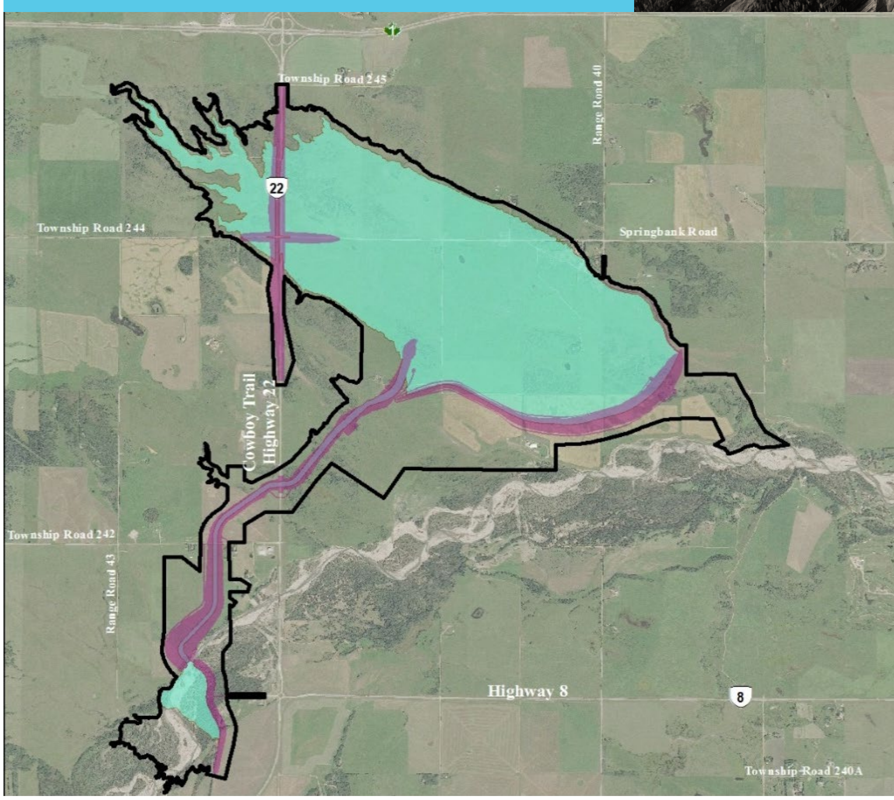
Springbank Off-stream Reservoir Project



Response to Agency Conformity Review of Round 1 Part 3, dated August 21, 2019

November 2019

Alberta Transportation

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List of Acronyms and Short Forms

AEP	Alberta Environment and Parks
Agency	Canadian Environmental Assessment Agency
CEAA 2012	*Canadian Environmental Assessment Act, 2012*
CEAR	*Canadian Environmental Assessment Registry*
CRA	Commercial, Recreational, or Aboriginal
DFO	Fisheries and Oceans Canada
DUS	Depression upland storage
ECCC	Environment and Climate Change Canada
EIA	environmental impact assessment
EIS	environmental impact statement
GCM	global circulation models
HD	hydrodynamic
IDF	intensity-duration-frequency
IR	information request
Kh	horizontal hydraulic conductivity
Kv	vertical hydraulic conductivity
LAA	local assessment area
MPM	Meyer-Peter and Müller
MT	mud transport
NRCan	Natural Resources Canada
PDA	Project development area
PMF	probable maximum flood
PMP	probable maximum precipitation
RAA	regional assessment area

RCP	greenhouse gas concentration scenarios
SCADA	supervisory control and data acquisition
SSC	Suspended sediment concentration
ST	sand transport
TDR	technical data report
VC	valued component
WSC	Water Survey Canada
VSMB	versatile soil moisture budget

Conformity IR3-01

Topic: **Climate Change**

Sources:

EIS Guidelines Part 2, Sections 6.2.2; 6.6.2

EIS Volume 1, Section 1

Tsuut'ina First Nation, Ermineskin Cree Nation, and Kainai First Nation – Technical Review of the EIS - Annexes – Combined (CEAR # 46, 47, 50)

Environment and Climate Change Canada Technical Review, June 18, 2018 (CEAR # 32)

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-01

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

Context and Rationale

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-01, the Agency required information on projected future changes in the regional climate and an evaluation of potential future climate change related effects on the Project. As noted in the information request, the EIS Guidelines require the proponent to describe multiple components of hydrology of the Elbow River watershed, and the effects of the environment on the Project.

In Alberta Transportation's response to IR3-01, climate change information is provided that suggests increases in precipitation could nearly double flood peaks, and increased snowmelt and peak river flow can create an increased flood risk from April to June. Although it is noted that there is a high degree of irregularity/inconsistency, Alberta Transportation acknowledges that climate change may cause floods with a return period similar to the 2013 flood to be of greater magnitude.

In IR3-01 b) i), the Agency required a flood frequency and size analysis considering future changes in regional climate. Alberta Transportation's response reiterates the flood frequency analysis that is provided in the EIS, without a rationale as to how this considers future climate change related effects.

In IR3-01 b) iv), the Agency also required an assessment of potential effects of the environment on the Project due to climate change, and associated effects to VCs. Alberta Transportation's response indicates that the Project accounts for climate change as the 2013 flood was an extreme event. However, this response does not account for the potential for a flood larger than

the design flood to occur or an increased frequency of flooding due to climate change. As noted in the information request, if the frequency and size of future flooding, size of diversions, and/or likelihood of reservoir exceedance are underestimated, direct and cumulative effects to valued components (including federal lands) may be greater than predicted.

Information Requests:

a) Provide a new flood frequency analysis given the potential increase in frequency and severity of floods.

b) Provide an assessment of effects of the environment on the Project should a flood larger than the design flood occur and should flooding occur more frequently due to climate change, and associated potential effects to VCs.

Response

a) There is no federal or provincial standard method to estimate the climate change impact on flood magnitude and frequency. A flood frequency analysis that considers the effects of current projections on climate change was executed using the IDF_CC tool that has been developed by the University of Western Ontario and the Institute for Catastrophic Loss Reduction (https://idf-cc-uwo.ca/). As indicated in their user manual, "one of the primary objectives of the tool is to standardize the IDF updating process and make the results of current research on climate change impacts accessible to practitioners". This tool was developed to help engineers and planners quantify the impacts of climate change projections on the intensity-duration-frequency (IDF) curves that are produced by Environment Canada and Climate Change (ECCC). ECCC's IDF curves are distributed under their Engineering Climate Datasets (https://climate.weather.gc.ca/prods_servs/engineering_e.html). These datasets are used across Canada in the design of municipal water management infrastructure.

The IDF_CC tool allows users to generate IDF curve information based on historical data, as well as future climate conditions that can inform infrastructure decisions. The IDF_CC tool stores data associated with 700 ECCC operated rain stations from across Canada. Version 3.5 of the tool uses version 3.00 of the EECCC IDF dataset, released on February 2019. The IDF_CC tool allows users to select multiple future greenhouse gas concentration scenarios (RCPs) and apply results from a selection of 24 global circulation models (GCMs) and 9 downscaled GCMs that simulate various climate conditions to local rainfall data.

In the design of the Project, the IDF data from the Calgary International Airport was used to develop synthetic design storms that were modelled using a calibrated hydrologic model built on the HEC-HMS software platform. This was reported in the environmental impact assessment (EIA), Volume 3B, Section 6.4 and in the assessment of the probable maximum flood (PMF) under various antecedent conditions (see Round 1 CEAA Package 3, IR3-02, Appendix IR2-1). Within the stations provided by the IDF_CC tool, which are the ECCC's stations across Canada, the Calgary Airport station is the closest and most reliable station (based on the length of precipitation timeseries) to the Project site.

This same HEC-HMS model and synthetic design storm distribution was used to assess the effects of climate change on flood frequency for this response using the following methods:

1. Two-day rainfall (48- hour) was estimated by extrapolation of the IDF curves published by ECCC for the 1:2 year to 1:100 year floods. A second extrapolation from the IDF data was done to estimate the 1:200 year and 1:500 year floods.
2. Rainfall intensities were multiplied by their duration to obtain the total rainfall depth.
3. Rainfall depths over the Elbow River basin were estimated using the same methods as was done for the probable maximum precipitation/probable maximum flood (PMP/PMF) analysis. The synthetic design storm's temporal distribution was then applied to the estimated rainfall depths.
4. The same design storm was applied to each of the HEC-HMS model's 11 sub-catchments for Elbow River. The model exercise assumed no difference in precipitation between the sub-catchments. No antecedent rainfall was applied to the model.
5. The model was run to calculate the peak flows produced from these design storms and those peaks were compared with the hydrometric station-based flood frequency estimates for their respective return periods.
6. Factors were applied to the total rainfall depths to calibrate the events to the flood frequency results estimated using the hydrometric station data to effectively calibrate the rainfall runoff model to the statistics estimated at the hydrometric station. The resultant flood frequency distribution is presented in Table 1-1.
7. The IDF_CC_Tool was then used to estimate the climate change impact on rainfall intensity-duration-frequency. The 'All Models' (Ensemble) option was selected on the PCIC – Bias Corrected (Version 2) dataset as provided in the tool, along with the future emissions scenario of RCP 8.5. The ensemble of all available datasets (in this case 24 models) was selected to represent all the different physics packages that could be used to calculate precipitation by each of the modelling centres around the world. The RCP 8.5 emissions scenario was selected to represent a "business as usual" emissions scenario and is the most risk averse approach because it assumes current trends hold. The year 2050 was selected as the projected time scope. The tool produced a series of climate affected IDF curves for the selected scenarios.
8. Step 1 to step 6 were then executed using the climate affected IDF rainfall data to produce a flood frequency distribution that considers climate change projections. The results are provided in Table 1-1 and Figure 1-1.

Table 1-1 Flood Frequency Distributions at the Diversion Structure with Climate Change Projections to 2050

Flood Return Period At the Diversion Structure (year)	Flow in Existing Condition (m^3/s)	Flow after Climate Change (m^3/s)	Increase due to Climate Change (%)
2	70	75	7%
5	140	150	7%
6	153	163	7%
7	165	178	8%
10	200	215	8%
20	330	360	9%
50	530	595	12%
100	765	860	12%
200	1110	1240	12%
240	1240	1389	12%
500	1800	2030	13%

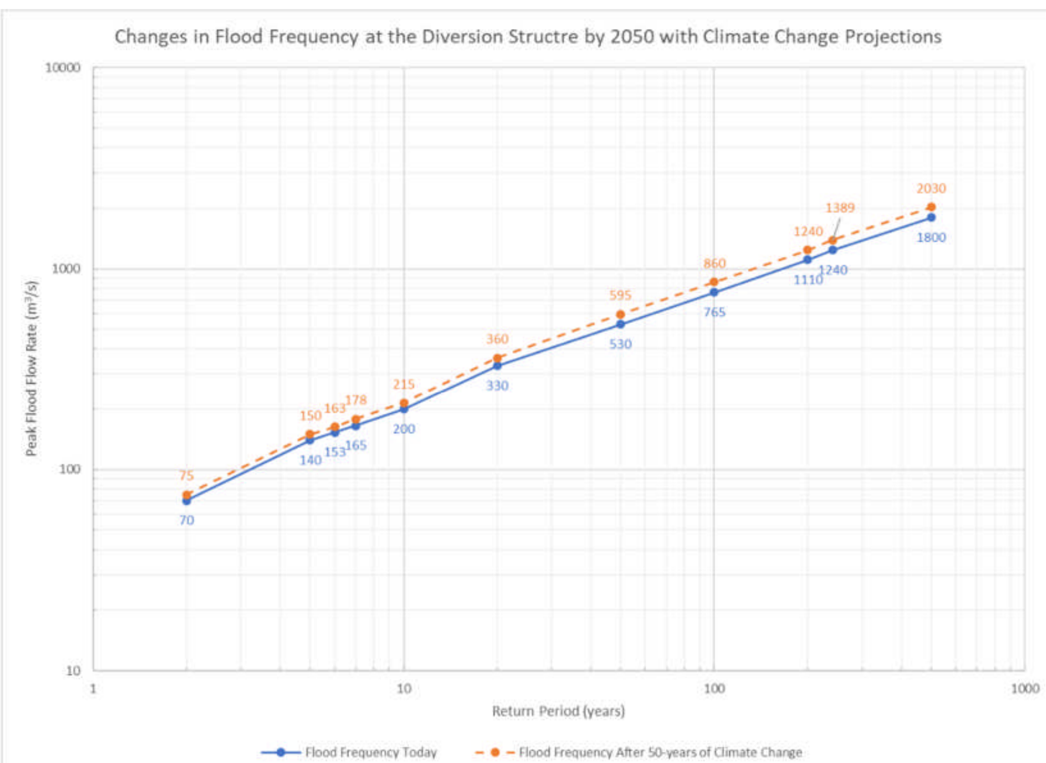


Figure 1-1 Flood Frequency Distributions with Climate Change Projections to 2050

The flood frequency analysis results suggest that the operational flow threshold of 160 m^3/s, which has an associated return period of approximately 1:7 years (i.e., 165 m^3/s in the second column of Table 1-1) may have an associated return period of approximately 1:6 years under climate change projections (i.e., 163 m^3/s in the third column of Table 1-1). The predictions indicate the severity of floods will be higher when climate change is considered (i.e., the flows with climate change in the third column for each specific flood return period in Table 1-1 is larger than the flow in the second column). As flood frequencies increase, there is a potential for the Project to be operated more frequently due to climate change effects.

