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File R6163

Western Economic Diversification Canada

Upper Qu'Appelle and Westside Irrigation Projects Summary Document



Clifton

21 August 2020

Attention: Rhonda Laing
Company: Western Economic Diversification Canada
Address: Suite 115, 101 22nd St E Saskatoon, SK

Upper Qu'Appelle and Westside Irrigation Summary Document

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Dear Ms. Laing:

We are pleased to submit this Summary Document which examines the engineering and economic viability of two major irrigation developments in south central Saskatchewan. The Upper Qu'Appelle and Westside Irrigation Projects, combined, offer the potential to irrigate more than 500,000 acres of prime agricultural land around Lake Diefenbaker.

Our work concluded that these projects are viable from both an economic and engineering perspective and would be a major step towards fulfilling the original vision of the South Saskatchewan River Project. The reader should note, however, that the economic analysis in this document has been updated in a separate report entitled: *Two Water Development Projects: A Socio-Economic Evaluation of the Upper Qu'Appelle Water Supply and the Westside Irrigation Projects, August 2020*

Thank you for the opportunity to advance this most interesting and vital project; we very much enjoyed working with your team and look forward to opportunities for future collaboration.

Sincerely,
Clifton Engineering Group Inc.



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Acknowledgements

The Project Team thanks the Western Economic Diversification Canada Management Committee consisting of:

Rhonda Laing, Davin Budreau, Jean-Paul Lapointe and Marc D'Eon for their help and direction of the work.

Many other individuals and agencies of the Government of Saskatchewan were helpful in providing information, including the Saskatchewan Ministries of Agriculture and Economy, the Water Security Agency, along with members of the Saskatchewan Irrigation Projects Association.

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This Summary Report is based on information extracted from two 2020 Clifton-Wood reports on the Upper Qu'Appelle Water Supply Project and The Westside irrigation Project, respectively.

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1.0 Introduction

For decades, Saskatchewan has experienced droughts, floods, and water quality concerns. While steps have been taken to mitigate those concerns, the water security vision put forward by the Prairie Farm Rehabilitation Administration (PFRA) in the South Saskatchewan River Project (SSRP) and has not yet been achieved. Therefore, only a minor portion of the economic, community and environmental benefits that were expected to accrue have been realized.

Irrigation development in much of Saskatchewan is dependent on the existence of the Gardiner and Qu'Appelle Dams and Lake Diefenbaker on the South Saskatchewan River as shown in Figure 1.1.

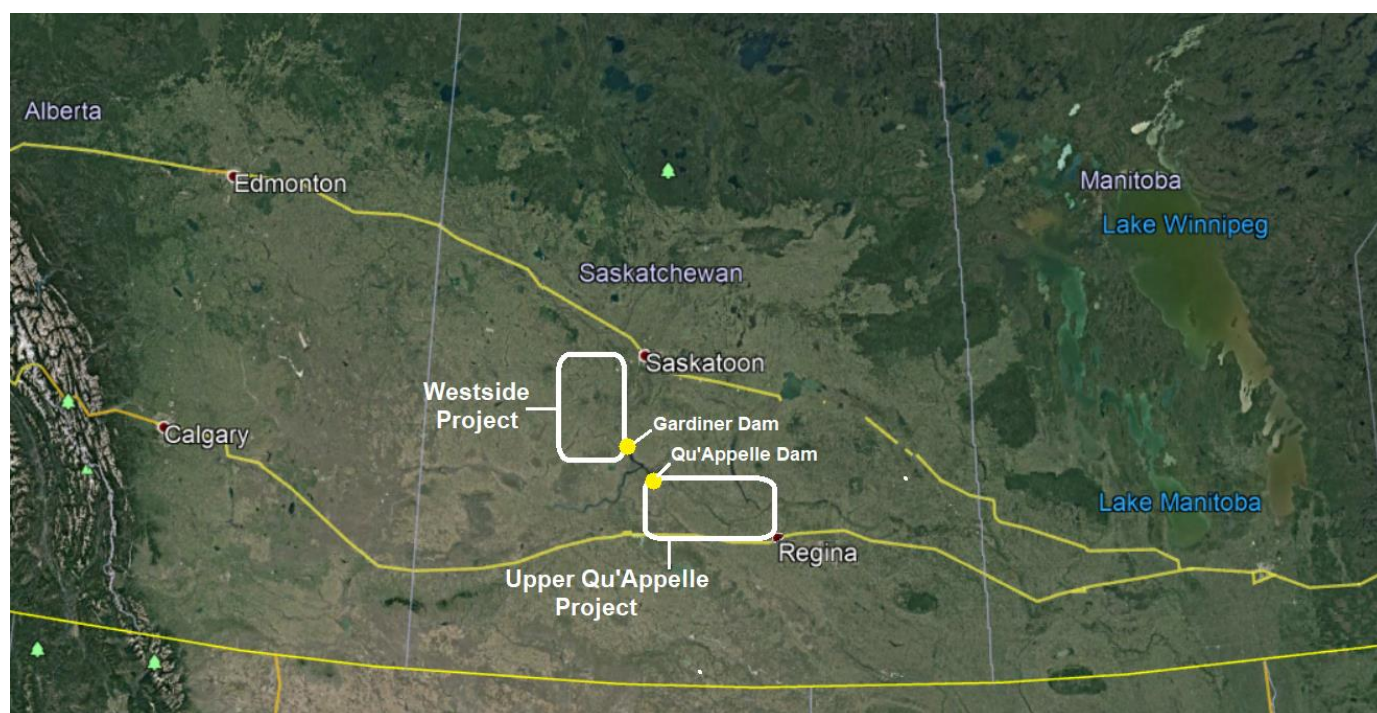


Figure 1.1: Location of Water Projects

The South Saskatchewan River was recognized as an important water source in southern Saskatchewan early in the 20th century. Although the findings of The Royal Commission on the South Saskatchewan River Project (1952) were not entirely favorable, the governments of Canada and Saskatchewan were convinced that development of a significant, secure and reliable source of water for the southern portion of the province was desirable.

The signing of a Federal-Provincial agreement in 1958 marked the official start of the South Saskatchewan River Project with the stated purpose:

"The project is to provide facilities for the irrigation of approximately 500,000 acres of land in Central Saskatchewan and in the Qu'Appelle Valley and to provide other benefits to the area including a source of hydroelectric power, a source of rural and urban water supply, flood control, and recreation facilities."

The federal government, through Prairie Farm Rehabilitation Administration (PFRA) built the Gardiner and Qu'Appelle River dams to impound water in the South Saskatchewan River valley. (Figure 1.2)



Figure 1.2: Gardiner and Qu'Appelle River Dams (Qu'Appelle River Dam, 2019)

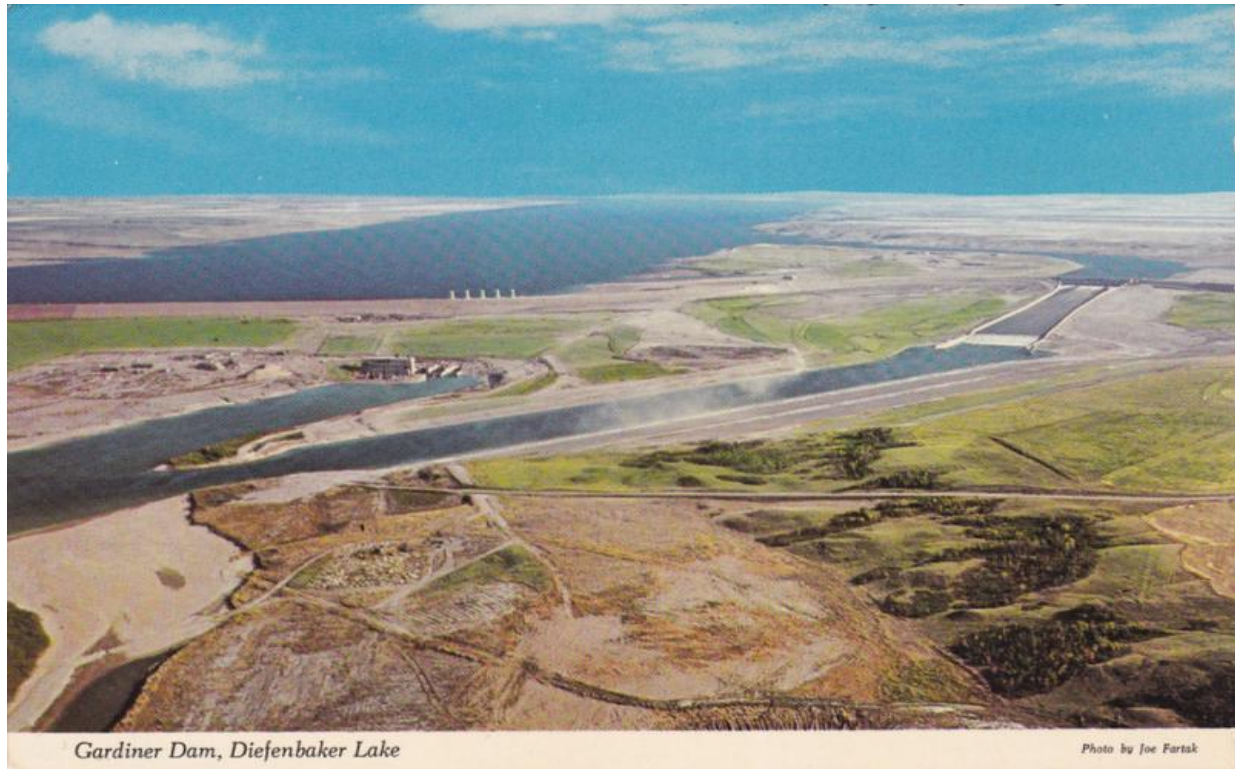


Figure 1.3: Gardiner Dam and Lake Diefenbaker (Hippostcard, n.d)

Lake Diefenbaker brought a secure water supply to south and central Saskatchewan and, with it, an opportunity to replicate the irrigated agriculture successes of Alberta. The opportunity is indicated by the relative degree of development and available water supplies in the two provinces (Figure 1.4). Given the superior soil conditions and favorable growing conditions, there is opportunity for further irrigation development in Saskatchewan.

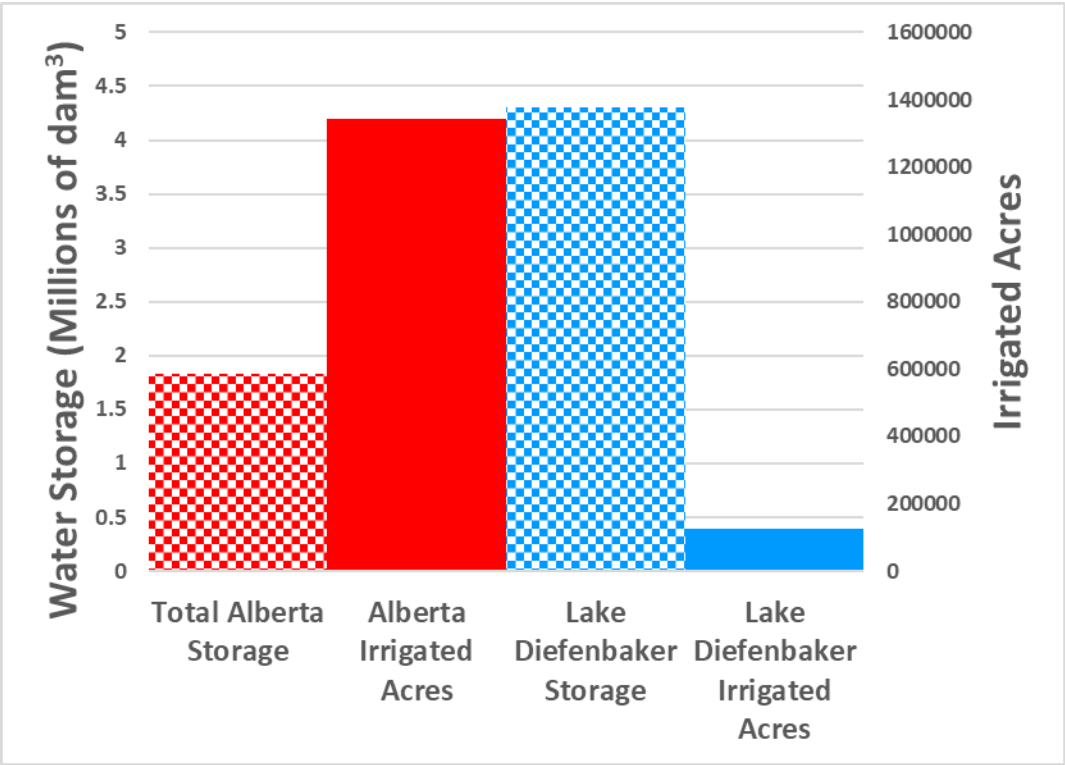


Figure 1.4: Comparison of Irrigated Acreages and Available Water Supplies in Alberta and Saskatchewan

The Upper Qu’Appelle Water Supply Project (UQWSP) and Westside Irrigation Project (WIP) (Water Projects) are unfinished pieces of the SSRP and aim to contribute to long-term water security in the Southeastern Saskatchewan by the creation of dedicated conveyances and ensuring a sustainable water supply to support emerging regional municipal, environmental, industrial, and agricultural needs (Figure 1.5).

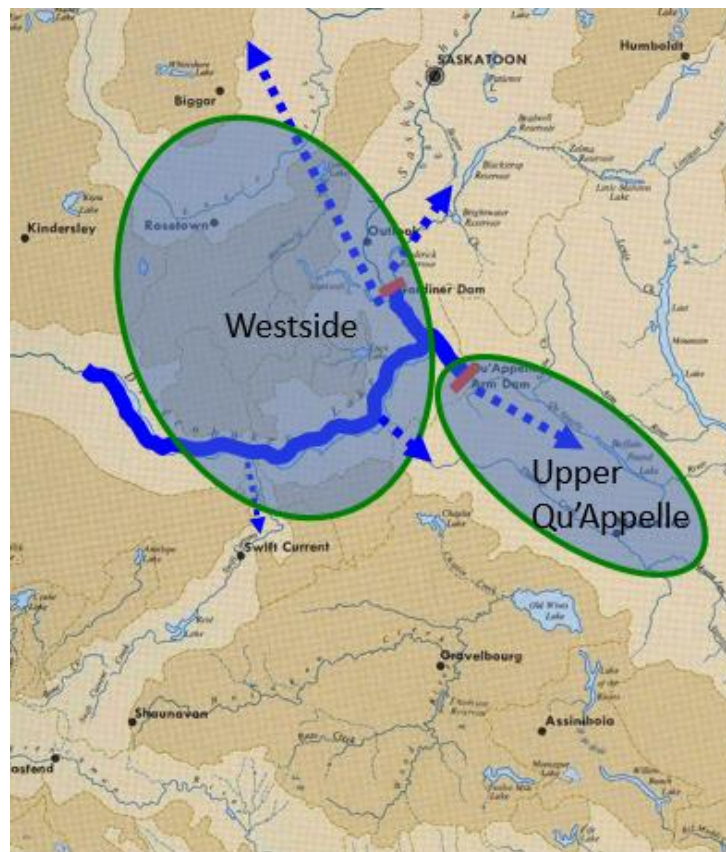


Figure 1.5: Water Projects as conceived by SSRP

Saskatchewan is recognized as a world-class food producing region. Recent formation of the Protein Industries Supercluster reinforces the importance of this Canadian region in maintaining world food supplies for an ever-expanding global demand. The addition of water security will enhance the ability to feed the world and transform the economy of the region while supporting adaption to global climate change and bringing increased resiliency to rural Saskatchewan and the provincial economy.

This report discusses some of the significant tangible and intangible socioeconomic impacts from the Water Projects; it investigates the feasibility of providing water security to the subject areas, summarizing the engineering aspects and economic rationale for investment in both the UQWSP and WIP, whether developed individually or together as an Integrated Water Project.

1.1 Report Scope

Western Economic Diversification Canada (WD) is exploring a transformational water strategy for the Canadian Prairies. The Water Projects were selected as a demonstration to show how a long-term, prairie-wide water security strategy will provide long-term economic, social and environmental benefits to the economies of Saskatchewan and Canada.

Clifton Engineering Group Inc. (Clifton) was retained by WD to review and update previous studies on the UQWSP by UMA (2007), AECOM (2012) and Clifton (2012); on the WIP by UMA-AECOM (2006) and CES (2015); and, to provide advice on potential solutions to enhance water security and water management in south central and southeastern Saskatchewan. The work was to be based on revisiting the existing reports, underlying data and analyses to assess if and to what extent current climatic and economic conditions alter the original conclusions.

This study provides updated information regarding:

- The degree to which the Projects remain an effective option to **enhance water availability, water security, and water management**.
- **Hydrological impacts** of an infrastructure project on stakeholders in the South Saskatchewan River Basin.
- **Updated cost estimates** for UQWSP and WIP (considering real and nominal changes in costs).
- **The economic impact** (including sensitivity analysis) of the project.
- Any other relevant aspects identified during execution of this assignment.

This work was accomplished from available information and consultations. No new field investigations were undertaken.

1.2 Methodology

The foundation of this report is the original documents (UMA 2006; UMA-AECOM 2007; AECOM, 2009; AECOM 2012; Clifton, 2011; Clifton, 2012). The Clifton-Wood team for this current assignment comprised individuals who had lead roles in preparing the earlier studies. Their background knowledge and familiarity with the industry and the specifics of the basin were invaluable in minimizing the time required to conduct this work.

In view of this, the methodology employed included:

- **Reviewing** the original reports to ascertain current applicability of the technical approaches employed and making any changes necessary.
- **Consulting** with relevant provincial and federal agencies, plus producers, to identify changes in project criteria that may be required (recognizing that ongoing consultation was also being conducted directly by WD).
- **Reviewing evaluation of land suitability** for irrigation to optimize the scale and reach of the water delivery scheme.
- **Estimating conveyance capacity**, routing and facilities placement to confirm the project general arrangement and typical elements.
- **Updating capital and operating** cost estimates.
- **Revising economic analyses**, including appropriate sensitivity analyses, to make them consistent with the 2020 economic environment.

- **Identifying environmental and legal issues** related to delivery of the projects.
- **Proposing an implementation plan and roadmap** to deliver the Projects

This report begins with a background review, followed by engineering considerations for hydrologic and regulatory settings. The report concludes with an updated financial analysis, project roadmap and a discussion of the rationale for investing as part of the post-Covid-19 economic recovery strategy.

2.0 Background Information

There is a perception amongst Canadians of an abundant water supply. However, most of the supply exists in northern Canada. By comparison, parts of southern Saskatchewan are semi-arid, with an intrinsic water deficit; where annual evapotranspiration exceeds annual rainfall. Continued water availability in these regions depends on efficient water use through facilitated supply and demand management.

The current water shortfall will be further exacerbated by global climate change. Climate models for the southern Prairies predict significant increases in the annual number of 30°C plus days (to more than 30 per year for the 2051-2080 period), effectively increasing evaporation and evapotranspiration across the southern prairies (Figure 2.1).

