SR1 Scope Escalation

Prepared by Karin Hunter, February 2021

Note: All Costs Include Bragg Creek Berms

1	**AMEC Report (Exhibit TBC: 2014, Volume 4, Appendix G) $209M**
2	Design 1:100
3	Flood Storage of 57000dam3
4	Permanent Reservoir of 9000dam3, 10M depth
5	Project Size 3610 acres
6	Dam Height 24m, length 3km, Freeboard 1.5M, Slope 3:1, riprap along dam pool and crest zone (1207m-1210m)
7	Diversion Inlet Height 9.5m
8	Floodplain Berm Height 7m (1217.9m elev)
9	Sluiceway 2 Openings @ 4m x 8m, Max Height 9.5m Note: 3m clearance normal operation
10	Diversion Outlet Height: 10.5m, 4 Gates @ 3m x 8m, Radial
11	Diversion Channel Bottom Width: 30m (3:1 Slope), 300cms, 3.6m water depth, up to 25m near intake
12	Reservoir Inlet 24m Chute Width, 60m length
13	Low Level Outlet: 1.5m x1.8m, one gate @1.2m x 1.8m
14	LLOW Design Flow: 20cms
15	Target Outflow for Elbow River 170cms
16	Emergency Spillway: On map but not mentioned in 2016 report
17	Other: "Numerous Pipelines" - "Nova and Foothills lines are of particular concern because of their size."
18	Other: Springbank Road $7,000,000 allowance
19	**2016 Project Description (Exhibit 02) NO COST OPINION**
20	*Design 1:200*
21	Flood Storage of 70,200dam3 (Increase of 13,200 dam3)
22	Diversion Inlet: Height 11m (increase of 1.5m), 4x10m gates, 46m long, 33m wide
23	Diversion Channel of 600cms (increase of 300cms), 4700m (*Very conceptual, pg 14), 6.4m water depth (increased from 3.6m)
24	Service Spillway/Sluiceway Height 11m (increase of 1.5m), 43m long, 33m wide
25	Floodplain Berm Height 7.5m (increase of .5m), 1200m long, 51m wide
26	Dam Height 27m (increase of 3m), length 3960m (increase of 960m), Base 205m
27	Outlet works - require additional engineering

28	**2018 EIA (Exhibit 20) $404.5M**
29	Project Size 3611 acres (2017 IBI Report)
30	Diversion Inlet (Two 20m wide x 4m high steel lift gates to improve debris passage) (Changed from 4x10 gates in 2016); Changed from radial gates to vertical lift)
31	Inlet crest geometry was changed for sedimentation (section 3.6)
32	Service Spillway: Two 24m gates (changed from 4x8) riprap added, Obermeyer crest gate, concrete stilling basin, riprap riverbank
33	Floodplain Berm 1000m (reduced by 200m) 6m crest width - Crest set at 1m above 1:1000 (PMF) to pass PMF
34	Auxillary Spillway *New* (roller concrete gravity structure, seeded) Crest 1.8m lower than floodplain berm
35	Diversion Channel Bottom Width: 22m (reduced from 30m) up to 150m, 4h:1v slopes (changed from 3:1 slode), depth of 8.3M includes 1.9m freeboard); base incl riprap, grass, bedrock, sides also inc l15cm topsoil & grass
36	Reservoir Inlet: grade controls structure & riprap
37	Emergency Spillway: *New Design* 354cms, 1,300 m upstream of dam, PDA no longer goes to the river (Exhibit 18 Fig 3-1), activated when reservoir full service elev of 1210.75, 135m concrete
38	Dam 77,800 dam3 (increase 7600dam3), dam height 30m, 3.5h:1v, 1212m elev at full pool, 2 embankments: one 3300m long, 30m high, the second is 400m long 23m high (reduction of 260m), no riprap, only grass (*New)
39	LLOW: Approach channel, gatehouse x1, 213m conduit (2.8m x 2.7m increase from 1.4m x 1.8m), outlet channel (most detail so far)
40	No changes to Springbank Road (change from relocated)
41	**MAY 2018 IR (Exhibit 81) DEBRIS DEFLECTOR**
42	*NEW* Debris Deflector at Diversion Inlet $9.63M excl engineering & contingency
43	Foundation: 160m long, 1.5m high, 6m wide supporting a vertical steel structure 6m high