Due to damage during the June 2013 flood, official data from the ECCC (Water Survey of Canada) gauging stations Elbow River at Bragg Creek and Elbow River at Sarcee Bridge (inflow to Glenmore Reservoir) was unavailable. However, ECCC supplied Alberta Transportation with preliminary 2013 peak instantaneous flows for Elbow River at Bragg Creek and at Sarcee Bridge as 1,150 and 1,240 m^3/s, respectively. The estimated peak flow rate of 1,240 m^3/s was supplied to Water Survey of Canada from water level hydrographs recorded by the City of Calgary at Glenmore Reservoir. This estimate of 1,240 m^3/s served as the design basis for the Project.

Some responses have referred to the 2013 flood as slightly larger than a 1:200 year flood. This simplification is from the sources of potential error in the available hydrometric data, the inherent limitations of flood frequency estimates, and the need to communicate concepts like flood frequency. To be precise, Alberta Transportation's estimates of the flood frequency for the 2013 flood were a 1:210 year flood at Glenmore Reservoir/Sarcee Bridge and a 1:230 year flood at Bragg Creek. The estimated return period of the 2013 flood at the Project's diversion structure would be somewhere in between these two estimates. As shown in Table 1-1, the precise return period associated with the design of the Project (1,240 m^3/s) is a 1:240-year flood at the diversion structure. This is the same flood and still carries a return period estimate of 1:210 year at Glenmore Reservoir (Sarcee Bridge). With a 12% increase in peak flow rate by 2050, as estimated from the climate change projections, the Project's design flood flow rate of 1,240 m^3/s will change to 1,389 m^3/s. Assuming today's statistical estimates remain static between now and 2050, this flow rate will have a change in associated return period from a 1:240 year flood at the diversion structure, to a 1:200 year flood at the diversion structure. This is in excess of the provincial flood hazard standard of a 1:100-year flood. Provisions for climate change are captured in Alberta through factors of safety in engineering design. The Project includes a 25% factor of safety in the design diversion rate and a 10% increase in the reservoir storage volume from what is needed to meet the project's intended purpose.

Should climate change increase the frequency or magnitude of floods, the Project will still function as designed, and it will protect downstream communities from a flood that is similar in peak and volume to that which occurred in 2013.

b) The maximum water management capacity of the Project is designed to divert, retain, and slowly release a portion of the flood water from a design flood of the 2013 flood, or equivalent. If a flood larger than the design flood should occur, the water in excess of the design volume would bypass the reservoir and flow down Elbow River. The effects on the environment would be similar to what a flood of that excess volume would do without the Project.

An increased frequency of flooding would result in increased Project activation when flows in Elbow River exceed 160 m^3/s, meaning the reservoir would be used in more years than it would under current flood frequencies. The potential effects of such an increase would be more noticeable with smaller floods because increased frequency may decrease the recovery time for valued components (VCs).

An increase in the frequency of larger floods would have less of an impact on recovery because it is the initial (early) years of recovery that is the most critical. For example, vegetation, terrestrial and aquatic habitat recovery commences in the first few years following flooding. For most VCs, the effects of more frequent flooding would be as described in Volume 3B of the EIA for each of the VCs (i.e., associated with reservoir filling, reservoir draining, partial cleanup of sediment if positive drainage in the reservoir is affected, and channel, road and bridge maintenance), but with the effects occurring more frequently.

More frequent flooding is not anticipated to alter the assessment of environmental effects, including impacts on the Tsuut'ina Nation Reserve. Although flooding would occur more frequently, the implementation of the mitigation measures for effects on all VCs would result in the residual effects being the same as described in the EIA.

The residual effects on the following VCs would be further affected by more frequent floods:

AIR QUALITY AND CLIMATE

Sediment deposition from more frequent diversion of flood waters to the reservoir may result in an accumulation of exposed sediment that could be prone to wind erosion. More frequent surface stabilization and partial cleanup of sediment may be required.

HYDROLOGY

More frequent draining of the reservoir following large floods would increase erosion of the unnamed creek. More frequent smaller floods are not expected to result in increased erosion of the unnamed creek because of the smaller volume and reservoir area covered.

VEGETATION AND WETLANDS

More frequent small floods such as the 1:10 year flood may occur before vegetation has had time to recover from the previous flood. Without the one-year period for vegetation to be allowed to re-establish on exposed surfaces, the generation of dust from the bare soil may occur. However, all exposed surfaces will be monitored for potential dust generation following reservoir drainage and mitigation measures taken as necessary. More frequent flooding of the reservoir in combination with a warmer and wetter climate may result in the growth and interconnection of the existing wetlands and the associated habitat.

EMPLOYMENT AND ECONOMY

More frequent flooding and use of the reservoir will result in greater costs for flood damage cleanup and restoration at the Project development area (PDA). Without the Project, the effects of increased frequency and magnitude of flooding under climate change are not mitigated and would result in an increase in flood damages, loss of life and recovery cost, borne by the populations that are currently at risk along Elbow River.

Conformity IR3-06

Topic: **Hydrology – Suspended Sediment**

Sources:

EIS Guidelines Part 2, Section 6.1.4; 6.2.2

EIS Volume 3B, Sections 6.4.1; 6.4.3

EIS Volume 4, Appendix J, Figure 3-12

Rocky View County – Comments on the EIS, June 15, 2018 (CEAR #571)

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-06

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

Context and Rationale

The EIS Guidelines require the proponent to assess changes to hydrology and water quality of the Elbow River, and direct the proponent to carry out modelling as required to present and substantiate anticipated changes.

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-06 c), the Agency required additional details on the sediment transport model, including a description of how the results for the MT and ST modules were combined.

Alberta Transportation's response to IR3-06 part c) indicates that there is no direct integration or information exchange between the MT and ST modules, which is consistent with the MIKE21 modelling system. As referenced in the information request, Rocky View County's comments note that interactions between suspended sediment and bed load transport are important in assessing degradation and aggradation in the river channel. No information is provided that addresses this concern or provides a rationale for why combining the MT and ST modules is not needed.

In IR3-06 d), the Agency required Alberta Transportation to provide a rationale for using the Meyer-Peter and Muller equation to estimate sediment transport and discuss whether the results on the sediment transport model were validated against a total load formula. Alberta Transportation's response to IR3-06 part d) indicates that the Meyer-Peter and Muller formula is used to simulate the transport and bed level changes of non-cohesive sand and gravel sediments and comparison between the sediment transport model and a total load formula has not been performed.

As noted in the information request, Rocky View County indicated that the Meyer-Peter and Muller equation is most suitable for estimating gravel transport and may underestimate sediment transport with fine sediments or high current speeds. Therefore, it may not be suitable for evaluating the fate of suspended sediment released from the reservoir and the high velocities associated with flows released into the tributary downstream of the low level outlet. Alberta Transportation's response does not provide a rationale for the use of the equation, or address the concern raised by Rocky View County regarding the potential underestimation of sediment transport with fine sediments or high current speeds. Additionally, the response does not discuss why a comparison of the sediment transport model and total load formula was not performed and what associated limitation this may result in.

Information Requests:

a) **Describe how the MIKE21 model accurately accounts for the degradation and aggradation in the river channel. Include a rationale for not combining the the MT and ST modules.**

b) **Provide rationale for using the Meyer-Peter and Muller equation to estimate sediment transport when the equation may underestimate sediment transport with fine sediments or high current speeds.**

c) **Discuss the limitation(s) of not validating the sediment transport model against a total load formula.**

Response

a) The mud transport (MT) and sand transport (ST) modules are individually coupled with the MIKE21 HD (hydrodynamic) module, they are essentially two separate models. The two modules use different transport equations and focus on different sediment sizes. Whether the modules are run independently or at the same time the modules do not communicate with each other. Estimates of aggradation and degradation typically focus on bedload as that is the sediment size component that influences the morphology of a gravel-bed river. Although the suspended load is important with regards to the overall sediment load of the river, bedload is the focus when investigating the effects of floods on aggradation and degradation. The MT module uses three size fractions (silt, sand and gravel) to model sediment transport, while the ST module focuses on bedload transport and utilizes the Meyer-Peter and Muller (MPM) equation. The HD) module simulates unsteady flows and is a basic computational component of the MIKE21 modelling system and it can be extended to simulate reciprocal interactions between flows and sediment transport by coupling with other modules such as the MT and ST modules.

   The accuracy of any model depends on the level of information that is used to develop it. Processes as complex as sediment transport have uncertainty. During development of the MIKE21 model, there was only historical field data available for bedload and bed level change for model calibration on local bed degradation and aggradation. Available historical data related to the river sedimentation was for suspended sediment concentration (SSC) only. The MIKE21 model (used to model sediment transport) was calibrated against the historical records of SSC in the study reach by adjusting the key parameters related to sediment degradation and aggradation (i.e., the critical shear stress for deposition and the critical shear stress for erosion). Shear stress is the measure of the force of water on the stream bed, when this force exceeds gravitational forces of the sediment on the bed, the sediment is moved. When the shear stress is lower than the gravitational forces, sediment will be deposited (Robert 2014; Bridge 2009.) These two key calibration parameters dominate the general process of sediment deposition, resuspension and erosion, and the resulting variations in the SSC in the water column. Therefore, the model may not be fully calibrated due to limitation of field available data at the time, but the calibration of the modelled shear stress using the observed SSC is a valid approach when data is limited.

b) The MPM sediment transport equation was used to model the bedload component of the total transported load. The MPM cannot model the fate of suspended sediment released from the reservoir. The MT module within Mike21 calculates the suspended load. The morphology of Elbow River and the processes of erosion and deposition are primarily a result of sediment on the channel bed. The MPM equation was used in the engineering studies and was retained for consistency within the assessment analyses. The transport of finer sediment-sized fractions is modelled using the MT module of MIKE21, not the MPM equation. Use of the MPM equation in the ST module of MIKE21 alone would have resulted in underestimation of the total sediment load because the model was developed to estimate bedload only.

The MPM equation estimates the rate of bedload transport in a river as a function of the shear force exerted by the water flowing over the bed. The equation represents the shear force by including the volumetric discharge of the river per unit width of channel. Discharge is the product of velocity and the cross-sectional area of the flow; thus, the model directly accounts for the high velocity.

c) The MPM equation was used to understand the potential effects of the Project related to either aggradation or degradation in Elbow River related to the Project. Aggradation and degradation are primarily a function of bedload movement, a total load formula would not improve the estimates provided. In fact, the results from the MPM equation cannot be validated using a total load equation because the MPM equation only calculates bedload and not suspended load.