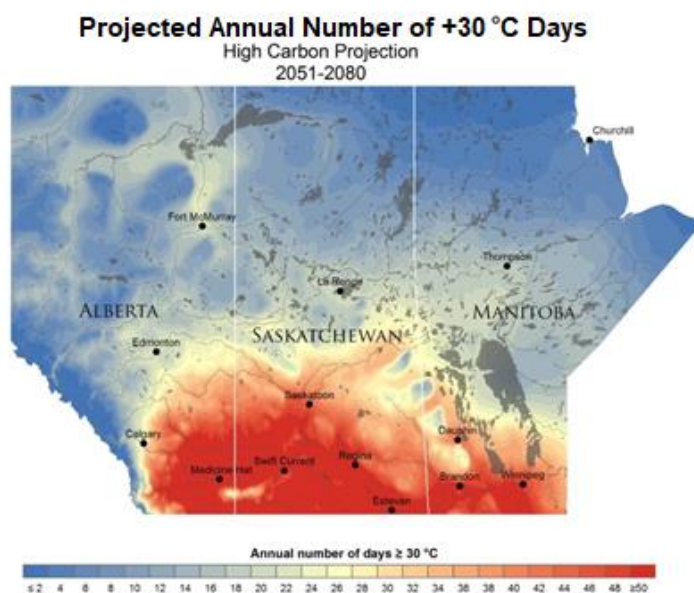


Figure 2.1: Future +30 °C Days (Government of Canada, 2014)

Water is an essential resource for ecological and economic sustainability. Saskatchewan is predicting significant population growth and economic expansion that will place added pressure on existing water supplies. Direct anthropogenic (i.e. due to human activity) water demand is projected to increase from 135,390 dam³ in 2010 to as much as 421,857 dam³ by 2060 (Kulshreshtha et al., 2012). The bulk of emerging demand will be as a result of expansion of irrigation, urban population growth, potash mining and other industrial activity.

In addition to anthropogenic-driven water demands, there will also be climate change impacts on the hydrologic cycle and water availability. The Prairie Adaptation Research Collaborative (PARC) has been researching climate change in the Prairie Provinces since 2000 (Andreichuk et al, n.d.). Using tree ring records, PARC has established that historic droughts in the prairies were much longer even than those experienced in the 1930s and late 1960s (Sauchyn, 2000). Further, PARC predicts a future with more extreme weather outside historical ranges. Forecasting that the climate of Saskatchewan will be warmer with more extreme precipitation events, longer growing seasons and declining summer river levels. Climate change adaptation measures are recommended to mitigate the impacts of 21st century natural disasters such as floods and prolonged droughts. The Water Projects described herein will assist in those mitigation measures.

The following Background sections address the growing global food demand and describe the concept put forward in 2012 and 2006 for the UQWSP and WIP (Water Projects).

2.1 Global Agri-Food Demand

The Water Projects are seen in the context of an increasing global food demand and with developments in agri-food production and technology that have made the industry more lucrative. This context is reflected in an expanding Saskatchewan agricultural economy from an increasing global food demand from a growing population and per capita food consumption (The World Bank, 2019) that is only exacerbated by an increasingly scarce global water supply. Some 2.7 billion people suffer water scarcity for at least one month of the year and by 2025 two-thirds of the population may face water shortages (World Wildlife Federation [WWF], 2019). In the context of these climatic changes, agricultural practices will need to evolve to more sustainable food production which will further expand international demand for Saskatchewan's agricultural products, technologies and fertilizers.

"How to feed nine billion people in 2050 is one of the biggest challenges of our era. Global food production must rise by at least 70 per cent by 2050. Without strong adaptation and mitigation measures, climate change might reduce food crop yields 16 per cent worldwide and by 28 per cent in Africa over the next fifty years. It is likely that price and yield volatility will continue to rise as extreme weather continues, further impacting livelihoods and putting food security at risk. Agriculture, including fisheries and forestry, have contributed to climate change but can be the solution to its challenges" (United Nations Food and Agriculture Organization, 2012).

There is growing demand for Canadian products, evidenced by the new trade agreements with many European and Asian Nations; including the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP).

While global markets indicate the continued economic success of Saskatchewan, water security remains a critical factor in sustained regional investment. The reality that Saskatchewan has a particularly volatile climate – that will only grow more volatile with climate change – may diminish investment. Water demand is a distinct concept from economic demand because it doesn't respond much to price change; it is essential, making water availability as important as the presence of raw materials.

2.2 The Upper Qu'Appelle Water Supply Project

Both the UQWSP and the WIP were envisaged in concepts for 82 projects PFRA proposed for the Saskatchewan Nelson Basin in 1972. The UQWSP was explored further by UMA (1981), again by AECOM (2009) examining how future water demands in the Qu'Appelle basin might be served and again by AECOM (2012) further developing this scheme and recommending that the province consider a dedicated upland channel to meet both future irrigation and downstream water demands. This concept, called the UQWSP, comprised a main pump station on Lake Diefenbaker and a main conveyance located on the south uplands, eventually spilling into Buffalo Pound Lake.

AECOM – based on studies by Kulshreshtha et al (2012) – recommended that the conveyance system be designed for 70 m³/s with 21 m³/s reserved to serve projected future downstream demands and 49 m³/s dedicated to irrigation and other uses along the conveyance channel including communities, recreation, environmental enhancement and value-added processing.

Figure 2.2 shows the general arrangement of the Upper Qu'Appelle Water Supply System as it was envisaged in 2012. The main components were:

- A main pump station (70 m³/s capacity) located on Lake Diefenbaker southwest of the Qu'Appelle Dam.
- The 31 km west canal, with a capacity of 70 m³/s, from the main pump station to the booster pump station.
- A wasteway (70 m³/s capacity) and balancing reservoir located immediately upstream of the booster pump station to accommodate short term operational shutdowns or storm inflows.
- A booster pump station (65 m³/s capacity) discharging into the east canal.
- The east canal, from the booster pump station discharge to a spillway into Buffalo Pound Lake.
- A spillway into Buffalo Pound Lake located at the west end of Buffalo Pound Lake.

Two options are shown in Figure 2.2:

- The low-level canal route which has a smaller lift requirement and basically follows the natural land contours which results in significant severance of land parcels and higher lifts for the adjacent irrigation system supply.
- A high-level canal option that requires a higher lift, but less land severance and less lift required to service adjacent land parcels.

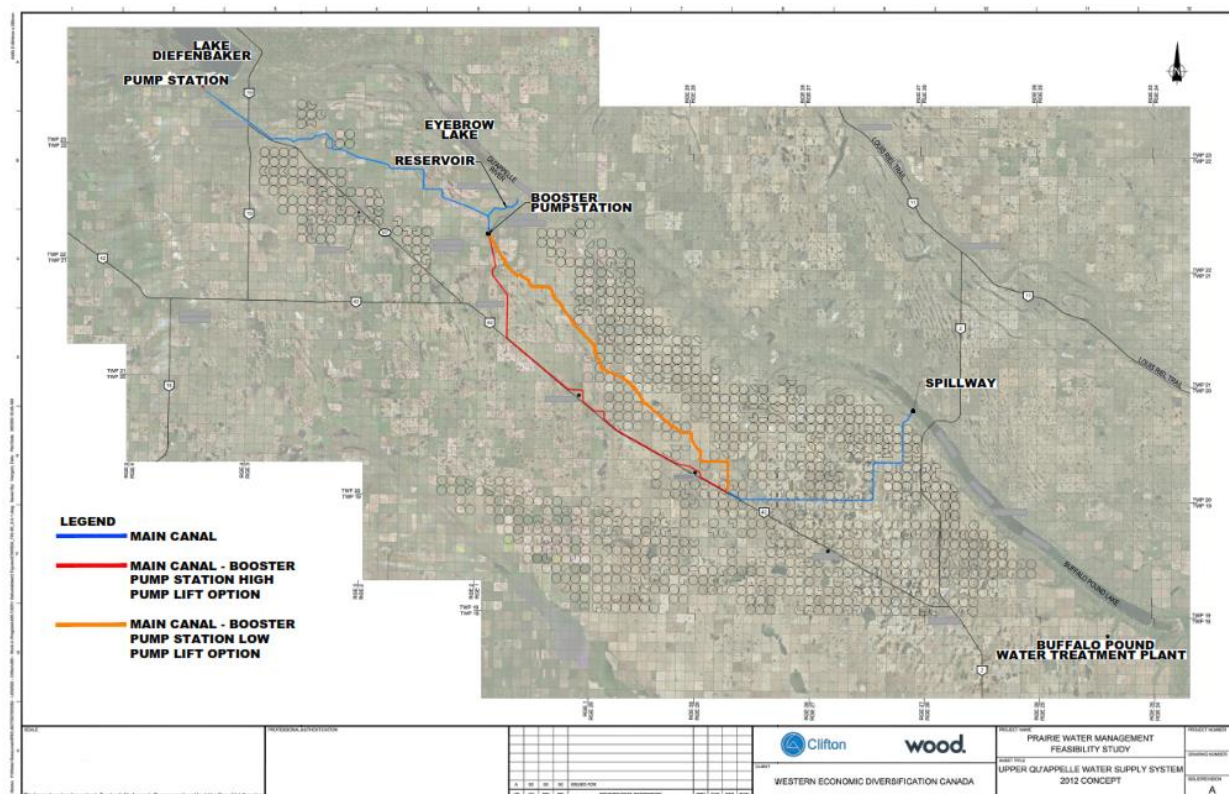


Figure 2.2: General Arrangement of the 2012 UQWSP.

The current canal alignments are considered reasonable as they were based on LiDAR data that was provided by the WSA. Minor alignment modifications may be required to address land features such as farmsteads, utilities and potential re-regulation reservoir locations; however, no significant alignment changes are anticipated.

2.2.1 Land Suitable for Irrigation: UQWSP

Land Suitability for irrigation was evaluated as part of the *Qu'Appelle South Irrigation Project – Conceptual Study* (UMA, 2007). The study area included three Rural Municipalities (Marquis No. 191; Eyebrow No. 193 and Huron No. 223) and a portion of a fourth Municipality (Maple Bush No. 224). The analysis was considered conservative, excluding a significant area that was considered marginal.

The evaluation used data from several previous studies including:

- General geology and groundwater information provided by the Saskatchewan Research Council.
- Prairie Farm Rehabilitation Administration (PFRA) investigation of the Grainland and Bridgeford-Tugaske portions (PFRA, 1985).
- 1986 Cameron study of integrated soils, geology and hydrogeology data for a portion of the study area.
- Saskatchewan Soil Survey detailed soil survey for lands considered potentially irrigable.
- Detailed soils information for the Bridgeford-Tugaske area as part of the Bridgeford-Tugaske project (halted in the early 1990's after completed the pre-design stage).
- Economic baseline for the WIP from SIPA major studies (Clifton, 2008)
- Study of project area (PFRA, 2002) which included almost all the project area. The report included maps that show soil salinity information on individual quarter sections. The study determined soils in the Upper Qu'Appelle basin are predominantly Dark Brown, and some Brown Soil Zones. Inhospitable land, including land with existing wetland or issues related to salinity was excluded from irrigable acres.

UMA (2007) estimated the Gross Potential Irrigable Acres at 168,000 acres. The reassessment carried out for this study identified in excess of 200,000 potential irrigable acres with increases due to improved irrigation technology and water delivery; irrigable area comprising 175,000 acres were incorporated into system design and economic analyses.

2.3 Westside Irrigation Project

The largest block of potentially irrigable land adjacent to Lake Diefenbaker is in an area west of Saskatoon parallel to the west bank of the South Saskatchewan River from Gardiner Dam to north of the Town of Asquith (Figure 2.3). This 340,000-acre (UMA-AECOM, 2006) block of land shown in Figure 2.4 is in an area with some of the highest heat units in the province, an important constituent for crop growth. Once irrigated, this area has the potential to be one of the most productive agricultural regions in Canada.

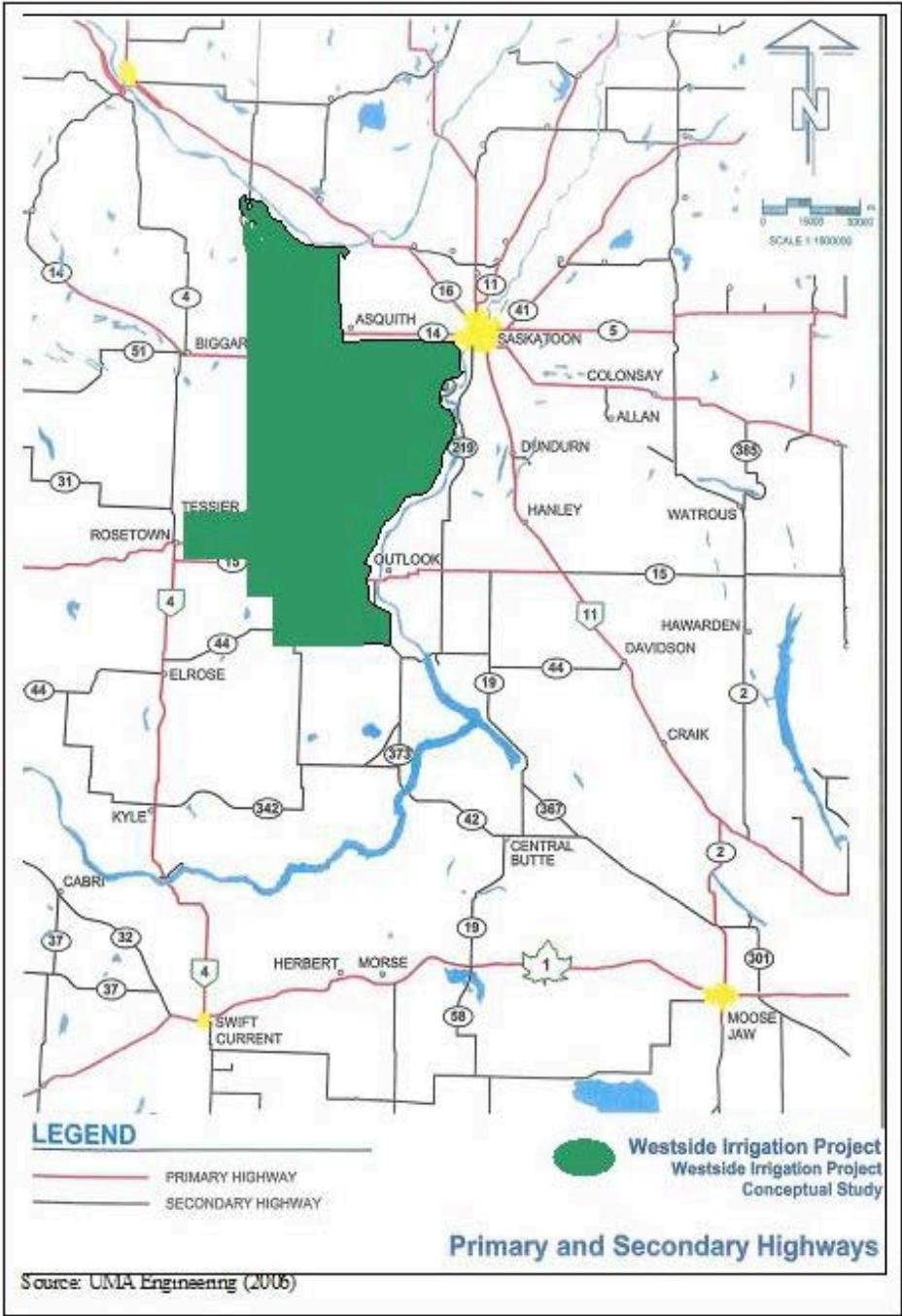


Figure 2.3: Westside Irrigation Project Location

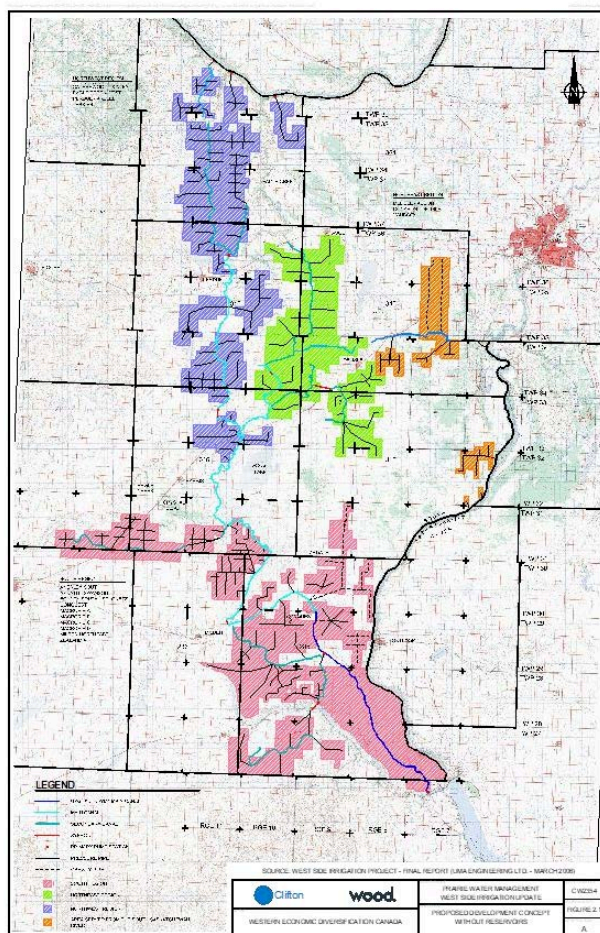


Figure 2.4: Potentially Irrigable Land for the Westside Irrigation Project

Three options were identified for irrigation development for the WIP. The first and smallest option is rehabilitation of the existing abandoned canal system, supporting approximately 63,500 acres of irrigated land. Construction of this option originally began in 1969 but was halted in 1972 with only partial construction of the substructure of the pump station, the Conquest Reservoir and about 43 km of canal constructed; a portion of this canal is now being used to supply water to about 3,000 acres for the Macrorie Irrigation District. None of the legacy facilities would meet current engineering and environmental standards and have limited salvage value.

The second option was expansion of the main canal and pumphouse to service about 182,500 acres; this option was deemed impractical since it would require design anticipating the third option, a full build out, supporting 334,000 acres of irrigated land; economies of scale make this option the most viable in the long-term.

The conveyance system for the full-build option includes the following major components:

- An upgraded Coteau Creek Pump Station delivering water into the West Main Canal (WMC);
- Three peaking reservoirs (Conquest, Eagle Hill Creek and Delisle);
- An enlarged and upgraded WMC, extending the WMC to the northwest to a point approximately 1.2 kms north of Tessier where it would divide into two smaller canals, one west to a syphon across Eagle Creek, and the other to the northeast;
- Buried piping systems to distribute water to individual properties; and,
- Instrumentation and controls to manage the systems.

2.3.1 Land Suitable for Irrigation: WIP

WIP land suitability was based on the assessment reported by UMA (2006). Irrigable blocks were selected based on soil survey information, topographic maps, water well maps and geological information. Heavy clay soils noted within the project area were deemed marginal and not suitable for irrigation.

The soil survey information included quarter-section salinity data based on municipal assessment data where it was available. A conservative irrigated area of 130 acres per quarter was used to calculate the potential gross area available. Conservatively, three hundred and seventy-eight thousand (378,000) acres were identified within the study area of which three hundred and thirty four thousand (334,000) acres were best served by enlarging and extending the abandoned WMC.

3.0 Hydrology Considerations

3.1 Water Demands in Saskatchewan

Water demands in southeast Saskatchewan were reviewed in 2011 and 2012 through a joint report by the University of Saskatchewan (U of S) and the WSA (Kulshreshtha et al. 2012). While this work covered a broader area than the current study, some of the detailed work regarding projected water demand for the municipal, industrial, agricultural and environmental sectors can be extrapolated from the earlier work to the current Water Project context.

