

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

Appendix IR35-1 Refined Cost Estimate Opinion, McLean Creek Dam
May 2019

**APPENDIX IR35-1 REFINED COST ESTIMATE OPINION,
MCLEAN CREEK DAM**

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May 2019

26 March 2019

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 Alberta Transportation
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 4999 - 98 Avenue
 Edmonton, AB
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Ref: 17Q-00007-00

RE: Refined Cost Estimate Opinion, McLean Creek Dam

1.0 MC1 DESIGN

Since the release of the Updated Conceptual Design Report, McLean Creek (MC1) Dam, August 23, 2017, the technical drawing for the concept have remained unchanged. This report presents refined cost opinion that was developed from further review of the construction staging and temporary works envisioned for the project. Additionally, there was refinement of the unit price components of the major cost items. The result of this was the creation of 13 new cost items and some revision to the unit rates. These modifications and updates are typical in the evolution of a construction cost estimate over the development of large infrastructure projects. This was discussed in the August 23, 2017 report and is consistent with the ACE International practice for cost estimating.

2.0 MC1 COST ESTIMATE OPINION

The August 23, 2017 Cost Estimate Opinion resulted in a project total of \$406.4 million. Through the refinement process various MC1 dam component total costs resulted in some elements being higher and others being lower, amounting in an overall lower total cost. The current updated Cost Estimate Opinion for MC1 is \$406.7M. Below is a summary of the revised MC1 Cost Estimate Opinion.

MC1 Cost Estimate Opinion R1	
General	
Mobilization	\$ 12,000,000
Care of Water	\$ 4,000,000
Total	\$ 16,000,000
Construction	
MC1 Dam	\$ 198,500,000
Highway 66 Relocation	\$ 34,341,000
Facility Relocation	\$ 22,853,000
Total	\$ 255,694,000
Environmental Habitat	
Wetland Compensation	\$ 708,000
Aquatic Habitat Management Plan	\$ 10,000,000
Total	\$ 10,708,000
SUBTOTAL CONSTRUCTION	\$ 282,402,000
Engineering/Environment/Engagement (20%)	\$ 56,480,400
Contingencies (20% including Engineering)	\$ 67,776,480
Total	\$ 124,256,880.0
Grand Total	\$ 406,658,880

Notes:

- 1) This Construction Estimate is based on the level of project information developed in the study.
- 2) Mobilization and Care of Water are for the construction of the dam only. These items were extracted from the dam cost estimate for comparison purposes to the past MC1 cost estimate and SR1.
- 3) Unit prices are based on calculated information, historic bid data, past project experience, and engineering judgement.
- 4) The summary information is rounded to nearest \$1000s.
- 5) The estimate is based on 2017 dollars.

The above Cost Estimate Opinion has been reviewed by a team of knowledgeable engineers. The following provides a summary of information and processes undertaken by the team to develop the cost estimate:

- Road and dam embankment quantities have been calculated using MicroStation, with the major earthworks quantities being confirmed independently using Civil 3D.
- Unit Rates for Tunnel, Cut-Off wall, grouting, and all concrete as well as all embankment soils for the Dam have been determined through a bottom up approach similar to the process a contractor would use to develop a bid. Quotes for cement, concrete plants, equipment, and labour, from various suppliers and sub-contractors were utilized to develop these costs and rates.
- The cost of the Infrastructure relocation (including reclamation of the existing site) has been based on a combination of direct pricing for building relocation, constructing new pre-engineered buildings, engineering knowledge, and experience.
- Information on contamination clean-up of \$3.6M has been provided by Hemmera and is included under the Infrastructure relocation.

The detailed cost estimate information is attached in Appendix A.