The modelling work was completed for three size fractions (1. silt and clays, 2. sand and 3. gravel) in the MT and ST modules of MIKE21. The MT module simulates the erosion, transport, settling and deposition of cohesive sediment (silts and clays). The ST module simulates the sediment transport capacity, initial rates of bed-level changes and the morphological changes of non-cohesive sediment (sand and gravels). The MPM equation was used in the ST module to model bedload transport. The combination of the MT and ST modules provides the necessary flexibility required to estimate Project effects on sediment transport. No work was completed to compare whether these results would be significantly different using total load formulas. However, as a range of sediment sizes were modelled, the estimates provided in the assessment are likely to be within the range of uncertainty of modelling sediment transport at the magnitude of streamflow modelled.

REFERENCES

Bridge, J.S., 2009. Rivers and floodplains: forms, processes, and sedimentary record. John Wiley & Sons.

Robert, A., 2014. River processes: an introduction to fluvial dynamics. Routledge.

Conformity IR3-08

Topic: Project Operation – Flood Frequency

Sources:

EIS Guidelines Part 2, Section 3.1; 3.2.2; 6.1.4

EIS Volume 1, Section 3.1 and 7.4

EIS Volume 3B, Section 3.2.8

Rocky View County – Comments on the EIS, June 15, 2018 (CEAR #571)

Piikani Nation – Technical Review of EIS, June 15, 2018 (CEAR #48)

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-08

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

Context and Rationale

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 2, IR3-08, the Agency required Alberta Transportation clarify at what flow volumes and flood frequency the Project would be in operation, and assess potential effects to each VC based on the highest frequency of Project operation. As noted in the information request, the EIS Guidelines require the proponent to describe the operation of key Project components.

Alberta Transportation's response to IR3-08 indicates the assessment of effects during the flood and post-flood phases addresses three floods: 1:10 year, 1:100 year and design (Volume 2, Section 7.1.1.2), and the rationale for selection of these floods, for both engineering design and assessment of effects, is provided in Volume 1, Section 3.1. However, no rationale is provided for the selection of these floods in Volume 1, Section 3.1.

Additionally, Alberta Transportation indicates a 1:10 year interval (200 m^3/s) is the closest flow volume to the activation flow volume of 160 m^3/s and was used in the assessment. However, the table that is referenced in the response (EIS Volume 1, Section 3-1, Table 3-1) notes that a 1:5 year flood has an estimated Peak Discharge at the Diversion Structure of 140 m^3/s. The 1:5 year flood volume is closer to 160 m^3/s than the 1:10 year flood amount. Although Alberta Transportation's response indicates the frequency of Project operation is correlated to Elbow River flood flow rates at and above 160 m^3/s, this does not demonstrate a conservative approach and may underestimate potential effects due to an actual frequency of operation of the project that is higher than the one used in the modelling.

Understanding the frequency of Project operation and when water management practices will be implemented is critical to the assessment of environmental effects.

Information Requests:

a) Provide a rationale for the selection of the three floods used in modelling: 1:10 year, 1:100 year, and design flood.

  i. Specifically discuss why the 1:5 year flood was not selected.

  ii. Describe why a 1:7 year flood, which corresponds to the activation flow volume of 160 m^3/s, was not an option.

b) Discuss what effects to VCs may be underestimated as the Project will be used more frequently than a 1:10 year flood rate.

  i. Consider long-term use of the Project at a 1:7 year frequency, rather than a 1:10 year frequency and the associated additional effects that were not considered.

  ii. Provide an analysis of the risk associated with the use of the 1:10 year flood frequency.

  iii. If no additional effects are anticipated, provide a rationale for why.

Response

a) i. The three floods are used to focus the assessment on a range of flows that would have potential effects on the environment. These three are a small flood (1:10 year), a large flood (1:100 year) and the equivalent of the 2013 flood for which the Project is designed. The 1:5 year flow was not selected because during the 1:5 year flood, peak flow would be 140 m^3/s, and the diversion structure would not be in operation; so, no Elbow River flow would be diverted to the reservoir during the 1:5 year flow and no Project effects would occur.

  ii. A 1:7 year flood with an instantaneous peak flow rate of 160 m^3/s was an option; but it was not selected for analysis in the EIA because, with a total flow of 160 m^3/s, there would be no diversion (0 m^3/s) to the reservoir and no Elbow River flow would be diverted to the reservoir.

  The 1:10 year flood was selected to represent the effects of a high frequency, low magnitude flood. The 1:10 year flood (200 m^3/s) was selected because in this case, a flow rate of 40 m^3/s (approximately the bankfull flow rate of Elbow River) would be diverted into the reservoir and there would be a reasonable potential for measurable effects. Diverting between 0 m^3/s and 40 m^3/s into the reservoir during floods between the 1:7 year flood and the 1:10 year flood amount to flow diversions of 0.6% to 20% of the total flood flow rate, respectively. Additionally, operations during floods less than the

1:10 year flood would result in the diversion of flows into the reservoir for less than 8 hours, which is the duration expected for a 1:10 year flood (EIA, Volume 3B, Table 6-4). Thus, even though the floods between the 1:7 year and 1:10 year floods may occur more frequently, the magnitude of the Project effect during those floods is lower than what was assessed in the EIA. Therefore, the 1:10 year flood included in the EIA conservatively represents flow rates between 160 m^3/s and 200 m^3/s.

b) i. Project operations for a 1:7 year flood (160 m^3/s) would have minimal effects on Elbow River because no water is diverted to the reservoir. Therefore, effects on VCs would be considered not measurable to negligible. Since 1934, four floods occurred that were greater than the 1:7 year flood and less than the 1:10 year flood. Two floods had a peak instantaneous flow of 170 m^3/s, and the remainder had peaks of 172 m^3/s and 181 m^3/s. These floods would have resulted in the diversion of 10 m^3/s (5.8% of total flood flow), 12 m^3/s (7.0%) or 21 m^3/s (11.6%) for a period of less than one day.

The magnitude (negligible to low), frequency (multiple irregular), duration (short-term) and reversibility (reversible) of effects associated with engaging the Project during 1:7 year (160 m^3/s) to 1:10 year (200 m^3/s) floods does not change the effects assessment on surface hydrology (based on hydrology assessment methods in EIA, Volume 3A, Section 6.1.5, Table 6-2, page 6.8).

ii-iii. Table 8-1 summarizes the risk of underestimating potential Project effects by not considering higher frequency, lower magnitude flooding between the 1:7 year flood and the 1:10 year flood. It also provides a rationale for why no additional effects are expected. At flood frequencies between 1:7 and 1:10 years, the environment would experience more frequent effects, since the Project would be activated more often, but the water diverted would cover a smaller area than that from a 1:10 year flood. As provided in Table 8-1, the effects of more frequent but lower flood flows are predicted to be negligible to low in magnitude and do not increase relative to the conclusions for the 1:10 year flood frequency for all VCs.

Table 8-1 Risks associated with using the 1:10 year flood frequency assessment

Valued Component	Risk Evaluation of Assessing the 1:10 Year Flood instead of Assessing the 1:7 Year Flood
Air Quality and Climate	The risk of only using the 1:10 year flood is low. With no water diverted to the reservoir during the 1:7 year flood, there is no potential for dust generation and no effects on air quality and climate.
Acoustic Environment	The risk of using the 1:10 year flood is negligible. Noise generation following a 1:7 year flood would be less than following a 1:10 year flood. Noise following a flood is associated with channel maintenance and road and bridge maintenance. Following a 1:7 year flood, maintenance activities are expected to be minimal to negligible. The effects would be not significant.
Hydrogeology	The risk of using the 1:10 year flood is low. No water would be diverted to the reservoir in the 1:7 year flood and the effects on hydrogeology would be negligible and not significant. Similarly, the effects of water diverted in floods between 1:7 and 1:10 years would be the same as, or less than, those for a 1:10 year flood which are assessed as not significant, given the low volume and short term of water diverted to the reservoir.
Hydrology	The risk of using the 1:10 year flood is low. As stated in the EIA, Volume 3B, Section 6.4.2.4, "The effect on the hydrological regime for the 1:10 year flood, in terms of (statistical) annual volume, is negligible in magnitude and transient and not significant. As a result, it is unlikely to have a measurable effect." The volume of water diverted during flood frequencies between 1:7 and 1:10 year is smaller than that diverted during a 1:10 year flood, with minimal water diverted to the reservoir. The effects are expected to be not measurable.
Surface Water Quality	The risk of using the 1:10 year flood frequency instead of considering the flood floods between 1:7 to 1:10 year flood frequencies is low. Water will only be diverted to the reservoir when Elbow River flows are greater than those of the 1:7 year flood. The effect will be less than that of a 1:10 year flood and considered negligible to low and not significant. The EIA considers the multiple irregular nature of flood frequency in Elbow River; increasing the frequency of low magnitude floods does not alter the assessment.
Aquatic Ecology	The risk of using the 1:10 year flood frequency instead of considering the floods between 1:7 to 1:10 year flood frequencies is low. The effects on fish and fish habitat, considering the 1:7 year flood, are based on a slightly higher frequency than used in the EIA, but the magnitude is lower (as discussed in part a of this response). The frequency and magnitude does not change from the frequency and magnitude ratings in the EIA and, therefore, the significance of the effects do not change; the increase in number of floods between 1:7 and 1:10 year frequency does not alter the assessment. Hydrologic and geomorphic processes will maintain fish habitat downstream of the diversion area during more frequent 1:7 year floods in a manner similar to the 1:10 year floods. Fish passage blockage would be more frequent but minimal during 1:7 year floods (i.e., diversion activities would be less than 10 hours). Fish entrainment would occur in the reservoir more frequently during floods between the 1:7 year and 1:10 year magnitude, but because of their small magnitude, few fish would be entrained and mitigation (i.e., fish rescue activities) would be more effective; because of the small amount of water diverted into the reservoir, holding times in the reservoir would be shorter.

Table 8-1 Risks associated with using the 1:10 year flood frequency assessment

Valued Component	Risk Evaluation of Assessing the 1:10 Year Flood instead of Assessing the 1:7 Year Flood
Terrain and Soils	The risk of using the 1:10 year flood is low. The effects of a 1:10 year flood is of low magnitude and not significant. Floods between 1:7 and 1:10 year frequency could result in a more frequent, but smaller areal extent and shorter duration inundation of soils; therefore, effects would be reduced relative to the EIA.
Vegetation and Wetlands	The risk of using the 1:10 year flood is low. Vegetation and wetland cover types inundated at a 1:10 year flood is 1.1% of the PDA; species of management concern are not affected, and the wetland value decreases by 1.3%. These changes are low magnitude and not significant. The effects of flood frequencies between 1:7 and 1:10 years would be less with smaller amounts of water diverted to the reservoir.
Wildlife and Biodiversity	The risk of using the 1:10 year flood is low. Effects of a 1:10 year flood have been assessed as negligible to low and not significant. Effects of floods between a 1:7 year and 1:10 year frequency would result in a smaller area of habitat disruption than that of a 1:10 year flood and the effects are assessed the same: negligible to low and not significant.
Land Use and Management	There is no risk because the effects of floods between 1:7 year and 1:10 year floods would be less than or the same as a 1:10 year flood. Land use in the reservoir would be temporarily suspended during a flood, but the effect is assessed as being not significant for a 1:10 year flood. Any suspension of land uses during a 1:7 to 1:10 year flood, were they to occur, would be shorter and not significant.
Historical Resources	There is no risk because the effects of a 1:7 year flood would be less than or the same as a 1:10 year flood. Reservoir draining following floods between 1:7 and 1:10 years would potentially affect any heritage resources near the unnamed creek, but the volume of water drained would be less than that from the 1:10 year flood and the effects would be not significant.
Traditional Land and Resource Use	The risk of using the 1:10 year flood is low. The effects on traditional land and resource use are influenced by those on the biophysical and other human environment VCs and the effects on these for floods between 1:7 and 1:10 years will be less than those of a 1:10 year flood.
Public Health	There is no risk of underestimating the effects of a 1:10 year flood instead of a 1:7 year flood because the effects of floods between 1:7 and 1:10 years would be less than or the same as a 1:10 year flood, which are assessed as being of low magnitude and not significant. The lower frequency floods would not result in increased residual effects on air quality, water quality or country food quality, as stated in the assessment of effects on air quality and climate and surface water quality above. Thus, there would be no increase in the effect on country foods from air emissions on vegetation or water quality effects on fish or wildlife.
Infrastructure and Services	There is no risk in using the 1:10 year flood to represent the 1:7 year flood because the effects of a 1:7 year flood would be less than or the same as a 1:10 year flood. The effects of a 1:10 year flood would not affect the existing road network or disrupt traffic on public roads. Floods between 1:7 and 1:10 year frequency would also not affect roads or disrupt traffic; the effects are not significant.

