Impact Assessment Agency of Canada (IAAC/CEAA)
National Resources Conservation Board (NRCB)

Delivered by email
Attention: Laura Friend (NRCB)
Jennifer Howe (IAAC / CEAA)

February 17, 2021

Re: SR1 Risk Comments

Our comments address CEAA's draft conditions of January 4, 2021 along with Package 4-Technical Review Round 2, March 23, 2020 and July 2020, and the Proponent's land-use plan from October 2020 (Question 4-05) among other items from the Proponent's prior submissions. We have not had the opportunity to adequately review the most recent December 18, 2020 Project Design given the holidays and requirement to comment on CEAA draft conditions by February 3, 2021. We remind regulators that we are community volunteers who spend inordinate amounts of time keeping up to date with submissions. We also express dismay that the NRCB Pre-hearing took place before the latest design was released. We did not have any indication that this updated design was imminent and it has created additional work for our volunteers. Additionally, the February 3, 2021 deadline for CEAA comments on conditions proposed on January 4, 2021 does not allow adequate time for robust review and comment. The CEAA deadline should at least include the expert evidence that arises at the NRCB hearing. To omit this evidence may result in missed-opportunities to improve Project outcomes.

In this submission, we highlight concerns with the Proponent's responses along with inconsistencies and gaps. We look to the regulators to provide robust technical analysis of the IRs, including assessing the engineering changes to SR1 for safety and risk.

General Comments

Dam Innovation:

Regarding embankment dams, USBR states [emphasis added][1]:

While modifications are necessarily applied to specific designs to adapt them to particular conditions, ***radical innovations are generally avoided, and fundamental changes in design concepts are developed and***

[1] Chapter 2: Embankment Design https://www.usbr.gov/tsc/techreferences/designstandards-datacollectionguides/finalds-pdfs/DS13-2.pdf

adopted gradually through practical experience and trial. Although the practice of gradual change through verified prototype designs may be criticized as being overly conservative, no better method has been conclusively demonstrated. *Where consideration is given to possible loss of life and extensive property damage that could result from dam failure, the major economic investment, and the importance of the stored water, ample justification is provided for conservative procedures.*

We ask regulators whether SR1 would be considered a *radical innovation* given its experimental nature with no relevant precedent presented for comparison. This project is not characteristic of "gradual change" referenced by the USBR. Therefore, we ask regulators to approach the project design and its operations with a generous amount of conservatism. Regulators should be asking "is this experiment superior to a tried and tested conventional dam approach at another location, such as MC1?"

Independent Expert Panel

Large scale capital projects typically have an independent expert review panel. The Proponent stated that such a panel exists[2], but we are vexed as to why its mandate, composition and outcomes are not mentioned anywhere. The Project has changed materially since it was identified, apparently without regard to cost or consequence. Has there been oversight by this Panel? If to, this information should be on the public record.

Proposed Condition: The Proponent shall release all documents relating to the mandate, activities and composition of this independent panel for inclusion in the CEAA report (Who are they? What are their qualifications? What role have they played? Are they unbiased?)

Project Design

The Proponent does not appear to lean towards a conservative approach to the design and operations of SR1. We contend that this project in its entirety, due to its unique nature, should be approached with a conservative lens. Rather, the Proponent, for whatever reason, does not appear to apply conservative standards to the design and operations of SR1. Rather, they are pushing back on additional erosion protection, operations, reporting and various other conditions. If they are motivated by a desire to reduce costs, this is utterly unacceptable. The horse has left the barn, so to speak. The priority should be to construct this Project with a safety factor that will endure over time, given the uncertainty regarding future flood events.

Inundation Mapping

The Proponent has not provided the worst-case scenario for flood mapping to inform what may occur during significant flood events. The only inundation scenario reviewed was a breach of the off-stream reservoir. This is not at all appropriate and we ask regulators to direct the Proponent to create a comprehensive set of flood maps that will provide regulators with the consequence of failures of components. Maps showing the consequences of the failures of the floodplain berm at the emergency spillway or gates need to be provided.

[2] Dec 21, 2020 Email from Matthew Hebert to Karin Hunter "In addition, Alberta Transportation engaged an independent Review Board throughout the design process. The purpose of this panel is to advise the government on all technical matters related to the design, construction and safety of high hazard structures such as major dams and their appurtenant structures, independent of the project designers."

If the floodplain berm fails, where doses the water go? Does it go over Highway 22? What about the consequences of activation of the emergency spillway during a large flood event? What happens to residence and businesses downstream where the spillway meets the Elbow River, which could have flood volumes. What in the inundation map of this scenario at various river flow rate?

Utterly ignored by regulators and the Proponent is the flooding that will take place between SR1 and the Glenmore Reservoir. This is unacceptable. It must be ON THE RECORD that residences and businesses along this corridor will still flood with volumes of over 600cms in a 1200 cms flood. SR1 can only take the peak of a flood – if it is managed properly. The peak is not fully managed and absorbed until it reaches the Glenmore Reservoir. This is a direct consequence of the choice to build SR1 over MC1.

We contend the Proponent has NOT fully presented the consequence of accidents and malfunctions. Further, they have not shown or discusses any consequences of a PMF. Why not? This project will be here for hundreds of years. This appears to be an attempt by the Proponent to distract from the reality that this Project is incapable of managing the flood risk for the City of Calgary.

Classification

The Proponent states that SR1 is an "Extreme Consequence" dam yet the floodplain berm is a "High Consequence" dam. These two items are connected intimately. BOTH structures should be designed to an Extreme Consequence rating as part of an EXTREME CONSEQUENCE system. To separate the classification of the two elements of one project as the Proponent has is not appropriate and we challenge regulators to review this approach by the Proponent.

Project Capacity

We maintain that the Project's capacity – volumes and rates - is insufficient to achieve the benefits identified in the benefit/cost analysis. Has the Proponent fully addressed uncertainty regarding future floods? We note that AEP, in its 2020 draft report for flood along the Bow and Elbow Rivers has a 1:200 flood rate of 1140cms for the Elbow River at Bragg Creek (range between 727 and 1930 to a 95% confidence interval, as below). Note the range here – this is an uncertain forecast. If a 1:200-year flood is at the upper range of the confidence interval, 2013 will be repeated for communities along the Elbow River between SR1 and Glenmore. What was the driving force NOT to build SR1 to the PMF? Cost? Location? Schedule?

Table E.1: Final Flood Frequency Flow Estimates – Natural and Naturalized Flows

WSC Station ID / Node ID	WSC Station Name / Location of Interest	Effective Drainage Area (km^2)	Distribution / Method	Comput									
				1000-yr		750-yr		500-yr		350-yr		200-yr	
ELBOW RIVER AND TRIBUTARIES													
05BJ004	Elbow River at Bragg Creek, extended using relationship established with Elbow at Sarcee Bridge based on Instantaneous floods, historic	791	*Historical adjustment ratio applied to 3P(MLH)³*	2150	4000	1930	3520	1660	2980	1440	2520	1140	1930
					1260		1150		1010		891		727

Climate change, combined with the long-term of SR1 life indicate that larger floods are expected. Does the Proponent acknowledge that extreme consequence dams should be built to PMF?

- Are flow rates expected to increase over time as a result of climate change? Can SR1 be adapted to this change? If so, how?
- Is there an increased risk of back-to-back floods due to climate change? Can SR1 be adapted to this change? If so how?
- Is there an increased risk of flood volumes due to climate change? Can SR1 be adapted to this change? If so, how?

If any of the above answers are "no", the Proponent is responsible for risk adjusting its benefits calculations.

Flood Forecasting Inputs:

When arriving at SR1 sizing, the Proponent excluded large floods in the late 1800s and early 1900s. Was this intentional? What is the basis for excluding this information when they would have yielded a different sizing for SR1? What is the impact of including those large floods? What is the risk to the City of Calgary and the benefit/cost analysis of ignoring those floods?

Further, regarding snowmelt, CEAA states (pg 43 of draft report) the following:

> The intensity of the 2013 flood event was the result of increased rainfall at high elevations, increased runoff from snowmelt over partially frozen soil and a 36 hour storm event. Localized pockets of high intensity convection driven rainfall over the foothills and plains, as well as in the upper Elbow River watershed, also contributed to extreme runoff conditions.

This is supported by AMEC's report, which states the following:

"Recent severe flooding in the Bow River watershed has been the result of precipitation from multi-day storms with low annual probabilities falling on snow. In these low probability events, approximately 70% of the resulting runoff originates directly from rainfall, with the remaining approximately 30% originating from snowmelt. These storms have occurred in late spring, while snowmelt is occurring and while streamflows are elevated by normal seasonal snowmelt."[3]

Yet, the Proponent states IR451: "snowmelt was determined not to have a major effect on peak flow". Is snowmelt missing from the Proponent's flood forecasting model? This would be a grievous oversight. If it is included, what is the explanation for the response to IR451?

Which is it and how should these competing statements be reconciled?

Comprehensive Risk Assessment

We request a fulsome structural and operating risk assessment on SR1 in advance of any rulings by IAAC and NRCB. The significant structural changes and apparent foundation challenges raise concerns about stability and structural integrity. An independent third party experienced in dike/ embankment projects should be engaged immediately and a comprehensive and quantitative risk assessment conducted. As community members, we cannot undertake this assessment as it will require significant and meaningful

[3] https://open.alberta.ca/dataset/8106746d-34af-4f2a-b104-3ff4cbfc65ab/resource/05b643dc-5d8b-42a3-9a16-01ed10709531/download/2014-volume-2-general-information.pdf

participation by the Proponent and a large budget. This is a new and unprecedented approach to flood mitigation. Combined with the challenging nature of flood forecasting in this region due to its proximity to the headwaters and the compounding effect of snowpack, Project operations must be thoroughly vetted prior to its approval.

Overall, we believe that the operational risks of SR1 have not been fully explored. There is much in the way of "a plan will be developed" -type statements by the Proponent and regulators.

