APPENDIX IR6-1 SR1 & MC1 OPTION BENEFIT/COST ANALYSIS – APRIL 2019

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT
RESPONSE TO NRCB AND AEP SUPPLEMENTAL INFORMATION REQUEST 1, JULY 28, 2018

Appendix IR6-1 SR1 & MC1 Option Benefit/Cost Analysis – April 2019
May 2019

Stantec

SR1 & MC1 Option Benefit/Cost Analysis – April 2019

Prepared for Alberta Transportation
by IBI Group

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1 Introduction

Flood mitigation projects are an investment for which present consumption is traded for future consumption, in the form of a reduction in future losses. In this way, it is similar to other financial investments that are assessed by calculating the present value of future benefits. Because money has many alternative uses, a measure of the project's value is needed to assist the decision making process. Estimating the present value of the expected future benefits and costs of a project allows an evaluation of its efficiency and a comparison of alternative investments.

In theory, the Benefit/Cost Analysis (BCA) can determine the net value of a project because it enumerates all changes in welfare to indicate which option or course of action is most efficient or maximizes welfare. In practice, however, we are constrained by methods to identify and accurately quantify all the potential impacts and address any controversial aspects of a public project. Therefore, best practice requires clear and defensible assumptions, acknowledgement of limitations, and recognition that a BCA is only one of many considerations for decision makers.

The assessment of flood mitigation options on the Elbow River upstream of Calgary has included multiple BCAs, each using the best information available at the time it was conducted.

- **February 2015** – Benefit/Cost Analysis for Flood Mitigation Projects for the City of Calgary (Prepared for ESRD, Resilience and Mitigation)
- **February 2017** – City of Calgary Flood Mitigation Options Assessment (prepared for the City of Calgary)
- **August 2017** – Benefit/Cost Analysis of Flood Mitigation Projects for The City of Calgary and Environs on the Elbow River with Emphasis on MC1 and SR1 (prepared for Alberta Transportation)

A summary of these analyses is presented in Section 3 – Summary of Previous Benefit/Cost Analyses.

2 **April 2019** – Additional Information and Benefit/Cost Analyses (April 2019 BCA)

Since submission of the August 2017 BCA, engineering and design work, engagement, environmental assessment, and the land acquisition process for SR1 has continued. What we know regarding costs and timing for SR1 has increased greatly while the MC1 Option remains conceptual.

The practice of conducting BCAs is limited by the ability to anticipate and quantify the amount and timing of all future benefits and costs. As a decision-making tool, a BCA must be viewed in the context of the time it was undertaken. The chronology of BCA analyses for Elbow River flood mitigation (Section 3) is intended to provide such context and illustrate that each was conducted with the best information available at the time and that the information relied on had limitations and was evolving.

At this time, the utility of using a BCA to compare a more fully developed SR1 to the preliminary estimates for MC1 becomes questionable. Not only do they continue to diverge in terms of the detail and confidence in cost estimates, but challenges arise in attempting to align the two projects for a fair BCA comparison. Should all costs and delays to date remain associated with SR1? Should similar values be expected for the MC1 alternative? One cannot return to 2015 or 2017 and fairly apply what is known now. In other words, one cannot update a previous BCA, only conduct a new one.

Key developments that impact variables used in the BCA are as follows:

- Construction costs have been updated for both projects however SR1 is at a preliminary design phase while the MC1 Option is at a conceptual stage. The details of these updates are included in Appendix IR35-1 and IR35-2.
- Additional details on the timing of costs and benefits are now available. For SR1, this includes five years (2014-2019) of actual costs related to engineering design, environmental assessment, regulatory approvals, and engagement. Construction is now expected to begin in 2021, eight years after initiation. The MC1 Option, on the other hand, is still conceptual in nature and despite including the appropriate contingencies, actual timing and costs prior to construction are largely unknown.
- Previous analyses did not include past costs, only projected costs. Between 2014 and 2019 (Fiscal Year End March 2020), an estimated $47.4 million will have been spent on engineering design, alternative assessment, engagement, environmental assessment, and regulatory approvals.
- Construction of SR1 requires the acquisition of private land. Land values and purchase costs were estimated for the benefit/cost analyses completed in 2015 and 2017. The market land value was assessed based on comparable sales for equivalent highest and best land uses. Typical compensation values for non-market transactions were added. A detailed assessment of individual property owner's specific damages was not possible. Since the original land acquisition estimates, Alberta Transportation has begun negotiations with land owners with the objective of achieving voluntary, willing sellers. During this process, it has become apparent that willing sales of the land will require much higher compensatory amounts than originally suggested. Accordingly, the current estimate for acquiring all land from affected owners has been revised to $140 million.
- The 2017 benefit/cost submission assumed that any residual land acquired outside the project footprint could be resold and the land within leased for compatible uses. Available lands on the periphery of the project may be sold following the construction of the project. Final costs will be known once voluntary land sales or expropriation is complete.
- The MC1 alternative is expected to provide additional benefits upstream of the SR1 project, primarily in protection of development in the Bragg Creek and Redwood Meadows area. Previously, no estimate of these benefits was available. IBI Group has since conducted an assessment of flood damages for this area, using consistent Provincial Flood Damage Assessment Tool (PFDAT) methodology and new flood elevation surfaces for the Elbow River between MC1 and SR1. The resulting additional benefit for MC1, over SR1 is $180,000 annually. This is 0.65%of the benefit to the City of Calgary. In terms of the BCA comparison, this amount is not significant.

