7.2 Long Term Flood Mitigation Program

EFDRP was conceived as a one-time program to financially and technically aid flood prevention work for the devastating flood event of 2011. Although the program helped over 1,200 proponents to prevent flooding on their property or within their communities, there remains a significant amount of work to complete. A permanent flood reduction program would result in cost-effective flood prevention, addressing the social issues of flooding, as well as the environmental issues related to implementing a flood reduction program.

In spring 2011, the federal government proposed discussions be held with the province regarding the development of a long term program. These discussions are ongoing.

8.0 Key Lessons

A review of the 2011 EFDRP allows for reflection on how best to approach this type of programming. Several lessons can be gleaned.

- ✓ When flooding is imminent, an emergency flood damage reduction program should be implemented as quickly as possible in order to provide technical advice and get preventative measures in place in a timely matter. Time spent developing a program, processes and guidelines is time that is unavailable for on-the-ground emergency response. Having basic program elements ready for use in anticipation of future emergencies would speed up the development stage.

- ✓ Immediate mobilization of adequate numbers of experienced, professional staff to provide advice is a critical part of program implementation. An important aspect of the success of the 2011 EFDRP was that the staff recruited for the implementation of the program were engineers and hydrologists with years of related experience. The circumstance did not allow the luxury of taking time to train staff. (As time moves forward, the availability of retired staff and trained individuals will decrease, affecting the viability of future programs.)

- ✓ Clear and extensive communications are an important part of program delivery. This includes enhancing public education about the program, providing easily accessible information about what activities are eligible and giving clear directions on how to access the program and submit claims.

- ✓ Related to this, clear process requirements and program limitations should be outlined for proponents. The proponent should be advised as to what is needed in order to properly process claims prior to the submission of invoices and records. Claim requirements would include documentation of the locations of permanent flood prevention work, providing a written summary of the projects and work completed, submitting maps and, if possible, including photographs of the project. The required level of detail for construction work and material costs should be specified. A clear understanding of this should reduce the need to contact proponents for more or different information in order to process a claim, and reduce the incidence of non-eligible claims.

- ✓ It would be beneficial to develop guidelines on proper engineering and best practices for flood prevention works and temporary mitigation measures. Guidelines could be distributed to communities and individuals, as well as to engineering and construction contractors, in order to help ensure work standards are met.

- ✓ An effective and easy to use database is extremely useful for storing, retrieving and analyzing program information. For example, the ability to access all records that relate to a single proponent, including the contact history, made delivery much more efficient. Being able to easily search and compare information adds much value to the data that has been collected. Considering program needs to build the right database upfront can save countless hours later. Effort should be made to ensure that the database is ready to use immediately upon program initiation.

- ✓ There must be clear and formal links established between an emergency flood damage reduction program and PDAP. The programs are complementary to one another and some proponents will need to access both programs. Strong communications and cross-referencing between the two programs in the early stages would result in less backtracking for agencies in the later stages, while streamlined file management could allow for proponent information to be shared, reducing workloads for both clients and administrators.

- ✓ Management of relevant regulatory processes with other provincial ministries and federal agencies is crucial. Development of clear rules around allowable emergency works and potential long term implications for these works would provide more direction to proponents, contractors and program officials, and ultimately provide more certainty around the decisions being made.

- ✓ Programs managers (and funders) must expect the unexpected. For example, the ability to adapt to changing circumstances by revising the process and rules for applications and advice was a necessary response to new and unforeseen flooding in late spring. Nimble program response and changes to the program itself should be not only accepted, but anticipated.

9.0 Conclusion

Through the time and dedication of staff at the Authority's offices, the staff hired to work on the program, the consulting engineers, and the engineering technologists, the program was able to provide timely and effective flood prevention support, both financial and technical. Not only did this program have an impact on the flood of 2011, the structures built and advice given will have positive effect into the future.

References

Art, H W. 1993. "Eutrophication" *in* Art, H.W., ed., *A dictionary of ecology and environmental science* (1st ed.). New York, New York: Henry Holt and Company, p. 196. (cited on US Geological Survey website at http://toxics.usgs.gov/definitions/eutrophication.html)

Associated Programme on Flood Management. 2007. *The Role of Land-Use Planning in Flood Management.* Publication, United Nations: World Meteorological Organization. http://www.apfm.info/pdf/ifm_tools/Tools_The_Role_of_Land_Use_Planning_in_FM.pdf

Axelson, J N, D J Sauchyn, and J Barichivich. 2009. "New reconstructions of streamflow variability in the South Saskatchewan River Basin from a network of tree ring chronologies, Alberta, Canada." *Water Resources Research* 45, W09422, doi:10.1029/2008WR007639

Delong, M D, and M A Brusven. 1994. "Allochthonous input of organic matter from different riparian habitats of an agriculturally impacted stream." *Environ. Manage.* 18: 59-71.

Dosskey, M G and P M Bertsch. 1994. "Forest sources and pathways of organic matter transport to a blackwater stream: A hydrological approach." *Biogeochemistry* 24: 1-19.

Edmonson, W T. 1972. "Nutrients and phytoplankton in Lake Washington." *Amer. Soc. Limnol. Oceanogr.* 1: 172-193.

Edmonson, W T. 1996. *The Uses of Ecology: Lake Washington and Beyond.* Seattle, Washington: University of Washington Press.

Environment Canada. 1989. "Reducing Flood Damage" (webpage). http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=72FDC156-1. Adapted from *Floodproofing: Protect Your Home against Flooding*. Environment Canada and New Brunswick Department of Municipal Affairs and Environment.