USBR has extensive Risk Analysis guidance that should be applied to SR1.[4] This is an experimental combination of structures used during high stress events and located on a site with an apparently questionable foundation. Unlike other dams or reservoirs, SR1 will fill up quickly and, given its pivotal role in protecting the Glenmore Reservoir, it does not appear to allow for much in the way of errors in judgment during use. We must take seriously the consequences of and sources of failure of various components.   **We call urgently for a thorough and independent and expert risk analysis, with a focus on potential failures modes and mitigations.**

[4] https://www.usbr.gov/ssle/damsafety/documents/PPG201108.pdf

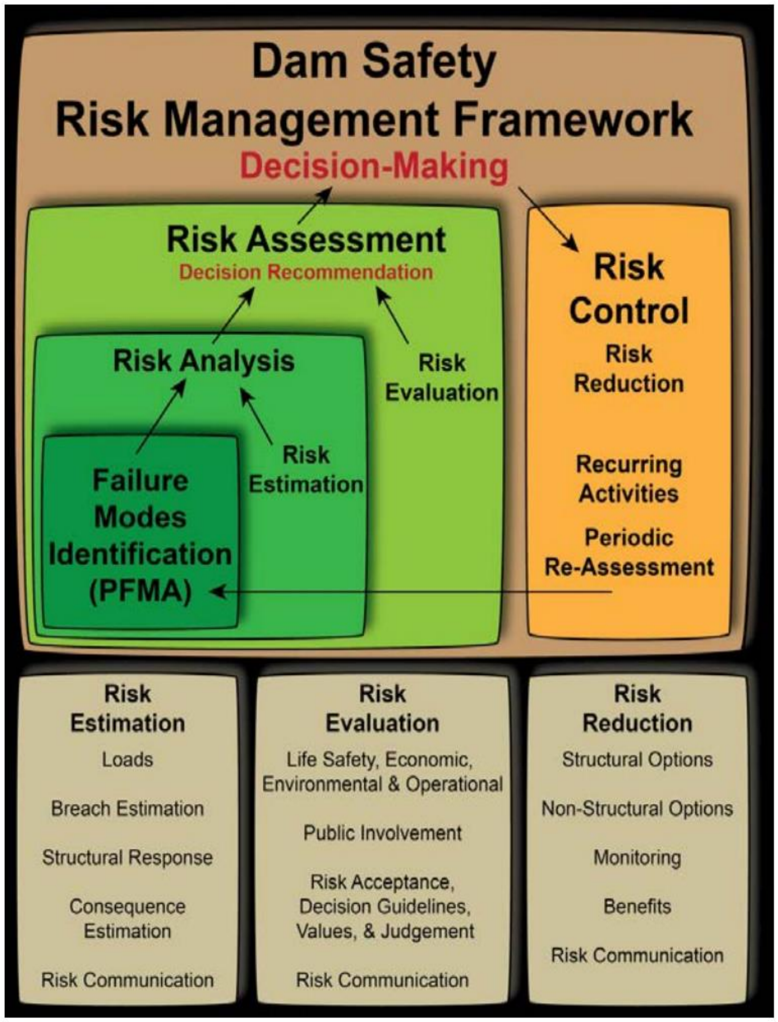


Figure A-9-1.—Relationship between risk analysis, risk assessment, and risk management.

There are current and comprehensive risk analysis Best Practices at USBR (2019) that should be used by the Proponent and/or regulators to evaluate the risks of SR1.[5] We expect that these current Best Practices be applied to SR1, given the consequence of the project and its experimental nature. A fulsome assessment of Potential Failure Modes (PFMs) is lacking. A brief overview of the various sections is below:

1. Semi-Quantitative Risk Analysis Technique[6] - "Semi-Quantitative Risk Analysis (SQRA) is a process to evaluate their significance from a risk perspective. SQRA is a risk categorization system that assigns likelihood and consequence categories to potential failure modes based on existing data and available consequence estimates."

[5] https://www.usbr.gov/ssle/damsafety/risk/BestPractices/Chapters/1-BestPracticesCover.pdf

[6] https://www.usbr.gov/ssle/damsafety/risk/BestPractices/Chapters/A4-Semi-QuantitativeRiskAnalysis.pdf

2. Failure Mode Analysis - understanding the ways, in detail, in which the structure(s) could fail, including operational errors [7] This is a critical step for SR1 given the many elements and structures that must work in concert for a successful diversion, retention and release.
3. Geologic Information Required For Dam and Levee Risk Analysis[8] - It appears that of utmost importance is the geologic information from the selected site. We know that the SR1 site was selected prior to any site-specific geologic analysis. If the Proponent has evidence of analysis prior to the selection of SR1 in 2013/2014, we would love to see it. According to USBR, "An initial geologic understanding of site conditions should always be developed in the earliest phases of the risk assessment because subsequent phases of work use the geologic information as basic site constraints; therefore, it is critical that the geologic data, interpretations, and ranges of uncertainty are all communicated to the risk assessment team".

4. Event Trees[9] - This is a critical necessity for SR1 and can be used to arrive at quantitative assessments of risk, using Monte-Carlo simulations. We point out that the Proponent's own Operational Process (Fig 1-1) for SR1 has many assumptions (including functioning river flow gauges), that if wrong, may compromise SR1 safety. "An event tree consists of a sequence of interconnected nodes and branches. Each node is associated with an uncertain event (a crack forms in the embankment) or a state of nature (existence of adversely oriented joint planes). Branches originating from a node represent each of the possible events or states of nature that can occur. Probabilities are estimated for each branch to represent the likelihood for each event or condition.)"

   For SR1, we are particularly concerned about flood operations. Given the requirement for human operation of the gates and real-time monitoring of data, we ask for Potential Failure Modes (PFMs) associated with human error.

5. Combining and Portraying Risk[10] - "After all potential failure modes (PFM) have been identified and described, and their risks have been evaluated, the results need to be combined and portrayed so that the technical reviewers and decision makers can understand and act upon them. This requires attention to detail, and if not undertaken properly, could result in an incorrect portrayal of the risk. This chapter describes some of the details needed to properly do the job. A risk analysis, whether by

[7] https://www.usbr.gov/ssle/damsafety/risk/BestPractices/Chapters/A3-PotentialFailureModeAnalysis.pdf "It is important to include, but also think beyond, the traditional "standards-based" analyses when identifying potential failure modes. Some of the more critical potential for uncontrolled release of water may be related to malfunction or misoperation issues, or behavior that cannot be analyzed using traditional standards-based engineering analyses. "

[8] https://www.usbr.gov/ssle/damsafety/risk/BestPractices/Chapters/A2-GeologicInformationRequiredForDamAndLeveeRiskAnalysis.pdf "Geologic conditions may constitute a flaw in a dam or levee component that could lead to a potential failure mode, and active geologic processes may cause changes in conditions that lead to component flaws and potential failure modes. Geologic materials form the foundations for almost all dam and levee systems because, ultimately, every dam or levee system rests upon earth materials that have been formed through geologic processes. As a result, a reasonable level of knowledge of geologic conditions at a dam site or under a levee system is needed for understanding site-specific hazards, and the potential failure modes that arise from these hazards."

[9] https://www.usbr.gov/ssle/damsafety/risk/BestPractices/Chapters/A5-EventTrees.pdf

[10] https://www.usbr.gov/ssle/damsafety/risk/BestPractices/Chapters/A8-CombiningAndPortrayingRisks.pdf

a team or by an individual, produces estimates of risk for individual potential failure modes. These estimates might include probability or risk values for different loading conditions, loading ranges, spatial segments, or other situations. The risks from individual potential failure modes are often combined in some way to express their collective effect."

6. Governance and Guidance[11] - "An independent group should review the draft risk analysis report and the safety case and then provide additional input and possibly revisions to any proposed actions. This independent group may identify additional factors to consider in the risk assessment or additional options for refining or reducing risk." Interestingly, the governance guidance in USBR does not consider unique elements of an off-stream embankment and its components of channel, floodplain berm and diversion structures. These additional components add incremental risk and PFMs that need to be contemplated. We have spoken with several engineers in the Calgary area who say that this project is too complex to review.

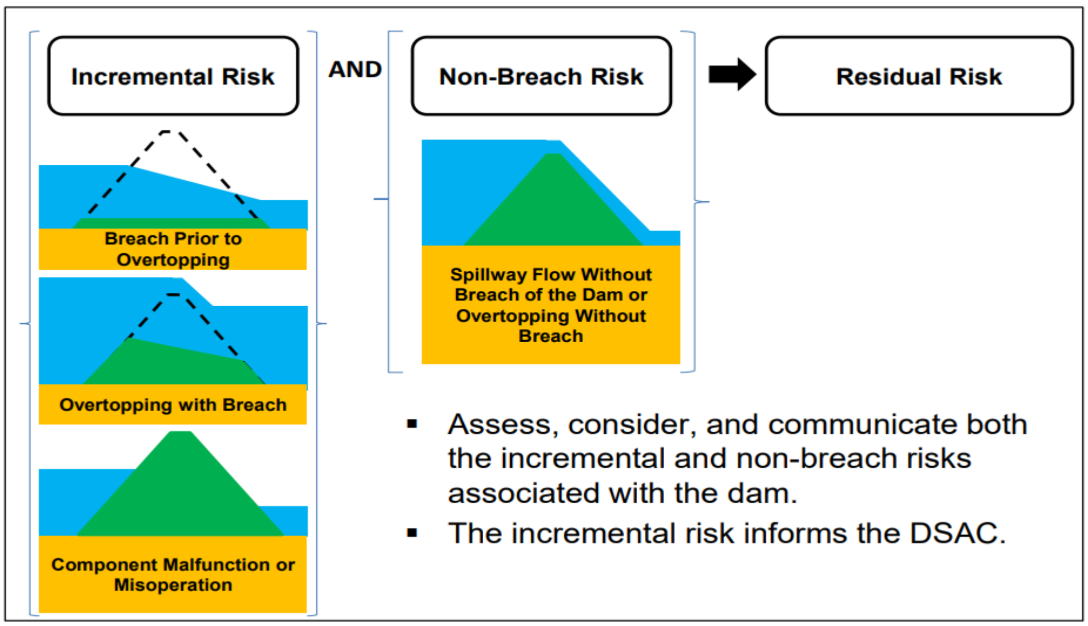


Figure A-9-3.—Residual risk.