The U of S - WSA study concluded:

“The baseline scenario uses the estimated activity levels for various anthropogenic and non-anthropogenic activities combined with water use coefficients to estimate water demand levels for the Qu’Appelle Basin. Increased amount of irrigated area and expansion of the potash sector are the main forces behind the change in water demand. Anthropogenic activities are projected to account for 41.8% of the total water demand by 2060, slightly less than doubling the 2010 share.”

The study projected a doubling of water demand for anthropogenic, municipal, agricultural, industrial, mining and recreation uses over the fifty-year interval evaluated. The main sources of increased demand are growth of irrigated agriculture and expansion of industry and mining. Municipal water consumption was estimated to remain static over the period despite a growing population, with some declines to 2040 as a result of the effects of municipal pricing in stimulating water conservation. Without impacts from Climate Change, natural (non-anthropogenic) water use was expected to remain constant.

A summary of the 2012 projected water demands by sector is shown below in Table 3.1.

Table 3.1: Baseline Water Demands in the Qu'Appelle River Watershed (Kulshreshtha et al. 2012)							
Water Demand Sector	Amount of Water Used (dam³)				% Change In Water Demand by Period		
	2010	2020	2040	2060	2020/10	2040/2010	2060/2010
Agriculture	64,668	67,061	165,330	206,324	4%	156%	219%
Industry and Mining	32,062	72,089	86,378	87,126	125%	169%	172%
Municipal (Domestic and industrial)	45,676	44,892	44,183	45,646	-2%	-3%	0%
Recreational	153	155	158	160	1%	3%	5%
Other human related water uses	357	331	1,791	1,787	-7%	402%	401%
Total Anthropogenic water uses* % of Total Water Use	142,886 (24%)	184,496 (28%)	297,807 (39%)	341,006 (42%)	29%	108%	139%
Non-Anthropogenic water uses* % of Total Water Use	463,934 (76%)	463,934 (72%)	463,934 (61%)	463,934 (58%)	0%	0%	0%
Total Water Use	606,820	648,430	761,741	804,940	7%	26%	33%

These estimates show that provincial agricultural and industrial growth will create a greater water demand. The water use coefficients used in developing these estimates are considered reasonable. As a result, these coefficients were extrapolated for UQWSP and WIP analyses, creating a 50-year water demand outlook that resulted in a similar water demand projection for each region. The WIP water demand was relatively less due to less industrial development.

In both studies, the water balance analysis was based on a conservative projection, however, there is potential for higher water demands arising from factors such as:

- Increased levels of economic activity.
- Increased global demands for fertilizers, energy and food products and the resumption of potash mining expansion in the Qu'Appelle watershed.
- A faster rate of irrigation uptake.
- Impacts from Climate Change.

It is difficult to identify scenarios that would reduce water demand below current levels. It is clear from the hydrological estimates that a water constraint will emerge in the future for the regions that would be served by the Water Projects.

3.2 Ability of Lake Diefenbaker to Serve Irrigation Demands

Lake Diefenbaker is the largest body of water in Southern Saskatchewan, it is a long narrow water body confined to the original river valley and coulees. It is generally 2 to 3 km wide and 225 km in length. At its Full Supply Level (FSL) of 556.87 m, it has a surface area of approximately 43,000 ha and contains 9,400,000 dam³ of water (1 dam³ is 1,000m³). The reservoir has 8,300,000 dam³ of live storage between the FSL and the Dead Storage Level (DSL) of 522.73m. Figure 3.1 shows the area-capacity curve and the relationship between elevation, flooded area and storage volume, with the red line being capacity in Dam³ and the blue line being flooded area in hectares.

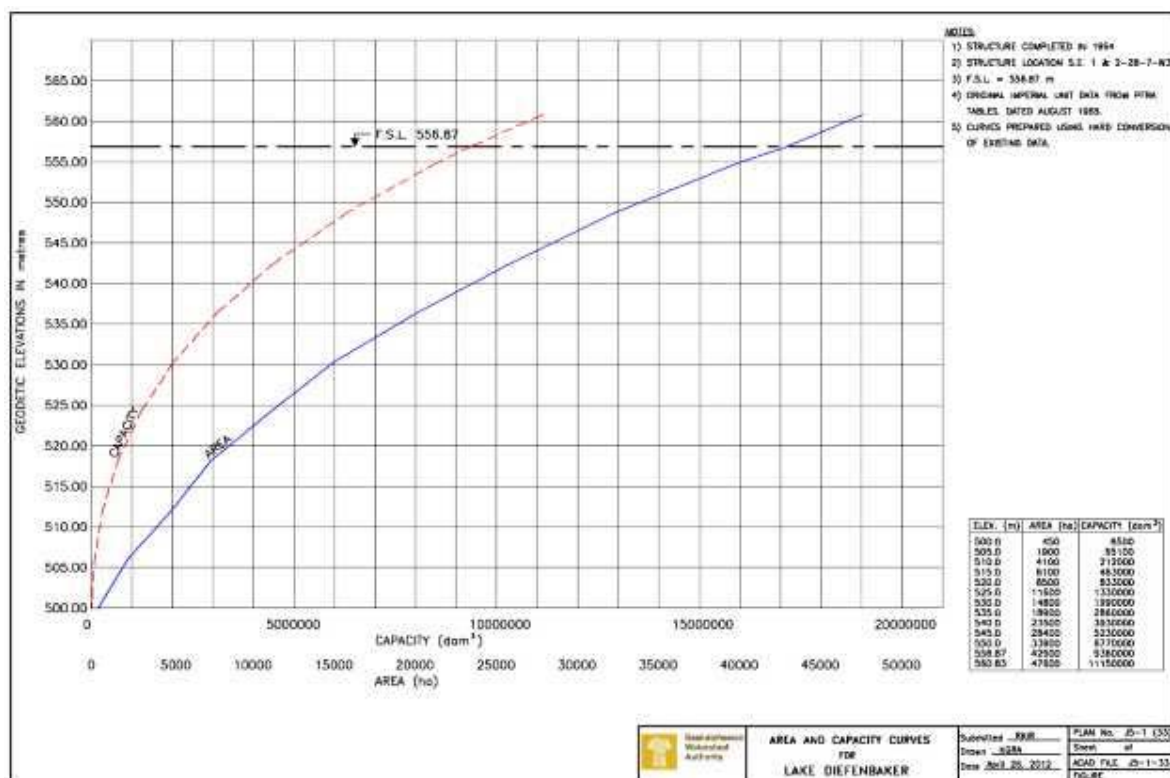


Figure 3.1: Lake Diefenbaker – Area-Storage Curve (Saskatchewan Watershed Authority, 2012c)

Lake Diefenbaker has become a multi-use reservoir, important for:

- Hydropower production.
- Water supply, including municipal, irrigation, and industrial water uses.
- Habitat.
- Recreation.
- Flood control and downstream flow regulation.

There are, many considerations in reservoir operations. The lake tends to be operated within a much narrower range than the theoretical range from FSL to DSL. Some of these considerations are summarised on Table 3.2 that was abstracted from Saskatchewan Water Authority *Lake Diefenbaker Reservoir Operations - Context and Objectives* (2012a).

Outflow Category	Explanation	Targets/Objectives/Constraints
Apportionment requirements	Apportionment requirements to Manitoba	Saskatchewan is obligated to pass one-half of the flow we receive from Alberta (South Saskatchewan, Red Deer, Battle, and North Saskatchewan) plus one-half of the natural flow of the Saskatchewan River System arising in Saskatchewan to Manitoba.
Hydropower	Avoid and/or minimize spill from Gardiner Dam. Allow production at the Coteau, Nipawin and E.B. Campbell SaskPower Hydro Stations	Produce hydropower at the most beneficial periods and times. Provide sufficient releases to maintain the licensed minimum daily average outflow from E.B. Campbell of 150 m ³ /s.
Downstream municipal allocation	Maintain daily average outflow for: effluent dilution at Saskatoon; water intakes at Outlook, Saskatoon, and St. Louis; private irrigators along the river; operation of ferries; QE cooling water, downstream recreational use and fisheries.	Maintain a daily minimum flow of 42.5 m ³ /s, representing 1,340,000 dam ³ annually. During open water season, attempt to maintain flows through Saskatoon between 60 and 120 m ³ /s. Maintain flows during the winter as steady as possible to avoid issues with ice cover on river.
Downstream municipal water supply	Supply municipal water supply for Saskatoon, Melfort, Humboldt, and others.	
Flood control	During flood events on the South Saskatchewan River	Provide as much flood control as possible with available storage while allowing for the possibility of subsequent flood events. Minimize flooding of agricultural land in the Saskatchewan River Valley. Flooding of the Muskoday First Nation Indian Reserve land begins when flows reach 2,500m ³ /s. Flooding of residential areas in the City of Saskatoon begins when flows exceed 5,400m ³ /s.
Flood control	During flood events on the North Saskatchewan River	Provide as much flood control as possible with available storage in Lake Diefenbaker to minimize flooding at Cumberland House (occurs when sustained flows are in excess of 2,500 m ³ /s) and flooding of Highway #124 (occurs below Tobin Lake when flows exceed 2,700 m ³ /s), while allowing for the possibility of subsequent flood events on either the North or South Saskatchewan Rivers.

Table 3.2: Management Considerations for Lake Diefenbaker (Saskatchewan Watershed Authority, 2012a)

3.3 Existing Conveyance: The Upper Qu'Appelle River System

The Qu'Appelle River flows from Lake Diefenbaker to join the Assiniboine River near the Manitoba border some 430 kms downstream. The river valley is the drain for the Upper Qu'Appelle, Lower Qu'Appelle and Wascana Watersheds, and is comprised of rich farmland, fresh-water lakes, provincial parks, recreational areas, 11 First Nations and many other seasonal and permanent residents.

The conveyance system from Lake Diefenbaker to Buffalo Pound Lake is approximately 95 km long and is referred to as the Upper Qu'Appelle River. As part of the South Saskatchewan Project, the upper portion of the Qu'Appelle River was channelized from the Qu'Appelle River Dam to approximately 35 km downstream.



Figure 3.2: Upper Qu'Appelle River System

Buffalo Pound Lake stores 92,000 dam³ of water and is the municipal water supply for a significant portion of the population of southern Saskatchewan, including the cities of Regina and Moose Jaw and the Moose Jaw-Regina Industrial Corridor. Water released from Buffalo Pound Lake supplies the water needs of the lower Qu'Appelle River. Figure 3.3 provides a schematic showing the profile of the Qu'Appelle River from Lake Diefenbaker to the Manitoba Border and the location of the various lakes in the valley.

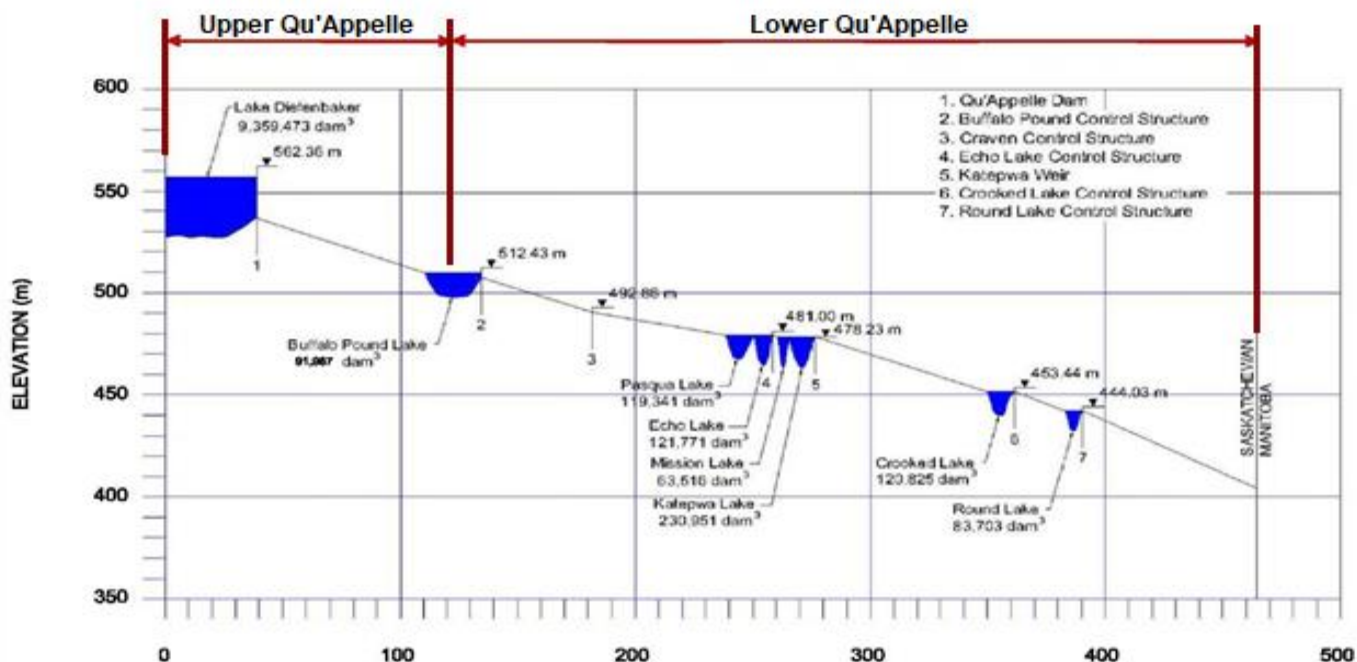


Figure 3.3: Schematic of the Qu'Appelle River from Lake Diefenbaker to the Manitoba Border (Clifton, 2012)

The design capacity of the channelized upstream portion of the Qu'Appelle River is estimated to be 14 m³/s, but due to weed growth, sloughing, and siltation, capacity is often reduced to 6 m³/s in summer (Clifton, 2012). A report (Stantec, 2014) investigated alternative measures to increase flow from Lake Diefenbaker to Buffalo Pound Lake either in the existing channel or in a new canal or pipeline. The report concluded that:

"The entire UQC has degraded significantly due to erosion and sedimentation. Prolific macrophyte growth in summer months reduces the capacity in the affected reach from 13 m³/s to less than 4 m³/s. Channel erosion results in sediment deposits in the upper portion of Buffalo Lake. Ice in winter months reduces the channel capacity to approximately 4 m³/s. Solutions are required to improve the performance of the existing channel and provide increased flows either in the existing channel or in a new canal or pipeline. At the current predicted rate of sedimentation, significant dredging will be required in the north basin of Buffalo Pound Lake within 30 to 50 years. If flows from the Qu'Appelle River Dam are increased to 17 m³/s and there is no work done to stabilize the channel, then costs to remove sediment from Buffalo Pound Lake could exceed \$650 M over the next years."

Kulshreshtha et al. (2012) estimated 2010 water use and forecast consumption for the basin by type of users for 2020, 2040 and 2060 period. That study indicated that future demands – exclusive of irrigation and industrial development – may reach 25 m³/s. It was noted that the Upper Qu'Appelle river system, as it was in 2012, would not be able to convey the required flow to meet the projected future demands.

3.4 UQWSP Impacts on Lake Diefenbaker

Analysis has concluded that maximum diversions for the UQWSP will not materially lower outflow from lake Diefenbaker in low, median and high water years – with water years defined by studies from the Saskatchewan Watershed Authority.

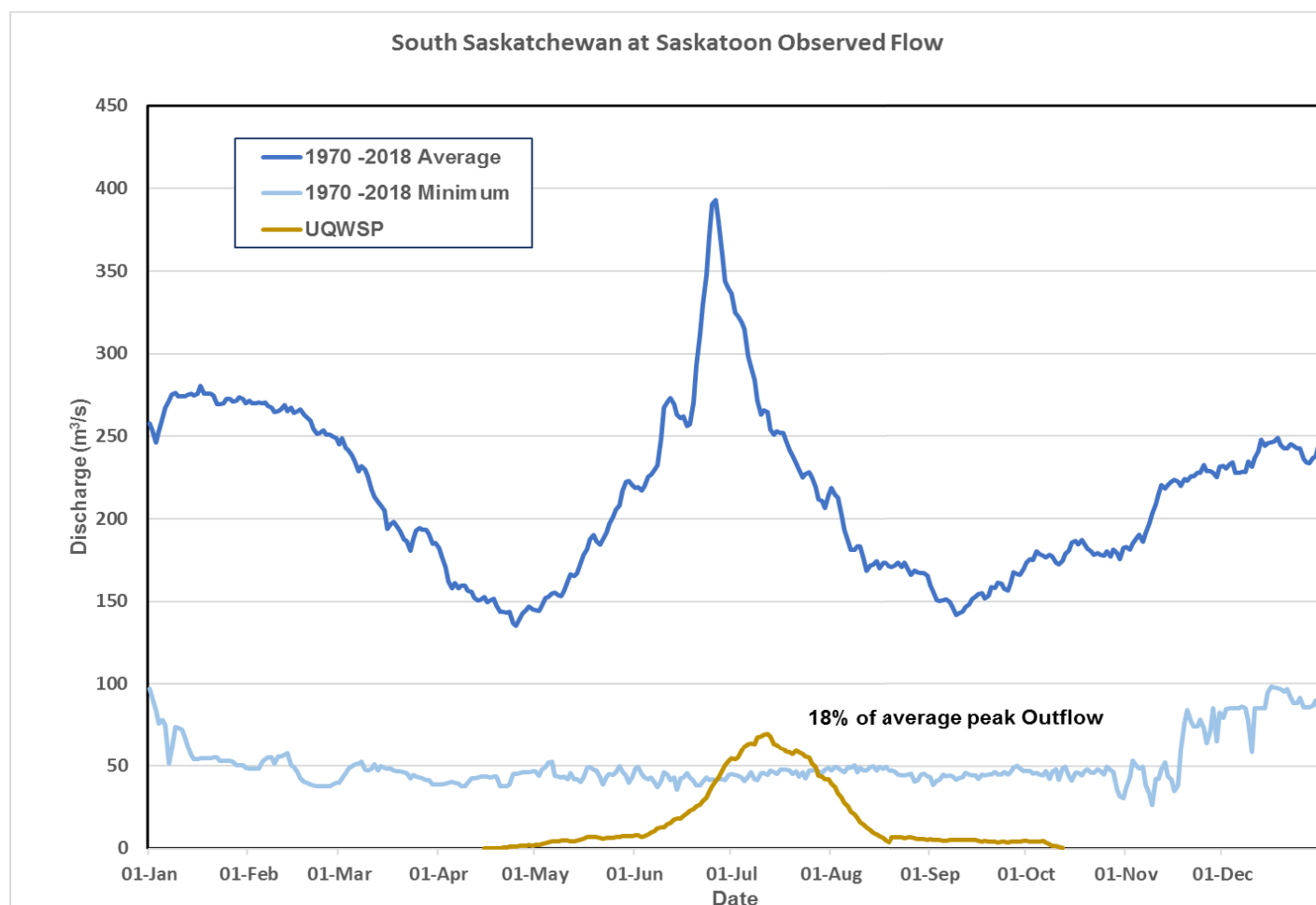


Figure 3.4: UQWSP Demands and South Saskatchewan at Saskatoon Observed Flows

This report considers a more extreme low water year using the following assumptions:

- Maximum diversions of:
 - 280,000 dam³ for the UQWSP
 - 220,000 dam³ for the Qu'Appelle River
 - 196,000 dam³ for the WIP (maximum licensed allocation)
- Maximum evaporation losses (Basis 1988 drought conditions)
- Minimum inflows (those that occur with 100% probability for the period analyzed [1928-2015])
- Alberta uses full water allocation.