Freedman, Bill. 2010. *Environmental Science.* 5th Edition. Toronto: Pearson.

Government of Saskatchewan. no date. "2011 Flooding Information: Lakeshore Development." *Government of Saskatchewan - Environment.* http://www.environment.gov.sk.ca (accessed November 23, 2011).

Government of Saskatchewan. no date. *Environment - 2011 Flooding Information.* http://www.environment.gov.sk.ca/Default.aspx?DN=65343e15-abf5-46a6-861e-2850fccdbddf (accessed 11 23, 2011).

Government of Saskatchewan. 1995. "Saskatchewan Wetland Policy." *Saskatchewan Watershed Authority.* http://www.swa.ca/AboutUs/Documents/SaskatchewanWetlandPolicy.pdf (accessed November 28, 2011).

Gray, D M. 1980. *Handbook on the Principles of Hydrology.* Water Information Center, NY.

Hickey, John T and Jose D Salas. 1995. "Environmental Effects of Extreme Floods." US-Italy Research Workshop on the Hydrometeorology, Impacts and Management of Extreme Floods. http://www.engr.colostate.edu/~jsalas/us-italy/papers/33hickey.pdf

Huel, Denis. 2000. "Managing Saskatchewan Wetlands: A Lanowner's Guide." *Saskatchewan Watershed Authority.* http://www.swa.ca/Publications/Documents/ManagingSaskatchewanWetlandsSaskatchewanWetlands.pdf (accessed Nov. 28, 2011).

International Association for Impact Assessment. 2003. *Social Impact Assessment: International Principles.* Special Publication Series No. 2., International Association for Impact Assessment, 2003. http://www.iaia.org/publicdocuments/special-publications/SP2.pdf

LandOwner Resource Center and the Ontario Ministry of Natural Resources. 1995. Extension Notes: *Options for Controlling Beaver on Private Land.* Queen's Printer for Ontario. http://www.lrconline.com/Extension_Notes_English/pdf/bvr.pdf

Mance, Elizabeth. no date. *A Landowner's Guide to Water Well Management.* Regina: Saskatchewan Watershed Authority, Saskatchewan Agriculture and Food, Saskatchewan Ground Water Association. http://www.swa.ca/Publications/Documents/ALandownersGuidetoWaterWell percent20Management.pdf

Martin, F R J. 2001. Addendum No. 8 to Hydrology Report #104, Agriculture and Agri-Food Canada PFRA Technical Service: Regina, Saskatchewan. 109 pp.

Natural Resources Canada. no date. *Atlas of Canada* (webpage). http://atlas.nrcan.gc.ca/site/english/index.html

PFRA Hydrology Division. 1983. *The Determination of Gross and Effective Drainage areas in the Prairie Provinces.* Hydrology Report #104, Agriculture Canada, PFRA Engineering Branch: Regina, Saskatchewan, 22 pp.

Pomeroy, J W, D de Boer and L W Martz. 2005. *Hydrology and Water Resources of Saskatchewan: Center for Hydrology Report #1.* Saskatoon: University of Saskatchewan. http://www.usask.ca/hydrology/reports/CHRpt01_Hydrology-Water-Resources-Sask_Feb05.pdf

SaskAdapt. no date. “Saskatchewan’s Climate Change Impact and adaptation information centre” (webpage). http://www.parc.ca/saskadapt/ (accessed March 2012).

Saskatchewan Ministry of Municipal Affairs. 2011. "Land Use Planning and Flood Management." *Community Planning, Land Use and Subdivision.* http://www.municipal.gov.sk.ca/Subdivision/Land-Use-Planning-Flood-Management (accessed December 2, 2011).

Saskatchewan Watershed Authority. 2010. *State of the Watershed Report.* Science, Information and Monitoring, Stewardship Division, Regina: Saskatchewan Watershed Authority. http://www.swa.ca/Publications/Documents/a_2010StateoftheWatershedReport.pdf

Saskatchewan Watershed Authority. 2011. "Backgrounder: Highlights of the Special Dam Review." *Government of Saskatchewan.* October 7, 2011. http://www.gov.sk.ca/adx/aspx/adxGetMedia.aspx?mediaId=1570&PN=Shared (accessed December 2, 2011).

Sauchyn, David, Harry Diaz and Suren Kulshreshtha. 2010. *The New Normal: The Canadian Prairies in a Changing Climate.* Regina, Saskatchewan: CPRC Press.

Schanze, Jochen, Evzen Zeman and Jiri Marsalek. 2004. *Flood Risk Management: Hazards, Vulnerability and Mitigation Measures.* The Netherlands: Springer.

Soskolne, C L., K E Smoyer-Tomic, D W Spady, K McDonald, J P Rothe, and J D A Klaver. 2004. *Climate Change, Extreme Weather Events and Health Effects in Alberta.* University of Alberta, Edmonton, Alberta. 31pp.

Square, D. 1997. “Hospital Evacuated, Mental Health Issues Dominated as Manitoba Coped with Flood of Century” *Canadian Medical Associated Journal* 156: 1742-45

Walker, G, K Burningham, J Fielding, G Smith, D Thrush and H Fay. 2005. *Addressing Environmental Inequalities: Flood Risk.* Bristol: Environmental Agency.

Wetzel, Robert G. 2001. *Limnology Lake and River Ecosystems.* San Diego: Academic Press.

Wolkowski, Dick. 2007. “Managing Soil Compacting Following the Heavy Rains of 2007.” (webpage). http://www.uwex.edu/ces/ag/issues/soilcompaction.html. Agriculture and Natural Resources University of Wisconsin.