Example: Spillways (USBR):

Probabilistic (in the form of a quantitative risk analysis), rather than deterministic, considerations will be part of any analysis/design for significant- and high-hazard dams and/or dikes, along with associated appurtenant structures (such as spillways) or critical components of associated appurtenant structures. The steps will be integrated with the previous design/analysis and include:

- *Identify and define credible PFMs for the existing, modified, and/or new spillway. Although each spillway may have some unique PFMs, common PFMs include:*
    - *Flood-induced overtopping of dam and/or dike.*

[11] https://www.usbr.gov/ssle/damsafety/risk/BestPractices/Chapters/A9-GovernanceAndGuidance.pdf

- *Flood-induced spillway operations that exceed the original/maximum design discharge, leading to overtopping of the chute wall and/or terminal structure walls, pressurizing the conduit and/or tunnel, or sweepout of the terminal structure, and leading to erosional headcutting of the spillway foundation or erosion of the dam and/or dam foundation.*

- *Flood-induced spillway operations that result in cavitation damage of the chute and/or conduit, leading to erosion of the foundation.*
- *Flood-induced operations that result in stagnation pressure (hydraulic jacking) and/or structural collapse of the chute and/or terminal structure, leading to erosion of the foundation.*
- *Seismic-induced structural collapse of the spillway crest structure or features (such as piers, walls, and/or gates).*
- *Based on Reclamation's public protection guidelines [7], estimate the sum of the baseline (existing) risks (11) for all credible PFMs for all loading (12) conditions associated with existing and/or new dams, dikes, and all appurtenant structures such as spillways and outlet works.*
- *For the modified or new spillway, if the estimated sum of AFP and/or ALL for all credible PFMs are "tolerably"(13) below Reclamation guidelines (1E-4 or a 1 in 10,000 chance during a given year for AFP; and 1E-3 or a 1 in 1,000 chance during a given year for ALL), designs may be acceptable; however, if not tolerably below Reclamation guidelines, additional design considerations/features will be necessary to lower the estimated AFP and/or ALL for the modified or new spillway.*

To address the uncertainties associated with using quantitative risk analysis to select an IDF, a robustness study is done to evaluate plausible operational and hydrologic/hydraulic scenarios that could increase the maximum RWS above the IDF-induced RWS. Typical scenarios that are evaluated include:

- *Misoperation.*
- *Change in hydrology.*
- *Debris blockage.*
- *Change in downstream consequences.*
- *Wind-generated waves.*

11 Risk includes the AFP and ALL.

12 All loading conditions include static or normal operations, hydrologic or flood conditions, and seismic or earthquake conditions.

13 Tolerably below Reclamation guidelines will be unique to each condition/situation and will be mutually agreed to by the designer of record and Reclamation's Dam Safety Office along with concurrence by Reclamation management. Consideration will include the level of uncertainty associated with estimates and future conditions that could increase the estimates (such as changes in downstream consequences).

Drought and Structural Integrity:

In the 2014 AMEC report, the following statement is made:

"Martz et al. (2007) assessed the impact of climate change on surface water supply in the SSRB. Their study indicated that temperatures could increase between 1.5°C and 2.8°C in this region by 2050, which would increase evaporation and evapotranspiration levels. This would lead to potential changes in annual flow of the rivers, with potentially significant declines in flow during the summer season. This is important as the large majority of water demand occurs during this season. The study showed that in-stream flows could decrease by an average of 8.4% across all basins (Figure 4.5):

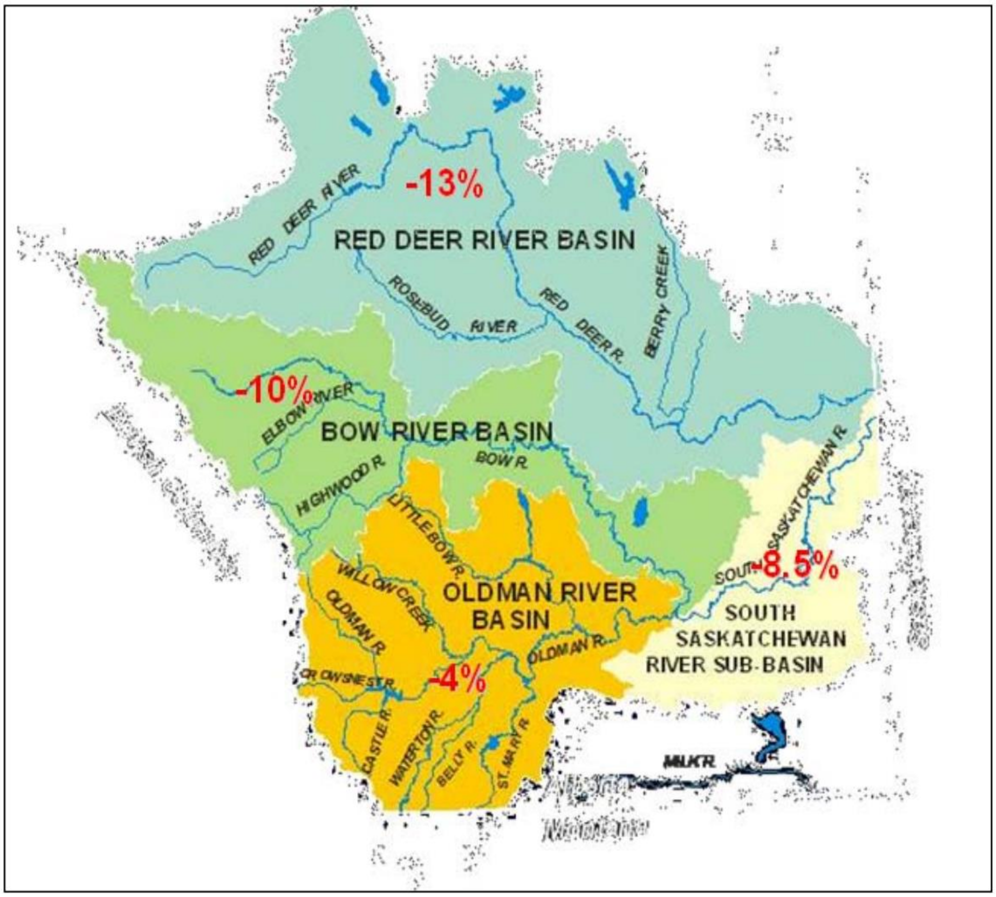


Figure 4.5: Projected Flow Reductions in the SSRB with Climate Change

The report goes on to say:

"Southern Alberta has insufficient water storage capacity to weather successfully a multi-year drought. Total storage capacity (on-stream and off-stream reservoirs) within the SSRB could sustain water demand for less than 2 hot, dry years, such as was experienced in 2000 and 2001. This time-frame may even be optimistic since no one can predict whether a single hot, dry summer will be followed by good winter precipitation, or if it signals the beginning of a drought. It is also not known how long the drought will last.

To address this issue, a study was carried out in the Bow River basin to assess Adaptation Strategies for Current and Future Climates in the Bow Basin (Alberta Innovates – Energy and Environment Solutions; and

WaterSMART Solutions Ltd. 2013). The project assessed a large number of options that could be applied in the basin to meet existing and future water demands under projected climate change scenarios and recommended a suite of practices that could be implemented.

The study generated 50 annual flow projections for the 2025 to 2054 period. From these flows, three annual low-flow scenarios were chosen to reflect dry conditions in the basin. The low flows showed significant impacts on water supply in the basin, including much lower storage levels (and at times, no storage) for TAC reservoirs and Calgary's Glenmore Reservoir, reduced flows through Calgary, adverse impacts for downstream aquatic health, and water shortages for the Western, Bow River, and EIDs. There were also shortages to non-municipal users throughout the Highwood River basin."

Given this research, where is the accounting for drought in SR1 and its structures? Where is the accounting for warming temperatures (and therefore SR1 waters)?

Research shows that fires in forested areas may exacerbate flood situations through the creation of flash floods. Where is the Proponent's statement on this risk? MC1 could have helped to manage forest fire risk, thus mitigating potential fire damage. [12]

Accidents and Malfunctions

Operating Risk:

Lack of a Detailed Operating Plan

The SR1 project is an unprecedented flood mitigation project – this has been acknowledged by Stantec at public meetings. This combination of structures must be operated in a time sensitive and high stress environment that necessitate that operating plans undergo detailed scrutiny. Unfortunately, the Proponent has provided a general set of protocols which are high level and do not fully address the range of operating conditions that exist. The success of the project is highly - and disproportionately – dependent on the success of flood operations activities and the specific conditions of a flood. The purpose of SR1 is to reduce – or attenuate - flood stream flows to the Glenmore Reservoir to a maximum of 600cms. Thus, if a flood surge or peak flow exists that is NOT captured by SR1, either because the reservoir is full, due to forecasting errors or environmental conditions (back-to-back storms, short but high intensity storm, etc.), SR1 will not be effective at capturing flood waters and preventing damage downstream. What is the point of infrastructure that MAY NOT capture the flood peak it is intended to capture? Nonetheless, the operating conditions for this project need to be detailed and clear IN ADVANCE OF APPROVAL. The current operating protocols are deficient and we ask regulators to demand detailed operating plans in advance of approvals.

Proposed Condition: The Proponent shall provide a detailed operating plan for the Project in advance of the final CEAA report.

There is an interconnected nature to SR1 operations that was identified in the Deltares Report (below).

[12] https://www.weather.gov/riw/burn_scar_flooding

Deltares

Enabling Delta Life

Date	Our reference	Page
October 7, 2015	1220924-001-BGS-0001-lk	4/8

ADDITIONAL CONSIDERATIONS:

The province should continue to pursue the multiple layers approach to flood mitigation as outlined in previous work on Room for the River, structural mitigation is only one element. Programs like wetland restoration, flood way regulations and removal of obstructions should continue. Temporary storage of water in detention areas is not a very robust measure, in the sense that it is effective up to a certain design condition, but when it is overcharged its effect is reduced to nil. And, moreover, it is very sensitive to 'sound operation and fast response time'. When floods up to the size of the June 2013 flood would be avoided, but anything above would not be reduced in size, the awareness of the people in the floodplain will further decline, making them (and society at large) even more vulnerable.

Deficient Consequence Analysis:

SR1 is composed of a complex series of components that must work in concert for successful operation. The Proponent seems to believe that this project is superior to a conventional on-stream dam. While we disagree on this point, it does not appear that operational risk was a criterion used in the decision-making process. We contend that this project is has unique risks due to its operation only during high-stress events. SR1 is the insurance policy against Glenmore Reservoir failing. SR1 is the insurance policy against Elbow River floods in Calgary. This is a high-stakes project with negative consequences that could be catastrophic. The urgency with which the Proponent is advancing this project is not in alignment with the risk the Project introduces to the Elbow River systems during flood. We must fully understand all the risk and Potential Failure Modes (PFMs) of SR1. It seems that PFMs are interconnected in many cases. It would be negligent to approve this project without a *comprehensive and independent* risk assessment that describes failure modes and their consequences in detail. We do not believe enough attention has been paid to the operations of SR1 during flood events.

Operating Protocol Review:

Assumptions:

The Proponent uses the following assumptions in their flood operations protocols[13]:

[13] https://www.nrcb.ca/download_document/2/83/10293/20200716-at-sir-to-agency-re-ir-response-package-4-round-2-unsecured

General Assumptions/Recommendations

- AEP flood forecasting shall provide continuous flood forecast modeling and is responsible for alerting personnel of impending flood risk.
- Automatic control with manual override (and remote available).
- City of Calgary and AEP are in frequent communication prior to flood season.
- All existing hydrometric stations are in operation prior to flood season.
- A hydrometric station is installed at the Highway 22 Bridge.
- Glenmore performs pre-flood draw down levels for all flood events. (See bottom left for Glenmore operations). *ASSUMPTION OF 10,000 DAM ^{3} OF AVAILABLE STORAGE IN GLENMORE*
- Priority should always be to divert into SR1 over Glenmore.
- Gate operating position will be adjusted at regular intervals.
- Assume annual OMS work is on-going, including exercising of gates, inspections, reservoir maintenance, etc.