Table 8-1 Risks associated with using the 1:10 year flood frequency assessment

Valued Component	Risk Evaluation of Assessing the 1:10 Year Flood instead of Assessing the 1:7 Year Flood
Employment and Economy	There is no risk using the 1:10 year flood to represent the 1:7 year flood. The effects on employment and economy are not measurably different for the two floods.
Federal Lands	The effects on federal lands are associated with effects on VCs that overlap federal lands and, as shown in the entries above for the VC's, the assessment of assuming 1:7 to 1:10 year return periods will not change the assessment of Project effects. There is no risk using the 1:10 year flood to represent the 1:7 year flood because the effects on federal lands will not differ between the two return periods.

Conformity IR3-09

Topic: Project Operation – Effects from Changes in Flood Frequency and Sediment Load and Transport on the Elbow River

Sources:

EIS Guidelines Part 2, Sections 6.1.4; 6.1.5; 6.2.2; 6.3.1; 6.3.3

EIS Volume 1, Sections 3.1; 7.4

EIS Volume 3A, Section 8.4.4

EIS Volume 3B, Sections 6.2; 6.4; 6.7; 8.2

EIS Volume 4, Appendix J, Table 3-4

Rocky View County – Comments on the EIS, June 15, 2018 (CEAR #571)

Piikani Nation – Technical Review of EIS, June 15, 2018 (CEAR #48) Samson Cree Nation – Springbank Off-Stream Reservoir Project Written Submission – June 25, 2018 (CEAR #52)

Montana First Nation – Review of Springbank Off-Stream Reservoir EIA, June 2018 (CEAR #51)

Alberta Transportation Responses to CEAA Annex 2: A) Early Technical Issues, May 11, 2018

Fisheries and Oceans Canada – Comments on the EIS, June 19, 2018 (CEAR #28)

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-09

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

DFO Round 1 IR Completeness Review Comments, June 28, 2019

Context and Rationale

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-09 a), the Agency required an assessment of the environmental effects of a reduced frequency of inundations of the Elbow River downstream of the Project. As noted in the information request, the EIS Guidelines require the proponent to present information on multiple components of hydrology of the Elbow River watershed, including those that affect water quality and quantity, sediment quality and quantity, and fish and fish habitat. Flows and associated sediment transport within river systems affect water quality as well as fish and fish habitat.

Alberta Transportation's response to IR3-09 indicates that the force of water released from the reservoir will mobilize bed sediments and change the morphology of the unnamed creek, but bed material is predicted to remain in the unnamed creek and minimal interaction with the Elbow River is expected (Volume 3B, Section 8.2.2, page 7.10). The proponent further quotes from the EIS on flood and post-flood effects to fish habitat and describes the potential effects to fish habitat from the predicted gravel fan (in response to IR3-09 d). However, changes to the magnitude of aggradation and degradation in the Elbow River to fish and fish habitat are not fully understood.

In IR3-09 b), the Agency required Alberta Transportation clarify how coarse sediments and bedload transport downstream will be maintained if discharges greater than 160 m^3/s will no longer occur/occur on a limited basis downstream of the diversion channel. Alberta Transportation's response discusses the potential for reduced mobilization on gravel bar heads and subsequent decrease in the magnitude of degradation and aggradation of those gravel bars, and the stabilization of banks and a corresponding increase in directly overhanging vegetation.

As referenced in the information request, Rocky View County noted that the minimum threshold to mobilize the thalweg armour layer is 500 m^3/s. Under existing conditions, the 500 m^3/s threshold is exceeded during the 50-year flood. As the project will divert flows above 160 m^3/s, and 600 m^3/s is diverted from the reach, the 500 m^3/s threshold would be exceeded only for flood with recurrence intervals of 200 years or longer. This suggests that general bed motion in the river downstream of the inlet will occur less frequently as flow is diverted. This concern or discussion about the effects to the thawleg armour layer are not discussed.

In IR3-09 d) the Agency further required an assessment of where sediment would be deposited downstream of the low level outlet channel, and on the type(s) of fish habitat it is predicted to settle on. Alberta Transportation's response notes that released sediment will result in a localized gravel fan at the confluence of the unnamed creek with the Elbow River. It is not clear if sediments smaller than gravel were considered, and if fine sediments will settle on suitable spawning substrates or the eggs of fall spawning fish species in the Elbow River downstream of the low level outlet channel.

Information Requests:

a) Assess Project effects of changes to the magnitude of aggradation and degradation in the Elbow River to fish and fish habitat.

b) Specifically discuss Rocky View County's concern regarding the reduced frequency of mobilization of the thalweg armour layer due to the Project diverting flood flows above 160 m^3/s.

c) Discuss how released sediment will result in a localized gravel fan at the confluence of the unnamed creek with the Elbow River.

- **Provide methodology used to make this prediction.**
- **Discuss whether suspended sediments smaller than gravel were considered.**

Response

a) Based on the discussion below in part b), channel processes will continue to maintain channel forming processes and as such, maintain fish habitat in a natural manner. Under all assessed floods, erosion and deposition of bar heads will be maintained, although the reduction in magnitude of erosion and deposition will be as follows (EIA, Volume 3B, Section 6.4.4, Hydrology, page 6.53):

- design flood will decrease aggradation and degradation 17% compared to no diversion
- 1:100 year flood will result in almost no shift in aggradation and degradation with an increase of 3% compared to no diversion
- 1:10 year flood will decrease aggradation and degradation 24% compared to no diversion

Bed elevation differences less than 0.2 m accounts for 99.0% of the overall area. A change of less than 0.2 m in bed elevation on bar heads is considered a small change to habitat and is not detrimental to fish habitat. Only 1% of this area will experience channel elevation differences greater than 0.2 m. Therefore, the overall impact is not anticipated to result in morphological change in Elbow River.

Bar head habitat primarily provides shallow, channel edge areas where young fish (e.g., mountain whitefish) and small species (e.g., minnows and dace) may feed or find refuge from larger aquatic predators that cannot navigate shallow waters. Much of the aggregated bar head habitat will be inaccessible as water levels naturally decrease through the year; however, degradation in other areas will render bar heads accessible for longer periods. Channel edge habitat is not limiting habitat in Elbow River; these shallow river habitats will continue to exist regardless of changes to gravel bar morphology.

b) Rocky View County is concerned the reduced frequency of mobilization of Elbow River thalweg armour layer due to the Project diverting flood flows above 160 m^3/s. In their submission dated June 15, 2018 (Canadian Environmental Assessment Registry (CEAR #571)), Hudson (1983) is referenced as follows: "*Hudson (1983) states that the shear stress required to mobilize the thalweg armour layer is only generated by flows of 500 m3/s or greater. This suggests that general bed motion in the river downstream of the inlet will occur less frequently as flow is diverted.*" The following specifically discusses this topic.

   Elbow River is a braided/wandering gravel-bed river in the reach effected by the Project. Braided and wandering gravel-bed reaches are wide and shallow, which is different than confined reaches that are narrow and deep (as studied by Hudson 1983). The mechanism of sediment transport in braided and wandering gravel-bed rivers is primarily through the erosion, mobilization, and deposition of sediment on mid-channel bars. By nature, the whole sediment grain size distribution in these rivers are highly mobile and lateral channel movement occurs frequently. Lag deposits that result from either glacial history, or low frequency high magnitude floods, may exist; but for the most part, the surface layer reflects sediments that are alluvial in nature and are mobile at much high frequency, lower magnitude floods.

   Hudson (1983) analyzed the hydraulics at the Water Survey Canada (WSC) station at Bragg Creek. The study found that flows of at least 500 m^3/s at this location would be required to mobilize the sediment found in the thalweg (D_{90} = 300 mm).

   Hudson's calculation was based on the hydraulic information available from the Water WSC station at Bragg Creek. This station is located in a relatively confined reach of Elbow River, relative to the Project location, and is influenced by the Balsam Avenue Bridge. The channel width used in his calculations was approximately 38 m. Average channel widths at the Project location range from 45 m to greater than 300 m. Thus, the local hydraulics and the grain size distribution of the bed sediment are likely very different between Hudson's site and the Project site. From sediment samples collected for the Project, the maximum D_{90} observed in the samples was 133 mm (EIA, Volume 4, Appendix J, Section 3, Table 3-8).

   The Project will result in diversion flows above 160 m^3/s and thus will result in the reduced mobility of sediment when flows are above the threshold for diversion. However, the application of the threshold of motion for the thalweg sediment of 500 m^3/s (as stated in Rocky View County comments) is not applicable to the Project site.

c) A small fan may develop near the confluence when sediment is transported from a tributary into a larger river. Whether a fan forms and the size of the fan depends on the volume and size of the material being supplied to the channel from the tributary and the ability of the larger river to transport the sediment downstream. The ability of the river to transport the material downstream depends on a range of factors, including slope of the river, the channel width and depth and the discharge in the river during the sediment input. A small fan, no fan or a scour pool may develop if the sediment is supplied to the larger river when the discharge is high. A larger fan may develop if the sediment is supplied when the river discharge is low.

The timing of the release of water from the reservoir through the unnamed creek was based on two criteria: (1) the flow within Elbow River is less than 20 m^3/s and (2) the length of time required to draw down the reservoir (42.4 days for the design full service volume of the reservoir). The 20 m^3/s discharge was chosen to avoid the resuspension of sediment within Elbow River. Bedload and coarser sediment suspended within the water column are likely to deposit near the confluence within Elbow River. Some suspended sediment within the flow from unnamed creek will likely remain in suspension downstream of the confluence. Sediment from the unnamed creek will be supplied to Elbow River when the flow within Elbow River is low and deposition is predicted to occur, based on the modelling.

The prediction of how released sediment will result in a localized gravel fan at the confluence of the unnamed creek with Elbow River is modelled using MIKE21. The model was calibrated with available historical SSC. The MIKE21 model that was used to model sediment transport was calibrated against the historical records of SSC in the mainstem of Elbow River by adjusting the key parameters related to sediment degradation and aggradation, i.e., the critical shear stress for deposition and the critical shear stress for erosion. These two key calibration parameters dominate the general process of sediment deposition, resuspension and erosion, and the resulting variations in the SSC in the water column.

The MIKE21 software package, a HD module that simulates unsteady flows, is a basic computation component of the modelling system, it can be extended to simulate reciprocal interactions between flows and sediment transport by coupling with other modules such as the MT and ST modules. The MT module simulates the erosion, transport, settling and deposition of cohesive sediment (silts and clays). The ST module simulates the sediment transport capacity, initial rates of bed-level changes and the morphological changes of non-cohesive sediment (sand and gravels). In the modelling study for the Project, both MT and ST modules are coupled with the HD module for the same flows and in the same time domain.

The modelling work was completed using three size fractions (silt, sand and gravel) in the MT module and MPM equation in the ST module to include the fine and coarse materials for suspended and bedload transport.

REFERENCES

Hudson, H.R. 1983. Hydrology and sediment transport in the Elbow River basin, SW Alberta. Unpublished PhD Thesis, The University of Alberta. 344 pp.