Only under this circumstance (476,000 dam³ of water diverted for irrigation) did the total outflow fall short of existing requirements. the total outflow rendered was 1,301,000 dam³. The minimum flow provided by the Lake Diefenbaker Operating Plan is 1,340,000 dam³.

3.5 WIP Impacts on Lake Diefenbaker

There are existing apportionment agreements of 196,000 dam³ for WIP water diversions.

Lake Diefenbaker hydrologic analysis considers existing water allocations as sufficient for the first Option of the WIP. For the second and third Options greater water diversions would be required.

Approximately 440,000 dam³ would be required for the third Option under the most extreme drought conditions. At a conceptual level, it is believed that this maximum diversion for the WIP would maintain flows greater than current outflow requirements, even under the most extreme drought conditions.

3.6 Water Projects Impacts on Lake Diefenbaker

Water diversion impacts from both the UQWSP and the WIP could be significant. The most extreme drought scenario diversions for the UQWSP and WIP could be 280,000 dam³ and 440,000 dam³ respectively; summing to 720,000 dam³. A comprehensive hydrology review is required to ascertain the hydrologic effects of diversions of this magnitude on both reservoir operations and downstream impacts since it is likely that this full demand would not likely be possible under an extreme drought scenario.

Having said that, it must be emphasized that this severe drought condition only applies to the lowest conceivable (historically derived) annual flow and that water diversions are not guaranteed; rather, diversions would only occur when warranted. With adaptive water management and the use of reservoirs, both irrigation projects could be achieved under most climatic scenarios but supply may be restricted under the most adverse scenarios.

Further evaluation is required to assess total impact from the Water Projects. Comprehensive and up-to-date hydrologic modelling should be pursued to evaluate impacts on both the Saskatchewan and Qu'Appelle rivers and downstream stakeholders. In addition, updating of forecasts of future demand in southeast Saskatchewan is recommended, along with a water management strategy that will outline how future water demand in that region will be supplied; this is a strategic consideration in confirming the basis of design for the UQWSP since the Conveyance will be a key element in future water solutions.

3.7 Conclusions

The downstream impacts on the South Saskatchewan River that result from diversions are expected to be minor even in the lowest flow year and can likely be mitigated in a revised operating plan for Lake Diefenbaker. As with the management of all multi-use reservoirs, the use of water for the water projects may change the volume of water available for other uses; however, the current and demonstrated management priorities can be met with minor changes in operation. Inevitably, there will be reductions in the volume of water available for hydroelectric production, however that reduction could become partially offset by hydroelectric capacity elsewhere in the system. These are issues that must be addressed in a comprehensive impact assessment of the projects.

4.0 Legal and Regulatory Considerations

The earlier discussions of the Water Projects were based upon the regulatory framework of that time. Since 2012 there have been changes on the regulatory front both federally and provincially. This section examines those that have a potential to impact project implementation in a material manner.

Perhaps the most significant change is the passing into force of a suite of federal legislation in August of 2019 collectively referenced as Bills C-68 and C-69

4.1 Legal Framework Overview

Federal, provincial and municipal water law and regulations have been a continually changing framework for water development projects in Saskatchewan. Over the years a large number of provincial Ministries and Agencies have held direct interests and responsibilities for water related issues, including for surface and groundwater quality and quantities, agriculture, irrigation, forestry, mining, municipalities, Crown corporations and utilities, First Nations, recreation and parks, public lands and emergency measures.

Often many of these interests were shared by government and the local stakeholders, some of the recent provincial water interests are summarized in Table 4.1.

Table 4.1: Historic Saskatchewan Provincial Ministries and Agencies with Water Interests

Number	Major Provincial Ministries and Agencies	Primary Interest/Function
1	Saskatchewan Watershed Authority Water Security Agency	Water Allocation and Licensing; Ground and Surface water rights and Licensing; Hydrometric services; Water Information Management, Water Quality and Supply, Protection of Water, Drinking Water Quality; Advisories and Emergency Orders; Waterworks and Sewage Works; Riparian Land
2	Saskatchewan Water Corporation	Public Water Utility Service Provider for Potable and Non-Potable Water Supply, Wastewater Treatment and Management, and Certified Operations and Maintenance.
3	Environment	Environmental Assessment and Protection; Protection of Water, Protection Orders, Environmental Codes of Practice
4	Health	Water Quality Testing
5	Saskatchewan Research Council	Water Research
6	Agriculture	Drought/Flood; Irrigation, Water and waste management on Farms; Farm Drainage.
7	Saskatchewan Power Corporation	River Flow and Water Regulation for Hydro and Thermal Power Cooling
8	Public Safety & Policing	Emergency Measures; Flooding
9	Local Municipalities	Water bodies, Waterworks, Sewage and Water Utilities, Drainage and Drainage Infrastructure
10	Municipal Affairs	Water and Sewage Infrastructure and Treatment
11	Tourism, Parks, Culture & Sport	Water Based Recreation Sites
12	First Nations & Métis	Traditional Hunting and Fishing Areas; Economic Development; First Nations Rights
13	Highways & Infrastructure	Highway and Water infrastructure
14	Natural Resources	Forests, Watersheds, Water Management in Parks

Table 4.1: Historic Saskatchewan Provincial Ministries and Agencies with Water Interests

Number	Major Provincial Ministries and Agencies	Primary Interest/Function
15	Economy	Sub-Surface Resources, Oil & Gas Development, Mining, Water Based Economic Development Initiatives; Investment Attraction; Water Technologies
16	SaskBuilds	Infrastructure Development

Other levels of government are also involved in Saskatchewan water management. The federal government has jurisdiction over international and inter-provincial waters. Twenty-two international, federal agencies and ministries have held water responsibilities in recent decades (Table 4.2).

Most recently, in August 2019, changes to the Canadian Environmental Assessment Act and the Canadian Impact Assessment Agency introduced increased levels of complexity into the development and approval of major water development projects. In total, some thirty-five separate federal and provincial and inter-jurisdictional regulatory agencies are now potentially engaged in oversight of Saskatchewan water development projects. The UQWSP falls under several legal frameworks which would need to be addressed as part of the implementation of the project. Regional cooperation is required where water management effects extend up and downstream to adjoining locations, across provincial boundaries and into international rivers.

Table 4.2: International, Inter-Provincial & Federal Department & Agencies with Water Interests

#	International, Inter-jurisdictional and Federal Departments & Agencies	Primary Interest/Function	#	International, Inter-jurisdictional and Federal Departments & Agencies	Primary Interest/Function
1	International Joint Commission and Boards Souris River Board Poplar River Board.	International River Water Protection, Quality and Equitable Flow. Administers International River Apportionment Agreements	10	Agriculture & Agri-Food Canada	Food production. Water protection. Rural water supply.
2	Prairie Provinces Water Board	Administers Prairie Provinces Water Apportionment Agreement	11	Freshwater Fisheries Marketing Board	Prairie Fish Marketing and Production

Table 4.2: International, Inter-Provincial & Federal Department & Agencies with Water Interests

#	International, Inter-jurisdictional and Federal Departments & Agencies	Primary Interest/Function	#	International, Inter-jurisdictional and Federal Departments & Agencies	Primary Interest/Function
3	Inland Water Directorate	Inland waters	12	Parks Canada	In Park Rivers, Lakes and Marshes Ecological Integrity
4	Environment & Climate Change Environmental Impact Assessment Agency of Canada	Environmental Assessment Trans-boundary flow Hydrological data	13	Canadian Wildlife Service	Wildlife Protection
			14	National Hydrology Lab	Water Research
5	Inland Water Directorate	Inland waters	15	Fisheries and Oceans	Inland and Ocean Fisheries
6	Transport Canada	Navigation	16	Fish and Seafood	Food Production
7	Health	Public health – drinking waters, waste treatment	17	Canadian Food Inspection Agency	Food Inputs Drinking Water
8	Natural Resources	Ground water Climate Change	18	Indigenous & Northern Affairs	On Reserve Waters
9	Canadian Rural Partnership	Rural Development	19	Foreign Affairs	International Boundary Waters
Source: Government of Canada			20	National Water Resources Institute	Water research

The interests of the various agencies will be reconciled during the permitting and licensing phase of the project.

4.2 Regulatory Framework

This section considers the overall process for approval of the Water Projects. The UQWSP and WIP may follow differing approval pathways. The quantity of water diversion to UQWSP, combined with water diversions into the Assiniboine drainage, raises the probability to trigger the IA provisions of Bill C-69; it is unknown if the WIP would trigger such provisions. Since a joint federal-provincial environmental assessment will likely be required for the UQWSP, approval could depend on a lengthy assessment.

The principal regulators that will be involved in issuing approvals for the Projects are discussed in the following sections.

4.2.1 Water Security Agency

The agency will be responsible in determining if water can be allocated and later to issue permits for construction and operations. Any further consideration of impact assessment will depend on WSA approval of the water allocations for the Projects.

4.2.2 Joint Federal and Provincial Environmental Assessment Process

Within the Federal Impact Assessment (IA) planning process, it should be determined who is to be included in First Nations consultations, as well as the information requirements the proponent is expected to deliver during the IA process.

Requirements for the IA should be outlined within a Terms of Reference document. Once the Terms of Reference are approved by Saskatchewan Ministry of Environment, Government Relations will issue a letter to the proponent and any Indigenous groups that require formal consultation. The IA/EIA will require public review for a minimum of 30 days, possibly more for the federal process.

Approvals will be required from all levels of government that administer legislation or regulations that apply to this project. In this case all three levels of government, plus First Nations and some provincial agencies or crown corporations, will have decision-making powers with respect to approvals, permitting and licensing.

In accordance with Treaty and Indigenous rights, First Nations will need to be consulted in a meaningful way to advance these water infrastructure projects. This is of the utmost importance, partly because of established rights, but also because of the substantial amount of Traditional Ecological Knowledge that could be contributed.

All of the issues outlined in the Terms of Reference document provided by the regulatory agencies must be addressed in due course as the project proceeds; gaining approvals at the federal and provincial level are a fundamental input to a positive investment decision.

5.0 Economic and Financial Analysis

5.1 Economic Justification for Water Projects

Long-term justification for water projects often includes consideration of upstream and downstream costs and benefits. Thus, costs can be considered against water revenues generated from power generation, agriculture, industry and municipalities for water supply, as well as the secondary economic, social and environmental benefits from secure water supplies. Figure 5.1 provides an illustration of the primary and secondary diversified impacts of a water project.

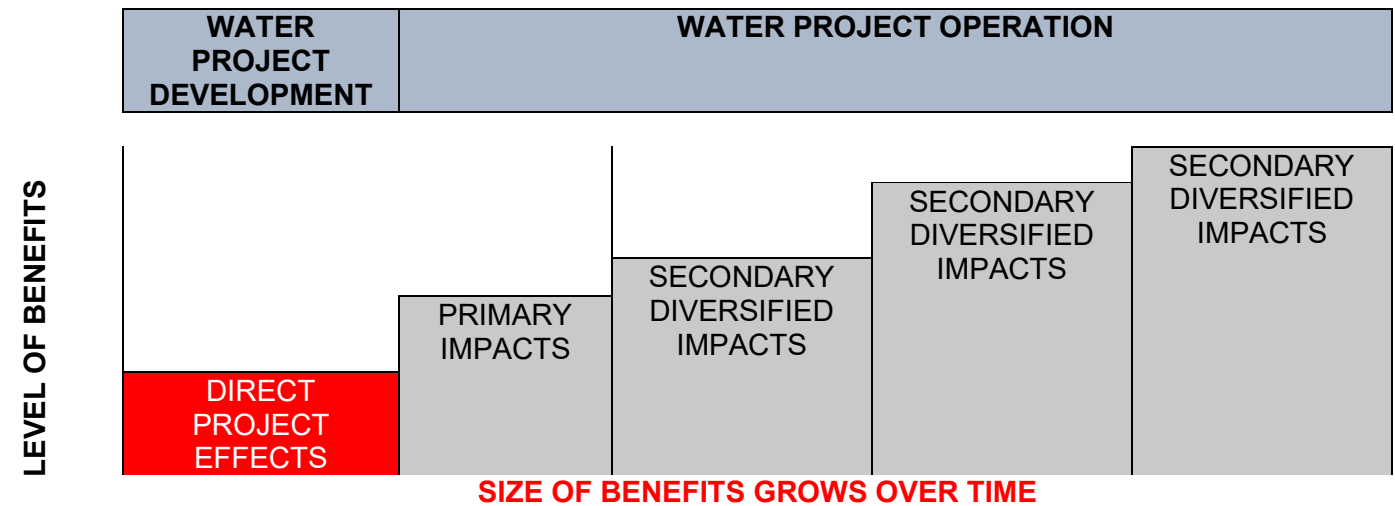


Figure 5.1: Primary and Secondary Effects of Projects Growth Over Time

There are many areas of impact activity that have been identified including direct, indirect and induced diversified impacts. Table 5.1 identifies some of these areas, including project construction, fiscal and economic impacts for federal and provincial governments, increased investment in food processing, mining and secure water supplies during droughts as well as some flood protection from extreme weather events.

Table 5.1: Scope of Primary and Secondary Economic, Social and Environmental Effects of the Upper Qu'Appelle Conveyance

Primary Direct Benefits	Secondary Diversified Benefits		
	Water Management, Security & Infrastructure	Social, Economic and Fiscal Effects	Other Environmental Benefits
Construction Impacts Long Term Water Security Agricultural Income Benefits Water Revenues and Supply for Agriculture, Industry and Municipalities	Regional and Community Water Distribution Networks Improved water management options for the Saskatchewan and Qu'Appelle Watersheds Flood Protection Drought Protection	Improved Investment Climate Increased investment Improve domestic water supply Improve parks and recreation Agri Food Value Chain Development Threshold levels of irrigation for manufacturing Net Power Generation Potential Sustainable Rural Communities Population Increases Lower Drought Payments by Government Lower Crop Insurance Costs	Lower Qu'Appelle Lake & Riverfront Water Level Stability Increased wetlands Carbon sink benefits from irrigation, sustainable wetlands and hydro development. Improved Adaptation Options for Global Warming Improved Fish & Wildlife Habitat Recreational Benefits
Source: Clifton Associates Ltd.			

5.2 Economic Model Methodology

The updated economic analysis employs similar methodology to that of the applied by Clifton (2012). It estimates the social, economic and environmental impacts of the Water Projects over a 50-year period through the following five steps:

- Defining the impact area that will be affected by the Project.
- Developing a scenario for the social, economic and environmental outlook for the impact area with the Project.
- Measuring the direct, indirect and induced effects on the economic impact area that result from the introduction of the Project.
- Calculating Cost Benefit Ratios for the Project over a 50 Year period.
- Completing a Sensitivity and Risk Analysis of the findings.

Large water infrastructure schemes have lives expected to last at least 50 years and probably much longer. With proper operation, maintenance and required rehabilitation the system should have a working life of over 100 years. The 50-year project life selected provides a time frame within which most of the benefits of the project can come into existence. Irrigation development may take many years before all irrigable acres can be brought into operation. Moreover, food processing opportunities can only be realized

when threshold levels of agricultural production that will justify processing investments, have been reached.

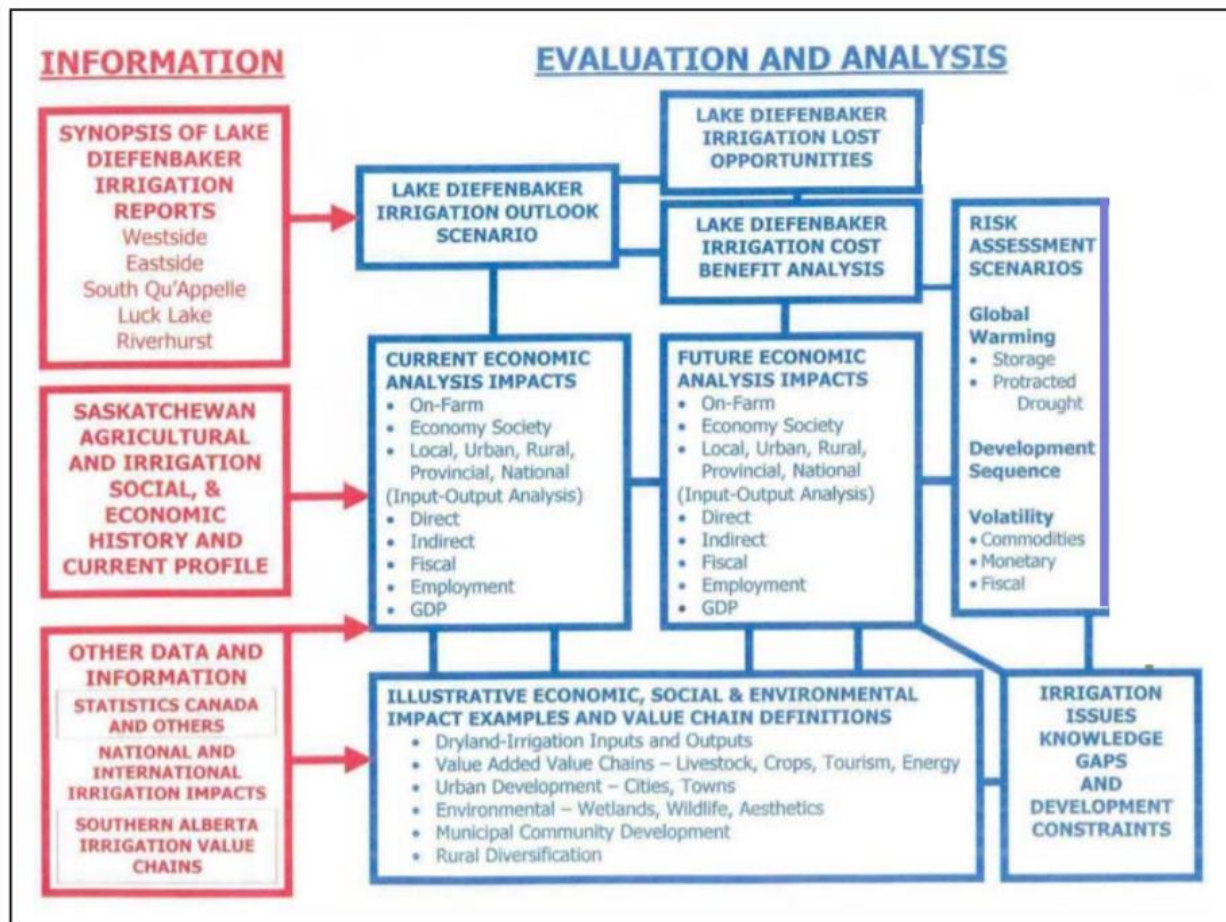


Figure 5.2: Methodology

5.3 Updated Building Blocks

Irrigation will provide an opportunity for expanded economic production, stimulating both forward linkages and greater value-adding industry; these are the economic building blocks. Updated Building Block selection is informed by four levels of analysis:

- Firstly, use of the Southern Alberta Irrigation Projects as a guide to establish potential agricultural building blocks.
- Secondly, a review of industrial activity in the area to determine which of the prior building blocks have been captured and to forecast emerging blocks.