Hydrometric Stations:

Is the assumption that hydrometric stations in operation DURING a flood event will be operational? The Proponent's statement uses the words "in operation prior to a flood season". What happens if the monitoring stations malfunction or do not properly read flood volumes as in 2013? What is the approach to diverting water? Visual cues? Based on what? This is a really big assumption and it would have been WRONG in 2013.

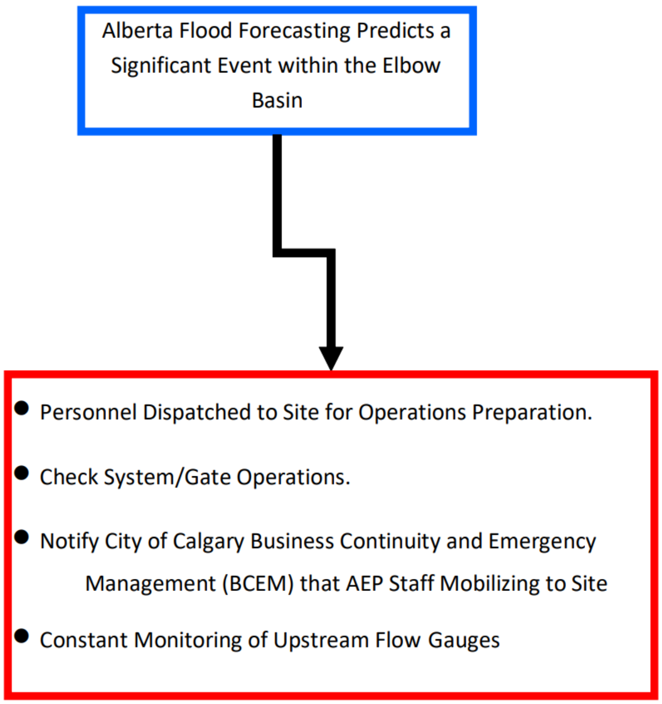
Priority to City of Calgary & Glenmore Reservoir:

The Proponent states that "the Priority should be to divert water to SR1 over Glenmore." This is a very risky statement in our view. The intent appears to be to maximize SR1 volumes. Yet, safety of SR1 must be the main priority. The risks of overtopping SR1 outweigh the risks of extra water in Glenmore. Or does the Proponent have a different view? Further, what is the lead time to close the gates? How much water is remaining in the diversion channel? What if the emergency closure protocols for the gates need to be implemented? How much time will this take? This GENERAL RULE is questionable and will result in a conflict between safety of SR1 and flood mitigation for the City of Calgary. Is there a situation where there will be high snowpack and a prolonged forecast of rain? Does this foretell a possibility of increasing flow rates and a full SR1 reservoir? Would there be a situation in which SR1 diversion would not take place at 160m/s3?

SR1 Preparation:

From the Proponent's operating protocols:

>48 Hours Prior to Flood



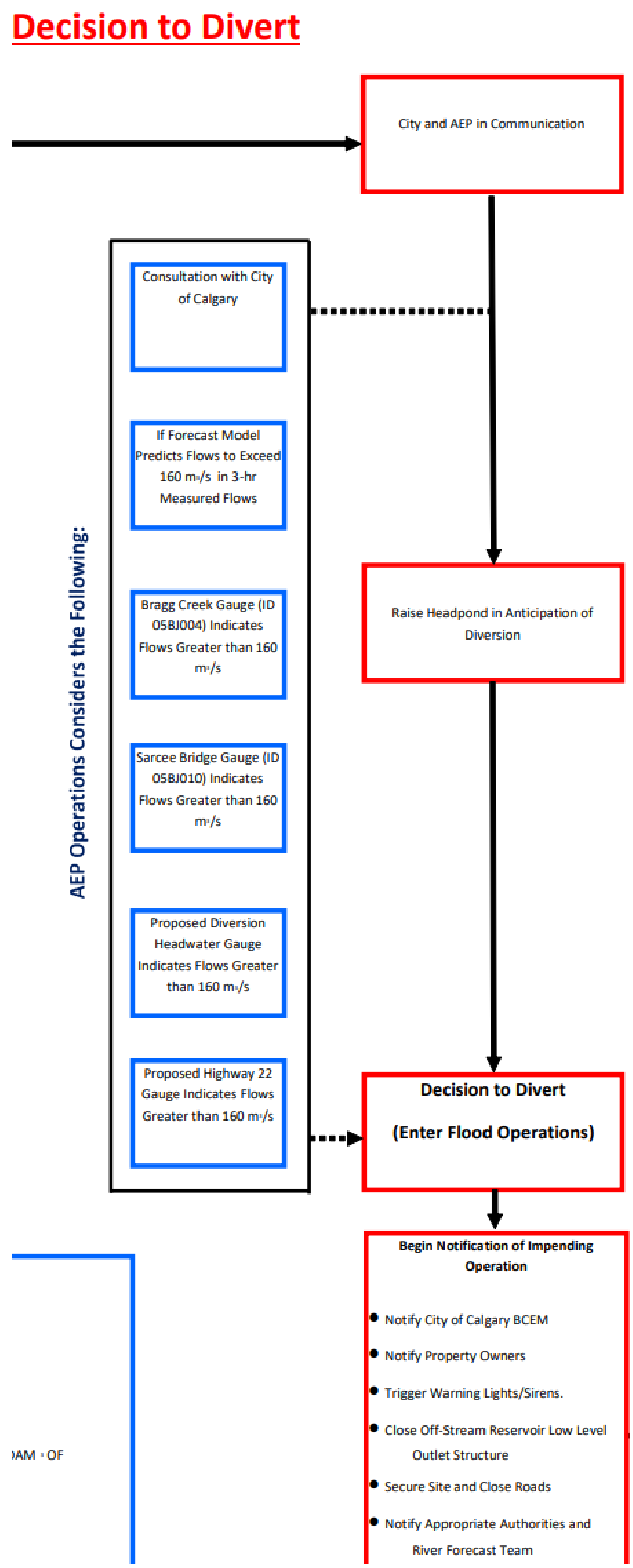
Comments:

- There is no notification of Rocky View County or area residents. That is an oversight that should be rectified.
- There is no mention of pre-flood clearing activities that are required for wildlife. When does this take place and what is the notification process?
- The >48 hours before flood is actually laughable if it weren't so deadly serious. No one really knows when a flood will be upon us to the day, let alone the hour. That is evident based on resident experiences from the Bragg Creek area in 2013. The flood forecasting conditions should be identified as a requirement for CEAA to prepare its final report on SR1 and for regulators to consider.
  - Days of rain? Actual? Forecast?
  - River flow and its trends? Using what locations? Which location is definitive?
  - Ground saturation?
  - Quantity of rain? Over what period? Within the last month? Week?
  - Snowpack? Reduction in snowpack?
  - Temperatures? Over what period? Historical? Future?
  - Date? Early May vs mid-late June?
- Who are these people who are responsible for operating SR1?
  - Are these personnel experts on SR1? Are they from different dams? Is it whoever is on call somewhere in the AEP system?

    - What training will these people have that will allow them to operate SR1 in a high-pressure situation with little room for error?
    - Where will these personnel be based? In Calgary or somewhere else? Will they stay nearby?
    - How many of them will be there? Are there people at the outlet and the intake at all times?
    - Is there any redundancy?
    - Will they have access to seismic and water readings from the embankment?
- We think it is fair to assume that each year there is some concern of flood.
    - Do the onsite personnel need 48 hours to prepare SR1? If so, they should be dispatched sooner. Floods will not be predictable. What trigger will be used to dispatch personnel to SR1?

Decision to Divert:

The Proponent provides the following illustration:



Comments:

- This is late for notification of residents in the area
- Also, closing roads will take time which is not considered

Questions:

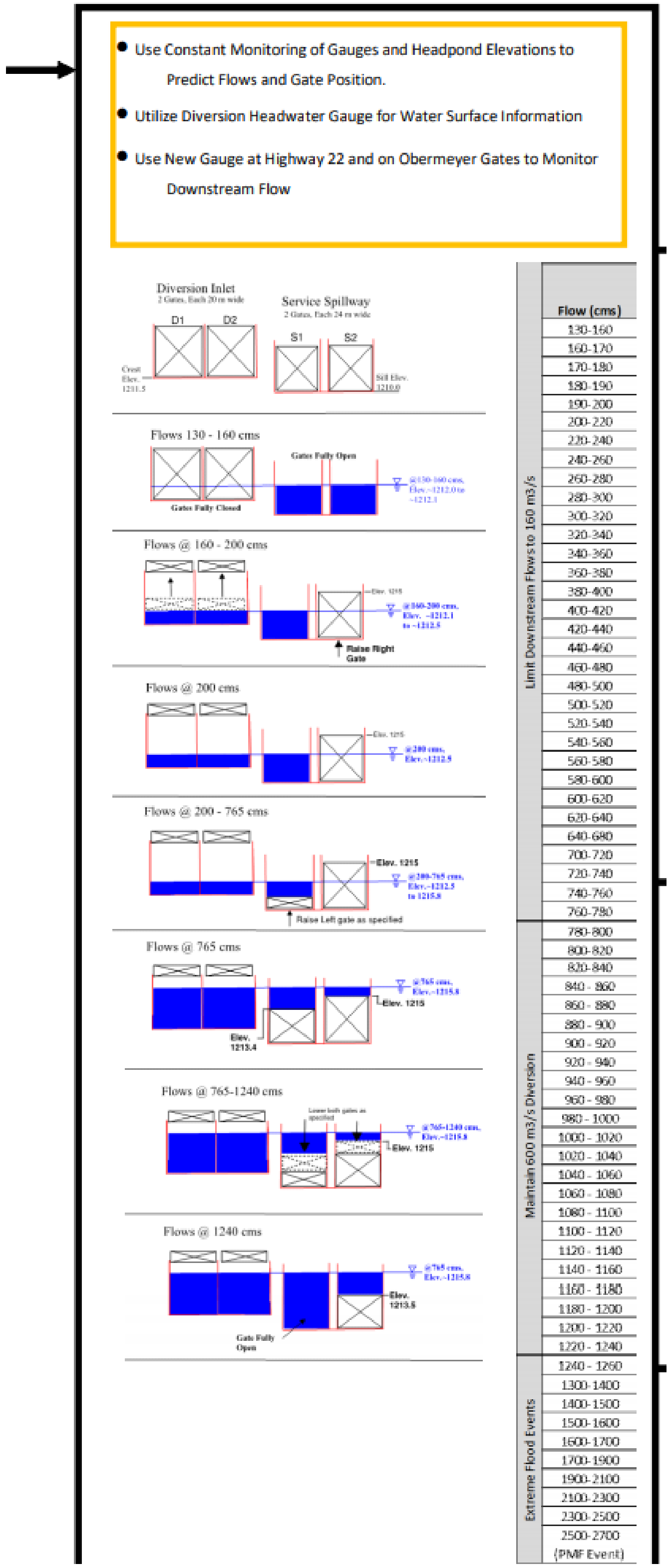
- Do all stations need to read >160cms?
- What if one station is not reading? Does it matter which station?
- What if more than one station is not reading? Does it matter which stations?
- What if the station readings are contradictory? I.e. some are <160cms and some are greater?
- Is it possible that the Diversion gauge may not be accurate due to backwater behaviour or impacts of debris?
- Which gauge is the leading indicator of flood? Bragg Creek? Are there no stations upstream of Bragg Creek?
- In a river that is increasing in velocity, what is the variance that can exist between Sarcee Bridge and Bragg Creek? How is this accounted for and incorporated into the decision? For instance, is there a scenario where Sarcee is <160cms but Bragg Creek is more? How will this be reconciled and used in operations?
- Will the diversion be stopped if data readings are contradictory or suspected to be impaired?