Conformity IR3-10

<u>Topic:</u> Project Operation – Water Retention in the Reservoir

<u>Sources:</u>

EIS Guidelines Part 2, Sections 3.1; 3.2.2; 6.1.4

EIS Volume 1, Section 6.3

EIS Volume 3B, Section 6.4

Rocky View County – Comments on the EIS, June 15, 2018 (CEAR #571)

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-10

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

<u>Context and Rationale</u>

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-10, the Agency required Alberta Transportation provide the volumes, depths, and surface area of water expected to be pre-existing in depressions in the reservoir pre-diversion and remaining in the reservoir post-release for each flood scenario. As noted in the information request, the EIS Guidelines require the proponent to describe the operation of key project components and any changes from the Project to water quality and quantity.

In Alberta Transportation's response to IR3-10, Alberta Transportation acknowledges that there are some wetlands that may hold shallow water seasonally or semi-permanently, and some human-made dugouts that are likely permanently flooded, and notes that water retention in wetland communities depends on a variety of factors and cannot be easily calculated. No volumes, depths, and surface area volumes are estimated for either the wetlands or dugouts. Although it is understandable that water retention can vary, it is important to understand what could be present within the reservoir pre-diversion. The size of the wetlands and dugouts, and potential water retention can still be discussed.

As referenced in the submission, Rocky View County raised the concern that if water exists within the reservoir in depressions prior to flooding, such as in the wetlands and dugouts, resulting limitations to storage capacity should be considered.

Understanding retention within the reservoir is required to accurately assess potential effects, including effects to water quality, fish and fish habitat, land use, physical and cultural heritage, and impacts to rights.

Information Requests:

a) Provide the volumes, depths, and surface area of water expected to be pre-existing in depressions in the reservoir pre-diversion.

b) Discuss limitations to storage capacity that could occur due to water existing in the reservoir prior to diversion.

Response

a) Estimated volumes, depths and surface area of wetlands and dugouts in the reservoir are provided in Table 10-1. Wetlands and dugouts are shown in Figure 10-1. Volumes and depths of surface water holding capacity were estimated using LiDAR, with 15 cm to 20 cm vertical accuracy. Volume and depth may be underestimated for dugouts because the available LiDAR (near infrared) is absorbed by standing water; therefore, an accurate measurement of the depth might not be possible.

The sum of the individual volumes of wetlands and dugouts is 41,845 m^3.

b) Should antecedent rainfall have filled all the wetland and dugouts prior to water diversion, then an estimated 41,845 m^3 of active temporary storage would be lost. This amounts to approximately 0.05% of the 77.8 million m^3 of active temporary flood storage capacity that the reservoir provides and is negligible. The 77.8 million m^3 of active temporary flood storage capacity includes 10% of additional volume over what is required to achieve the design (2013 flood) basis, for both sediment accumulation or precipitation in the unnamed creek basin.

Table 10-1 Estimated Wetland and Dugout Surface Area, Volume and Depth

Wetland ID	Wetland Class	Surface Area (ha)	Maximum Depth (m)	Maximum Volume (m^3)
1	Temporary graminoid marsh	0.48	0.32	380.77
2	Temporary graminoid marsh	0.67	0.43	700.36
3	Temporary graminoid marsh	0.01	0.43	25.26
4	Temporary graminoid marsh	0.06	0.30	52.46
5	Temporary graminoid marsh	0.08	0.20	27.88
6	Seasonal graminoid marsh	0.11	0.69	373.27
7	Seasonal graminoid marsh	0.58	0.77	2388.24
8	Ephemeral waterbody	0.15	0.21	25.26
9	Seasonal graminoid marsh	0.54	0.50	782.28
10	Seasonal graminoid marsh	0.20	0.33	118.36
11	Seasonal graminoid marsh	1.22	0.53	1108.79

Table 10-1 Estimated Wetland and Dugout Surface Area, Volume and Depth

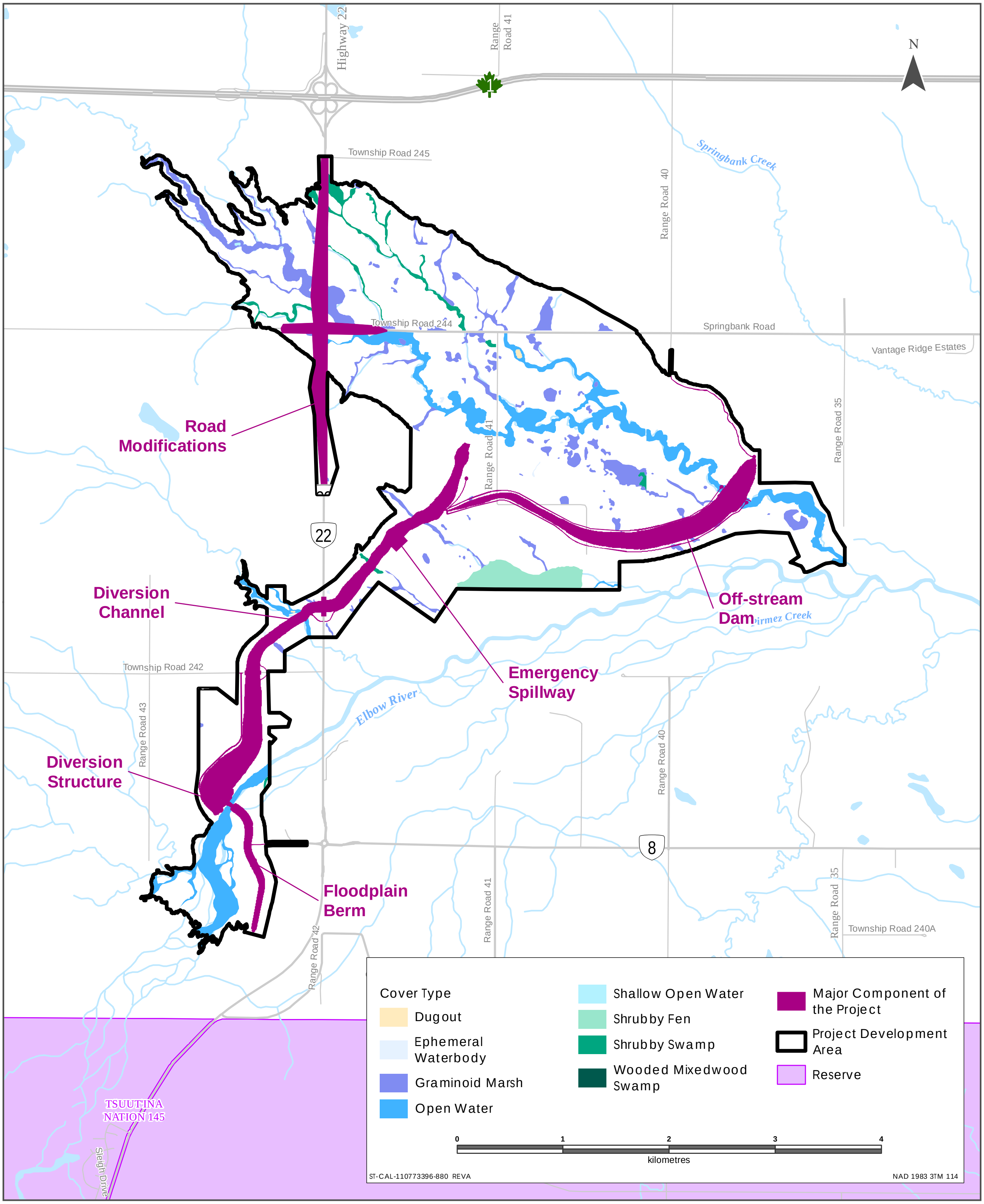
Wetland ID	Wetland Class	Surface Area (ha)	Maximum Depth (m)	Maximum Volume (m^3)
12	Seasonal graminoid marsh	1.57	0.41	698.18
13	Temporary graminoid marsh	0.02	0.19	13.31
14	Temporary graminoid marsh	0.12	0.26	112.05
15	Ephemeral waterbody	0.04	0.27	52.85
16	Temporary graminoid marsh	0.05	0.20	35.67
17	Temporary graminoid marsh	0.04	0.13	15.33
18	Seasonal graminoid marsh	0.30	0.53	525.72
19	Semi-permanent graminoid marsh	6.63	0.62	9213.29
20	Temporary graminoid marsh	0.06	0.16	23.20
21	Seasonal graminoid marsh	0.15	0.45	74.90
22	Seasonal graminoid marsh	0.03	0.31	37.47
23	Seasonal graminoid marsh	0.60	0.50	669.46
24	Seasonal graminoid marsh	0.29	0.36	176.60
25	Seasonal graminoid marsh	0.05	0.30	34.63
26	Seasonal graminoid marsh	0.26	0.24	47.56
27	Temporary graminoid marsh	0.03	0.31	57.04
28	Seasonal shrubby swamp	0.68	0.17	32.85
29	Temporary graminoid marsh	1.11	0.25	103.62
30	Seasonal graminoid marsh	0.08	0.98	484.32
31	Seasonal graminoid marsh	0.07	0.33	62.36
32	Seasonal graminoid marsh	0.26	0.45	462.28
33	Seasonal graminoid marsh	1.28	0.50	1082.57
34	Temporary graminoid marsh	0.06	0.48	154.72
35	Seasonal graminoid marsh	0.23	0.34	117.00
36	Seasonal graminoid marsh	1.58	0.66	234.69
37	Temporary graminoid marsh	0.82	0.08	1.93
38	Seasonal graminoid marsh	1.15	0.18	122.37
39	Temporary graminoid marsh	0.07	0.26	59.91
40	Seasonal graminoid marsh	0.13	0.24	37.98
41	Seasonal graminoid marsh	0.24	0.38	237.61
42	Temporary graminoid marsh	0.50	0.48	487.45
43	Ephemeral waterbody	0.15	0.53	99.43
44	Seasonal graminoid marsh	0.77	0.49	774.14
45	Temporary graminoid marsh	0.06	0.11	12.93

Table 10-1 Estimated Wetland and Dugout Surface Area, Volume and Depth

Wetland ID	Wetland Class	Surface Area (ha)	Maximum Depth (m)	Maximum Volume (m^3)
46	Temporary graminoid marsh	0.20	0.48	467.97
47	Temporary graminoid marsh	0.66	0.16	31.17
48	Temporary graminoid marsh	1.54	0.16	45.03
49	Seasonal graminoid marsh	0.10	0.13	11.17
50	Temporary graminoid marsh	1.18	0.21	88.54
51	Seasonal graminoid marsh	0.17	0.70	162.54
52	Seasonal shrubby swamp	1.87	0.33	82.63
53	Semi-permanent graminoid marsh	4.76	1.53	910.51
54	Seasonal graminoid marsh	0.14	0.37	98.23
55	Seasonal graminoid marsh	0.19	0.33	205.50
56	Temporary Shrubby Swamp	1.34	0.31	117.59
57	Seasonal graminoid marsh	0.77	0.97	634.97
58	Temporary graminoid marsh	0.14	0.37	80.90
59	Temporary graminoid marsh	0.21	0.16	35.95
60	Temporary graminoid marsh	6.44	0.50	846.42
61	Ephemeral waterbody	0.06	0.10	2.07
62	Temporary graminoid marsh	0.09	0.16	22.49
63	Seasonal graminoid marsh	1.22	1.15	1717.41
64	Seasonal graminoid marsh	0.12	0.30	40.48
65	Temporary graminoid marsh	0.04	0.24	40.25
66	Seasonal graminoid marsh	0.36	0.86	1707.76
67	Semi-permanent graminoid marsh	0.16	0.31	66.62
68	Temporary graminoid marsh	0.58	0.05	1.46
69	Seasonal graminoid marsh	0.07	0.11	1.57
70	Temporary graminoid marsh	0.58	0.18	23.80
71	Seasonal graminoid marsh	0.44	0.24	25.33
72	Temporary graminoid marsh	3.29	0.17	45.94
73	Semi-permanent graminoid marsh	1.37	0.14	11.90
74	Temporary graminoid marsh	1.59	0.26	160.84
75	Seasonal graminoid marsh	0.06	0.28	63.92
76	Seasonal graminoid marsh	0.57	0.36	245.08
77	Seasonal graminoid marsh	0.00	0.05	0.14
78	Temporary graminoid marsh	0.07	0.24	14.79
79	Seasonal graminoid marsh	0.77	0.82	312.10