- Construction of MC1 would require the cancellation of 31 dispositions within the project area. The number of leases by category is listed in **Exhibit 2.1**

Exhibit 2.1: Current Dispositions within MC1 Project Area

Number	Category
1	Miscellaneous Lease
4	Disposition Reservation
6	Easement
1	Grazing Lease
1	Holding Reservation
1	Licences of Occupation
1	Mineral Surface Lease
2	Tourism Parks and Recreation Easement
1	Pipeline Agreement
2	Provisional Roadway
1	Recreational Lease
3	Registered Roadway
2	Consultation Notation
5	Protective Notation

The potential cost of cancelling these disposition for construction of MC1 is unknown at this time. The dispositions are governed by section 81 and 82 of the Public Lands Act (PLA). Alberta Transportation has a contingent liability for cancelling these disposition which cannot be quantified until the parties negotiate the amount payable, or failing negotiation as determining by the Land Compensation Board as set out in subsection 82 (6) and (7) of the PLA.

- In addition to the disposition cancellation costs, the study team at IBI Group strongly believes that any analysis of the MC1 project should consider the cost of land. Although no formal purchase of lands would occur, the land is very valuable to Albertans. As a recreational and natural asset, it is utilized by many more residents than equivalent private land is. Such land is in limited supply in proximity to major population centres. Therefore, the value of replacement land should be considered even if Alberta Transportation does not ordinarily include such costs in a benefit/cost analysis. As indicated in section 4.2.3 of the August 2017 benefit/cost submission, IBI Group has estimated that the cost of comparable replacement land for the project footprint at $57.75 million. Considering the total land area impacted, including relocation of the highway, the value would increase to $88.6 million.
- Operating and maintenance costs have been refined. The estimated annual operating cost for SR1 is $975,000 with a $12 million capital cost every 10 years. The estimated annual operating cost for MC1 is $675,000 with a $13.2 million capital cost every 10 years.
- SR1 is estimated to offer partial protection (1:100-year event) after the second year of construction, with design level protection after the third year of construction. The associated benefit in Average Annual Damages is $14.8 million and $27.7 million, respectively.

- MC1 is estimated to offer partial protection (1:50-year event) after the second year of construction, with design level protection after the fourth year of construction. The associated benefit in Average Annual Damages is $3.4 million and $27.9 million, respectively

The most recent cost estimates and timing of cost and benefits is presented in **Exhibit 2.2**.

2.1 2019 Benefit/Cost Analysis Results

Because the benefits for both projects are nearly the same, the benefit/cost results are sensitive to cost and timing. At present, there are two possible scenarios from which to apply the revised costs and timing information as presented in Exhibit 2.2:

1. Apply costs and benefits as presented in Exhibit 3.1, from 2014 onwards.

   For the benefit/cost ratio, this is the same as aligning the projects with a common start date because both the benefits and costs are discounted at the same rates. However, the SR1 costs and timing to date are not directly comparable to the MC1 Option assumptions. In 2014, one would not have made assumptions for SR1 that reflect what has occurred to date nor have such assumptions been applied to the MC1 Option.

   No costs to date have been associated with the MC1 Option because the design and environmental screening costs are considered as part of the Alternative Assessment for the SR1 Project. Therefore, all costs from 2014 are being attributed to SR1.

   The environmental assessment, regulatory approval process, and engineering design for the MC1 Option has been estimated to take at least 5 years. Costs for this period are assumed to be covered by the 20% contingency amount in the MC1 estimate. However, construction for the MC1 Option would begin in August due to fish protection and low river flow. Therefore, for the purposes of this BCA, construction is assumed to begin in 2025. The results are below in **Exhibit 2.3**.