Flood Operations

The Proponent provides the following illustration:

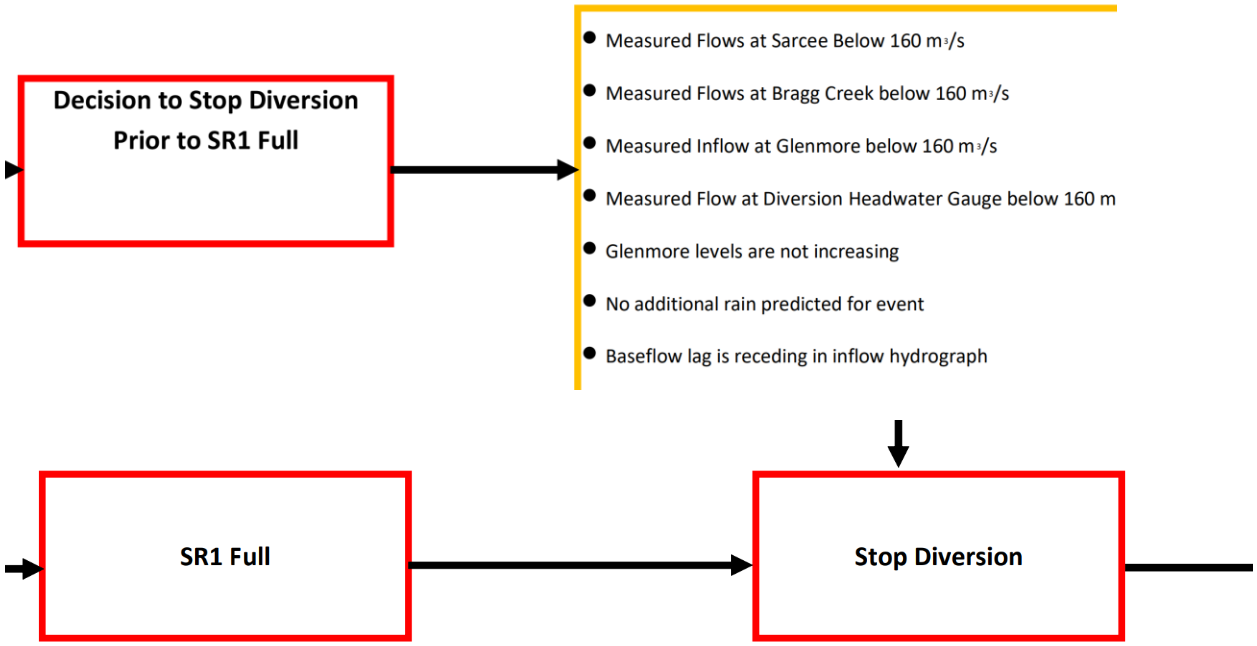
Comments:

- Operations over 1240cms are not identified.
- There is no reference to measuring the reservoir elevation here at all in order to assess if SR1 is approaching its full capacity. How will this elevation be measured and what level of confidence exists around this measurement?



Stop Diversion:

The Proponent provides these illustrations:

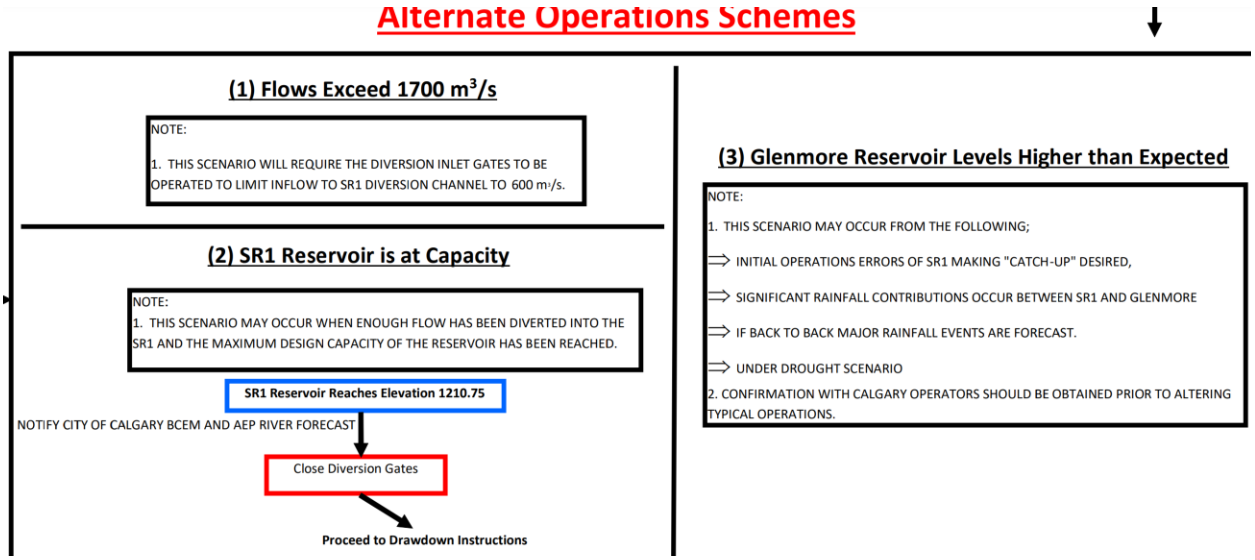


Comments:

- The SR1 "Full" box is glaringly empty.
- How is SR1 determined to be full and how is water in the diversion channel accounted for?
- Is someone monitoring the emergency spillway to see if it is activated as an indicator of full pool?
- There should be some warning or indicators for "SR1 Full" assessment, should there not? Will the water levels in SR1 be difficult to read if there is wind or unexpected behavior of the water in the reservoir (waves)?
- What is the impact of sediment deposition in the reservoir and its impact on elevations / volumes?

Alternate Operations:

The Proponent provides the following illustration:



Comments:

- It is clear that the focus is protecting Glenmore "Confirmations with Calgary operators should be obtained prior to altering typical operations". Is this the right protocol? Again, the main priority of SR1 operations should be to SAFELY operate SR1. That may sometimes contradict the best interests of Glenmore Reservoir operators and result is competing outcomes.
- We are concerned that the first fill(s) of SR1 will be full of uncertainty and operating risk. How will this elevation be established during a frantic diversion during a severe weather event? What is the margin of error here?

Diversion Inlet:

Human Error:

How likely is it that an appropriate amount of water is diverted? One would think that safety of SR1 would lead to the result that less water would be diverted to SR1 thus eroding benefits to the City of Calgary, however the pressure to maximize retention at SR1 is a factor.

Humans will operate the diversion gates and one of 3 outcomes will take place:

- The right amount of water is diverted to minimize water to YYC and maximize water to SR1 (this probably will never happen).
- Too little water is diverted to SR1.
- Too much water is diverted to SR1.

Unlike conventional dams, which are generally predictable (water levels raising based on rates), SR1 is not predictable. This is a risk that has not been documented.

Diversion Inlet Risk:

What is the margin of error for diverting water during flood? What is the consequence of diverting water too late or too early under various flood scenarios (durations and intensities)?

- Is the structure able to pass a PMF?
- What is the timeline for making changes to water level in the reservoir based on the intake to the diversion structure?
- How much room for error is there at diversion?
- Need measurement systems to be accurate and timely across locations (unlike 2013).
- What is the failure scenario of blockage of any and all of the intake structures?
- Lead time between diversion gate area and reservoir level?
- Will sediment accumulation or debris in reservoir / channel / diversion affect measurements? Much room for error here.
- How will sediment deposition at the headpond impact measurements during a flood? How will this sediment be measured in a flood situation or accounted for?
- What if measurement systems fail or are not accurate, as in 2013? Will visual assessments replace measurements or will the diversion be stopped in the interest of safety?

Floodplain Berm

If water pools at floodplain berm before entering SR1, what is the effect of all the new upstream riprap at Bragg Creek and Redwood Meadows? Will rocks deposit here? Will it go down the river? Will it enter the diversion channel? We have not seen an accounting of this. Most riprap from Redwood Meadows along key scour paths washed away in 2013. Will the measurement gauge here be at risk from debris? How will the Proponent mitigate that risk?

One would think that SR1 floodplain berm is an unknown - how far upstream are measurement systems from this area because water must behave differently here before it enters SR1. Can this pooling area impact upstream water behaviour and for how far (headpond?) Are flow rates in the diversion channel consistent with rates in or near the floodplain berm area?

What is the risk and consequences of a failure of the floodplain berm?

What is the risk and consequence of a larger flood at this area? The Proponent discusses sediment deposition at near the inlet (PRELIMINARY DESIGN REPORT, Bedload Sediment Transport 5.1.3.6 Conclusions):

- Sediment deposition will occur in the headpond upstream of the Service Spillway.
- Deposition will begin at the upstream point where the water surface elevation affected by gate operation meets existing grade.
- Deposition patterns will advance downstream as the river channel aggrades and the upstream water surface gradients increase.
- Bedload transport into the Diversion Channel is not anticipated until the area upstream of the Diversion Inlet increases to the fixed weir at Elevation 1211.5 m.
- Simulation results indicate that this deposition is unlikely to occur over a single flood event.
- If it does occur, model results indicate sufficient excess capacity is available within the Diversion Channel and Diversion Inlet to achieve design diversion rates.
- Sediment deposition within the headpond could result in a modest increase in upstream water surface elevations. Freeboard provided for the Auxiliary Spillway and Floodplain Berm crest is sufficient to manage the risk of overtopping under the simulated conditions.

