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Stantec

Abbreviations

AAD	average annual damage
LAA	local assessment area
NPV	net present value
PV	present value

17.0 ASSESSMENT OF POTENTIAL EFFECTS ON EMPLOYMENT AND ECONOMY

The scope of the assessment and existing conditions for employment and economy are presented in Volume 3A, Sections 17.1 and 17.2. Section 17 of this volume assesses the effects of the Project on employment and economy during flood and post-flood operations.

17.1 PROJECT INTERACTIONS WITH EMPLOYMENT AND ECONOMY

Table 17-1 identifies the project components and physical activities that might interact with employment and economy during flood and post-flood operations. These interactions are discussed in detail in Section 17.3 in the context of project pathways, standard and project-specific mitigation and residual effects. A justification for no interaction is provided following the table.

Table 17-1 Project-Environment Interactions with Employment and Economy during Flood and Post-Flood Operations

Project Components and Physical Activities	Environmental Effects			
	Change in Provincial Economy	Change in Regional Labour Force	Change in Regional Economy	Financial Cost of Floods
Flood and Post-Flood Operations				
Reservoir filling	–	–	–	–
Reservoir draining	–	–	–	–
Reservoir sediment partial cleanup	–	–	–	–
Channel maintenance	–	–	–	–
Road and bridge maintenance	–	–	–	–
Road construction	–	–	–	–
Flood damage cleanup and restoration		–	–	✓
NOTES: ✓ = Potential interaction – = No interaction				

During a flood, the Project would be operated to prevent or minimize flooding downstream. During reservoir filling, additional personnel may be required to operate the reservoir, but because of the short duration of this flood, the economic effect would be minimal. Similarly, a limited number of personnel would be involved in the controlled release of flood waters from the reservoir during draining.

The assessment of the financial cost of floods considers flood damage at different return periods and compares the financial costs if the Project were not built.

17.2 EXISTING CONDITIONS FOR EMPLOYMENT AND ECONOMY

17.2.1 Change in Regional and Provincial Economy and Change in Employment

Existing economic conditions within the local assessment area (LAA) are presented in Volume 3A, Section 17, including information on population, labour force, labour income, education attainment, local and regional businesses, the provincial economy, and Alberta Transportation infrastructure and service planning and investment.

17.2.2 Cost of Floods

17.2.2.1 2013 Flood

The June 19, 2013 flooding of the Bow and Elbow Rivers, resulting in inundation of Banff, Canmore, Calgary, Bragg Creek and other communities. Flooding submerged over half of the community of High River. In Calgary, the flood damaged 14,500 homes; flooded 3,000 other buildings and 4,000 businesses; washed away 1,000 km of roads, as well as rail lines, transit systems, pedestrian bridges, and culverts; and inundated dozens of Calgary city parks.

The 2013 flood was of similar magnitude to a 1:200 year flood and resulted in extensive flood damages. This included approximately $2 billion in insured losses to private property, uninsured costs to private property, disaster relief and management costs, as well as costs to repair and restore damaged public infrastructure.

17.2.2.2 1:50, 1:00 Year, and 1:200 Year Floods of the Elbow River and Bow River, without the Project

The Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary and Environs on the Elbow River with Emphasis on MC1 alternative and the Project (IBI Group 2017) compares the costs and benefits of the Project and MC1 alternative flood mitigation projects (see Volume 4, Supporting Documentation). This includes an estimate of flood damages without mitigation, at various return periods, estimated reduction in AAD due to the flood mitigation projects, and a benefit-cost comparison of the MC1 alternative and the Project.

Flood damage estimates provided in IBI 2017 reflect updated hydrology and hydraulic modeling, which simulated higher average water levels of both the Bow and Elbow Rivers as compared to previous modelling. This resulted in a larger areal extent of inundation, particularly for lower frequency floods (IBI 2017). IBI 2017 also considers revised groundwater damage estimates, and revised estimates for indirect and intangible damages. Due to these adjustments, the magnitude of potential flood damage estimated in IBI 2017, as reflected in the annual average damages (AAD), has been estimated at double that provided in the previous estimates, provided in IBI and Golder (2015).