3.0 COMPARISON TO PREVIOUS OPUS MCI COST OPINION

REVISED COMPONENTS	OPUS 8/23/17 (millions)	OPUS Revision 1 (millions)	Difference (millions)
A) Care of Water	\$3.0	\$4.0	\$1.0
GENERAL TOTAL	\$3.0	\$4.0	\$1.0
B) Main Dam Embankment	\$98.7	\$89.0	\$-9.7
C) Diversion Tunnels	\$36.6	\$43.0	\$6.4
D) Fish Passage	\$5.3	\$6.6	\$1.3
E) Service Spillway	\$45.9	\$58.8	\$12.9
F) Auxiliary Spillway	\$1.5	\$1.1	\$-0.4
REVISED DAM TOTAL	\$188.0	\$198.5	\$10.5
G) Engineering/Environment/Engagement	\$54.2	\$56.5	\$2.4
H) Project Contingency	\$81.3	\$67.8	\$-13.4
REVISED COMPONENT TOTAL	\$326.5	\$326.8	\$0.3

A) CARE OF WATER: \$ 1.0M

The original cost opinion estimated the care of water cost at \$3.0M to be consistent with the original AMEC cost estimate. The updated cost of \$4.0 M is based on conceptual temporary works, water management, pump requirements and miscellaneous dewatering.

B) MAIN DAM EMBANKMENT: \$-9.7M

The primary change to the cost of the main dam is the reduction of the unit rate for the 42 m deep left cut-off wall. This update is supported with back up pricing from a contractor that specializes in deep cut off wall and slurry wall construction. Additionally, the other main reduction is from the overall cost of the Drilling and Grouting.

C) DIVERSION TUNNELS: \$6.4M

Subsequent to the August 2017 report, a review of the diversion tunnel and the related construction staging and temporary works, identified the addition of 13 new unit items and modifying some unit prices. The new items were related to the inlet and outlet structure and stilling basin, as well as the gate shaft temporary earthworks. The most notable change was the increased unit price for the gate shaft concrete to \$2000/m³. The primary driver for this relatively high unit rate is the specialized and possible single-use nature of the formwork for the tunnels.

D) FISH PASSAGE: \$1.3M

Similar to the Diversion Tunnels, this update identified temporary construction works for the fish passage inlet and outlet, the gate structure and stilling basin. The cost of constructing the gate shaft structure in the August 2017 was an early concept level. This update includes considerations of some requirements and details presented by suppliers of the gate equipment and has resulted in updated costs.

E) SERVICE SPILLWAY: \$12.9M

After the submission of the August 23, 2017 report, further review of the spillway construction has produced new considerations. The cost of constructing the service spillway was underdeveloped (concept level) in the report. At the time of reporting, a concrete rate of \$730/m³ was calculated from consideration of the onsite concrete batch plant and worker camp combined with historical data. The cost estimate for 32 MPa concrete was further developed post-report and was found to be greater (\$1000/m³). Additionally, there was an increase in the unit rate for the sheet and secant piling within the spillway. This cost increase was based on subcontractor information related to mobilization overhead due to the overall reduction of subsurface works across the project

F) AUXILIARY SPILLWAY: \$-0.4M

The cost of constructing the service spillway was underdeveloped in the reported estimate. At the time of reporting, a common earthworks rate of \$6/m³ was used based on historical data. The cost estimate for common excavation was further developed post-report and was found to be less at \$3/m³.

G) ENGINEERING/ENVIRONMENT/ENGAGEMENT: \$2.4M

The estimate for engineering, environment and engagement was increased by \$2.4M. This was due to the total estimated cost increase of the dam as this item was estimated based on a percentage of the total cost of construction.

H) CONTINGENCY: \$-13.4M

Further to the Section 11.3 - Contingency in the August 23, 2017 report, the value of the contingency needs to be re-considered given the level of detail of the concept design, construction staging, subcontractor supporting information and bottom up approach to the cost items.

The original report considered various methods to rationalize a contingency, such as range estimating and risk assessment. A modified range estimate exercise for the major project component was undertaken along with a review of the values determined during Workshop 3 Risk Assessment. Through these reviews, the 'Expected' and '95th' percentile contingency support the revised contingency value of \$ 58 to 81 million.

With this additional detail it is reasonable to review the AACE contingency practice and the value for this cost opinion.

ESTIMATE CLASS	Primary Characteristic	Secondary Characteristic			
	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical variation in low and high ranges [a]	PREPARATION EFFORT Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	L: -3% to -10% H: +3% to +15%	5 to 100

Notes: [a] The state of process technology and availability of applicable reference cost data affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.
 [b] If the range index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

Given the combined information to date, the contingency as a percentage has been rationalized to be 20%.