- Thirdly, working backwards (back-casting) from building block capacities to balance projected primary production with projected building blocks. For example, a 100,000 head per annum slaughterhouse depends on the availability of 100,000 animals from feedlots and cow-calf operations.
- Fourthly, evaluating emerging global demand for agricultural products from the project region and Canada.

The updated economic model is conservative in its assessment to avoid overstating economic benefits. A full description of the economic analysis is attached as Appendix A.

5.4 Costing Update

The foundation of the cost estimating is the early reports by AECOM (2006, 2012) that estimated the capital and operations costs for the Pump Station, Canal, Booster Station, Spillway, and Reservoirs. Updating the costs relied on several price indices from Statistics Canada, selecting those most pertinent to deliverables. For example, the cost of pumps and compressors has fluctuated substantially since 2012, so rather than using the Consumer Price Index (CPI) which only exhibited marginal change, the Machinery and Equipment Price Index for Pumps and Compressors was used to establish a more definitive cost.

Price Index analysis was supplemented by updating the cost estimates for deliverables deemed likely to have exhibited unique price fluctuation and could not be reconstructed using Price Indices. These significant cost items were reviewed separately due to their impact on the analysis and are now based upon current (2019) tendered prices. This supplementary analysis provided insight into the accuracy of cost updating using Price Indices by verifying the degree of precision by comparison of the two developed costs.

In general, prices are not materially different than those provided within the 2012 analyses. While some items are marginally more expensive, others are marginally less. In real monetary terms, the costs are similar.

5.5 UQWSP Economic Analysis

The start of economic analysis of a project is the capital investment required for basic infrastructure. For water projects, development of the main conveyance system is considered to be this starting point. As a result of increased water availability, this investment would spur several types of economic activities directly, notably irrigation and industrial developments. The economic contribution of these activities would lead to further regional development of Saskatchewan through the multiplier effect.

The estimated total investment, for the scenario analyzed, is summarized in Table 5.2. The total nominal cost of developing the UQWSP infrastructure is estimated at \$1.37 billion while other on-farm related infrastructural investment would be about \$756 million. On the top of these investments are the agricultural and industrial building blocks which would require an investment of almost \$0.5 and \$6.4 billion respectively. As one can see the project has a high investment multiplier – \$1.37 billion investment in the UQWSP would attract significant linked investment.

Table 5.2: Total Cost of the Upper Qu'Appelle Water Supply Project and Its Components in Nominal Dollars			
	Capital Cost in Nominal Dollars		
	Public	Private	Total
	Values in Millions of Dollars		
UQWSP Infrastructure	1,369		1,369
On-Farm Irrigation		756	756
Agriculture Building Blocks		490	490
Industrial Building Blocks	Potash Mine	5,021	5,021
	Fertilizer Plant	1,263	1,263
	Greenhouse	121	121
	Total	6,405	6,405
Total Investment Cost	1,369	7,651	9,021

These investments would not take place all at once. The estimated time-path of investment is shown in Figure 5.3. Initial investment is a result of development of the water supply infrastructure. The later spikes, related to development of industrial building blocks are shown as near instantaneous events for the purpose of modeling but, in reality, would take place at a more deliberate rate.

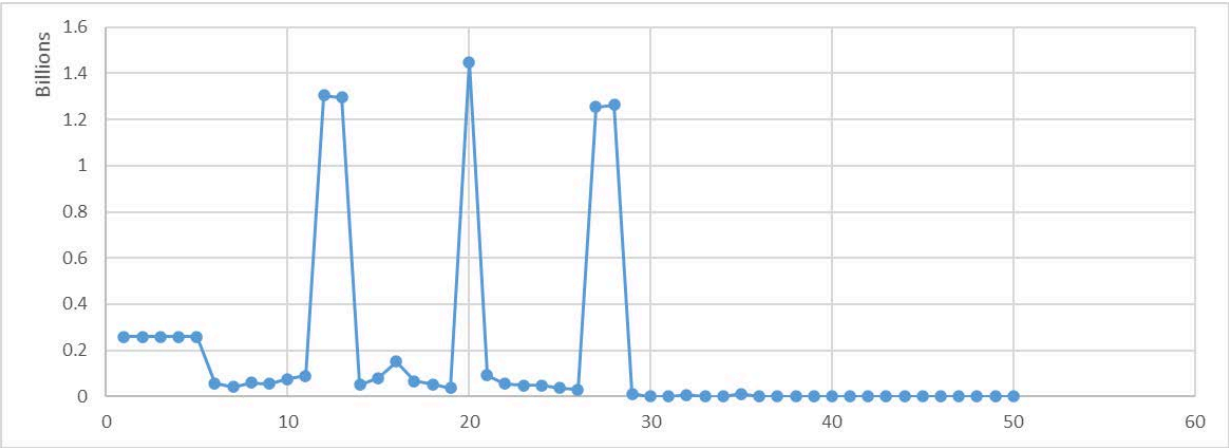


Figure 5.3: Planned Rate of Investment in UQWSP in Nominal Dollars

Operating expenditures (OPEX) will accrue as the project is constructed and dryland is converted to irrigated agriculture. The estimated OPEX for the pumping stations and canals is summarized in Figure 5.4, while Table 5.3 summarizes the real costs of OPEX and CAPEX per irrigated acre.

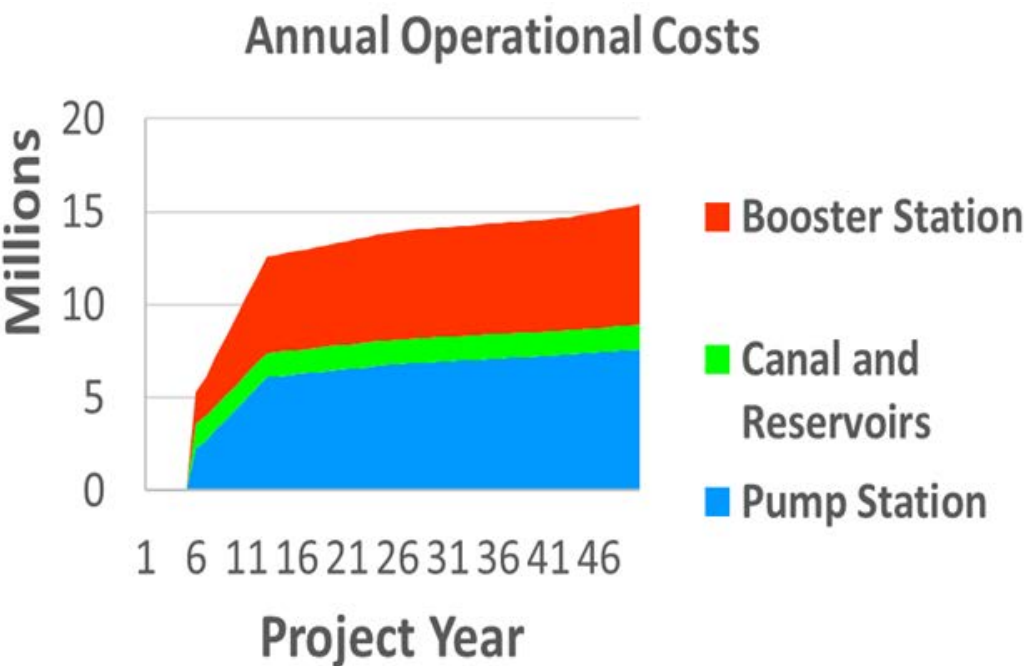


Figure 5.4: Operational Costs Over Project Life

Table 5.3: Project Costs on a Per Acre Basis	
	\$/Acre
CAPEX	7,444
CAPEX (Inclusive of On-Farm Irrigation)	10,622
OPEX (at Project Maturity)	81

Over the life of the project significant contributions would be made to the economic well-being of the Saskatchewan residents. Two measures of this well-being are the level of personal incomes, and the gross domestic product (GDP). The projected distribution of these measures with time are shown in Figures 5.5 and 5.6.

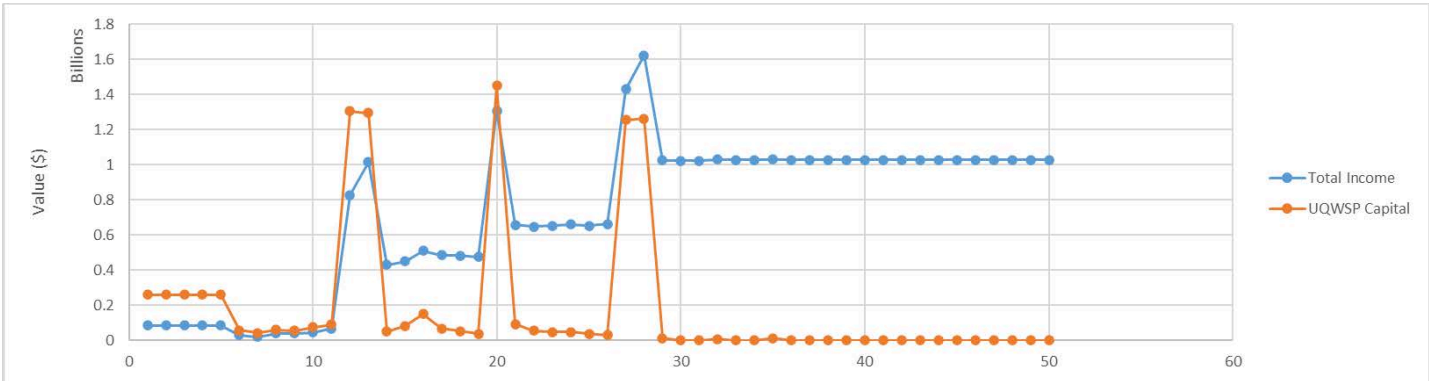


Figure 5.5: Distribution of Personal Incomes Generated Over Time by the UQWSP from the Upper Qu'Appelle Water Supply Project

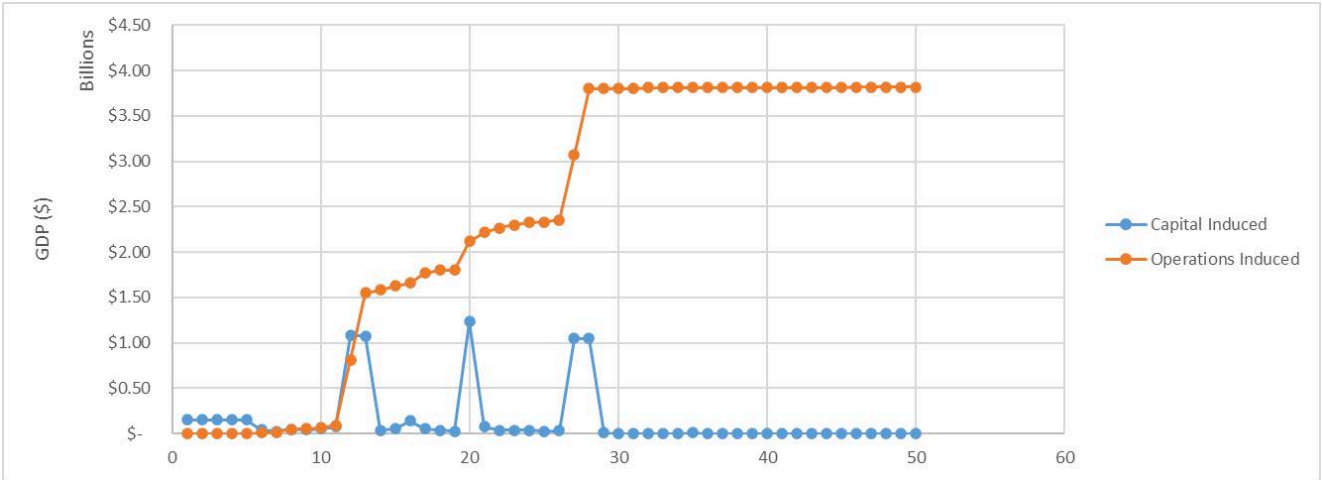


Figure 5.6: Gross Domestic Product Generated Over Time for UQWSP

The UQWSP would create employment during construction of the UQWSP, through ongoing operations and through its resulting indirect and induced effects on other areas of the economy. The majority of jobs would be created through operations of the irrigation infrastructure, irrigated production and other related building blocks. At the maturity period of the project, some 15,000 person-years of employment are created per annum.

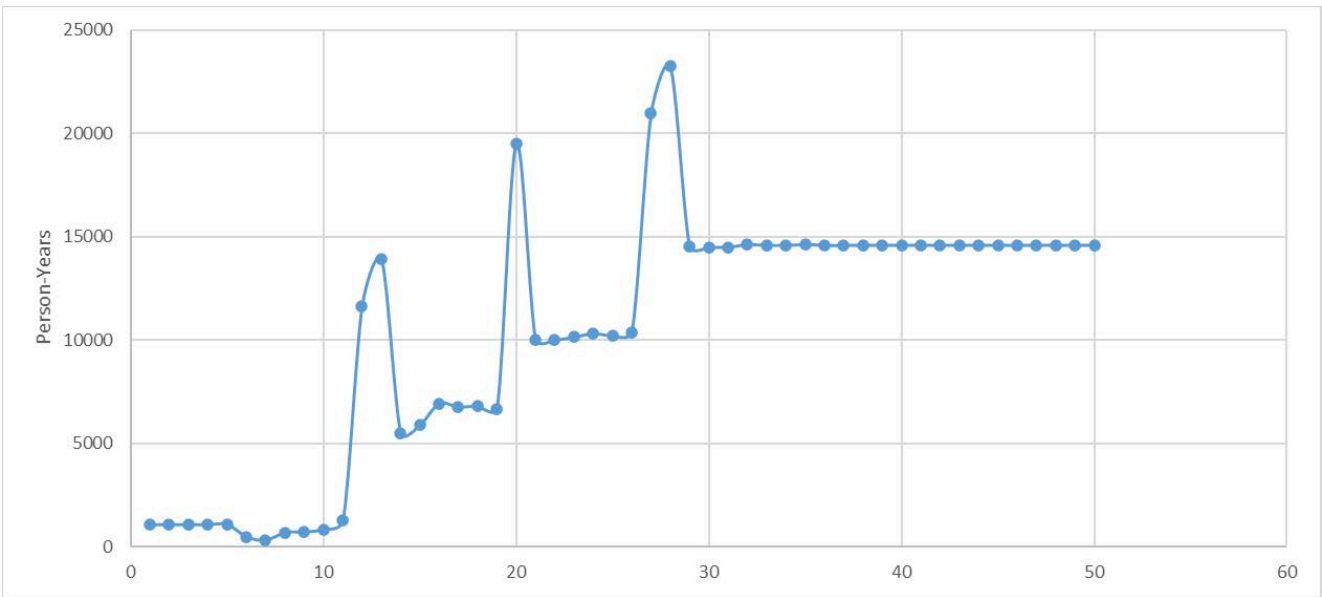


Figure 5.7: Total Employment Generated with Time by the UQWSP

The Saskatchewan economy and people would be better off with the project in place. Project benefits would not be contained within the province, some spill over to other parts of Canada and even to other parts of the world. These leakages are a result of Saskatchewan firms importing goods and services from these regions.

Canada will experience a GDP gain of approximately \$60 billion. The project will create \$47 billion as Saskatchewan GDP and a total GDP of \$12 billion in rest of Canada.

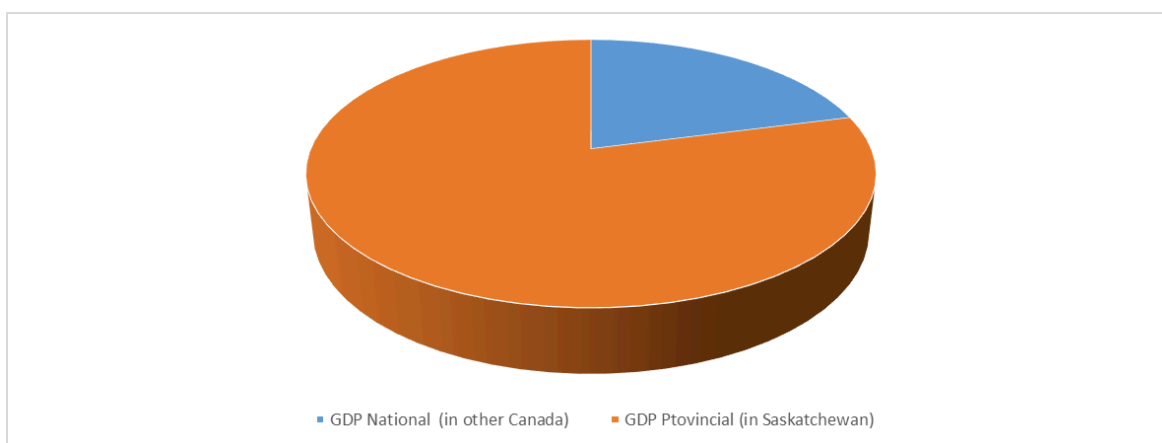


Figure 5.8: Distribution of Lifetime Gross Domestic Product (Discounted at 2.5%) Generated by the Upper Qu'Appelle Water Supply Project

Widespread GDP creation results in fiscal returns to the governments of Saskatchewan and Canada. Namely, \$3.7 and \$14 billion in returns to Federal and Provincial Governments respectively.

5.5.1 Sensitivity

UQWSP sensitivity analysis was undertaken for the rate of irrigation uptake and a depressed industrial development scenario (no potash or fertilizer building blocks).

Decreasing the irrigation uptake rate (from 20 to 30 years) required several adjustments in the analysis, including delay of investment in the downstream irrigated value chain such as livestock expansion and food processing as well as the associated operational costs. As a result of a sufficiently long project life, decreasing uptake rate only diminished nominal GDP by 1.29%.

Significant fluctuation in Potash prices has created wavering backing for the industry; the future of potash in Saskatchewan is uncertain. Hence, a scenario was undertaken without potash and fertilizer building blocks. Resulting in a significant decrease to potential revenues and GDP. Having said that, Benefit to Cost Ratios (BCRs) continue to remain highly positive given that the greatest contributor to economic efficiency are the agricultural building blocks; while potash building blocks are highly lucrative, they also have significant costs.

5.6 WIP Economic Analysis

WIP infrastructural costs are higher, there are fewer industrial building blocks (related to diminished opportunity for potash development) and more agricultural building block opportunity.

The estimated total investment, for the scenario analyzed, is summarized in Table 5.4. The total nominal cost of developing the water supply infrastructure is estimated at \$1.9 billion while on-farm related infrastructural investment would be about \$1.5 billion. On the top of these investments are the agricultural and industrial building blocks which would require an investment of almost \$1 and \$0.1 billion respectively.

Table 5.4: Total Cost of the Westside Irrigation Project and Its Components in Nominal Dollars			
	Capital Cost in Nominal Dollars		
	Public	Private	Total
	Values in Millions of Dollars		
UQWSP Infrastructure	1,905		1,905
On-Farm Irrigation		1,503	1,503
Agriculture Building Blocks		980	980
Industrial Building Blocks		121	121
Total Investment Cost	1,905	2,604	4,509

These investments would not take place all at once. The estimated time path of investment is shown in Figure 5.9.