Flood damages are broadly categorized into tangible and intangible costs. Tangible costs can be estimated in dollars, while intangible costs include potential social costs, such as the inconvenience, stress, and anxiety caused during and after floods.

Tangible costs are classified intro direct and indirect costs. The direct costs include the costs to repair damage to buildings and other structures, as well as the costs to repair or replace damaged contents and external items (e.g., vehicles) of affected properties. Indirect costs include residential displacement, business disruption, traffic delays, habitat restoration, emergency response, and waste disposal (IBI Group 2017).

IBI 2017 estimates direct and indirect costs for three categories of damage: residential, commercial, and infrastructure. Damages estimated do not consider existing mitigation measures; therefore, the estimates overpredict damages that could occur (IBI 2017). Direct costs are based on the quantity and type of properties and structures that could be affected by flooding at various return periods. Indirect costs are based on a percentage of direct costs. Depending on the property affected, indirect costs can be less than or greater than direct costs. For example, flooding of private residences would result in mostly direct costs, resulting from damage to and/or loss of contents and external items. By comparison, a damage to a commercial business may result in a higher proportion of indirect costs due, for example, due to loss of revenue during and the period following the flood. An example provided in IBO and Golder (2015) involves the estimated flood damage to the Calgary Stampede, should this result in a total closure of the 10-day event (IBI and Golder 2015).

Intangible damages are those that represent a loss of quality of life, such as illness, worry, loss of services, community relations, or less of enjoyment of community assets (IBI 2017). Such damages were estimated by IBI using an approach based on households' wiliness-to-pay to avoid flooding effects.

Predicted Flood Damages without Existing Mitigation

Table 17-2 summarizes modelled direct and indirect costs of 1:50 year, 1:100 year, and design flood (1:200 year flood) of the Elbow and Bow rivers that do not consider the reduction in flood damage that would be associated with protection works. In the 1:50 year flood, total damages are estimated at approximately $2 billion, of which $1.3 billion (66%) would be direct costs, and 25% would be indirect costs, and 8% induced costs. Damage and disruption to residential properties would account for the highest proportion of costs, at 46% of total, followed by damage and loss of commercial properties (29%), and community infrastructure and services (25%). A 1:100 year flood of the Bow and Elbow rivers would be an estimated 1.64 times as damaging as the 1:50 year flood, resulting in an estimated $3.3 billion in damages. Compared to a 1:50 year flood, a higher proportion of flood damages would occur to commercial properties. (Table 17-2). A 1:200 year flood would cause an estimated $5.3 billion in damages. In the design flood (1:200 year flood), damage to commercial properties would be the largest property class affected, accounting for an estimated 43% of flood damage, followed by residential (39%), and community infrastructure and services (18%).

Table 17-2 Flood Damage Cost from Elbow and Bow Rivers by Return Period, Unmitigated

Cost Type	Cost Category	Return Period (Years), Cost ($ millions)		
		1:50 Year Flood	1:100 Year Flood	Design Flood
Direct	Residential	$705	$1,109	$1,615
	Commercial	$218	$399	$733
	Infrastructure	$392	$549	$706
	Subtotal	$1,315	$2,057	$3,054
Indirect	Residential	$41	$68	$114
	Commercial	$361	$740	$1,535
	Traffic Disruption	$14	$53	$71
	Habitat Restoration	$8	$11	$14
	Emergency Response	$67	$94	$120
	Waste Disposal	$14	$23	$37
	Subtotal	$506	$989	$1,891
Intangible		$164	$211	$310
Total		$1,985	$3,257	$5,255
SOURCE: IBI 2017				

Figure 17-1 illustrates the proportion of flood damage to buildings (including direct, indirect, and intangible damage to residential and non-residential buildings, but excluding infrastructure, traffic, habitat, or emergency response) that would be attributed to flooding from the Bow and Elbow rivers, based on the 1:50 year, 1:100 year, and design floods. Flooding of the Bow River would result in the majority of total flood damage, ranging from 69% for a 1:50 year flood to 61% for a 1:200 year flood. Flooding of the Bow results in substantially higher non-residential damages, particularly during the higher frequency floods (IBI 2017).