Table 10-1 Estimated Wetland and Dugout Surface Area, Volume and Depth

Wetland ID	Wetland Class	Surface Area (ha)	Maximum Depth (m)	Maximum Volume (m³)
80	Temporary graminoid marsh	0.50	0.20	77.78
81	Temporary graminoid marsh	0.67	0.15	28.04
82	Seasonal graminoid marsh	0.94	0.36	335.20
83	Temporary graminoid marsh	0.12	0.16	14.88
84	Temporary graminoid marsh	0.27	0.23	31.22
85	Seasonal graminoid marsh	0.08	0.11	4.86
86	Temporary graminoid marsh	0.15	0.28	21.16
87	Seasonal graminoid marsh	0.12	0.12	4.31
88	Shallow open water with submersed and/or floating aquatic vegetation	0.15	0.43	419.36
89	Semi-permanent graminoid marsh	0.16	0.22	149.52
90	Semi-permanent graminoid marsh	0.29	0.79	1496.94
91	Seasonal shrubby swamp	0.41	0.40	176.69
92	Seasonal graminoid marsh	14.11	1.75	7104.08
93	Dugout	0.40	0.53	1319.45
	Total	73.08	35.32	41844.88



Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Wetlands in the PDA

Conformity Response 3

Figure 10-1

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Conformity IR3-15

Topic: Hydrogeology – Groundwater Sampling, Monitoring, and Follow-up

Sources:

EIS Guidelines Part 2, Sections 6.1.4; 6.2.2

EIS Volume 3A, Section 5.2

EIS Volume 3B, Section 5.2

EIS Volume 4, Appendix I Hydrogeology Baseline Technical Data Report, Sections 2.3, 3.1 and 3.2

Tsuut'ina First Nation, Ermineskin Cree Nation, and Kainai First Nation – Technical Review of the EIS - Annexes – Combined (CEAR # 46, 47, 50)

Natural Resources Canada – Comments on the EIS, June 19, 2018 (CEAR #45)

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-15, Appendix IR15-1

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

NRCan Round 1 IR Completeness Review Comments, July 2, 2019

Context and Rationale

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-15 d), the Agency required more details on monitoring and follow-up of groundwater, including a discussion of the potential for use of dedicated monitoring wells for groundwater head monitoring, use of current monitoring wells, sampling prior to construction, effects of high detection limits, and a specific follow-up and monitoring program for groundwater on Tsuut'ina IR 145. As noted in the information request, the EIS Guidelines require the proponent to present information regarding groundwater, including baseline information such as location of monitoring wells, and changes to groundwater quality and quantity resulting from the Project.

In Alberta Transportation's response to IR3-15, Alberta Transportation provides a draft groundwater monitoring plan. However, no specific discussion regarding the potential for the use of dedicated monitoring wells for groundwater head monitoring is included. As noted in the information request, the EIS only discusses the use of domestic water wells in follow-up and monitoring. The purpose of the follow-up program is to validate the results of hydrogeological modelling and domestic wells on their own are of limited value to evaluate water level predictions. The use of dedicated monitoring wells to allow groundwater head monitoring for both dry operations and flood/post-flood response should be considered.

Additionally, the draft groundwater monitoring plan indicates that all monitoring wells to be included in the plan have been or, in the case of proposed wells, will be developed following completion. This does not provide clarity on whether any current monitoring wells will be maintained for use in follow-up and monitoring.

Tsuut'ina IR 145 is shown in the figures for the draft groundwater and monitoring plan for reference; however, information specific to what will be occurring on Tsuut'ina IR 145 is not included. For readability and clarity purposes, a specific section of the plan on follow-up and monitoring for Tsuut'ina IR 145 is required.

In IR3-15 e), the Agency required details on initial sampling of domestic wells prior to construction in order to establish pre-project baseline conditions. Alberta Transportation's draft groundwater monitoring plan indicates that during baseline data collection, there will be highly rigourous baseline monitoring (already ongoing) prior to any Project disturbances, but no additional details are provided. Further details on initial sampling, including timing and locations, are still required to ensure that Alberta Transportation will establish accurate pre-project baseline conditions.

Information Requests:

a) Update the draft groundwater monitoring plan to include:

- **A discussion on the potential use of dedicated monitoring wells (current or new) for groundwater head monitoring (i.e. with dataloggers) for both dry and flood/post flood operations.**
- **A discussion of whether current monitoring wells will be maintained for use in follow-up and monitoring.**
- **Details on initial sampling of domestic wells prior to construction. Discuss how Alberta Transportation intends on ensuring appropriate baseline conditions will be obtained prior to construction.**
- **A specific section regarding follow-up and monitoring for groundwater on Tsuut'ina IR 145. Include surveys and monitoring of Tsuut'ina's private water wells for water levels, prior to and during construction and during dry operations until groundwater under Project conditions reaches static conditions and well interference can be assessed.**

Response

a) The information requested in the bulleted list has been provided in the response below. This information will be included in the next update to the Groundwater Monitoring Program (current draft version is in Alberta Transportation's response to Round 1 CEAA Package 3, IR3-15, Appendix IR15-1). A specific section regarding follow-up and monitoring for groundwater on Tsuut'ina IR 145 will also be included in the updated plan.

As stated in the draft Groundwater Monitoring Plan, Section 6.2, "S*ome existing wells (either Project specific monitoring wells, or previously existing domestic wells) could be retained for incorporation into the monitoring program, depending upon their location, depth, and potential risk of inundation during a flood.*" Wells that are at risk of inundation and that are completed below the unconsolidated material in bedrock, would be decommissioned prior to the operational phase as noted above. A number of monitoring wells that are within the inundation area and are completed in unconsolidated deposits will be retained, if practical.

With respect to the question regarding the use of "dedicated" monitoring wells, Alberta Transportation confirms that monitoring wells that make up the proposed monitoring network will be dedicated and will be used throughout all phases for hydraulic head monitoring and other parameters, with exceptions as follows:

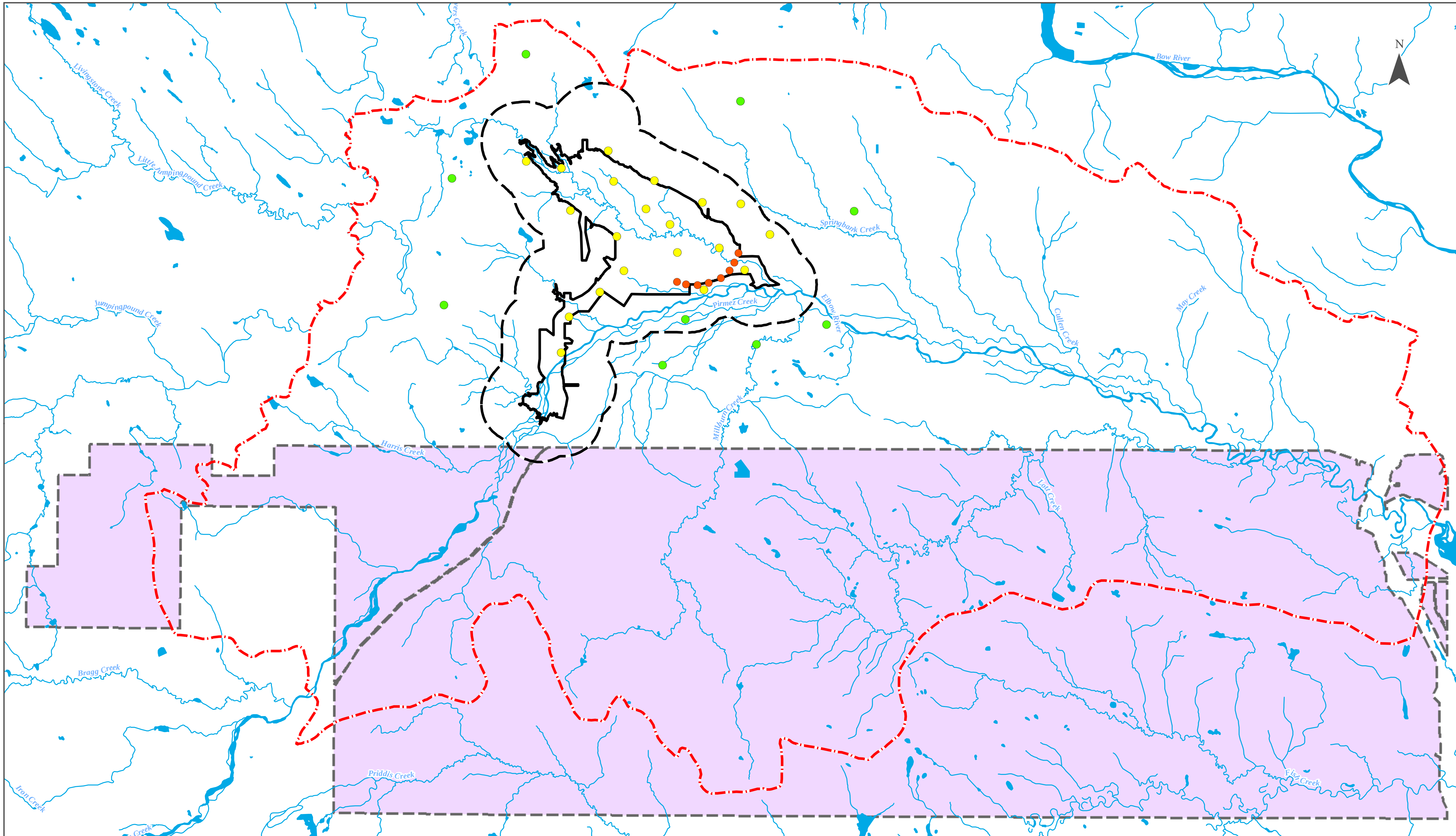
- Monitoring wells located in areas that are at risk of inundation during a flood will only be used for the baseline and construction phases and will be decommissioned prior to the operational phase. These wells are indicated in Table 15-1.
- Wells that are in the construction footprint will be decommissioned prior to construction.

The proposed monitoring network is presented in Figure 15-1 (adapted from the Groundwater Monitoring Plan). A total of 11 Project wells will be decommissioned, nine Tier 2 wells will be decommissioned and replaced, and 12 Tier 2 wells will be retained. The monitoring wells that are planned to be decommissioned and replaced will be replaced as close as possible to the original location but outside the inundation area or construction footprint. In addition to the Tier 2 wells that will be retained or replaced, three new monitoring well locations will be established around the perimeter of the PDA to improve the spatial distribution of the monitoring network.