4.0 DISCUSSION

The August 23, 2017 report indicated that the Engineering/Environment/Engagement Costs were based on;

“An additional allowance of 20% has been included for the cost of project management, detailed engineering, environmental assessment and permitting, stakeholder engagement and other work required by the consultants.”

The typical industry practice, which is founded in the historical outcomes from completing infrastructure, highway and heavy civil projects indicates a few ranges of expected costs for the costs associated with a project. In Alberta, the Engineering/Environmental/Engagement costs for regular infrastructure project would typically cost between 5 and 10% of the total construction cost. Large Bridge and complex Freeway projects would be in the order of 12 to 15%. Heavy civil projects such as a Dam are around 20%, due to more complex engineering, environmental regulatory processes, stakeholder engagement and construction administration/inspection.

The estimated 20% cost was rationalized by the MCI project team lead members with past dam project experience. This amounted to \$56.5M, which was gauged by an accumulative dollar value assessment of the primary tasks listed above as well as considering the construction administration, monitoring and other consultant services during construction. For MCI, the value of the Engineering/Environmental/Engagement resulted in the estimated cost of \$56.5M.

The MCI Cost Estimate Opinion is based on the updated conceptual design, and therefore the same Contingency applied to the construction of 20% was also applied to the Engineering/Environmental/Engagement.

5.0 CLOSURE

We trust that the details presented above sufficiently inform and describe the foundation for which the Opus Cost Estimate Opinion is based upon.

Should you require anything further to process this request, please do not hesitate to contact the undersigned.

Regards,

WSP/OPUS




Rob Lonson, P.Eng.
Director, Urban Design Centres
APEGA PERMIT No. 292

Reviewed by Harvey Walsh – WSP Director Dam Safety & Hydropower
Attachments: Appendix A Cost Estimate Opinion - McLean Creek Dam Rev 1

cc: Ron Kruhlak

APPENDIX A


COST ESTIMATE OPINION - MCLEAN CREEK DAM REV 1

		R1 SUMMARY ESTIMATE		
MC1 DAM CONSTRUCTION			File:	S39001
			Date:	15-Nov-2018
	UNIT	ESTIMATE QUANTITY	UNIT PRICE	TOTAL
MOBILIZATION	LS	1	\$ 12,000,000	\$ 12,000,000
MAIN DAM				
Site Preparation				
Clearing (other than Hwy.)	HA	59	\$6,000.00	\$354,000
Clearing & Timber Salvage	HA	45	\$10,000.00	\$450,000
Strip & Stockpile Topsoil	M3	275,000	\$6.00	\$1,650,000
Recontour, topsoil, seeding, 200mm thick	M2	800,000	\$4.00	\$3,200,000
Common Excavation	M3	585,586	\$6.00	\$3,513,516
Rock Excavation for benches	M3	12,000	\$28.00	\$336,000
Common Excav. Reroute McLean Crk.	M3	80,040	\$4.00	\$320,160
McLean - Rip Rap (1.0m thick)	M3	10,121	\$140.00	\$1,416,940
McLean - Rip Rap Bedding (0.5m thick)	M3	5,060	\$140.00	\$708,400
McLean - Rockfill Berm	M3	5,830	\$7.00	\$40,810
Common Excav. Reroute SW creek	M3	3,500	\$15.00	\$52,500
Slush Grout	M3	500	\$400.00	\$200,000
Dental Concrete	M3	200	\$430.00	\$86,000
Fills				
Zone 1A- Impervious	M3	735,275	\$9.00	\$6,617,475
Zone 2A- Unclassified Fill	M3	1,043,460	\$9.00	\$9,391,140
Zone 3A- Fine Filter	M3	447,526	\$16.00	\$7,160,416
Zone 3B- Drainage Layer	M3	338,259	\$16.00	\$5,412,144
Zone 4D - Pit Run Granular	M3	950,498	\$10.00	\$9,504,980
Zone 5C- Riprap Bedding/Cobbles	M3	60,342	\$58.00	\$3,499,836
Zone 6- Rip Rap	M3	30,500	\$150.00	\$4,575,000
Granular Base Course (Crest)	T	4,600	\$40.00	\$184,000
Gravel Surfacing (Crest)	T	1,500	\$40.00	\$60,000
Miscellaneous				
Topsoil & Seeding- DS Slope	M2	120,000	\$6.00	\$720,000
Cable Barrier	M	4,400	\$140.00	\$616,000
Cable Barrier End Terminals	EA	4	\$7,000.00	\$28,000
Security Fence at Turnaround	M	160	\$280.00	\$44,800
Instrumentation	LS	1	\$785,000.00	\$785,000
Safety Boom Across River	LS	1	\$30,000.00	\$30,000
Drilling and Grouting				
75mm x 10m Grout Holes- C'dam- OB	M	760	\$210.00	\$159,600
75mm x 20m Grout Holes- C'dam	M	1,520	\$320.00	\$486,400
75mm x 20m Grout Holes- Dam	M	2,000	\$280.00	\$560,000
Packers	EA	800	\$140.00	\$112,000
Washing & Pressure Testing	HR	160	\$140.00	\$22,400
Cement Take (No Sand)	TO	70	\$420.00	\$29,400
Cut-Off Walls				
Left Abut.- Plastic Concrete- PFC	M2	12,600	\$950.00	\$11,970,000
Right Abut.- Soil/Slurry Wall - PFC	M2	11,000	\$750.00	\$8,250,000
Bentonite Blend COW Cap	M3	50,000	\$130.00	\$6,500,000
SUB-TOTAL, MAIN DAM				\$89,046,917