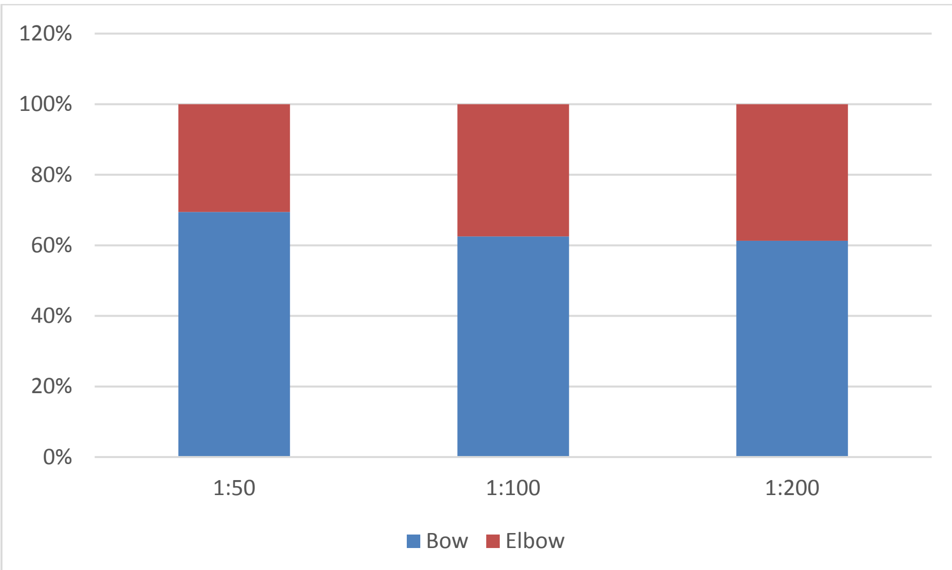


Figure 17-1 Proportion of Flood Damage to Buildings by River and Return Period, Unmitigated

The average annual damages (AAD) is the cumulative annualized damages, calculated in consideration of the magnitude of damage caused by a flood of a specific return period and the probability of such a flood. The AAD is calculated using the following formula:

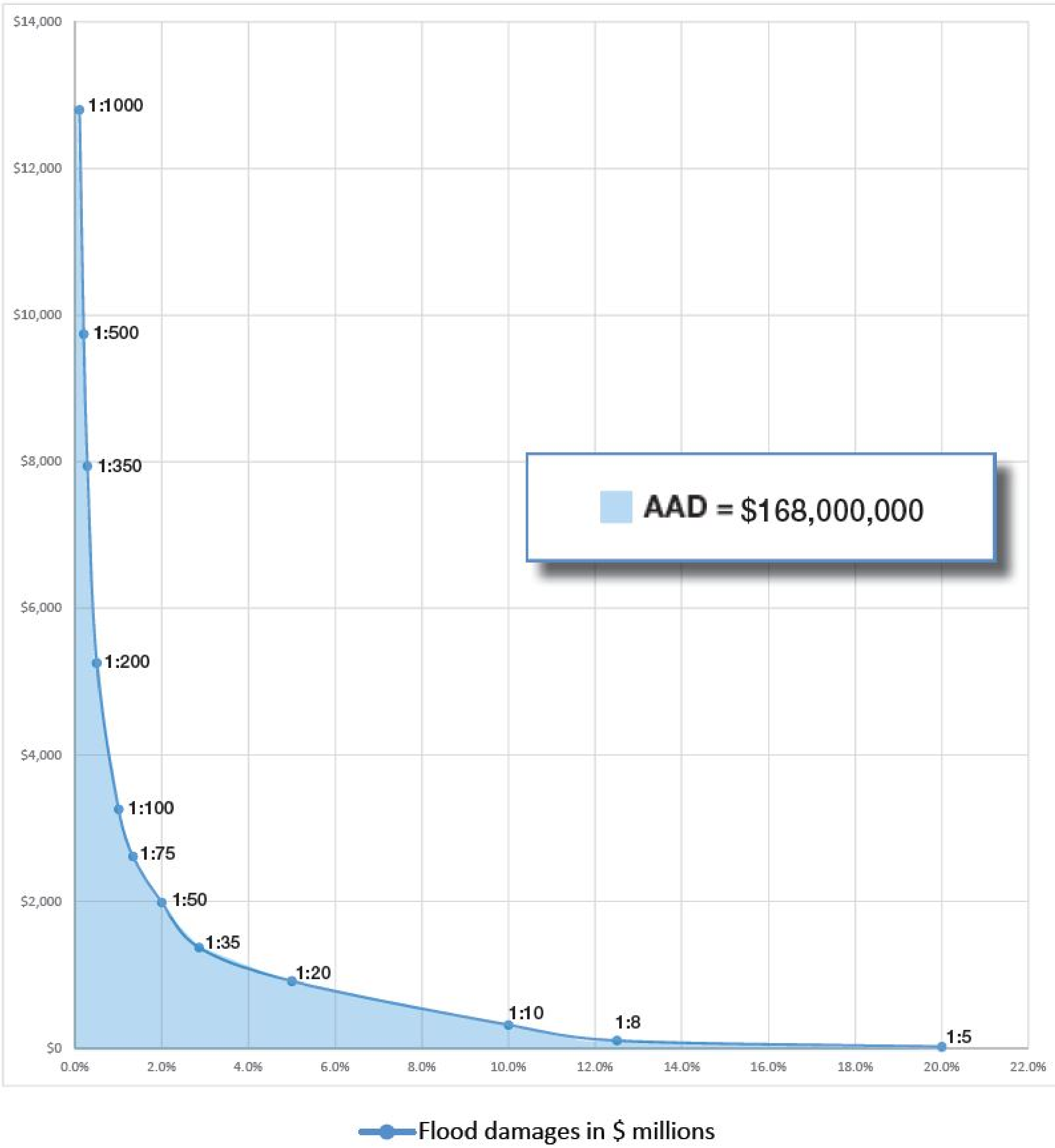
$$AAD = sum(FC_{RP} \times P_{FP}), \text{ where:}$$

FC = total damages caused by a flood of a return period

P = annual probability of a flood with a return period

RP = return period

The AAD for flooding from the Bow and Elbow rivers, if unmitigated, is $168 million, Of this, 68% ($114 million) of AAD would be attributed to flooding of the Bow River and 32% ($54 million) of AAD would be attributed to flooding of the Elbow River (IBI 2017).



SOURCE: IBI 2017

Figure 17-2 Average Annual Damage from Elbow and Bow Rivers Flooding, Unmitigated

Predicted Flood Damages with Existing Mitigation

Parts of the City of Calgary are protected from flooding by several existing structures and works including hydro facilities and reservoirs in the Bow River basin, the Glenmore reservoir, stormwater outfall gates and/or pumps at various locations, and existing barriers and dykes (IBI 2017). Table 17-3 summarizes modelled direct and indirect costs of 1:50 year, 1:100 year, and design floods, considering existing mitigation measures. In the 1:50 year flood, total damages are estimated at approximately $1.4 billion, of which $1.0 billion (72%) would be direct costs, 16% would be indirect costs, and 11 % induced costs. Considering existing mitigation measures 1:100 year and design floods from the Bow and Elbow rivers would result in an estimated $2.7 billion and $4.7 billion in damage, respectively.