Table 15-1 Fate of Existing Monitoring Wells

Well Name	3TM East[1]	3TM North[1]	Completion Unit	Monitoring Network Status
MW16-1-15	5659967.3	-33327.5	Sandstone	decommission and replace
MW16-2-6	5659623.9	-31947.3	Glaciolacustrine Clay	retain
MW16-3-7	5659073.5	-31904.4	Glaciolacustrine Clay and Silt	decommission
MW16-4-22	5658717.4	-32259.3	Sandstone	decommission
MW16-5-11	5658164.7	-31863.2	Sandstone	retain
MW16-6-11	5658135.3	-31100.5	Glacial Till	decommission
MW16-6-20	5658133.9	-31100.4	Claystone/Siltstone	decommission
MW16-7-5	5658895.2	-31098.8	Glaciolacustrine Clay and Silt	retain
MW16-8-8	5659641.1	-30875.7	Glacial Till	retain
MW16-8-19	5659641.2	-30877.5	Sandstone	retain
MW16-9-6	5659076.8	-30236.4	Glaciolacustrine Clay and Silt	decommission
MW16-10-15	5658478.2	-30461.4	Glacial Till	retain
MW16-11-15	5657742.9	-30269.8	Glacial Till	retain
MW16-12-3	5657858.3	-29160.3	Glacial Till	retain
MW16-13-37	5659064.0	-29610.3	Claystone	retain
MW16-14-33	5659018.4	-28592.2	Siltstone/Claystone	retain
MW16-15-34	5658214.9	-27818.8	Siltstone	retain
MW16-16-11	5655154.3	-33453.6	Glacial Till	decommission and replace
MW16-17-5	5656140.6	-33226.5	Glaciolacustrine Clay	decommission and replace
MW16-18-6	5656749.5	-32406.6	Basal Silt and Sand	decommission and replace
MW16-18-10	5656750.6	-32406.7	Claystone	decommission and replace
MW16-19-8	5657262.2	-31684.6	Basal Silt and Sand	decommission and replace
MW16-19-19	5657263.2	-31684.5	Sandstone	decommission and replace
MW16-20-21	5657498.6	-31218.4	Sandstone	decommission
MW16-21-11	5656987.1	-30383.8	Sandstone	decommission
MW16-22-26	5656907.3	-29330.9	Glacial Till	retain
MW16-23-14	5657309.6	-29019.7	Glacial Till	decommission and replace
MW16-23-36	5657308.3	-29019.3	Siltstone	decommission and replace
MW16-24-30	5657740.5	-28761.8	Sandstone	decommission
MW16-25-9	5658231.0	-29274.7	Glacial Till	decommission
MW16-26-18	5659178.1	-32702.7	Claystone	decommission
MW16-27-12	5659766.2	-32702.3	Glacial Till	decommission

NOTE:
[1] Coordinate system is NAD83 3TM 114



Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.

Groundwater Monitoring Network
- Tier 1
- Tier 2
- Tier 3

- Regional Assessment Area
- Project Development Area
- Local Assessment Area
- Tsuut'ina

0 1 2
kilometres
NAD 1983 3TM 114

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Conceptual Groundwater Monitoring Network Layout
Conformity Response 3

Figure 15-1

Tier 3 monitoring wells will also be dedicated wells consisting of either all new wells installed specifically for the Project or a combination of new wells and existing domestic water wells. Domestic wells water wells are generally of limited use in long-term monitoring programs due to a variety of circumstances including unknown well completion details, poor physical condition, existing pumping/distribution infrastructure, proximity to other pumping stresses, future accessibility, and others. However, if wells are found that are appropriately constructed for monitoring purposes and not currently being used, then these wells could be used to reduce the number of new wells required for the Tier 3 set of wells. The wells would need to be in appropriate locations, be screened at appropriate depths, have good surface seal integrity, and not be in use or near other wells in use such that water levels are not influenced by pumping.

The draft Groundwater Monitoring Plan describes 10 monitoring locations hydraulically downgradient of the dam and diversion infrastructure, which could be located either between the PDA and Tsuut'ina Nation Reserve, or on the reserve. These monitoring well locations would be used to identify potential impacts to groundwater quality or quantity (hydraulic head) prior to any effects being observed on the Tsuut'ina Nation Reserve.

Although there are no predicted effects on groundwater quality or quantity south of Elbow River beyond the floodplain, Alberta Transportation is currently consulting with Tsuut'ina Nation regarding groundwater monitoring specific to their reserve lands to address their concerns. Subject to applicable federal requirements, newly installed and dedicated Project wells are preferred over the use of domestic wells for the reasons stated above; however, domestic wells would be screened for potential use based on the criteria presented above. Additional monitoring wells on the Tsuut'ina Nation Reserve, or between the PDA and the reserve, would be monitored and sampled at the same timing and frequency as the Tier 3 monitoring wells, including a baseline period prior to construction, during construction, dry operations and flood conditions. Data logging pressure transducers would be installed in these monitoring wells to assess potential interference from the Project.

The finalized monitoring plan will include additional detail regarding the timing of monitoring events and finalized monitoring locations. Finalization of the monitoring plan is dependent on several factors. The land access and right of entry agreements will be required for all proposed monitoring locations on land not owned by Alberta Transportation; this is likely to include all Tier 3 monitoring wells, and as well as the potential use of appropriate domestic water wells. The timing for finalizing the monitoring program is dependent on the timing of Project approval and the final monitoring plan will also need to consider Project approvals and associated conditions. Alberta Transportation will work with Tsuut'ina Nation to identify appropriate groundwater monitoring requirements for wells on Tsuut'ina Nation Reserve.

Conformity IR3-17

Topic: Hydrogeology – Groundwater Modelling

Sources:

EIS Guidelines Part 2, Sections 6.1.4; 6.2.2

EIS Volume 3B, Section 5

EIS Volume 4, Appendix I, Hydrogeology Baseline Technical Data Report, Section 3

EIS Volume 4, Appendix I, Groundwater Numerical Modelling Technical Data Report, Sections 2.2; 3; 4.1; 4.2; 5, 5.1; 6

Tsuut'ina First Nation, Ermineskin Cree Nation, and Kainai First Nation – Technical Review of the EIS - Annexes – Combined (CEAR #46, 47, 50)

Natural Resources Canada – Comments on the EIS, June 19, 2018 (CEAR #45)

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-17, Appendix IR14-1

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

NRCan Round 1 IR Completeness Review Comments, July 2, 2019

Context and Rationale

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-17, the Agency required additional details regarding the hydrogeology model. In Alberta Transportation's response to IR3-17, Alberta Transportation notes that Appendix IR14-1 provides an updated Hydrogeology Technical Data Report. Alberta Transportation's responses to IR3-17 refer to this report. However, it is not clear whether the concerns noted in IR3-17 still exist within the new model, are no longer applicable, or have been responded to in the report.

In IR3-17 a), The Agency required Alberta Transportation to apply distributed groundwater recharge across the hydrogeological model domain, or provide a rationale as to why it does not need to be considered. Alberta Transportation's response notes that distributed recharge was added over the model domain; however, NRCan noted that distributed recharge does not appear to be applied in the hydrogeology Technical Data Report update.

In IR3-17 b), the Agency required additional details on the boundary conditions used in the hydrogeology model, including a rationale for the use of prescribed boundary conditions as the main condition along the model exterior, any constraints on prescribed head boundary conditions, and a description of why intermittent streams have isolated locations of prescribed boundary conditions.

In Alberta Transportation's response to IR3-17 b), Alberta Transportation notes that Section 4 of the updated Hydrogeology Technical Data Report describes setup and calibration of the numerical model, including the implementation of various boundary conditions. However, it is unclear if the concerns regarding the prescribed boundary conditions noted in part b still exist.

In IR3-17 d) the Agency required Alberta Transportation to describe how hydraulic conditions are treated in each model layer (free, phreatic, confined or dependent). In Alberta Transportation's response to IR3-17 d), Alberta Transportation notes that Section 4 of the updated Hydrogeology Technical Data Report describes setup and calibration of the numerical model; however, it appears that a description of how hydraulic conditions are treated in each model layer is not provided.

In IR3-17 e) the Agency required Alberta Transportation to provide additional details on hydraulic conductivities. In Section 4.5.3 of the Hydrogeology Technical Data Report, Alberta Transportation provides a table that notes the various hydraulic conductivities for each hydrostratigraphic unit. However, this table does not show the initial and final (calibrated) values, and does not report the anisotropy ratio as requested in IR3-17 e). Additionally, it is unclear if the concerns regarding hydraulic conductivities noted in part e still exist.

As noted in the information request, the EIS Guidelines require the proponent to present information regarding groundwater, including baseline information and changes to groundwater quality and quantity resulting from the Project, and to carry out modelling as required to present and substantiate anticipated changes. Additional information is required to understand the potential changes to groundwater and the effects of those changes, including effects on federal lands and on Indigenous peoples.

Information Requests:

a) Describe how distributed groundwater recharge was applied across the model domain.

b) Considering the updated hydrogeology model, discuss each request below and indicate if the concerns still exist within the new model, if they are no longer applicable, or if a response has been provided. If the concerns still exist and a response has not been provided, respond or provide a rationale for not responding.

- **Provide rationale for the use of prescribed boundary conditions as the main boundary condition along the model exterior and along intermittent streams.**

- **Document the use of any constraints on prescribed head boundary conditions (e.g. the use of "seepage face" boundary conditions).**
- **Indicate why several of the intermittent streams have isolated locations of prescribed boundary conditions.**
- **Describe how hydraulic conditions are treated in each model layer (free, phreatic, confined or dependent).**
- **Provide a table that shows the initial and final (calibrated) hydraulic conductivities value for each hydrostratigraphic unit and report the anisotropy ratio.**
- **Provide maps and cross-sections of final calibrated hydraulic conductivities values, and the three zones of calibrated bedrock hydraulic conductivity**
- **Provide a rationale for the range in calibrated hydraulic conductivity values for the shallow bedrock and compare them with the measured values.**
- **If a response has been provided in the report, provide the specific subsection in which the response can be found.**

Response

a) The application of distributed recharge across the model domain is described in the Technical Data Report (TDR) Update (see Alberta Transportation's response to Round 1 CEAA Package 3, IR3-14, Appendix IR14-1, Section 4.4.2) as follows:

> "A net recharge flux was added within the updated model to the top of the model domain. The land surface elevation gradient, type of soil and vegetation present at surface is an important factor in determining whether precipitation will run off, based on surface water flow processes, or enter the subsurface as groundwater recharge. Literature values for recharge appropriate for the region are used (Klassen et al. 2018). The recharge estimates produced in the First-Order Groundwater Availability Assessment for Southern Alberta were rigourously developed specifically to account for terrain characteristics such as depression focused recharge following Farrow et al. (2014) and Pavlovskii et al. (2017). The terrain analysis was used as in input parameter for a 1-D, multi-layer recharge simulation model referred to as the Versatile Soil Moisture Budget (VSMB) with a depression upland storage (DUS) module. In addition to the terrain analysis, the VSMB-DUS model is driven by meteorological data (e.g., hourly precipitation, air temperature, relative humidity), evapotranspiration parameters (e.g., growth curves), and soil properties (e.g., wilting point, field capacity; Klassen et al. 2018).
>
> Groundwater recharge rates ranging from 12 mm/year to 25 mm/year were established by the regional groundwater study (Klassen et al. 2018). Given the regional nature of the study cited, and the large topographic variability of the regional assessment area (RAA) with many areas without significant depressions (i.e., well drained slopes without prairie-like depressions), the minimum recharge value of 12 mm/year was used. Relatively good

model calibration resulted from application of 12 mm/year recharge, as assigned to the hydrostratigraphic units exposed at the top of the model domain."

b) The following are responses to the bullet points in the question:

- The rationale why prescribed boundary conditions are used along both the perimeter of the model domain and along intermittent streams is it is not expected that there would be significant changes to groundwater levels during the simulation period along these two boundaries. If there was an expected significant change (e.g., more than 1.5 m during the simulation period), prescribed boundary conditions would no longer be valid, and those boundary conditions would have been changed to transfer boundaries. In the case of transfer boundaries, the hydraulic heads are no longer held at the prescribed levels and the model determines whether groundwater is feeding the stream or the stream is feeding groundwater.

  Surface watershed boundaries are used to establish the extent of the model domain, however the groundwater flow divides are not presumed to strictly follow the surface watershed boundaries. As such, prescribed head boundary conditions are applied along the model perimeter, therefore fluxes in/out of the domain at those nodes were calculated.

  There are also specified flux-out and flux-in boundary conditions prescribed along the nodes that represent Elbow River leaving and entering the model domain, respectively.

- Prescribed head boundary conditions equivalent to the elevations are assigned in the reservoir area with a zero-flow rate applied as constraint (called as seepage face boundary conditions). These seepage face boundary conditions are prescribed in stages such that, as the reservoir fills and the flooded area covers a larger area, boundary conditions are expanded out to the larger area in a stepwise fashion. The "seepage face" boundaries are prescribed with modulation functions (i.e., time series changes to boundary conditions) that specify the levels over the transient simulation periods, in accordance with the rise and fall of water levels as the reservoir is being filled and drained.