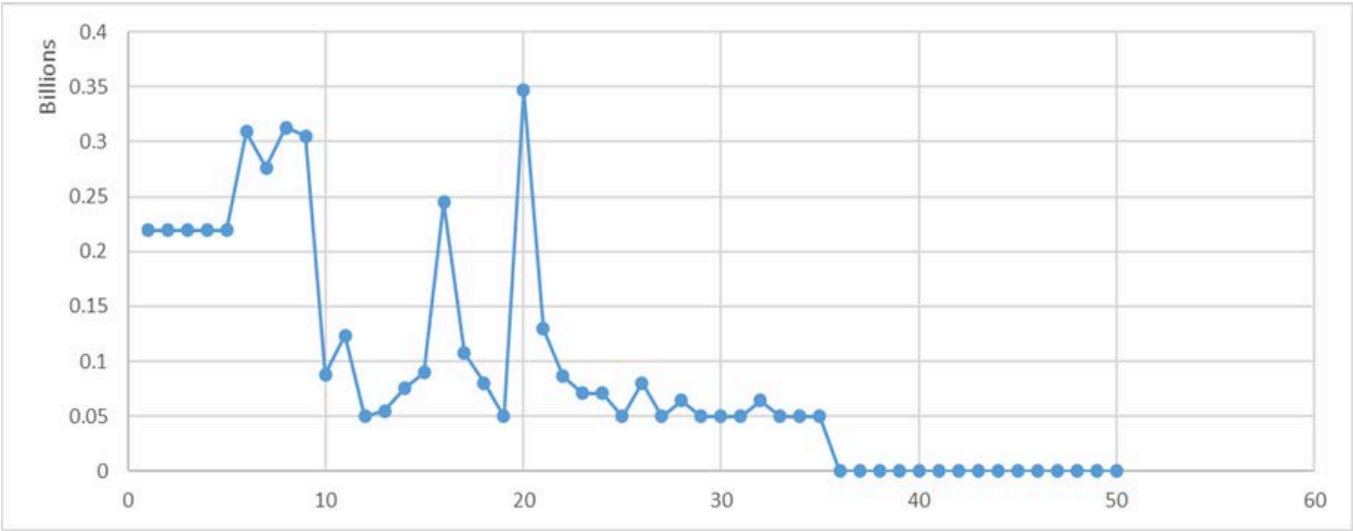


Figure 5.9: Planned Rate of Investment in Westside Irrigation Project in Nominal Dollars

The estimated OPEX for the pumping stations and canals is summarized in Figure 5.10, while Table 5.5 summarizes the real costs of OPEX and CAPEX per irrigated acre.

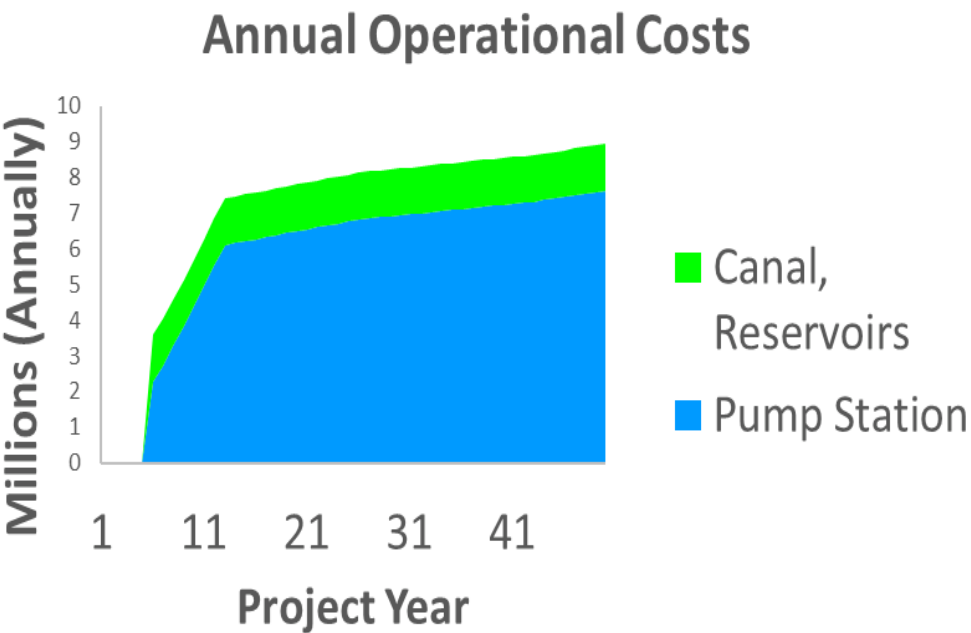


Figure 5.10: Operational Costs Over Project Life

Table 5.5: Project Costs on a Per Acre Basis	
	\$/Acre
CAPEX	5,229
CAPEX (Inclusive of On-Farm Irrigation)	8,073
OPEX (at Project Maturity)	25

The estimated time path of income and GDP is shown in Figure 5.11 and 5.12 respectively.

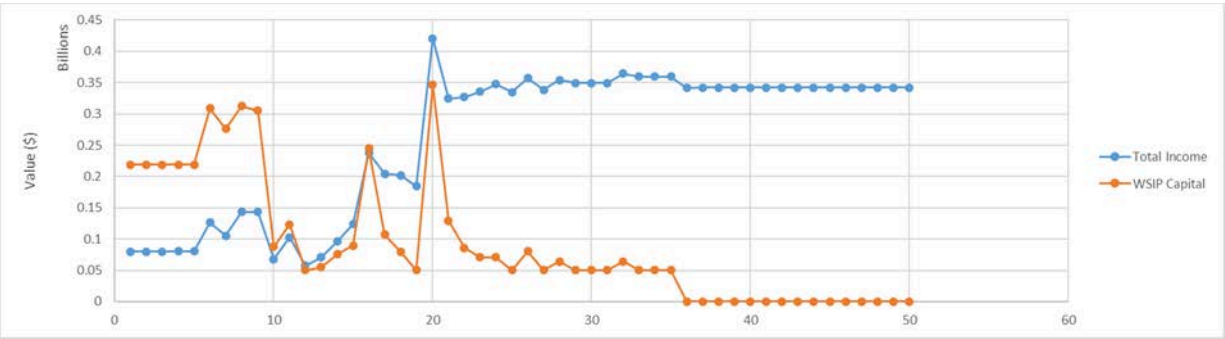


Figure 5.11: Time Path of Direct and Personal Income and Total (Direct, Indirect and Induced) Incomes from the Westside Irrigation Project Option 3

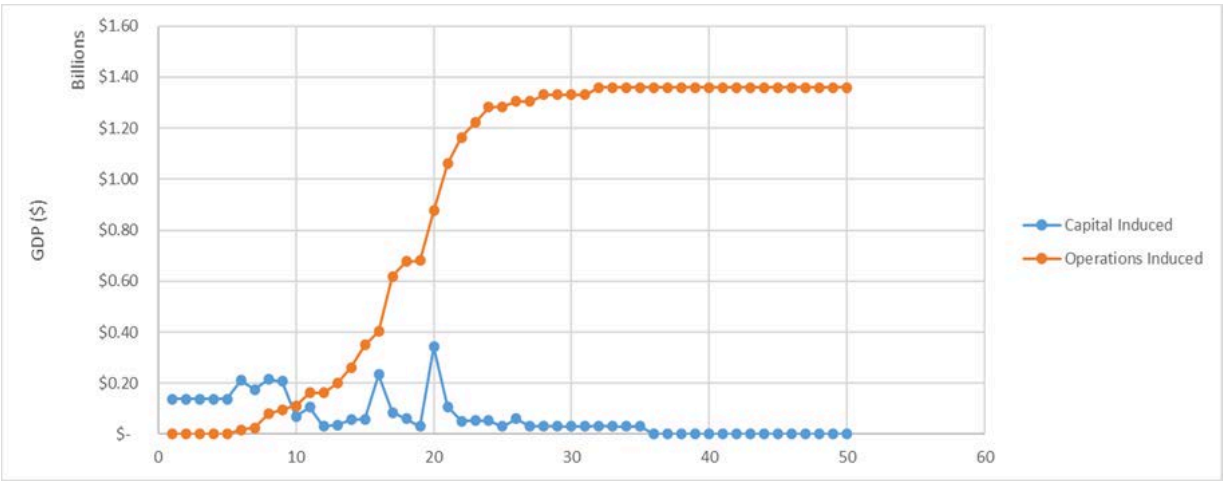


Figure 5.12: Time Path of Gross Domestic Product Generated by the Westside Irrigation Project Option 3 Project, by Phase of Development

Figure 5.13 shows the time path of employment growth associated with the WIP. At the maturity period of the project, some 8,000 person-years of employment are created per annum.

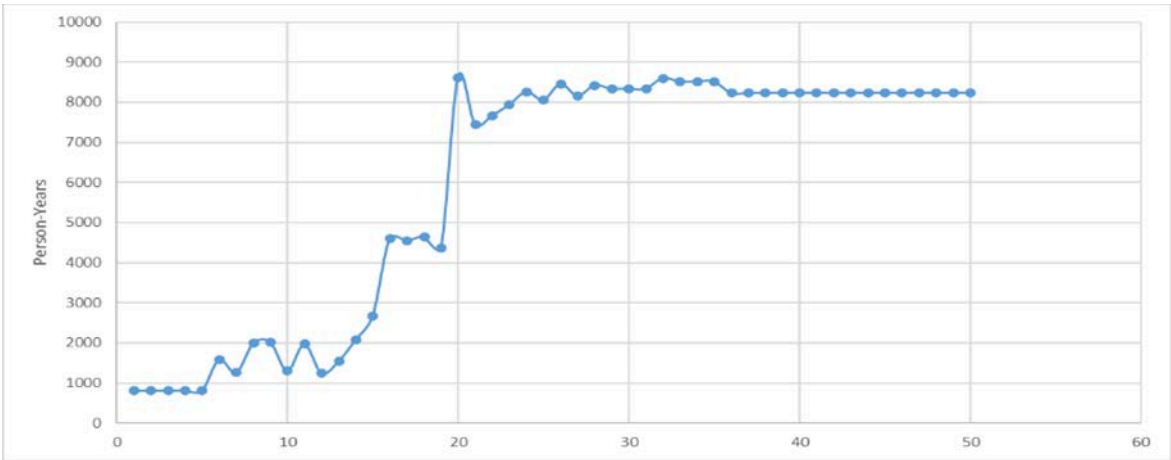


Figure 5.13: Time Path of Total (Direct, Indirect and Induced) Employment Generated by the Westside Irrigation Project Option 3

Canada will experience a GDP gain of approximately \$23 billion. The project will create \$15.5 billion as Saskatchewan GDP and a total GDP of \$7.5 billion in rest of Canada.

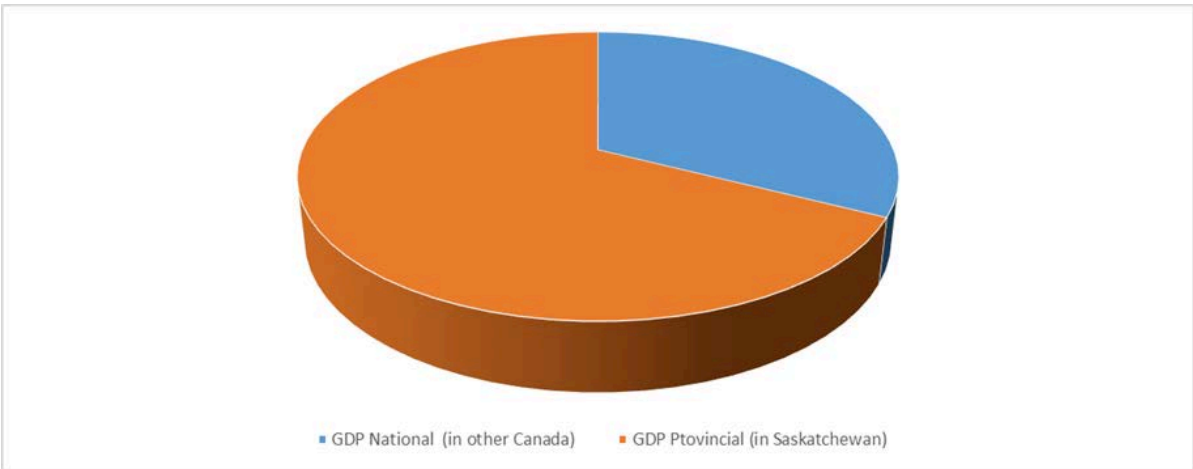


Figure 5.14: Distribution of Lifetime Gross Domestic Product (Discounted at 2.5%) Generated by the Westside Irrigation Project Option 3

Widespread GDP creation results in fiscal returns to the governments of Saskatchewan and Canada. Namely, \$2.2 and \$4.6 billion in returns to Federal and Provincial Governments respectively.

5.7 Integrated Water Project Economic Analysis

The integration of the two projects economic impacts are provided below.

The estimated time path of income and GDP is shown in Figure 5.15 and 5.16 respectively.

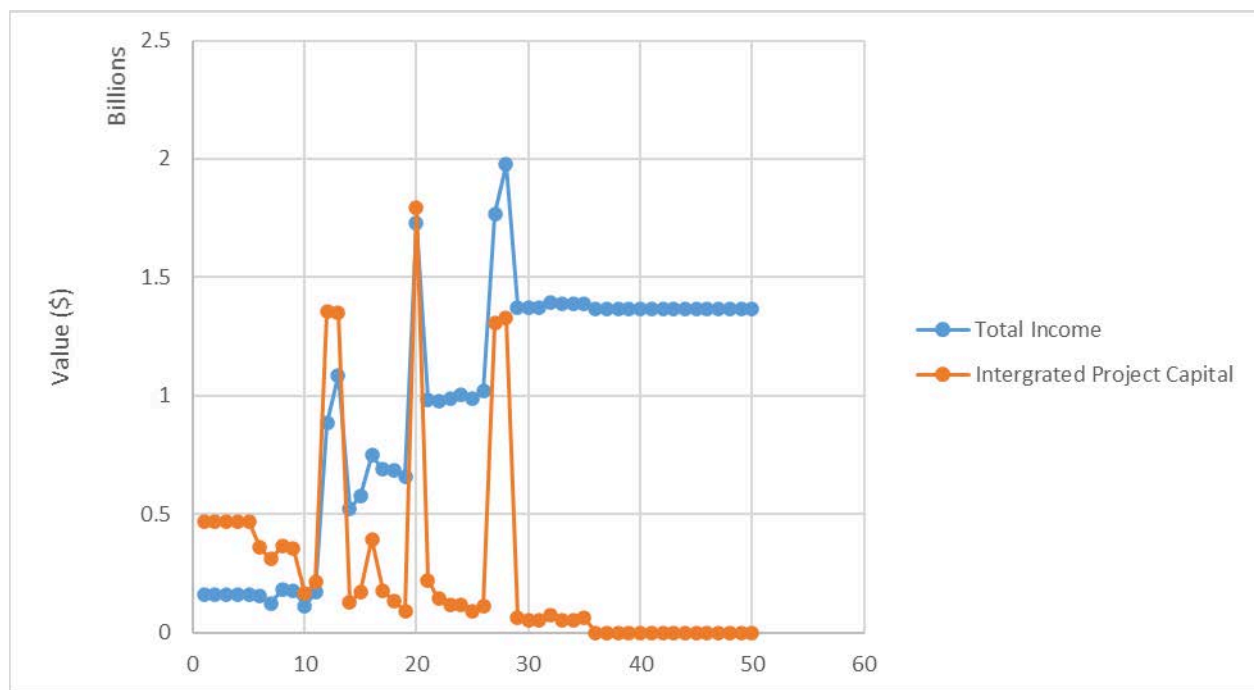


Figure 5.15: Time Path of Direct and Personal Income and Total (Direct, Indirect and Induced) Incomes from the Integrated Water Project

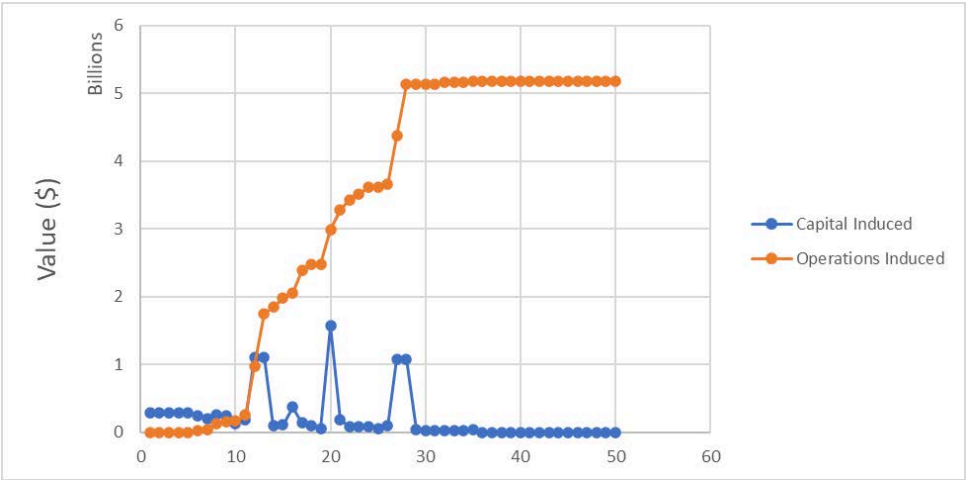


Figure 5.16: Time Path of Gross Domestic Product Generated by the Integrated Water Project, by Phase of Development

Figure 5.17 shows the time path of employment growth associated with the Integrated Water Project. At the maturity period of the project, some 23,000 person-years of employment are created per annum.

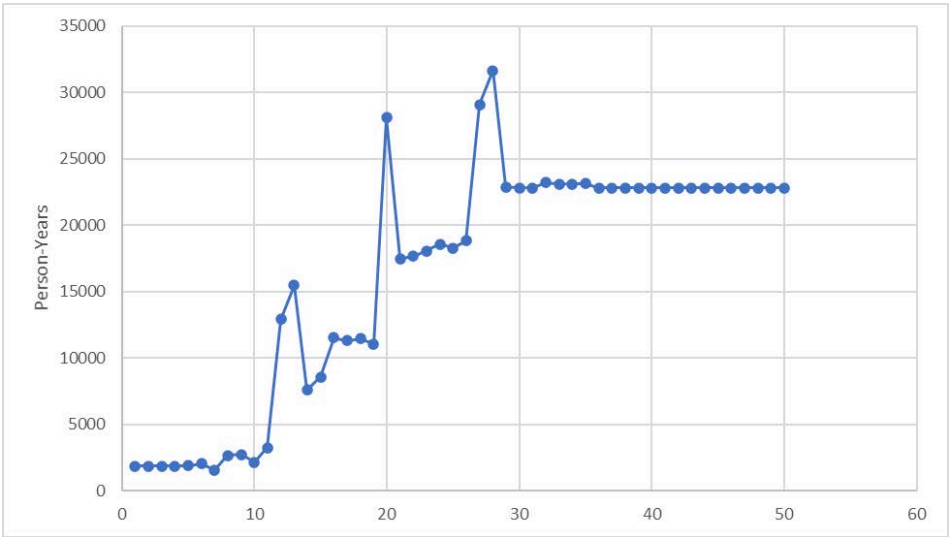


Figure 5.17: Time Path of Total (Direct, Indirect and Induced) Employment Generated by the Integrated Water Project

Canada will experience a GDP gain of approximately \$83 billion. The project will create \$62.5 billion as Saskatchewan GDP and a total GDP of \$19.5 billion in rest of Canada.