   Exhibit 2.3: From 2014 Start - All Costs to Date Attributed to SR1

Indicator	SR1	MC1
PV Benefits	$483,815,000	$393,270,000
PV Costs	$391,464,000	$279,847,000
Net Present Value	$92,351,000	$113,423,000
Benefit/Cost Ratio	1.24	1.41

2. Disregard the costs to date and compare both projected costs and timelines from 2019 onwards.

   This allows comparison of the two projects from today. Funds spent to date are considered common as both are part of the flood mitigation program undertaken by the Government of Alberta, in an attempt to arrive at the best alternative for flood protection for the City of Calgary and downstream communities. The results are below in **Exhibit 2.4**.

   Exhibit 2.4: From 2019 Start – Projected Costs Only

Indicator	SR1	MC1
PV Benefits	$591,610,000	$481,467,000
PV Costs	$432,258,000	$340,832,000
Net Present Value	$159,352,000	$140,635,000
Benefit/Cost Ratio	1.37	1.41

SR1 and MC1 Option – Benefit and Cost Timing

			year															
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Costs	SR1	Construction								$106,674,485	$67,584,937	$88,341,663							$262,601,085
		Engin/Envir/Engag	$2,896,367	$3,804,511	$15,930,667	$9,318,157	$7,836,285	$7,604,296	$757,375	$4,834,499	$4,524,219	$3,293,624							$60,800,000
		Land						$70,000,000	$70,000,000										$140,000,000
		Total	$2,896,367	$3,804,511	$15,930,667	$9,318,157	$7,836,285	$77,604,296	$70,757,375	$111,508,984	$72,109,156	$91,635,287	$0	$0	$0	$0	$0	$0	$463,401,085
	MC1	Construction												$58,000,000	$144,882,400	$88,000,000	$48,000,000		$338,882,400
		Engin/Envir/Engag*						$4,000,000	$6,000,000	$6,000,000	$6,000,000	$5,000,000	$4,000,000	$8,000,000	$14,776,480	$9,000,000	$5,000,000		$67,776,480
		Land																	$0
		Total	$0	$0	$0	$0	$0	$4,000,000	$6,000,000	$6,000,000	$6,000,000	$5,000,000	$4,000,000	$66,000,000	$159,658,880	$97,000,000	$53,000,000	$0	$406,658,880
Benefits	SR1											$14,761,000	$27,736,000	$27,736,000	$27,736,000	$27,736,000	$27,736,000	$27,736,000	$181,177,000
	MC1															$3,454,000	$3,454,000	$27,916,000	$34,824,000

Operation & Maintenance

	Annual	10 yr capital
SR1	$975,000	$12,000,000
MC1	$675,000	$13,200,000

* The MC1 Option is assumed to have a regulatory approval period of at least five years and construction must begin in August or September. Therefore, for the purposes of this table, there are six calendar years of costs shown prior to construction, including the current year 2019.

-SR1 benefits begin with 1:100-yr protection in 2023 and design protection in 2024

-MC1 benefits begin with 1:50-year protection in 2026 and then design protection in 2028

In both cases, the MC1 Option has no costs to date. Therefore, the benefit/cost ratio is the same. However, the timing (discounting) affects the present values. From the 2019 scenario (Exhibit 2.4), the NPV of SR1 is higher than MC1 due to the significantly greater benefit accumulation from the earlier start. The revised land acquisition estimate for SR1 is significantly higher than previously estimates, due to increased compensatory payment expectations. This reduces the benefit/cost ratio of SR1, but both projects maintain positive ratios that are relatively close.

If the $57,750,000 in estimated replacement land value was added to the MC1 costs in the year prior to construction, the benefit/cost ratio for MC1 would decrease to 1.23.

3 Summary of Previous Benefit/Cost Analyses

3.1 **February 2015** – Benefit/Cost Analysis for Flood Mitigation Projects for the City of Calgary.

Following completion of the Provincial Flood Damage Assessment Tool[1] (PFDA study) and its application in the estimation of flood damages in the City of Calgary[2], a BCA was performed on three identified options: Springbank off-stream flood storage[3], McLean Creek Flood Storage[4], and Glenmore Reservoir diversion.[5]

- The benefits for all projects was the a reduction of flood damages within Calgary, based on the damage estimated from the 2015 PFDA study, City of Calgary pilot study. That study, in turn, was based on flood elevation data from the output of the HEC-RAS Model provided by the City of Calgary from the Bow and Elbow River study completed by Golder Associates, dated April 2012.
- The SR1 and MC1 construction costs were taken from AMEC Environmental & Infrastructure, Southern Alberta Flood Recovery Task Force, Volume 4 – Flood Mitigation Measures, Appendix G – Springbank Off-Stream Storage Project, and Appendix F – Elbow River Dam at McLean Creek, May 2014.
- SR1 land acquisition costs were originally estimated based on the project footprint of the preliminary design, which was approximately 1,760 acres. Total land costs were estimated at $40 million. Shortly after the submission of this report, two new pieces of information were provided: the project footprint was increased and a land use study was prepared for the area by Brown and Associates. A new land cost estimate was prepared, finding it essentially unchanged as the larger area was offset by the land use study's conclusion that the highest and best use was agricultural development.