Table 17-3 Flood Damage Cost from Elbow and Bow Rivers by Return Period, Existing Mitigation

Cost Type	Cost Category	Return Period (Years), Cost ($ millions)		
		1:50 Year	1:100 Year	Design
Direct	Residential	$587	$1,043	$1,558
	Commercial	$91	$223	$556
	Infrastructure	$325	$512	$701
	Subtotal	$1,002	$1,778	$2,814
Indirect	Residential	$32	$65	$109
	Commercial	$108	$450	$1,219
	Traffic Disruption	$11	$50	$71
	Habitat Restoration	$7	$10	$14
	Emergency Response	$55	$87	$119
	Waste Disposal	$12	$22	$36
	Subtotal	$225	$684	$1,568
Intangible		$159	$220	$329
Total		$1,387	$2,682	$4,711
SOURCE: IBI 2017				

Existing mitigation measures would reduce predicted flood damage by an estimated $598 million for the 1:50 year flood. The reduction in flood damages due to existing mitigation is $576 million for the 1:100 year flood and $544 million for the design flood, indicating that the effectiveness of some measures decline with increased magnitude of flooding.

The AAD from flooding by Elbow and Bow rivers, in consideration of existing mitigation measures, is $117 million, of which $75 million (64%) would be attributed to flooding of the Bow River and $42 million (36%) would be attributed to flooding from Elbow River (IBI 2017).

17.3 ASSESSMENT OF RESIDUAL ENVIRONMENTAL EFFECTS ON EMPLOYMENT AND ECONOMY

17.3.1 Financial Cost of Floods

17.3.1.1 Analytical Assessment Techniques

The flood damage savings resulting from the Project is estimated by comparing annualized average damages (AAD) between the no-Project and Project scenarios. Information presented in IBI Group's "Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary and Envrions on the Elbow River with Emphasis on MC1 and SR1" (2017) formed the basis of quantitative analysis for this section. The IBI report is included in Volume 4, Supporting Documentation.

17.3.1.2 Assumptions

The analysis considers the mitigating effects of the Project only on Elbow River floods; it does not include potential synergistic benefits through the application of flood control structures on the Bow River. The analysis assumes that if a flood exceeding the design flood occurs, the full economic damage from that flood would occur. The total flood control benefit assumes an operational life of 100 years and a 4% discount rate.

17.3.1.3 Project Pathways

The Project would divert waters of the Elbow River into a retention reservoir. Retained waters are subsequently released when Elbow River flows are naturally reduced to safe levels.

17.3.1.4 Mitigation and Enhancement Measures

The Project provides a benefit because it reduces the likelihood of flooding. The Project itself is a mitigation measure for flooding effects from Elbow River.

17.3.1.5 Residual Effects

In a 1:50 year flood, the Project would reduce flood damage by the Elbow River by approximately 86%, from approximately $474 million to approximately $69 million (Table 17-4).

Table 17-4 Flood Damage Avoidance for the 1:50 Year Flood from the Elbow River

Cost Category		Return Period (Years), Cost ($ millions)		
		Existing	Project	Savings
Direct	Commercial and Residential	$243.2	$47.1	$196.1
	Infrastructure	$104.0	$1.7	$102.3
Indirect	Residential	$9.5	$2.6	$6.9
	Commercial	$33.1	$3.3	$29.9
	Traffic Disruption	$3.6	$0.0	$3.6
	Habitat Restoration	$2.2	$0.1	$2.1
	Emergency Response	$17.7	$0.3	$17.4
	Waste Disposal	$4.1	$0.8	$3.3
Intangibles		$56.3	$12.6	$43.7
Total		$473.9	$68.6	$405.3

For a 1:100 year flood, the Project would reduce flood damage from Elbow River by approximately 91%, from approximately $1.1 billion to approximately $100 million (Table 17-5).

Table 17-5 Flood Damage Avoidance for a 1:100 Year Flood from Elbow River

Cost Category		Return Period (Years), Cost ($ millions)		
		Existing Mitigation	The Project	Savings
Direct	Commercial and Residential	$559.0	$59.8	$499.2
	Infrastructure	$234.2	$1.0	$233.1
Indirect	Residential	$27.8	$4.4	$23.5
	Commercial	$150.9	$13.6	$137.4
	Traffic Disruption	$22.7	$0.1	$22.7
	Habitat Restoration	$4.7	$0.0	$4.7
	Emergency Response	$39.9	$0.2	$39.7
	Waste Disposal	$9.5	$1.0	$8.5
Intangibles		$89.9	$20.7	$69.2
Total		$1,138.7	$100.8	$1,037.9

For a design flood, the Project would reduce flood damage from Elbow River by approximately 77%, from approximately $1.9 billion to approximately $430 million (Table 17-6).