44	**JUNE 2019 IR (Exhibit 138) PROJECT CHANGES (No cost estimates)**
45	Added: 4.8ha (12 acres) to construction area for LLOW changes
46	LLOW: Moved 190 to the SW from original location (reduced foundation risks)
47	LLOW: Added Second, mid-slope gate tower for a second back-up gate
48	LLOW: Construction of NEW channel from Unnamed creek to LLOW in reservoir (500m upstream)
49	LLOW: Construction of NEW channel from Unnamed creek to LLOW outside of reservoir (700m downstream)
50	LLOW: NEW erosion protection through the unamed creek (from NONE to FULL LENGTH)
51	Diversion Inlet: Added 5 large boulders and 3 boulder clusters
52	EIA: 2.5km of Diversion Channel reseeded, with balance riprap (2.2km); NOW 1.8km reseeded
53	Property access changes to 10 properties that require replacement or modification (1.1ha/3 acres added to PDA)
54	Total Project Footprint 1439ha (3556 acres)
55	**2020 Design (Exhibits 159 and 160) $527M**
56	Diversion Inlet Height 13m (increase from 11m and 9.5m)
57	Debris Deflection Barrier now 170m long an 7m tall (from 160m and 6m)
58	Service Spillway Height 12m (changed from 11m and 9.5m), Crest length 48m (increase from 43m), elev 1210
59	Auxillary Spillway Length 208m, elev 1215.8m, Discharge capacity 620cms
60	Floodplain Berm length 1033m (increase 33m), elev max 1221.5
61	Diversion Channel; Water depth at 600cms 6m (reduced from 6.4m)
62	Dam Height 29m (reduced from 30m), 1210.75 elev, Max base width 275m (increase from 205m), top width 10m
63	LLOW discharge at 27cms (up from 20cms)
64	Service Spillway: Added three rock v-weirs downstream of service spillway for bank stabilization and fish pasage
65	Diversion Channel: Changed slope through rock to 2:1 from 3:1, 5m bench included at soil/bedrock interface; additional riprap added to bottom of soil sections
66	Dam: 10m benches instead of 5m benches every 10 vertical meters, addition of 6m tall rock toe with 10m top for stability where soils are deepest

Historical Review of SR1 Project Costs

Prepared by Karin Hunter, February 2021

	A	B	C	D	F	G	H	I	J	K	L	M	N
1	**Report**	**AMEC Report (2014)**	**2015 IBI Benefit/Cost Report**	**Deltares Report 2015(1)**	**AEP DECISION REPORT (2015)**	**2017 IBI Report to YYC**	**2018 EIA**	**2019 Dec Cost Update**	**2020 Update - Open Houses**	**2021: Estimate by SCLG**	**$ Change 2020/ 2014 (I - A)**	**% Chg 2020/ 2014 (I/A-1)**	**$ Change 2020/ 2015 (I - D)**	**% Chg 2020/ 2015 (I/D-1)**
2	**Cost Component:**	Exhibit X, Vol 4, Appendix G	Exhibit TBC	Exhibit 13	Exhibit X:	Exhibit 78, Pg 1	Exhibit 20, page 2.13	Exhibit 159 Appendix G.2	Exhibit TBC: Page 22					
3	**DESIGN + BUILD COST**	**$159,767,800**	**$159,767,800**	**$214,768,000**	**$248,100,000**	**$291,711,750**	**$291,711,750**	**$340,628,065**	**$352,000,000**	**$352,000,000**	**$192,232,200**	**120%**	**$103,900,000**	**42%**
4	Construction Cost	$102,145,800	$102,145,800			$206,962,000	$206,962,000	$229,759,404						
5	Contingency ($)	$26,661,000	$26,661,000			$31,045,000	$31,045,000	$34,463,911						
6	Engineering	$26,661,000	$26,661,000			$38,000,000	$38,000,000	$60,700,000						
7	Utilities	$4,300,000	$4,300,000			$15,704,750	$15,704,750	$15,704,750						
8														
9	Land Acquisition Cost - Gro	$40,000,000	$40,000,000	$40,000,000	$40,000,000	$140,000,000	$140,000,000	$140,000,000	$140,000,000	$140,000,000				
10	Land Cost Recovery	$0	$0			-$60,000,000	-$60,000,000	-$60,000,000	-$60,000,000	$0				
11	**Net Land Cost**	**$40,000,000**	**$40,000,000**	**$40,000,000**	**$40,000,000**	**$80,000,000**	**$80,000,000**	**$80,000,000**	**$80,000,000**	**$140,000,000**	**$40,000,000**	**100%**	**$40,000,000**	**100%**
12														
13	**Total SR1 Direct Costs**	**$199,767,800**	**$199,767,800**	**$254,768,000**	**$288,100,000**	**$371,711,750**	**$371,711,750**	**$420,628,065**	**$432,000,000**	**$492,000,000**				
14														
15	**UPSTREAM MITIGATION**													
16	**Bragg Creek Berms**	**$8,900,000**	**$8,900,000**	**$8,900,000**	**$8,900,000**	**$32,800,000**	**$32,800,000**	**$32,800,000**	**$42,200,000**	**$42,200,000**	**$33,300,000**	**374%**	**$33,300,000**	**374%**
17														
18	**Adjustments (not comprehensive):**													
19	Changes between Dec 2019 and Dec 2020									TBD				
	Pipelines									TBD				
20	Adjustments for Mitigations / Risk									TBD				
21	Wetland Replacement(2)									$833,000				
22	RR40 - Upgrades for Detour(3)									$1,250,000				
23	Highway 22/Twp Rd 205 (Upgrades for Safety)									TBD				
24	Cash Comitment to RVC May 12, 2020								$10,000,000	$10,000,000				
25	Non-Cash Comitments to RVC May 12, 2020								$10,500,000	$10,500,000				
26	Grant to Tsuut'ina Nation April 1, 2020								$32,000,000	$32,000,000				
27	Payment to CalAlta for Water Rights									TBD				
28	**Adjustments (TBC)**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$52,500,000**	**$54,583,000**				
29														
30	**ADJUSTED COST**	**$208,667,800**	**$208,667,800**	**$263,668,000**	**$297,000,000**	**$404,511,750**	**$404,511,750**	**$453,428,065**	**$526,700,000**	**$588,783,000**	**$318,032,200**	**152%**	**$229,700,000**	**77%**