The lack of consideration of a larger-than-planned flood and the impacts on this area – sediment deposition, debris accumulation on the functioning of SR1 is glaring. How much more sediment will a PMF deposit? The Proponent states that sediment deposition "could result in a modest increase in upstream water surface elevations." What is modest? .05m? What is upstream referring to? At Redwood Meadows? Redwood Meadows residents are concerned that the project may cause water backup at impact flooding at Redwood Meadows. **Are we to interpret that these concerns are founded?**

Debris Deflector

We would like regulators to acknowledge that this is a NEW and consequential element of the Project. It has changed in the latest Design Report from December 18, 2020 to be larger. What is the rational for this?

- Further if a flood >design comes down river, what is the outcome at this important element? Can the debris deflector / gates manage 2x or 3x the debris?

Is this structure built to retain riprap from upstream during flood events? Most riprap from Redwood Meadows washed away in 2013 and had to be replaced. Assuming this patter repeats, where will the riprap end up?

Why is the structure not built to PMF? What would cause it NOT to be built to PMF? What are the risks of NOT building this to PMF when the debris flows from a flood larger than design may cause operating issues?

The Proponent should have to estimate the debris flows in foods up to PMF to determine whether or not the debris deflector is appropriately sized and if, not, what the consequences are of it not being able to accommodate that level of debris.

Diversion Channel

What is the risk of the diversion channel being compromised during a flood situation? Where would the water go?

What are the water velocities at various points along the diversion channel and what is the velocity at the entrance to SR1? Does the water slow down as it nears the reservoir? What is the risk of sediment being deposited along the diversion channel and impeding flow?

Emergency Spillway:

Why is the emergency spillway not capable of passing the 600cms that will enter the diversion channel? What is the basis of this decision and does it add risk to the operations of SR1 as it approaches full pool, is at full pool, or incurs as failure of malfunction at the diversion inlet?

Proposed Condition: The Emergency Spillway should be designed to match the volume of the diversion channel.

Reservoir

According to USBR, reservoirs are at high risk when the reservoir level reaches a new height or during first fill. Risk of failure during first fill is elevated relative to normal operation conditions. We state here that there will be no normal flood operating condition for SR1. Most reservoirs are on-river and fill gradually, with various monitoring technologies used to assess structural integrity. It seems that the risk of filling SR1 to capacity during its first use, or when it reaches a new level on the embankment, the risk should be best managed by stopping filling of the reservoir to ensure monitoring is indicating the embankment is stable. Filling the reservoir over 36 hours is a risk endeavour that is not typical of embankments.

"The initial filling of a reservoir is the first test that the dam will perform the function for which it was designed. A carefully managed first filling is crucial to the future success of a dam. According to a study completed by the Bureau of Reclamation on internal erosion failure modes, "approximately two-thirds of all failures and one-half of all dam incidents occur on first filling or in the first 5 years of reservoir operation." [14]

And:

"…it is vital for dam operators and engineers to have as much control over the first filling as possible allowing as much time as needed for appropriate surveillance, including the observation and analysis of instrumentation data….For example, evidence of seepage, cracking, and erosion are often noted when the reservoir is raised to new levels for the first time. Inspection and assessment of these potentially hazardous conditions prior to the completion of filling is important and it may be necessary to halt filling or in some cases lower the reservoir before the desired operating water level is achieved to investigate signs of seepage, cracking and erosion." [15]

[14] https://damfailures.org/lessons-learned/the-first-filling-of-a-reservoir-should-be-planned-controlled-and-monitored/

[15] https://damfailures.org/lessons-learned/the-first-filling-of-a-reservoir-should-be-planned-controlled-and-monitored/

We ask regulators to challenge the Proponent to discuss this risk that is UNIQUE to SR1. The Proponent has not discussed this risk at all and this is a glaring oversight in risk and safety analysis.

Regulators should also specifically comment on the expedited filling of SR1 during a flood from empty to full in 36 hours which is NOT TYPICAL of embankment dams. Regulators should consider appropriate safety mechanisms should be considered to mange the risk.

We ask regulators to consider:

Fast Filling: Monitoring for Risk

We are highly concerned that the rapid filling of SR1 will impede the ability of operations personnel to review and assess the safety monitoring systems and that perhaps the rapid filling will not provide complete information as to the integrity of the embankment. The Proponent has not identified monitoring and measurement technology for the embankment, nor how it will be applied in a rapid filling scenario. Typical dams fill up gradually, over the course of months, so this is a very UNIQUE situation that requires diligence and responsiveness.

1. Is there a precedent for SR1 that could be used to understand the unique risks or challenges with filling a reservoir in 36 hours?
2. Does the rapid filling of SR1 impact the Proponent's ability to monitor the stability of the embankment and its components? If so, how?
3. What monitoring technology is typically used to monitor first fill in a dam and will it be used with SR1 during each flood?
4. How will the measurements of a filling of a traditional dam differ from the filling of SR1 over a short time period?
5. What information will be used to judge the stability of the embankment during filling? What red flags exist and what is the protocol if a redflag appears?
6. What happens if the embankment is compromised during filling given there is no rapid dewatering alternative?

Pattern of Reservoir Pool / Filling

1. What is the water velocity of water in SR1 reservoir? Is there a model of how the reservoir fills that illustrates where the water goes and how quickly? What is the water velocity at Springbank Road in a design flood?
2. At what water velocities will silt of various sizes cease to be suspended by the water and where does this occur?
3. Will the silt depositions be similar to a delta, such as seen at the mouths of rivers? Where will this occur?
4. What is the likelihood of the silt depositing at the reservoir entrance in such a manner that causes water to back up in the diversion channel?

Impact of Sediment:

1. How will the volumes of the reservoir be measured? Is this visual? Is it based on the continuous readings for diversion flow rate times the number of hours or minutes of the diversion? Elevation in the reservoir? What if the readings and the elevations are inconsistent?
2. What is the likelihood of the silt depositing in the newly described outlet channel within the reservoir being inundated with silt and affecting drainage of the reservoir?
3. What is the likelihood of the silt depositing in the newly described outlet channel external to the reservoir being inundated with silt and affecting drainage of the reservoir?

Emergency Operations:

1. How quickly can diversion gates be closed if a risk is identified?
2. How much water will continue to inundate the reservoir once the gates have closed, across various flood scenarios?

Risk Management for Rapid Filling of SR1:

We ask regulators to consider whether the amount of water entering SR1 be managed proactively to limit risk during early flood events in order to monitor the embankment's stability and effectiveness of operating protocols and SR1 components. For instance, perhaps it would be prudent to prohibit the first use of the SR1 structure to 20% of its capacity and successive uses of SR1 from increasing more than 25% over prior volumes?

Springbank Road

1. When reviewing the BC dike guidelines, dikes should be built parallel to the flow of water. Springbank Road, which acts a dike, appears to be completely perpendicular to the flow of water, while also having none of the requisite dike characteristics, such as slope 3:1 and erosion protection. How is this possible? Is this acceptable?
2. In IR478, the Proponent does not answer whether or not Springbank Road acts as a dam but acknowledges that Springbank Road is a dam according to definitions. In our view, Sprigbank Road is a "dam" and should be designed as such. It appears that the lack of clarity on response from the Proponent is an attempt to manage the cost of this categorization. Who makes this determination such that proper planning can ensure for Springbank Road?
    a. What are the structural upgrades required to Springbank Road, or will the road be moved as originally contemplated? We note that the design of Highway 22 allows for 3m+ culverts. Why would Springbank Road be any different given it is more likely to be inundated than Highway 22?
    b. What is the cost of all this work – erosion control, culverts, etc.?

Pipelines:

Is it not possible that once the Plains pipelines are moved that their current/ original path may become a conduit for water? How is this risk being managed?

Generally, we do not think that the pipeline changes have been adequately considered. The depth of the diversion channel and the associated leadup to this for pipeline slope has not been discussed. IT appear that the Proponent is using outdated estimates for pipeline and have provided NO design documents to review. Area residents are concerned about this significant work which is NOT addressed in the Proponents submissions. If there are new costs for the pipeline work (as determined by an independent third party or the pipeline companies) it should be provided.

We request the regulators require the Proponent to provide more details on the pipeline work required for SR1 and more detailed cost breakdowns. We have heard that the Nova pipelines alone could cost more than $20M while the Proponent has $3M in its budget.

Reservoir Drawdown

Does the Proponent contemplate that drawdown may need to be done more quickly than the LLOW can achieve, if for instance, an embankment monitoring identifies risk during retention or during back-to-back floods? How will this occur? There does not appear to be a mechanism for rapid dewatering of the reservoir.

"The ability to quickly and safely perform reservoir drawdown can be crucial to the protection and preservation of a dam. A reservoir low level outlet works and/or drain system with adequate capacity should be provided in all dams to provide a method of lowering the reservoir level in an emergency within a reasonable period. In several instances, dam failures have been averted by lowering the reservoir in response to emergency conditions detected at dams."[16]

It appears in the latest responses the Proponent identifies the US Bureau of Reclamation (USBR) as the source of guidelines for planning the emergency drawdown of SR1 flood waters.[17]

In IR04-01 "The capacity of the low-level outlet works is based on dam safety criteria for drawdown of reservoirs. However, The Canadian Dam Association (2013) Guidelines and the Alberta Dam and Canal Safety Directive (Government of Alberta 2018) do not address requirements for sizing of outlet works or evacuation times for reservoirs. In the absence of provincial and federal governing criteria, criteria from the United States Army Corps of Engineers (USACE) and the United States Department of the Interior Bureau of Reclamation (USBR) were reviewed."

The USBR drawdown document referenced is from 1990 and does not appear particularly relevant to SR1, as it is more appropriate for permanent reservoirs, with the exception of the following statement:

" The sill elevation of the intake structure should be set above the predicted IOO-year sediment accumulation level or a multiple-level intake structure should be provided to prevent the outlet works from being plugged by sediment during the life of the project."

[16] https://damfailures.org/lessons-learned/all-dams-need-an-operable-reservoir-drain-system/

[17] https://damfailures.org/wp-content/uploads/2020/03/PB95102133.pdf

Is this the case for SR1 which has the following statement:

"The gravity conduit section was developed based on normal depth open channel flow within a closed conduit, with maximum depth limited to 75 percent of the conduit height (USBR Design of Small Dams)."[18]

What is the basis and justification for using Small Dam design from USBR when SR1 is not a small dam classification?

Doesn't the design of this mean that the water can't totally drain? What is the vertical height of the intake relative to projected silt deposition? Will there not be water accumulating in the reservoir given the intake is elevated? How will the reservoir drain?

We note that our concerns about sediment accumulation impacting reservoir operations, and the conduit in particular, have not been addressed. We are unsure if there is an appropriate comparison for the level of silt arriving at SR1 during a large flood and ask for comparable projects to provide reference points.