Table 17-6 Flood Damage Avoidance for a Design Flood from Elbow River

Cost Category		Return Period (Years), Cost ($ millions)		
		Existing Mitigations	The Project	Savings
Direct	Commercial and Residential	$935.2	$235.3	$699.9
	Infrastructure	$318.6	$46.4	$272.3
Indirect	Residential	$54.8	$10.8	$44.0
	Commercial	$340.1	$43.1	$297.0
	Traffic Disruption	$32.1	$3.1	$29.1
	Habitat Restoration	$6.2	$1.1	$5.1
	Emergency Response	$54.3	$8.2	$46.2
	Waste Disposal	$15.9	$4.0	$11.9
Intangibles		$152.8	$81.8	$71.0
Total		$1,910.1	$433.7	$1,476.4

With the Project, the AAD of floods on the Elbow River would be reduced from approximately $42 million to less than $14 million.

Assessed in IBI (2017), the Project has a beneficial economic effect because the present value of its benefits is greater than the present value of its costs. Over an assumed 100 year operating life, the Project would result in a net present value (NPV) of $264 million (Table 17-7).

Table 17-7 Net present value of the Project

Indicator	$ millions
PV Benefits	$653
PV Costs	$389
Net Present Value	$264
SOURCE: IBI 2017	

17.3.2 Summary of Project Residual Effects

Table 17-8 summarizes the residual environmental effects on employment and economy during flood and post-flood operations.

Table 17-8 Project Residual Effects on Employment and Economy during Flood and Post-Flood Operations

	Residual Effects Characterization								
Residual Effect	**Project Phase**	**Timing**	**Direction**	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Ecological and Socio-economic Context**
Financial Cost of Floods	F	N/A	P	H[1]	RAA	LT	IR	R	R

KEY

- Not assessed

See Table 17-5 in Volume 3A for detailed definitions

Project Phase
F: Flood Operation
PF: Post-flood Operation

Timing Consideration
S: Seasonality
T: Time of day
R: Regulatory

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

[1] A high positive magnitude is one where the measurable change will cause a substantial economic benefit.

Geographic Extent:
PDA: Project Development Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term;
MT: Medium-term
LT: Long-term

N/A: Not applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
R: Resilient
NR: Not Resilient

17.4 DETERMINATION OF SIGNIFICANCE

The Project results in beneficial effects, so a significance determination was not made.

17.5 PREDICTION CONFIDENCE

There is a moderate degree of confidence in the assessment of effects on employment and economy. The estimates of flood costs are based on numerous assumptions, including assumptions on river hydrology and hydraulic behaviour during floods, effectiveness of mitigations measures, and nature and magnitude of damages for various cost categories. The criteria of timing is not applicable because effects from Project activities would be similar regardless of season or other timing characteristics.

17.6 CONCLUSIONS

In consideration of existing mitigation measures, the financial cost of 1:50, 1:100, and design floods from Elbow River is estimated at approximately $470 million, $1.1 billion, and $1.9 billion respectively, with the AAD estimated at approximately $42 million, construction of the Project would reduce the AAD of floods by $28 million to $14 million. Over an assumed 100-year operating life, the Project's discounted benefits in terms of flood damage avoidance, exceed its costs; therefore, it would have a net economic benefit.

17.7 REFERENCES

IBI Group. August 2017. Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary and Environments on the Elbow River with Emphasis on MC1 and SR1. Prepared for the Government of Alberta, ESRD – Resilience and Mitigation.

IBI and Golder 2015. February 2015. Provincial Flood Damage Assessment Study, City of Calgary: Assessment of Flood Damages. Prepared for the Government of Alberta, ESRD – Resilience and Mitigation.