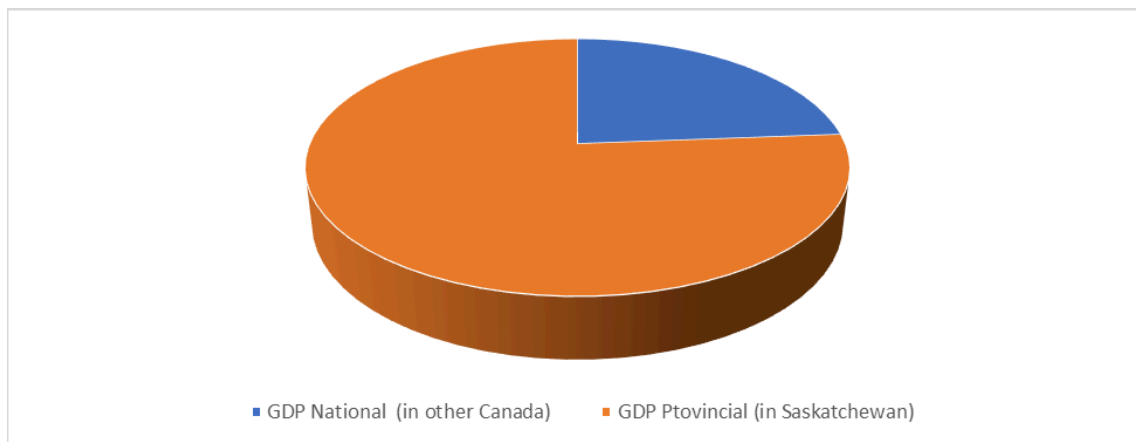


Figure 5.18: Distribution of Lifetime Gross Domestic Product (Discounted at 2.5%) Generated by the Integrated Water Project

Widespread GDP creation results in fiscal returns to the governments of Saskatchewan and Canada. Namely, \$5.9 and \$18.6 billion in returns to Federal and Provincial Governments respectively.

5.8 Summary and Benefit to Cost Ratios

BCR analysis is a policy assessment method that quantifies – in monetary terms – the value of all policy consequences to all members of society. Since any development project uses resources (which impart a cost to the society), society would be better off only if the benefits from the project are higher than the cost. The results are typically presented as a BCR. A BCR of greater than one signifies that the project is economically desirable and if implemented would make society better off. The analysis contained within this report sets the capital costs against benefits from Total Income. It should be noted that assessment of the environmental benefits and costs are unconsidered and have the potential to be significant. A more comprehensive BCR analysis is contained within the technical appendix.

The economic rationale for the projects lies in the projected returns associated with the project. In all cases, including the sensitivity analyses, the returns are positive and strongly support investment in the project.

The main economic impacts and BCRs from investment in the UQWSP and WIP are summarized in Table 5.6. The Combined Water Project impacts are presented as a summation. In reality, the combination would have a symbiotic relation; total output would be greater than individual sums. Through a secure water supply and increased agricultural output, the projects would make Saskatchewan a global agri-food center with significant opportunity for value added opportunity.

Table 5.6: Summary Economic Impacts Estimates Upper Qu'Appelle Water Supply Project Over a Fifty-Year Period

Major Effects	Project		
	UQWSP	WIP	Integrated Water Project
Millions (\$)			
Nominal Project Investment	1369	1,905	3,274
Irrigated Acres	175,000	334,000	509,000
Real CAPEX/Acre (Incl. On-Farm Irrigation Costs)	10,622	8,073	8,686
OPEX/Acre at Maturity	81	25	44
Gross Domestic Product	59,417	22,899	82,316
Federal Fiscal Returns	3,730	2,223	5,953
Provincial Fiscal Returns	14,095	4,647	18,742
Ratio			
Cost Benefit Ratio (Income Based)	2.86	1.94	2.53
Person-Years			
Total Employment	519,225	295,576	814,801

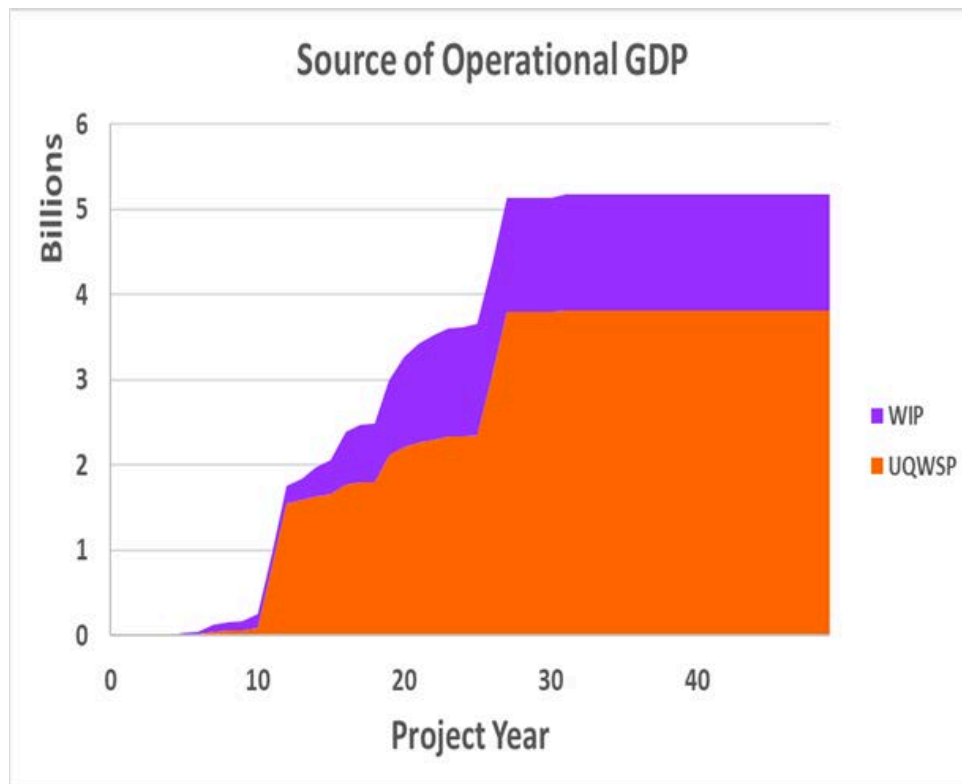


Figure 5.19: Integrated Water Project GDP Allocation

Finally, it is important to note that these findings are based on a conservative and somewhat limited view of the economic outlook for the project area. While individual projects may not proceed, or may be deferred, it is likely that others will take their place and generate similar, though not necessarily identical, levels of return to industries, society and the environment. The common critical element for continued provincial agricultural affluence is the security of the long-term water supply to support a sustainable economy, sustainable communities and a sustainable environment in the 21st Century.

6.0 Albertan Irrigation Impacts as a Proxy

The social and economic outcomes of the Saskatchewan Water Projects will resemble the comprehensive development of water for irrigation in the driest part of Southern Alberta.

The *Economic Value of Irrigation in Alberta* (Paterson Earth and Consulting Ltd., 2015) study provides a comprehensive economic assessment of the Albertan irrigation industry. Alberta has been developing irrigation since the late 1800s, establishing a total of 690,000 hectares which accounts for almost 70% of Canadian irrigated area. Most of the Albertan irrigated acres – 98% – occurs in the South Saskatchewan River Basin (SSRB). The SSRB produces a diverse set of high-value crops that cannot grow under dryland

conditions including potatoes, hybrid canola seed, dry beans, sugar beets, and a variety of fresh vegetable crops. Irrigated croplands produced an average revenue of \$1,147/ha compared to \$260/ha for dryland acres, contributing to the Alberta economy by providing:

- \$3.6 Billion to Alberta's annual provincial GDP;
- \$2.4 billion in labour income; and
- The annual creation of 56,000 FTE jobs.

Irrigation is unquestionably a significant part of the Alberta agricultural landscape, occurring on less than 6% of the cultivated land base in the province, but contributing more than 19% of the gross primary agricultural production.

6.1.1 Extrapolating Alberta Experience to the UQWSP

The climate of much of southern Alberta is classified as arid or semi-arid, similar to the Upper Qu'Appelle and Westside basins. Moisture is erratic and often insufficient, limiting production of modern agricultural crops; however, there is abundant sunshine and heat that will support many profitable crops if water were not a limiting factor. Irrigation producers can grow a great diversity of crops, with more than 40 different types of crops being grown in Southern Alberta.

Irrigators have the water security needed to sustain farm enterprises, even during times of adverse market swings in commodity prices. Because of the significant block of land irrigated in southern Alberta, value-added industries that require a reliable source of agricultural production have developed; however, that market flexibility did not come to the producer without a significant investment in irrigation equipment and other agricultural production systems.

Irrigation (district and private) in Alberta accounts for 96% of total water allocations for the agricultural sector while allocations for stock watering, feedlots and other uses together make up the remaining 4%. As of 2005, registrations and licenses allow withdrawals of up to 4,307,429 dam³; this accounts for 45.3% of total water allocations in Alberta. As a result of continually improving irrigation efficiencies, total water allocations are rarely used by irrigators (Figure 6.1).

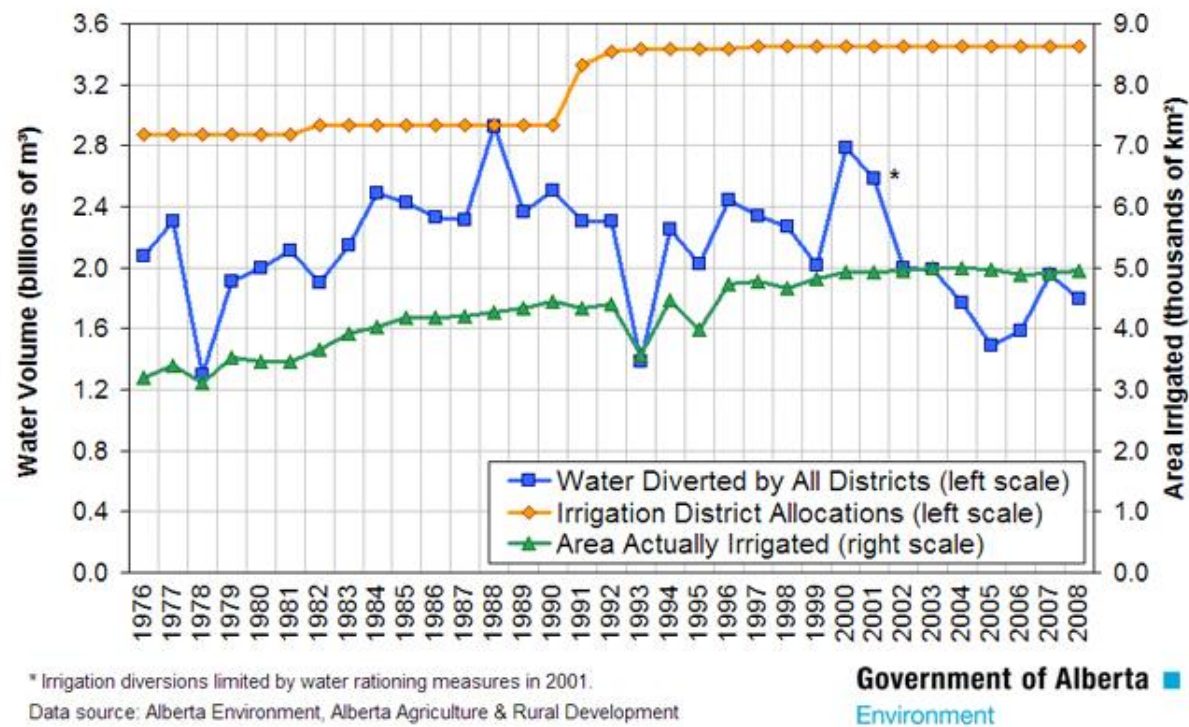


Figure 6.1: Water Diverted for Irrigation Purposes in Alberta (Alberta Water Portal Society, n.d.)

6.1.2 Irrigation Efficiency Improvements in Alberta

Over the past two decades, changes in irrigation systems and water conveyance infrastructure have reduced gross demands by about 108 mm per acre, with an 81 mm per acre reduction in on-farm demands and a 27 mm per acre decrease in conveyance losses.

Table 6.1 below summarizes the recorded changes in several areas that resulted in improvements in water usage from 1999 to 2016 in Southern Alberta Irrigation Districts.

Table 6.1: Comparison of Changes within Alberta Irrigation Districts between 1999 & 2016

Improvement	Component	Percent Change	
		1999	2016
Conveyance (Irrigation District Infrastructure)	Rehabilitated Lined Canal	11.6%	10.6%
	Rehabilitated Earth Canal	15.1%	17.4%
	Un-rehabilitated Canals	50.2%	17.9%
	Pipelines	23.1%	54.1%
On-Farm Systems	Wheel Move	30.0%	8.6%
	Gravity	16.5%	7.7%
	High Pressure Pivot	18.1%	7.8%
	Low Pressure Pivot	34.4%	75.1%
	Other	1.1%	0.8%

In addition to these irrigation-related enhancements, opportunities exist to improve the energy efficiency by incorporating “green” power production, such as solar or wind, into the development plan to reduce energy costs while moving to a sustainable, non-emitting energy source.

Figure 6.2 shows the irrigation diversion rates for the Lethbridge Northern Irrigation District (LNID), a comparable UQWSP district, servicing nearly 200,000 acres with one reservoir approximately at the midpoint of the conveyance system. Figure 6.1.2 shows the maximum, average and minimum diversion rates throughout an irrigation season.

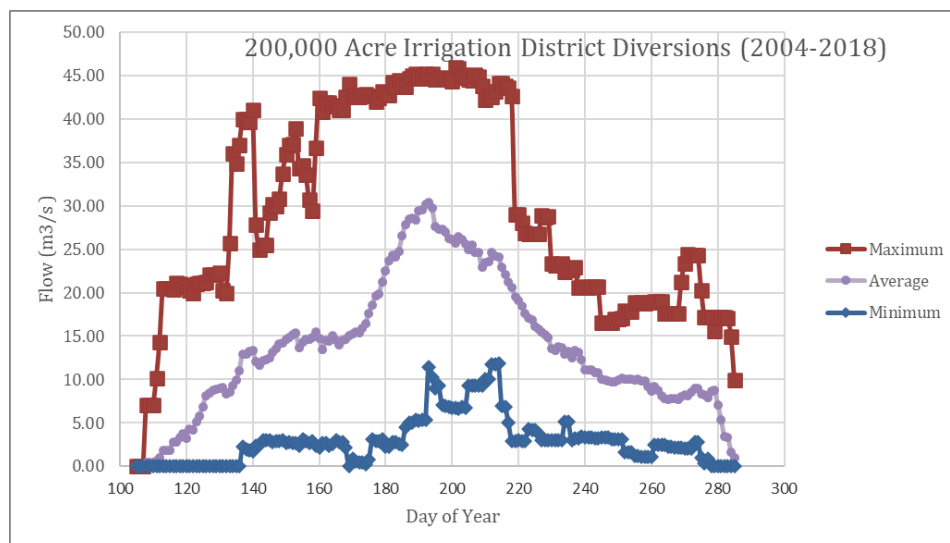


Figure 6.2: Average Irrigation Diversion during the Year for the LNI

These real-world experiences in Southern Alberta can reasonably be expected from investment in the UQWSP. Saskatchewan, with available water, suitable climate and quality soil conditions, could equal or exceed the Alberta experience in productivity increases and wealth creation. A critical irrigated land mass is the first pre-requisite to achieving that goal.

7.0 Social Impacts

7.1 Environmental Impacts

Water Infrastructure is more than just irrigation. An infrastructural response will be required for an increasingly volatile climate with extreme weather events.

The UQWSP, WIP and their associated reservoirs make environmental contributions by providing a secure water supply and protection against drought conditions. As such it will help with the ecologic security of the agricultural sector of Saskatchewan's economy.

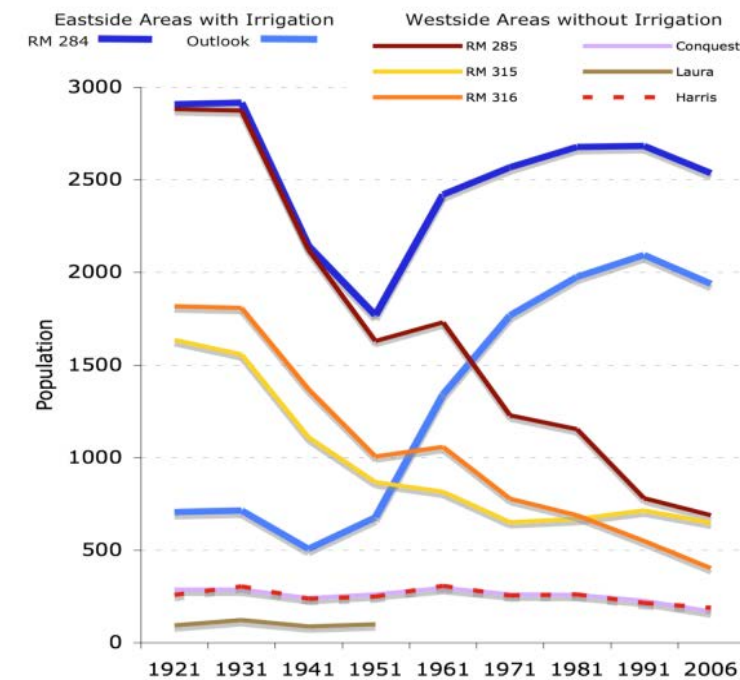
The canal alone is a linear piece of infrastructure with limited capacity to offer flood protection beyond the project footprint. However, the project should also be viewed in the context of the overall planning in the Upper Qu'Appelle watershed; additional flood control capability may be incorporated if the projects are considered on a basin-wide basis.

Flood protection will depend on a comprehensive basin study, a fundamental component for implementation of an integrated water strategy. The results of such a study could promote informed

planning and design of drainage, flood control and irrigation through considering the interconnections within the watershed.

7.2 Rural Socio-economic Impacts

Historically, irrigation projects have enhanced rural resilience and sustainability in Saskatchewan. The historic impact of irrigation on rural communities is convincingly demonstrated by comparing the change in population of irrigated (e.g. east side of the River) vs non-irrigated (e.g. west side of the River) municipalities following development of Lake Diefenbaker in the late 1950's (Figure 7.1). The westside communities began an uninterrupted decline in population beginning in the 1930's, while a similar decline on the east side was reversed with development of Lake Diefenbaker and investment in irrigation. It can reasonably be predicted that the Water Projects will play a similar role in rural revitalization once irrigated agriculture is developed in currently non-irrigated municipalities.



Source: Statistics Canada

Figure 7.1: Population Trends in Non-irrigated vs Irrigated Rural Municipalities in the Vicinity of Diefenbaker Lake

8.0 Project Development Roadmap

Fundamental for project delivery will be financing. Approaches to financing could depend on water pricing. Historically, Canada has not priced water as a commodity, however the costs for administrative, treatment, delivery, and operations are borne by the user. Existing price structures are usually insufficient to meet full system costs of building, replacing and maintaining the required water infrastructure. Ultimately, this has resulted in movement towards more innovative water pricing that applies science-based water resource management, aiming to limit demand and stimulate conservation.

A review of Net Willingness to Pay (Appendix) indicates that revenue generation from the irrigated producers will be finite and limit their ability to bear full infrastructure costs, an alternative may be public funding to amortize development costs over a specified term.