Structural Risk

Given that elements of SR1 are not designed to PMF, we ask regulators to consider whether the intake structures (floodplain berm, debris deflector, river inlet) should be designed to PMF, rather than the design flood.

Embankment Design

1. Downstream Slope: It appears that, according to USBR[19], the following should apply for the downstream embankment slope [emphasis added].
   2.2.5.4 Downstream Slope Protection

   If the downstream zone of an embankment consists of rock or cobble fill, no special surface treatment of the slope is necessary. Downstream slopes of homogeneous dams or dams with outer sand and gravel zones should be protected against erosion caused by wind and surface runoff using a layer of rock, cobbles, or sod. ***Because of concerns with burrowing animals and the difficulty of obtaining adequate slope protection using vegetative cover at many damsites, especially in arid regions, slope protection using cobbles or rock is preferred and should be used where the cost is not prohibitive.*** *Figure 2.2.5.4-1 shows the downstream cobble slope protection at Jordanelle Dam. Layers 24 inches in normal thickness are easier to place; however, a 12-inch-thick layer usually affords sufficient slope protection. Often, this type of material can be obtained by separating oversized materials from borrow areas or aggregate processing. If grasses or other vegetation are planted, those suitable for a given locality should be selected, and a layer of topsoil is usually required. The advice of an agronomist should usually be obtained to ensure success.* ***Vegetation that will conceal seeps, animal burrows, etc., should not be used. Exit surfaces to internal drainage layers should not be covered by vegetation. Any vegetative covers should be maintained in a***

[18] https://www.nrcb.ca/download_document/2/83/10664/20201218-at-sir-to-nrcb-re-preliminary-design-report

[19] https://www.usbr.gov/tsc/techreferences/designstandards-datacollectionguides/finalds-pdfs/DS13-2.pdf

condition that will not conceal deleterious conditions. Slopes should be flat enough to allow access for maintenance equipment.

2. Upstream Slope Protection - The Proponent does not seem concerned with upstream slope protection on the embankment. We, however, are very concerned by this. USBR references that riprap is the ideal protection. Given that SR1 slope protection seems to rely on seeding, we ask for a more fulsome understanding of this decision, specifically noting that:

   2.2.5.3.2 Selection of Type of Slope Protection

   Experience has shown that, in the majority of cases, properly graded and placed riprap with adequate durability properties furnishes the best type of upstream slope protection at the lowest cost. Reclamation experience with riprap is summarized in Dams Branch Report No. DD3, "Rock as Upstream Slope Protection for Earth Dams - 149 Case Histories" [21] and REC-ERC-73-4, "Riprap Slope Protection for Earth Dams: A Review of Practices and Procedures" [22]. Approximately 100 dams, located in various sections of the United States with a wide variety of climatic conditions and wave severity, were examined by the U.S. Army Corps of Engineers to provide a basis for establishing the most practical and economical means for slope protection [23]. The dams ranged in age from 5 to 50 years old and were constructed by various agencies. This survey found that:

   - Dumped riprap failed in 5 percent of the cases where it was used; failures were attributed to improper size of stones.
   - Hand-placed riprap failed in 30 percent of the cases where it was used; failures were attributed to the lack of interlocking resulting from single-course construction.
   - Concrete pavement failed in 36 percent of the cases where it was used; failures were due to poor design and construction details.

   This survey substantiated the premise that dumped riprap, described in the next section, is the preferable type of upstream slope protection.

3. The design of the embankment includes a budget of $90,255 for riprap as included in Attachment G of the Preliminary Design Report. Meanwhile, the unnamed creek has a budget of over $2 million.

Revised December 3, 2019

	Item	Unit	Quantity	Unit Price	Estimated Cost (2017 CAD)
200	**Off-Stream Storage Dam**				
201	**Dam Embankment**				
202	Topsoil and Subsoil Stripping	m^3	252,670	$ 3.00	$ 758,011
203	Topsoil Placement	m^3	107,934	$ 3.50	$ 377,770
204	Common Excavation	m^3	471,793	$ 5.50	$ 2,594,862
205	Overhaul of Common Excavation	m^3*km	0	$ 0.85	$ -
206	Zone 1A - Impervious Fill	m^3	1,748,035	$ 1.50	$ 2,622,053
207	Zone 2A - Random Fill	m^3	2,841,518	$ 2.25	$ 6,393,416
208	Toe Buttress - Random Fill Zone 2A(3)	m^3	222,884	$ 2.25	$ 501,489
209	Drainage Zone - Zone 3B	m^3	18,858	$ 24.00	$ 452,592
210	Fine Filter - Zone 3A	m^3	240,119	$ 55.00	$ 13,206,545
211	Dam Face Drainage Flumes (Riprap Zone 6B)	m^3	547	$ 165.00	$ 90,255
212	Non-Woven Geotextile	m^2	811	$ 3.50	$ 2,839

The Proponent appears to be cost-conscious on this item and we contend the focus on cost at the expense of safety is the wrong approach to an extreme consequence structure that will be used in high pressure flood events.

CEAA Proposes a condition for this erosion protection 3.14:
install riprap material on the diversion channel side slopes outside curves, on the water face of the off-stream storage dam, and where the diversion channel enters the reservoir to prevent future bank erosion;

Yet, the Proponent pushed back on that requirement. Best practice would be to install riprap as CEAA identified and we agree with the CEAA conditions. In our view, the Proponent's response is an attempt to manage costs rather than manage risk.

4. Additionally, we have significant wind events within the Springbank area. Last summer alone, we have seen significant and sustained wind events >30km/h as measured by Springbank Airport (June 26, 30, July 2, 4, 7, 8, 12, 14, 16, 17, August 1, 10, 11, 14, 17, 28, 22)[20]. This does not account for gusts, which frequently reach 90km hour. How is wave action predicted to impact the upstream slope under these conditions? How will wind erosion in non-flood conditions be realistically managed as the reservoir drains?

Emergency Spillway

1. What levels of redundancy does SR1 have in relation to uncontrolled release of large flows, as reference below in the more comprehensive 2011 USBR standards which refer to spillways:

   "Because many of the spillways are associated with significant- and high-hazard dams/dikes, and failure of gates/valves may result in uncontrolled release of large flows, some redundant features/equipment might be required. Therefore, it may be advisable to design to stricter requirements than commonly called for by professional codes, standards, and/or guidelines."

[20] https://acis.alberta.ca/weather-data-viewer.jsp. On July 8, there were 8 hours straight of wind measurements over 29.5km/h. On July 4, there were 5 hours >33.5 km/h.

2. We highlight that there is nothing like SR1 in Canada, as evidenced by the Proponent's own statements and reliance on guidance from the USBR. The fact that the best references for SR1, with any similarities at all, are found in the US, continues to be concerning. The use of USBR for the drawdown (1990 standards) is telling. In understanding the LLOW changes identified by the Proponent, we reviewed the USBR standards for embankments[21] along with FEMA spillway guidelines[22], a more robust and fulsome document updated in 2011. The drawdown referenced by the Proponent appears to be used for permanent reservoir which may not be appropriate.

In Seciton 9.6.2 of the December 18, 2020 Preliminary Design report, the Proponent states the following:

> The Emergency Spillway design concept is located along the Diversion Channel alignment. The Emergency Spillway consists of a 135 m-wide side channel concrete drop structure, a short riprap exit channel between retaining walls, and an excavated outlet channel, where the flow will continue to the Elbow River. The crest elevation of the drop structure overflow weir is Elevation

What does the Proponent mean by a "short riprap" exit channel? 1 meter? 10 meters? 100 meterrs? There is no riprap cost estimate for the emergency spillway:

Springbank Off-Stream Storage Project (SR1)
Civil Works Cost Opinion - Type B
Revised December 3, 2019

	Item	Unit	Quantity	Unit Price	Estimated Cost (2017 CAD)
157	**Diversion Channel**				
158	**Emergency Spillway (EMS)**				
159	Structural Concrete (Class A)	m^3	859	$ 1,340.00	$ 1,151,060
160	Structural Concrete (Class B)	m^3	3,977	$ 1,340.00	$ 5,329,180
161	Metal Railings	m	140	$ 450.00	$ 63,000
162	Foundation Treatment	m^2	3,321	$ 200.00	$ 664,200
163	Structure Foundation Drains	m	135	$ 550.00	$ 74,250

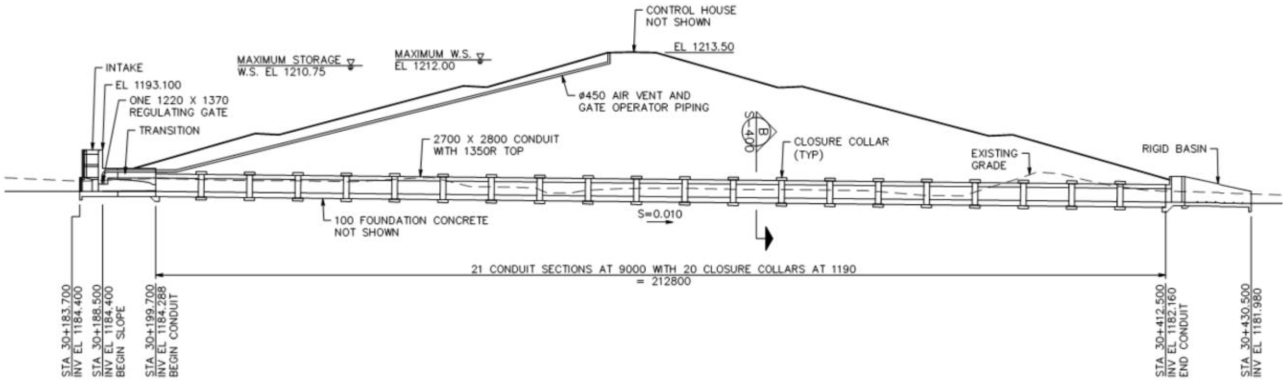
We ask Regulators to consider whether the entire emergency spillway should be riprap. What is the expected erosion of the emergency spillway during an event that requires it be activated at its full volume of 360cms? If the unnamed creek is riprap or erosion protected at flows <28cms, how is it possible that the emergency spillway has little to no erosion protection? For cost again?