1 Provincial Flood Damage Assessment Study (2015), Environment and Sustainable Resource Development. Prepared by IBI Group. Available at: https://open.alberta.ca/publications/7032365#detailed
2 Provincial Flood Damage Assessment Study City of Calgary: Assessment of Damages (2015), Environment and Sustainable Resource Development. Prepared by IBI Group. Available at https://open.alberta.ca/publications/7032715
3 Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary: Springbank Off-Stream Flood Storage (2015), Environment and Sustainable Resource Development. Prepared by IBI Group. Available at: https://open.alberta.ca/publications/benefit-cost-analysis-of-flood-mitigation-projects-for-the-city-of-calgary-springbank-off-stream
4 Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary: McLean Creek Flood Storage (2015), Environment and Sustainable Resource Development. Prepared by IBI Group. Available at: https://open.alberta.ca/publications/benefit-cost-analysis-of-flood-mitigation-projects-for-the-city-of-calgary-mclean-creek
5 Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary: Glenmore Reservoir Diversion (2015), Environment and Sustainable Resource Development. Prepared by IBI Group. Available at: https://open.alberta.ca/publications/benefit-cost-analysis-of-flood-mitigation-projects-for-the-city-of-calgary-glenmore-reservoir

- An additional $49 million was added to the MC1 construction costs to include relocation of infrastructure and impact studies not included in the costs from the AMEC report[6].
- It was recognized that MC1 would provide additional benefits upstream of the other projects, particularly for Bragg Creek and Redwood Meadows. Ideally these benefits would be added to the MC1 analysis. However, no current estimate of these benefits (flood damage reduction) were available at that time. Therefore, the estimated cost at the time for flood defenses at Bragg Creek[7] plus infrastructure in Bragg Creek, Tsuu T'ina Nation, and Rockyview County was added to the cost of both the Glenmore diversion and SR1 projects. This amount was $8.9 million.
- Due to uncertainty in the indirect damage estimates, particularly the business interruption amounts, The City of Calgary damage estimates included two cases: a higher or "worst case" condition and a lower "anticipated case".
- The BCA used a 100-year time period with a discount rate of 4%.
- Net benefits were computed on the assumption that the projects will provide protection downstream of Glenmore Dam to the 1:100 and 1:200-year flood events, based on the 2012 flood model.

The results of the 2015 BCA analysis are summarized in **Exhibit 3.1**.

Exhibit 3.1: Benefit/Cost Results, February 2015

Mitigation Project	High Damage Scenario		Low Damage Scenario	
	1:100 Year Protection	1:200 Year Protection	1:100 Year Protection	1:200 Year Protection
SR1	1.87	2.07	1.32	1.32
MC1	1.43	1.65	1.01	1.05
Glenmore	1.21	1.20	0.81	0.83

3.2 **February 2017** – City of Calgary Flood Mitigation Options Assessment

In 2015, IBI Group and Golder Associates were retained by the City of Calgary to conduct an assessment of various flood mitigation scenarios. The study included two phases. The first was an update of the PFDA methodology to include groundwater modelling, the application of new hydrologic and hydraulic information and flood surfaces, and improved methods for estimating some indirect damages. The second phase involved the selection and assessment of 13 mitigation scenarios or combinations of structural and non-structural options. The final report was submitted in February 2017. The report has been included in this submission as Appendix IR23-1.

A major component of the assessment was the estimation of the damage reduction value for each of the mitigation scenarios. One of these scenarios included an upstream storage facility on the Elbow River upstream of Calgary. This facility was the only mitigation on the Elbow River in this scenario and, for the purposes of the City report, was assumed to be the SR1 project.

[6] AMEC, Southern Alberta Flood Recovery Task Force, Flood Mitigation Measures for the Bow, Elbow and Oldman River Basins, Volume 4 – Flood Mitigation Measures, Appendix F – Elbow River Dam at McLean Creek, May 2014

[7] AMEC, Southern Alberta Flood Recovery Task Force, Flood Mitigation Measures for the Bow, Elbow and Oldman River Basins, Volume 4-Flood Mitigation Measures.