NOTE: Yellow highlighting denotes new items.

**OPUS****R1 SUMMARY ESTIMATE**

MC1 DAM CONSTRUCTION			File:	S39001
			Date:	15-Nov-2018
	UNIT	ESTIMATE QUANTITY	UNIT PRICE	TOTAL
DIVERSION TUNNELS/LOW LEVEL OUTLET				
Tunnels				
Excavation- 7m x 7m nominal	M3	35,000	\$150.00	\$5,250,000
Rock bolts- 35mm x 3m- Epoxy Grouted	EA	2,800	\$140.00	\$392,000
Wire Mesh-	M2	9,300	\$25.00	\$232,500
Shotcrete- 50mm thick	M2	15,200	\$50.00	\$760,000
32 MPa Concrete Lining	M3	11,100	\$800.00	\$8,880,000
Contact grouting	M	840	\$100.00	\$84,000
Inlet & Outlet Structures				
Common Excavation	M3	80,000	\$6.00	\$480,000
Rock Excavation	M3	69,200	\$25.00	\$1,730,000
Outlet Secant Pile Wall	M2	120	\$4,200.00	\$504,000
Rock Bolts & Dowels	LS	1	\$350,000.00	\$350,000
32 MPa Concrete	M3	12,000	\$780.00	\$9,360,000
Re-Bar- Supply, cut, bend, place	T	600	\$4,000.00	\$2,400,000
Stilling Basin Excavation				
Common Excav.- River Re-alignment	M3	80,000	\$6.00	\$480,000
Rock Excav. for Stilling Basin	M3	30,000	\$20.00	\$600,000
Rock Bolts	LS	1	\$280,000.00	\$280,000
Shotcrete	LS	1	\$350,000.00	\$350,000
Common Excav. For Stilling Basin	M3	44,000	\$6.00	\$264,000
Rip Rap DS of Stilling Basin	M3	1,600	\$280.00	\$448,000
Gate Shafts				
Common Excavation	M3	6,000	\$10.00	\$60,000
Backfill Shaft Excavation	M3	6,000	\$12.00	\$72,000
Rock Excavation	M3	1,300	\$28.00	\$36,400
Rock Bolts- 35mm x 3m, Epoxy Grouted	EA	300	\$280.00	\$84,000
Wire Mesh- 50x50mm	M2	660	\$28.00	\$18,480
Shotcrete- 50mm Thick	M2	660	\$35.00	\$23,100
Gate Shaft Retaining wall/Access pad	M2	875	\$1,100.00	\$962,500
32 MPa Concrete	M3	1,620	\$2,000.00	\$3,240,000
Re-Bar- Supply, cut, bend, place	T	81	\$4,000.00	\$324,000
Gates, Guides & Hoists				
Embedded Parts - Supply	KG	150,000	\$9.00	\$1,350,000
Stop Logs & Lifting Beam- Supply	KG	120,000	\$9.00	\$1,080,000
Gate Hoist & Structure- Supply	KG	57,000	\$18.00	\$1,026,000
Install Guides, Gates, and Hoists	KG	327,000	\$5.00	\$1,635,000
S & I Gen. Set for hoist	LS	1	\$250,000.00	\$250,000
SUB-TOTAL, DIVERSION TUNNELS/LOW LEVEL OUTLET				\$43,005,980