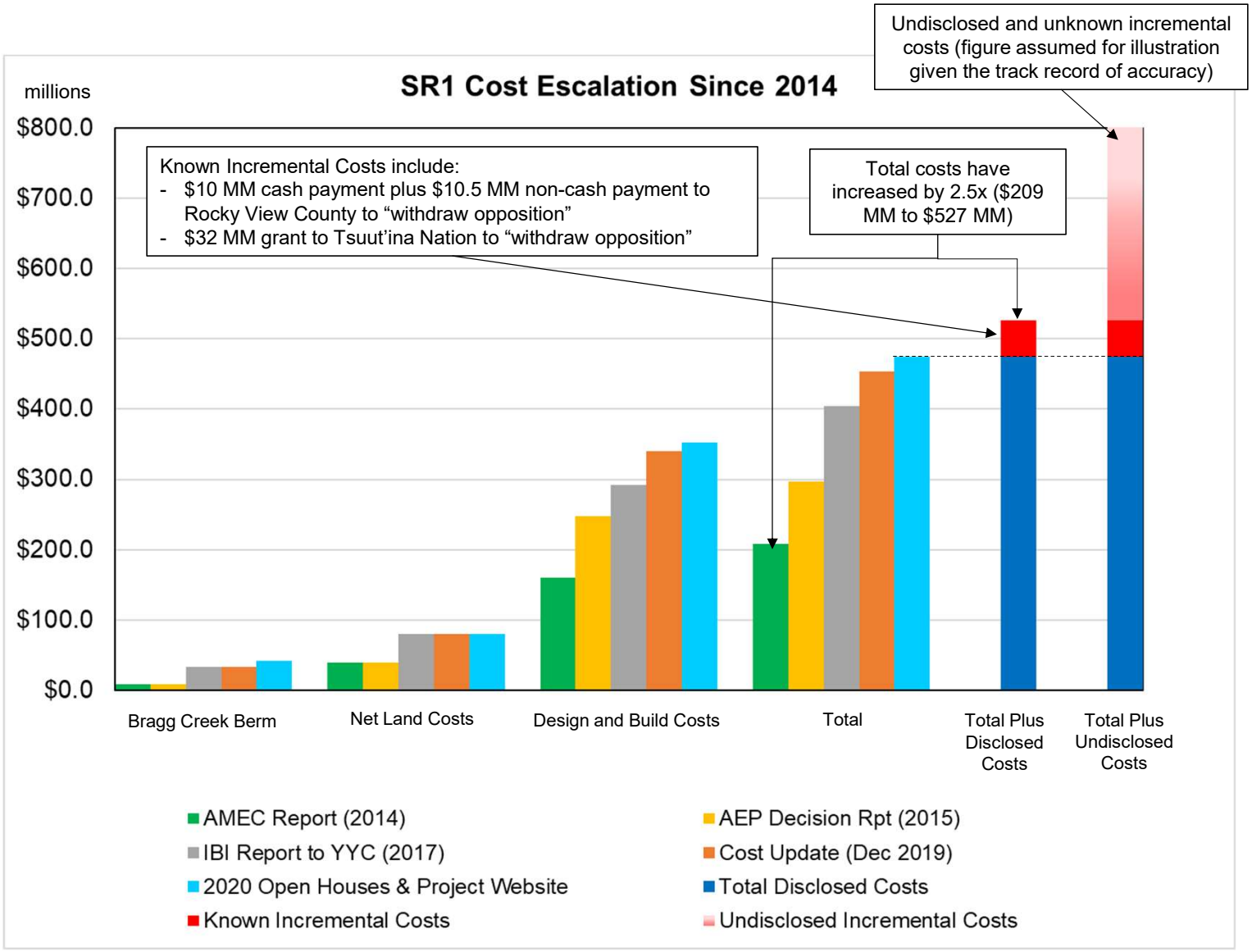
31 *(1) Deltares Report uses 1:100 in the text of the document, but the costs are 1:200*