Each scenario was assessed against a variety of triple-bottom-line criteria, including a BCA. Key points about this study in relation to the BCA for SR1 and MC1 are as follows:

- The scenario that was identified as SR1 (scenario 1) also included the operating agreement between TransAlta and the Government of Alberta for Bow River facilities along with existing and planned barriers and pump stations along the Bow River. Upstream storage (SR1) was the only measure on the Elbow River however, the BCA was for the entire scenario (both the Bow and Elbow Rivers).
- A high-level estimate of $500 million was used for the Elbow River upstream storage facility.
- Although the BCA and benefits were reported by scenario, the damages for each scenario could be classified as occurring due to the Bow or Elbow River, allowing for an extraction of benefits on the Elbow River attributed to the upstream storage option.
- The level of protection and benefits would have been the same if it was assumed to be MC1 upstream on the Elbow River because the scope of the assessment was limited to the City of Calgary.
- The damages were based on updated flood modelling that included consideration of the preliminary data for the June 2013 flood event. This included 2015 peak discharge estimates, the 2013 high water marks, the latest LiDAR data for the floodplain, and the river cross-sectional survey post the 2013 flood. The simulated water levels using the 2015 model are on average 0.38 m higher than those using the 2012 model for the Elbow River.
- In previous studies, the mitigated conditions were not modelled and benefits were assumed to be the Average Annual Damages, (AAD) from all damages below the design flood. For this study, each scenario was modelled, producing flood surfaces for each event probability. This resulted in higher residual damages with mitigation, particularly due to potential groundwater flooding.
- This study included an investigation into groundwater flooding associated with high river levels and the creation of estimated groundwater surface profiles for each return period. These surfaces were appended to the overland flood surface for the estimation of damage to buildings.
- The upstream storage scenarios were modelled with an extended release of stored floodwaters. In the model, this results in propagation of groundwater further from the surface flooding. Therefore, many buildings that are protected from surface flooding in the model still receive groundwater damages. The groundwater modelling was based on limited data and thus has a high level of uncertainty. The conservative approach to groundwater damage may greatly overstate the residual damages and thus underestimate the benefit of the upstream storage.

3.3 **August 2017** – Benefit/Cost Analysis of Flood Mitigation Projects for The City of Calgary and Environs on the Elbow River with Emphasis on MC1 and SR1.

This report was submitted as part of Volume 4, Supporting Documentation. As stated in the report, the intent was to utilize the most recent benefit and cost estimates available.

- The benefits were derived from the 2017 City of Calgary Flood Mitigation Options Assessment. As stated above, benefits within the City of Calgary were assumed to be the same for either project. These benefits were the reduction in the AAD for the Elbow River from the existing baseline conditions. As with the Calgary study, the benefits were estimated using modelled river flows for the mitigation rather than

complete protection to the design level, including residual damages from groundwater. This is a more conservative approach to benefits than in previous studies.

- SR1 design and construction costs were provided by Stantec, totaling $291.7 million. It was noted that the cost opinion was still in progress and under review.
- MC1 design and construction costs were provided by Opus (now WSP), totaling $406.4 million.
- IBI Group, working with a licensed real estate appraiser, assessed the probable costs of land acquisition for the SR1 project footprint. It was assumed that any additional land acquired outside of the footprint would be re-sold for similar values, resulting in a recovery of those costs. Total land costs, including damages were estimated at $66 million. An additional $14 million contingency was added to account for the anticipated negotiating timeframe, administration and other unforeseen damages. The total land cost used was $80 million.
- It was assumed that a portion of the lands within the project perimeter could be leased for compatible uses after construction of the reservoir. A potential annual lease income of $715,000 per acre was added to the annual operation of SR1.
- The MC1 project would be located on public land and no formal purchase of lands would be required. However, the land is very valuable to Albertans and in limited supply. Therefore, the study team strongly believes that the value of replacement land should be considered even if it is not a cost included in the BCA. The cost to replace the land required by MC1 was estimated at $57.8 million. This cost was not included in the BCA.
- At the time of the report, details about the timing of costs were not available and the BCA was conducted with assumptions that SR1 would be constructed in two years, with annual benefits accruing in year 3. MC1 was assumed to require five years, with benefits accruing in year 6.

The results of the benefit/cost calculations are detailed in **Exhibit 3.2**

Exhibit 3.2: Benefit/Cost Results, August 2017

Indicator	SR1	MC1
PV Benefits	$653,008,000	$578,997,000
PV Costs	$388,943,000	$402,999,000
Net Present Value	$264,065,000	$175,998,000
Benefit/Cost Ratio	1.68	1.44