If the new water pricing establishes a net revenue the project could be financed and operate as a public or private entity. Resulting in many potential financing options, any of which can be used independently or in combination with other options.

One option could be a Public Private Partnership (P3) model, where project risk is shared amongst the public and private entities involved with the aim to improve efficiency, long-term maintainability, and timing of projects. There are several P3 structures depending on private sector involvement, but all require creation of a sustainable revenue stream to support the required return on investment.

The Design-Bid-Build system has been the traditional model for delivery of irrigation upgrading in Alberta. Under this system, the Owner has responsibility for engineering design and preparation of contracts and tender packages that are subsequently tendered for bids by qualified contractors. It is the contractor's responsibility to construct the project as tendered but the Owner accepts responsibility for cost increases due to regulatory delay, land availability, changed or unforeseen conditions. These risk factors can be substantially mitigated by thorough pre-engineering; rigorous permitting and licensing processes; land purchase well in advance of need; and, tailoring procurement methods plus terms and conditions of contracts to address special conditions that may prevail for any portion of the project.

The Alberta experiences in constructing and upgrading their extensive irrigation system can inform a potential delivery model for the Saskatchewan Water Projects. The essential elements of that model include:

- A knowledgeable Owner vested with the authority to deliver the project;
- A private-sector project manager that has responsibility to:
 - Conduct sufficient pre-engineering to confirm typical project details, project feasibility and budgets;
 - Oversee the baseline studies, environmental assessments, permitting and licensing necessary to obtain approval to construct;

- Oversee acquisition of land to ensure all required rights of way are in hand prior to start of construction;
- Establish system-wide standards for all elements of any project;
- Subdivide any project into work packages that could be designed and constructed by local forces;
- Coordination among designers, contractors and stakeholders to maintain harmonious relations;
- Oversight of tendering and procurement and providing recommendations to the Owner;
- Cost and schedule control; and,
- As-constructed documentation and operating manuals for the constructed works.
- Private-sector consultants (one per work package), responsible for:
 - Investigations, designs and tender package preparation for individual work packages;
 - Assistance during tendering and award of contracts;
 - Engineering services during construction; and,
 - As-constructed documentation for that work package.
- Contractors, responsible for:
 - Constructing the works in accordance with the drawings, specifications, schedules and prices agreed to.

The advantages of this model are that it allows investment to proceed in an orderly fashion to meet demand and respect availability of financing. It also supports maximum use of local resources and leaves a residual of experienced engineers, contractors and operators in the communities, maximizing local benefits while making those capabilities available for future maintenance or system upgrades. A potential disadvantage is that some residual risk does accrue to the owner, but this can be mitigated through a rigorous approach to ensure, to the extent possible, comprehensive preliminary investigations, design engineering and tender package preparation.

8.1 Implementation plan

Many Factors will impact the implementation of the project. These include, among others:

- Available cash flow.
- Available resources (engineering and construction).
- Regulatory approvals timeline.
- Land acquisition.

From the economics feasibility perspective, the shorter the time frame for the implementation of the project, the sooner the benefits are gained. Ideally, the engineering and construction of the various components can be done concurrently.

8.1.1 Overview

A summary of the Implementation plans are shown in Figures 8.1 and 8.2; the detailed implementation plans are attached as Appendix.

The implementation plan assumes the following:

- The Prime Consultant will select an environmental consultant(s) to conduct the necessary work to gain environmental assessment approvals from the authorities having jurisdiction. This work would include public engagement and First Nations Consultation on a priority basis. It would also entail supporting the Prime Consultant in preparing applications for Approval to Construct the works.
- Upon conformation of the location of facilities and land requirements for construction, land agents would be engaged to obtain land and crossing agreements, supported by the appropriate consultant, survey and legal services.
- Construction of the UQWSP could be completed with eight (8) fiscal years and the WIP in nine (9) years, with several packages being designed and/or constructed at one time.
- Construction of the combined Water Projects could be achieved in about 15 years, depending on the length of time required to obtain the required regulatory approvals, among other factors.

It must be emphasized that these implementation plans are aggressive; they assume that the projects will be adequately financed to enable delivery of the entire projects. It will require that the environmental and related regulatory approval process start as early as possible, ideally as soon as the pre-engineering phase is approved. It is also assumed that the regulatory approvals can be obtained to allow construction to commence not later than the fall of year 2.

8.1.2 Summary of Key Activities

The key activities for both the UQWSP and WIP include the following tasks that would be executed under direction of the Prime Consultant:

- Phase 1: Prime Consultant will work collaboratively with sub-consultants, partners, stakeholders and indigenous rights holders to finalize the basis of design and location of key elements of the Conveyance Systems and obtain required environmental approvals;
- Phase 2: Retain consultants to design and prepare tender packages for the main Conveyance and associated works;
- Phase 3: Design of irrigation pumps and distribution systems; and
- Phase 4: Engineering services during construction, inspections and post-construction documentation.

A detailed implementation plan has not been prepared for the combined Water Projects but the sequencing and duration of activities will be similar to those shown in Figures 8.1 and 8.2.

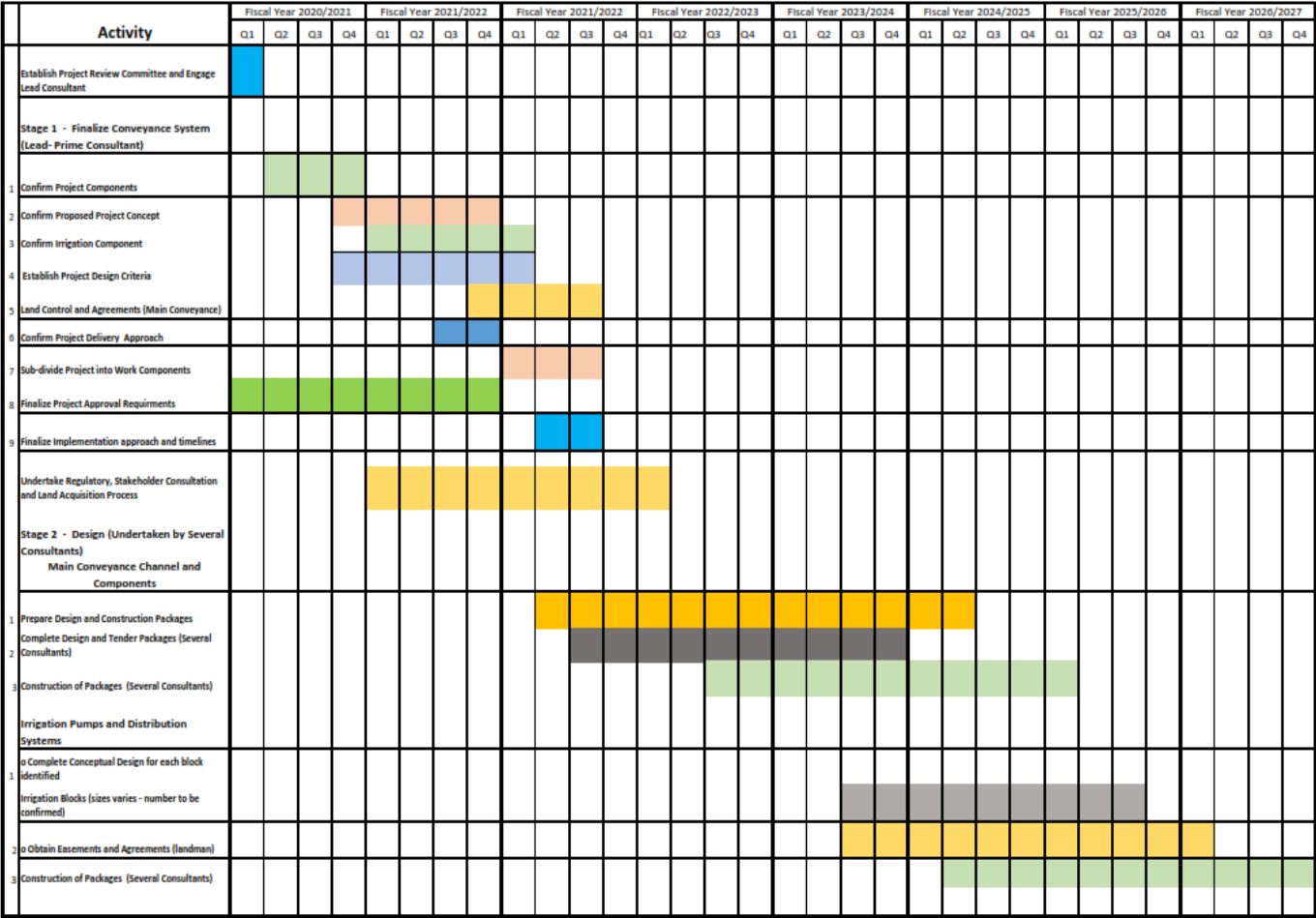


Figure 8.1: UQWSP Implementation Plan Overview

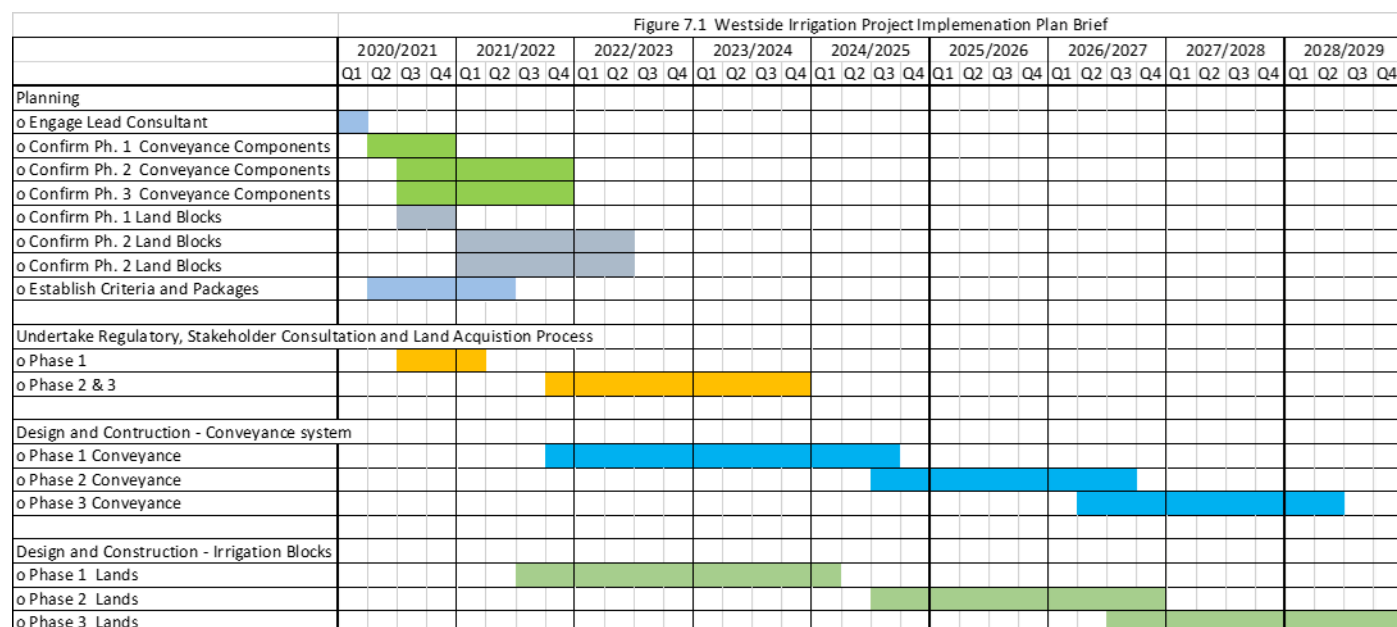


Figure 8.2: WIP Implementation Plan Overview

8.2 Synergies From An Integrated Water Project

Development of both the UQWSP and the WIP simultaneously as **an Integrated Water Project presents opportunities to optimize both the costs and benefits of these investments**. Some of the opportunities that will accrue include:

- **Economies of scale in that:**
 - Executive, administrative and engineering functions can be more efficiently applied to a larger capital base;
 - Continuity of workflow will promote economies through innovation, productivity and skills improvements;
 - Critical design and construction capabilities will be maintained through sustained workflow in this specialized sector; and,
 - Adjusting project design and construction schedules to optimize the project investment strategy.
- **Coordination of critical environmental approvals by:**
 - Ensuring a common approach in engagement and consultation activities;
 - Consistency in environmental submissions including Project Descriptions and documentation of public engagement and Consultations;
 - Developing a trust relationship with project teams for both the owner and the regulatory agencies; and,
 - Expediting environmental approvals on a “phased” basis to achieve the earliest possible start of construction.
- **Flexibility in scheduling and project development;**

- Adjusting the rate of construction to respond to demand and rate of irrigation uptake;
 - o Avoid over-building in one area if demand is slower; and,
 - o Scaling development to match available industry capacity to optimize costs while maintaining health of that construction sector.
- **Identifying Project segments that could be “bundled”** to appeal to alternative delivery methods, e.g. design-build.

The integrated, larger, base investment presented by two major irrigation parcels would allow greater flexibility in project delivery, facilitating the ability to optimize irrigation construction progress, user demand and construction market conditions, thereby avoiding over-heating the market and inflating construction costs. Considering the size of the overall irrigation play, this could be a significant moderating influence on the construction industry.

In terms of environmental considerations, a comprehensive watershed and regional approach is recommended. Broadly-based water planning will enable a comprehensive overview of water security goals; further, stakeholder engagement at the planning stage will facilitate stakeholder collaboration as the projects are implemented, mitigating any potential public concerns that might arise.

9.0 Summary and Conclusions

In 1967 the South Saskatchewan River Project (SSRP) became a reality with the opening of the Gardiner and Qu'Appelle dams to create Lake Diefenbaker and the foundational water infrastructure for south central Saskatchewan with the primary objective of irrigation.



Figure 9.1: Gardiner Dam

While the Governments of Canada and Saskatchewan cooperated on the SSRP, major elements of the original project were unfinished. Including water distribution infrastructure on the east and west sides of the Lake; the Upper Qu'Appelle Water Security Project and the Westside Irrigation Project. Together, these projects (Integrated Water Project) would develop the infrastructure to provide water security to a large area in South and Central Saskatchewan.

9.1 Unfinished Projects

Over the past forty years there have been many engineering studies and assessments completed regarding irrigation, improved water management and enhanced water security for the increasingly volatile Prairie Climate.

9.1.1 UQWSP

This review of recent engineering evaluations, water supply studies and socio-economic update has confirmed:

- **The water conveyance** from Lake Diefenbaker across the uplands to Buffalo Pound has an estimated current cost of \$1.37 Billion over an eight-year construction period.
- **The Conveyance can supply peak irrigation water demands for up to 200,000 acres** of irrigation as well as other social, economic and environmental water demands throughout southeastern Saskatchewan.
 - Hydrological estimates suggest these water volumes are readily available from Lake Diefenbaker in both wet and dry years.
- **Updated socio-economic impacts of the Conveyance** in Saskatchewan and Canada over the 50-year period, including:
 - Creation of \$60 Billion in Gross Domestic Product;
 - Private investment of \$4.85 Billion, significantly larger the infrastructural investment;
 - Increased labour incomes of \$17.4 Billion; and.
 - Nearly 15,000 person years of sustained employment.
 - It should be noted that these benefits are shared between Canada and Saskatchewan who together also receive \$18B in fiscal revenues, well over any initial public investment in the project.
- Beneficiaries and participants in the project are more than dry statistics. Members of the First Nations living in the Qu'Appelle valley could benefit as well as small and large rural communities in the southeast.

Sensitivity assessments of the project were completed on three key variables:

- Discount rates of 1% and 5%, both of which proved positive for BCR, with ratios of 2.68:1 and 3.26:1.
- Variations in the uptake rate of irrigation, where faster uptake increases returns.
- A depressed potash development scenario.
- All of the sensitivity scenarios resulted in positive benefit-cost ratios and strongly positive GDP contributions.

9.2 WIP

This review of recent engineering evaluations and socio-economic update has confirmed:

- **A water conveyance project West of Lake Diefenbaker with** an estimated current cost of \$1.9 billion over a nine-year construction period.
- The Conveyance can supply peak irrigation water demands for up to 340,000 acres of irrigation as well as other social, economic and environmental water demands.
 - Hydrological estimates suggest these water volumes are readily available from Lake Diefenbaker in both wet and dry years.
- **Updated socio-economic impacts of the Conveyance** in Saskatchewan and Canada over the 50 year period, including:
 - Gross Domestic Product of \$23 Billion;
 - Additional private investment of \$1.7 Billion;
 - Increased labour incomes of \$6.5 Billion; and
 - Over 8,000 person years of sustained employment.
 - These benefits are shared between Canada and Saskatchewan who together also receive \$7 Billion in fiscal revenues, well over any initial public investment in the project.

9.2.1 Integrated Water Project

These results suggest that individually, the UQWSP or WIP are viable projects with the potential to create a sustainable new socio-economic platform within Saskatchewan.

Having said that, there are synergistic benefits that would arise through an Integrated Water Project and through making Saskatchewan an Agri-Food keystone in the emerging global food market. Especially in coordination with the Protein Supercluster and the Canadian Food Manufacturing industry.

9.3 Moving Forward

Realizing the Integrated Project benefits will depend on completing engineering, establishing a governance structure and cooperation from federal and provincial governments for legal and regulatory project approvals and permits. Specifically, long term success will depend on:

- **A Strategic Water Management Plan**
 - A regional strategic water management plan for the Saskatchewan watersheds, establishing the long-term goals and the basis of design for the water infrastructure.
- **Preliminary Engineering, Approvals and Permits**

Under the direction of a prime consultant:

 - Complete sufficient preliminary engineering for the Project, establishing the detailed budget, schedule and implementation plan;
 - Conduct necessary environmental assessments, engagement and Consultations to support environmental approvals and permits to construct; and,
 - Identify land requirements and expedite acquisition and access as required.
- **Governance and Financing Structures**

- Federal, provincial and private interests will require accommodation within a single governance structure to move seamlessly from approval, to financing, to construction and operation.
- **Federal, Provincial, Municipal Legal and Regulatory Structures**
 - There are a large number of water, agricultural, land use and environmental approvals and permits prior to construction. These include environmental assessments, provincial irrigation act requirements, water licensing, municipal approvals and a number of construction approvals. In many cases these activities require a high level of public consultation and communication.

All of these and other related issues were resolved expeditiously for the SSRP under the cooperative administrative framework of the Prairie Farm Rehabilitation Agency. Today, it will be important to continue a high level of federal, provincial and local cooperation to advance the project.

9.4 A Good Time to Proceed

The current socio-economic environment in Canada, Saskatchewan and the World supports early implementation of the Integrated Water Projects. Recovery from the Covid19 Pandemic will require large and continuing increases in investment to stimulate Canada's regional and national economies. Growing global demands for foods and related agricultural technologies and products can restore Canada's global food leadership, lost in recent years.

Adapting to the new realities of global warming will increase in cost over time. The Integrated Water Project will provide for improved water management over a larger section of the Basin providing improved water security through both wet and dry years.



Figure 9.2: Prairie Conveyance

Too often, in Saskatchewan and Canada, opportunities for positive change are lost. Currently conditions are aligned to complete a project; following over four decades of evaluation; the original concept has been confirmed.

Completing the Integrated Water Project will go a long way to realizing the original vision for the SSRP.



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