(2) Wetland Replacement Exhibit 194 Comments to CEAA - General 15.3ha permanently, 11.7ha post-flood (using MC1 costs), Exhibit 94 Section 6 Terrestial IR421

(3) Cost of 2.5km of roadway using $500,000/km based on $250,000/km in 2014 AMEC report cost x 2 for paving & widening upgrade

SR1 Cost Escalation

- Alberta Transportation stated that SR1 represented the lowest cost alternative
- Since the decision was made to pursue the SR1 option, the costs have escalated from $209 million (AMEC 2014) to $527 million (Total plus Known Incremental Costs for Rocky View County and Tsuut'ina Nation to withdraw opposition)
  - This represents a 2.5x increase in costs
  - This does not include any undisclosed costs



Pipeline Cost Analysis

Desktop Analysis Using Lows/Highs

- Prepared by Karin Hunter

This is NOT expert analysis; only a desktop excerise to determine range of possible pipeline costs based on widely available data

Adjustment Factor: Materials & Labor Only	80%	Labour 40% & materials another 40% of costs
Cost/inch/mile - Low ($USD)	$ 100,000	https://www.gem.wiki/Oil_and_Gas_Pipeline_Construction_Costs
Cost/inch/mile - High ($USD)	$ 300,000	

	Pipeline (SR1): Source Exhibit 159	Pipeline Diameter (inches)	Estimated Distance (miles)	Cost Low (Est)	Cost High (Est)	AB Transp (2016)
1	TCE 80096-28 (Table 33) Natural Gas	36	1	$2,880,000	$8,640,000	
2	TCE 80006-28 (Table 33) Natural Gas	36	1	$2,880,000	$8,640,000	$3,030,000
3	Caledonian 7850-23 (Table 33) High Pressure Vapour	4.5	1	$360,000	$1,080,000	$718,750
4	Pembina 14766-2 High Pressure Vapour (Table 33)	6.6	1	$528,000	$1,584,000	$722,500
5	Plains Oil - High pressure - Remove and replace on new path 5844-15 (Table 38)	12.75	3	$3,060,000	$9,180,000	$7,672,500
6	Plains Vapour- low pressure - remove and replace on new path 26431-1 (Table 38)	4.5	3	$1,080,000	$3,240,000	
7	Plains Remove 3084-1 (Table 38)		3	*No estimate possible		
				$10,788,000	**$32,364,000**	**$12,143,750**

AT does not provide a breakdown for Plains or TCE

Source: https://www.allaboutpipelines.com/HDD_Calculation/HDDArticle

Geo-technical data for River Crossings: River crossings require additional information such as a study to identify river bed, river bed depth, stability (lateral as well as scour), and river width. Typically, pipes are installed to a depth of at least 6m below the expected future river bottom, considering scour. Soil borings for geotechnical investigation are generally conducted to 12m below river bottom.

https://www.gem.wiki/Oil_and_Gas_Pipeline_Construction_Costs

American Petroleum Institute 2017 Estimate

In its study of infrastructure through 2035, the API estimated average U.S. pipeline costs of $178,000 per inch-mile for 2016 (in nominal dollars) for large gas transmission pipelines. Combined with the estimate of 30 inches for average pipeline size, that amounts to $5.34 million per mile for gas pipelines, or $3.32 million per km. The API also estimate regional costs multipliers:[6]

- Central - 0.65
- Midwest - 1.20
- Northeast - 1.68
- Offshore - 1.00
- Southeast - 0.80
- Southwest - 0.74
- Western - 0.94

https://uconline.com/magazine/2012/january-2012-vol-67-no-1/features/2012-pipeline-construction-report*

After analyzing costs of 120 pipelines from the past decade, Ziff Energy Group's results show the average estimated shale gas pipeline rose in 2011 to almost $200,000/inch-mile (the cost per pipeline diameter inch per mile), three times higher than 2004.

*North America