[21] Design Standards No. 14: Appurtenant Structures for Dams (Spillways and Outlet Works) Design Standards 1-16 DS-14(1)-4 October 2011 https://www.usbr.gov/tsc/techreferences/designstandards-datacollectionguides/finalds-pdfs/DS14-1.pdf

[22] Conduits through Embankment Dams: Best Practices for Design, Construction, Problems Identification and Evaluation, Inspection, Maintenance, Renovation, and Repair https://www.fema.gov/media-library-data/20130726-1515-20490-8766/fema484.pdf

Outlets

InIR475, the Proponent provides the following outlet diagram:



The description provided for outlet works is as follows:

- A reinforced concrete Intake structure incorporates eight 2,500 mm by 2,500 mm trash rack panels and a 1,200 mm wide by 1,500 mm high sluice gate with hydraulic operator that can continue operating when submerged.
- A reinforced concrete conduit will provide the hydraulic transition from the intake structure gate opening to the main conduit section over a length of 10.5 m.
- A reinforced concrete 2,700 mm wide by 2,800 mm high modified horseshoe shaped conduit with a length of 212.8 m set on a 0.010 slope runs through the embankment dam.
- A reinforced concrete, 18 m long, rigid stilling basin located at the downstream end of the conduit and downstream toe of the embankment will provide at-grade energy dissipation of flow releases.
- A designed channel will be excavated from the stilling basin to the unnamed creek.

1. What, precisely, is the new configuration of the outlet works? Where exactly is the backup gate? How does this new configuration differ from the recommended outlet works identified in FEMA guidelines?
2. How is the intake for the low-level outlet going to avoid becoming blocked by silt?
3. Given that the intake for the low-level outlet appears to be above ground, how is it possible that the reservoir will entirely drain? This is not described by the Proponent.

Conduit

1. How is the conduit going to be maintained to avoid silt depositions within the conduit during flood events and reservoir drainage? It seems unlikely that silt will not accumulate at the intake or within the conduit itself. How will silt be removed from the conduit?

2. Conduit: According to USBR: The recommendation is to avoid conduits through embankments. Isn't that exactly what the Proponent proposes? Is there no other alternative? What is the risk of running the conduit through the embankment, which contravenes accepted practice?

> From a dam safety perspective, constructing an outlet works through/beneath an embankment dam and/or dike should be avoided to limit contact between the outlet works conduit and embankment materials and to minimize the potential for internal erosion of embankment soils into or along the conduit. A preferred alternative is to construct a tunnel outlet works through the reservoir rim area including the abutments where the embankment soils are not in direct contact with the outlet works.
>
> If an outlet works must be placed through or beneath an embankment dam, special care and attention must be provided to the embankment zoning adjacent to the outlet works. These special considerations include avoidance of abrupt geometry changes, such as those associated with seepage collars or counterforts, and narrow cuts that require special compaction of backfill soils within them. The embankment zoning around outlet works should include properly designed filter materials that prevent loss of fine-grained soils from the impervious core with the seepage flows through the dam. During construction, extra attention is required in the placement and compaction of filter zones around outlet works conduits.
>
> DS-13(1)-4 October 2011 1-21
>
> **Design Standards No. 13: Embankment Dams**
>
> The outlet works requires close coordination between outlet works and embankment designers to ensure that the needs of both specialties are adequately fulfilled.

Meanwhile, the Proponent states:

IR476 The conduit will be constructed at, or above, grade and constructed prior to embankment placement. Embankment material consistent with the zone in which the conduit is located will be placed against and above the conduit to required specifications (Alberta Transportation 2006). The *cast-in-place concrete conduit within the embankment will be protected against infiltration from retained flood water as well as water seepage from conduit flowing into the fill using several methods.*

3. Collar: Regarding the use of collar in the conduit through the embankment, USBR states the following, which appears to contravene the approach taken by the Proponent [emphasis added]:

   However, the majority of embankment dam engineers argue that cutoff collars do not perform the intended purpose of controlling seepage and could be detrimental. Compaction of the embankment around cutoff collars has the same problems as discussed previously for rigid structures through the embankment. The pros and cons of cutoff collars are discussed in Assistant Commissioner – Engineering and Research (ACER) Technical Memorandum No. 9, "Guidelines for Controlling Seepage Along Conduits Through Embankments," [17] which was prepared by a task group of Reclamation engineers. An additional excellent reference is a technical manual on conduits through embankments sponsored by the Federal Emergency Management Agency (FEMA) [18]. ***Reclamation policy is that cutoff collars should not be used as a seepage control measure, and any other protruding features on a conduit should be avoided.***

Unnamed Creek

Is there any protection planned for the area of the Elbow River where the newly erosion-protected unnamed creek spills out into near flood water levels since the release is planned to be early?

Can we infer from Appendix G of NRCB Exhibit 159, riprap is planned for the unnamed creek? Or is this not the case and riprap is planned for the new constructed channel that results from moving the outlet? This is too uncertain and this length of the unnamed creek is 1.2km of meandering watercourse, as illustrated the following image from google earth – the dark green is the unnamed creek. Will there be riprap along this entire path?

Conditions

Re : Section 10, Draft Conditions and including other items:

Identification and Notification

10.1 "*The Proponent shall take all reasonable measures to prevent accidents and malfunctions that may result in adverse environmental effects and to mitigate any adverse environmental effect from accidents and malfunctions that do occur.*"

Proposed Condition: The Proponent shall identify all possible accidents and malfunctions and their consequences prior to construction. These must be shared with the public, along with 10.1, mitigations and cost of mitigations.

10.1.1 update the probable maximum precipitation and hydrologic modelling for the Designated Project, including the parameters values, the precipitation variations and spatial and temporal evolution of the 2013 Alberta flood.

Comment: Is this prior to construction, commissioning or as a requirement for the final CEAA report? We know that the proponent has chosen to exclude floods from the late 1800s that were estimated to be larger than the 2013 flood. How will this information in incorporated?

10.6 The Proponent shall develop, in consultation with Indigenous groups and potentially affected parties, a communication plan for accidents and malfunctions occurring in relation to the Designated Project, including accidents and malfunctions occurring within the project development area which may affect area(s) outside of the project development area. The Proponent shall develop the communication plan prior to construction and shall implement and keep it up-to-date during all phases of the Designated Project. 10.6.1 the types of accidents and malfunctions requiring the Proponent to notify Indigenous groups and potentially affected parties;

Comments: First Nations have little to nothing to do with the accidents and malfunctions of SR1. Meanwhile, if there is an SR1 failure, the consequences are catastrophic and borne by Rocky View County and City of Calgary residents. Rocky View County, the City of Calgary and Springbank area residents should be explicitly mentioned here by CEAA.

The plan shall include: 10.6.2 the manner by which Indigenous groups and potentially affected parties shall be notified by the Proponent of an accident or malfunction and of any opportunity to assist in the response to the accident or malfunction; and 10.6.3 the contact information of the representatives of the Proponent that Indigenous groups and potentially affected parties may contact and of the representatives of each Indigenous groups and potentially affected parties to which the Proponent shall provide notification.

Comments: First Nations have little to nothing to do with the accidents and malfunctions of SR1. Meanwhile, if there is an SR1 failure, the consequences are catastrophic and borne by Rocky View County and City of Calgary residents. Rocky View County, the City of Calgary and Springbank area residents should be explicitly mentioned here by CEAA. Additionally, this project is massive. Failures could take place anywhere between Redwood Meadows, near the intake and 14km away at the embankment. A plan will need to be developed specifically for each area. Will there be air raid sirens? Door to door evacuations? Cell phone alerts? Many homes have gates in this area.

Designation of Critical Infrastructure

We ask regulators whether SR1 should be classified as "Critical Infrastructure".

Bill 1, the *Critical Infrastructure Defence Act*, protects essential infrastructure from damage or interference caused by blockades, protests or similar activities, which can cause significant public safety, social, economic and environmental consequences.

The act builds on existing trespassing laws to create offences for trespassing on, destroying, damaging, and obstructing the use or operation of any essential infrastructure.

Lack of Regard for New Emergency Planning

New Emergency Planning Capabilities for Rocky View County

We are concerned that Rocky View County will need to increase its emergency response capabilities to respond to any one of a number of SR1-related incidents. We look to regulators to require the Proponent to include staffing, training, technology and infrastructure required for Rocky View County.

Proposed Condition: The Proponent shall estimate the requirements for Rocky View County and other authorities that will be necessary to respond to an SR1-related emergency. The requirements shall include staffing, technology, resources (vehicles, stations, etc), communications systems and other elements that will ensure a robust emergency planning response.

Roads

In 2013, various Rocky View County roads were closed or inundated. The choice of SR1 over MC1 means that can happen again. SR1 can only take 600m/s3 while MC1 could have taken the entire peak flow, if the reservoir had capacity. That means that with a flood > design, those roads can be closed once again. SR1 therefore causes DIRECT hardship to Rocky View residents and Redwood Meadows residents. We ask regulators to direct the Proponent to fairly mitigate these negative outcomes with infrastructure upgrades that will facilitate emergency access.

Proposed Condition: The Proponent shall ensure that SR1 accidents and malfunctions do not result in adverse impacts in the communities surrounding and downstream of SR1 including at: Highway 8 near Highway 22, Highway 22 Bridge Crossings, Highway 8 near Elbow Valley, Ranage Road 40 South of the Elbow River and Bragg Creek.

Highway 8:

In 2013, Highway 8 was inundated and Elbow Valley area residents could not leave or return to their homes.

We challenge regulators to direct the Proponent to upgrade Rocky View County roads to avoid flood and SR1-accident-related road closures. This may mean an additional access for Elbow Valley homes. It may mean raising the road to above the high-water mark.

Additionally, we need assurance from the Proponent that failures at or near the inlet will NOT result in inundation of Highway 22 near the traffic circle. If there is a possibility this area will be inundated, we ask regulators to direct the Proponent to upgrade these roads.

Highway 22:

In 2013, the Highway 22 bridge was closed. We challenge regulators to direct the Proponent to upgrade Rocky View County roads to avoid flood and SR1-accident-related road closures. As the Highway 22 bridge is not designed yet, we cannot comment on the specific plan for ensuring Highway 22 remains open, but we ask regulators to direct the Proponent to design the bridge (and connecting highway) to a conservative level that would accommodate the PMF.

RR40:

Range Road 40 south of the Elbow River ends in a valley. Emergency response for this road and its inhabitants must be considered as a requirement of the Project. This area is directly south across the river from the massive earthen embankment. A failure of the embankment would send a mudslide over these homes. This cannot be overlooked.

West Bragg Creek:

There is one way in a one way out of Bragg Creek on the west side. In 2013, people were trapped – they could not get home and could not leave. Parents were separated from children. This will happen again unless emergency planning and infrastructure upgrades are included with this project. MC1 would have prevented this terrible outcome.

We challenge regulators to direct the Proponent to provide emergency access to west Bragg Creek, which was trapped during 2013 and may be again as a direct result of the SR1 decision.

Summary

The latest submissions from the Proponent raise new concerns for safety / risk. The July 2020 structural changes imply that the location of the Project is not ideal for this massive embankment. Meanwhile, there are still glaring omissions in the areas of project operations, flood forecasting and project sizing.

Once again, thank you for your consideration of our concerns.

Regards,

Karin Hunter

President, Springbank Community Association