 R1 SUMMARY ESTIMATE				
MC1 DAM CONSTRUCTION			File:	S39001
			Date:	15-Nov-2018
	UNIT	ESTIMATE QUANTITY	UNIT PRICE	TOTAL
FISH PASSAGE TUNNEL				
Tunnel				
Excavation and Temporary Support - 3. 6 m by 3.8 m nominal	M	260	\$4,500.00	\$1,170,000
Tunnel Concrete Lining & Contact Grouting	M	260	\$4,500.00	\$1,170,000
Inlet & Outlet Excavation				
Common Excavation	M3	95,400	\$6.00	\$572,400
Rock Excavation - upstream only	M3	13,200	\$28.00	\$369,600
Engineering Fill - US & DS	M3	7,100	\$30.00	\$213,000
Geotextile - US & DS	M2	7,100	\$20.00	\$142,000
Place 50 cm Cobbles for Natural River	M3	3,600	\$20.00	\$72,000
Recontour, topsoil, seeding	M3	3,800	\$6.00	\$22,800
Earth Fill - DS only	M3	11,400	\$6.00	\$68,400
Rip Rap - DS only	M3	413	\$140.00	\$57,820
Gate Structure Concrete	M3	400	\$2,900.00	\$1,160,000
Re-bar Supply, Cut, Bend, Place	KG	20,000	\$4.00	\$80,000
Embed. Mtl, Gate, Hoist - Supply	LS	1	\$900,000.00	\$900,000
Embed. Mtl, Gate, Hoist - Install	KG	81,750	\$7.00	\$572,250
SUB-TOTAL				\$6,570,270
SERVICE SPILLWAY				
Earthworks/Cut-off Walls				
Common Excavation	M3	84,000	\$4.00	\$336,000
Crushed Stone- Drainage Piping	M3	7,200	\$14.00	\$100,800
Granular Fill Under Slab	M3	35,000	\$14.00	\$490,000
Clean Backfill (Outside Walls)	M3	8,700	\$14.00	\$121,800
Underslab Drainage System	LS	1	\$300,000.00	\$300,000
Spillway - Sheet Pile -PFC	M2	1,510	\$3,300.00	\$4,983,000
Spillway - Secant Piles -PFC	M2	1,500	\$2,250.00	\$3,375,000
Concrete				
32 MPa Concrete- Ftgs, Walls, Ogee, Flip	M3	44,000	\$950.00	\$41,800,000
Re-Bar- Supply, Cut, Bend, Place	T	2,200	\$3,300.00	\$7,260,000
SUB-TOTAL SERVICE SPILLWAY				\$58,766,600
AUXILIARY SPILLWAY				
Common Excavation	M3	158,000	\$4.00	\$632,000
Strip & Stockpile Topsoil	M3	30,000	\$6.00	\$180,000
Recontour, topsoil, seeding	M2	60,000	\$4.00	\$240,000
SUB-TOTAL, AUXILIARY SPILLWAY				\$1,052,000.00
TOTAL: DAM & HYDRAULIC STRUCTURES			Total	\$210,441,767
Extract Mobilization				\$11,999,511
			Round Total	\$198,500,000

NOTE: Yellow highlighting denotes new items.