- The prescribed boundary conditions along intermittent streams are incorporated into the model based on the stream network obtained from Natural Resources Canada for the Province of Alberta[1]. In the absence of transient water level data for these streams, prescribed boundaries are considered to be appropriate given the variable flow conditions and potential for these streams to contribute water to the groundwater system (i.e., shallow groundwater conditions near these streams are likely close to ground surface even if there is no measurable flow in the stream).

[1] Natural Resources Canada. CanVec Hydrographic Features. Retrieved from opencanada.ca

- As indicated in the TDR Update, Section 4.3.1) Layer 1 of the model was set in FEFLOW to "phreatic" mode. All other model layers are set as "unspecified" mode, meaning the layers may be fully or partially saturated depending on hydraulic conditions.
- Table17-1 presents the initial and final (calibrated) horizontal and vertical hydraulic conductivities for each hydrostratigraphic unit along with the anisotropy ratios for each.
- Figure 17-1 and cross sections (Figure 17-2 and Figure 17-3) present the calibrated hydraulic conductivity through the local assessment area (LAA). Two zones of calibrated bedrock hydraulic conductivity are used in the revised numerical model presented in the TDR Update. The use of two model layers is considered appropriate to represent an upper layer of the bedrock (Layer 6) which is considered to have more open fractures (i.e., higher permeability) compared to the lower bedrock (Layer 7). The calibrated hydraulic conductivities for the two bedrock units support this interpretation.
- The range of calibrated hydraulic conductivity values for the shallow bedrock Layer 6 are similar to the initial values obtained during the Project field assessment and presented in the TDR Update (Section 3.2.1). The initial and calibrated horizontal hydraulic conductivities (Kh) for Layer 6 are identical at $1.4x10^{-6}$ m/s.

  The vertical hydraulic conductivity (Kv) for Layer 6 differ by an order of magnitude with an initial value of $1.4x10^{-6}$ m/s and a calibrated value of $1.4x10^{-7}$. Because Kv could not be measured directly, a Kh/Kv anisotropy ratio of 1 is chosen as a starting point because of the potential for Kv to be high as a result of fracturing. Although the calibrated value is lower than the initial value, it is representative of fractured bedrock. Considering the lithology of the bedrock material (interbedded sandstone, siltstone and mudstone/claystone), unfractured Kv would be much lower than$1.4x10^{-7}$ m/s.

  Initial Kh and Kv for underlying bedrock Layer 7 are the same as for Layer 6 at $1.4x10^{-6}$ m/s. The calibrated Kh and Kv for Layer 7 are both lower than initial values. The calibrated Kv of $2.7x10^{-9}$ is much lower, but it is considered to be representative of a reduction in secondary porosity, either due to less fracturing or mineralization (closure) of fractures.

Table 17-1 Initial and Final (Calibrated) Horizontal and Vertical Hydraulic Conductivities

Hydrostratigraphic Unit	Initial Horizontal Hydraulic Conductivity (m/s)	Initial Vertical Hydraulic Conductivity (m/s)	Initial Anisotropy Ratio	Calibrated Horizontal Hydraulic Conductivity (m/s)	Calibrated Vertical Hydraulic Conductivity (m/s)	Calibrated Anisotropy Ratio	Calibrated Specific Storage (1/m)	Calibrated Specific Yield (Dimensionless)
Clay	1.4E-07	1.4E-08	10	5.1E-06	5.1E-07	10	3.5E-03	0.07
Fluvial sand and gravel	5.0E-04	5.0E-05	10	2.8E-03	2.8E-04	10	2.3E-05	0.25
Grouped Bedrock layer 6	1.4E-06	1.4E-06	1	1.4E-06	1.4E-07	10	1.1E-05	0.17
Grouped Bedrock layer 7	1.4E-06	1.4E-06	1	2.7E-07	2.7E-09	100	1.1E-05	0.17
Lower silt, sand and gravel	4.6E-06	4.6E-07	10	8.3E-05	8.3E-06	10	2.3E-05	0.2
Till North	4.7E-10	4.7E-10	1	7.2E-08	7.2E-08	1	4.0E-03	0.04
Till South	4.7E-10	4.7E-10	1	7.2E-07	7.2E-07	1	4.0E-03	0.04
Till-high conductivity North	4.7E-10	4.7E-10	1	8.3E-05	8.3E-05	1	3.8E-03	0.04
Till-high conductivity East	4.7E-10	4.7E-10	1	1.0E-04	1.0E-04	1	3.8E-03	0.04

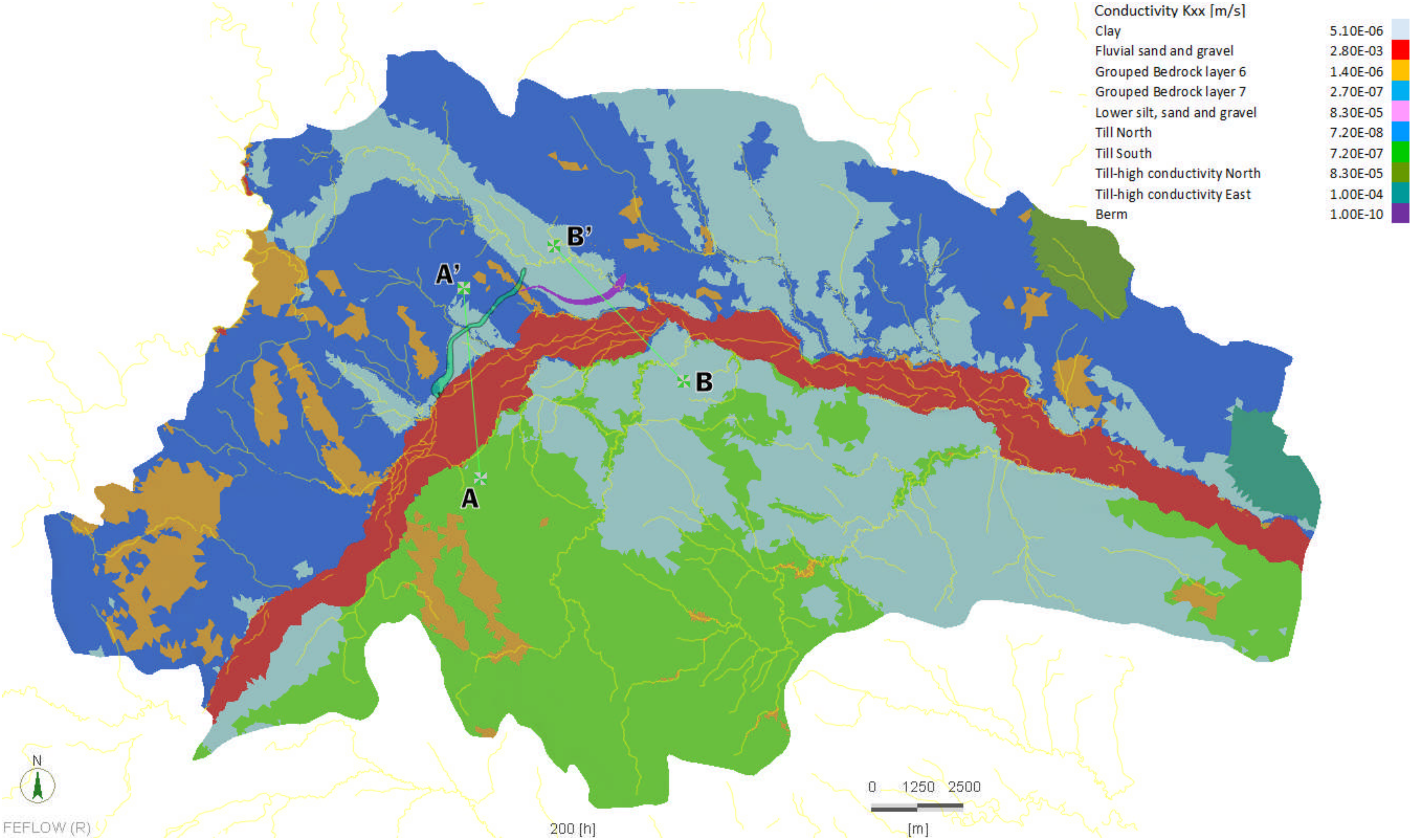


Figure 17-1 Calibrated Hydraulic Conductivity Through the Local Assessment Area

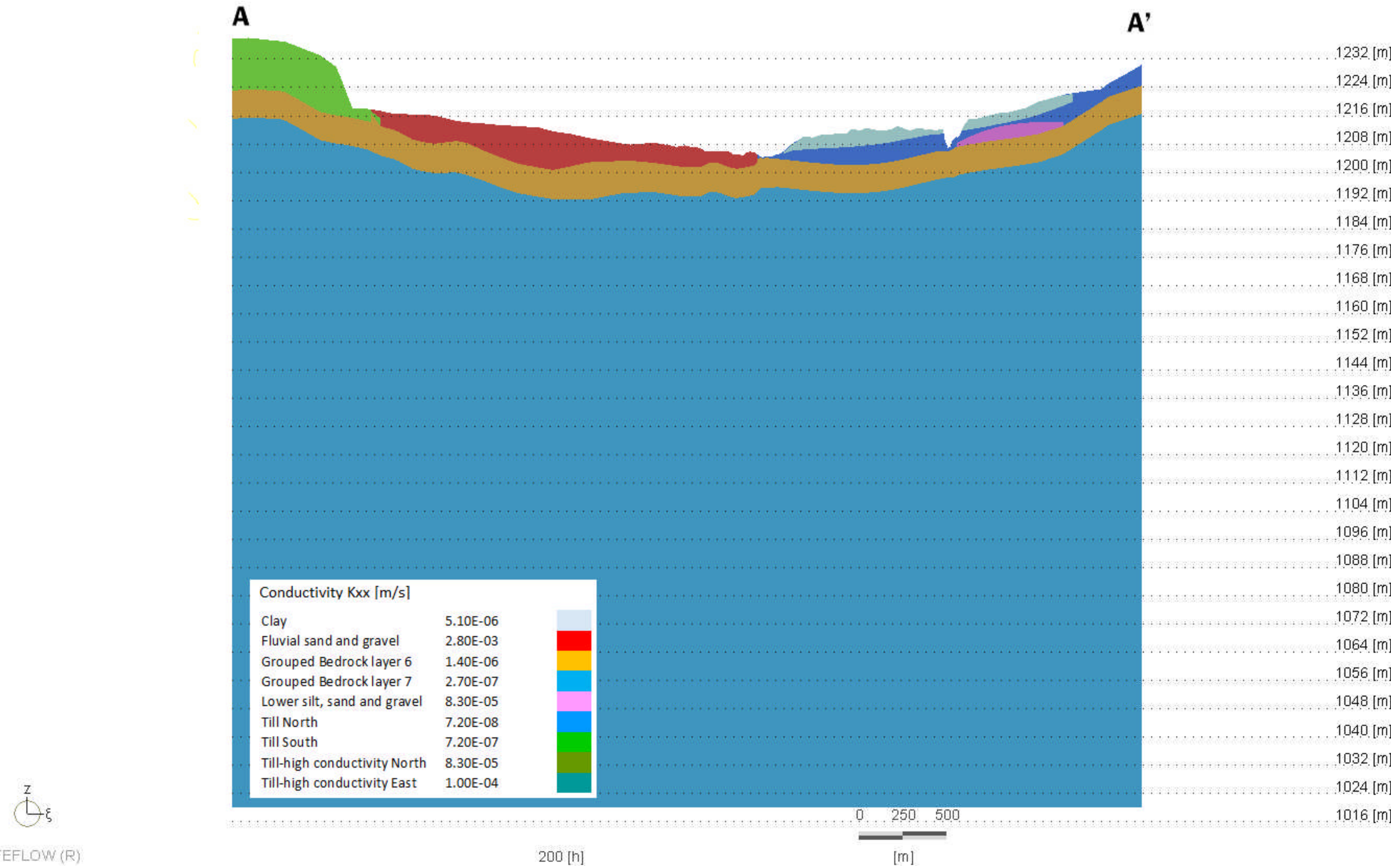


Figure 17-2 Calibrated Hydraulic Conductivity Through the Local Assessment Area, Cross Section A to A'

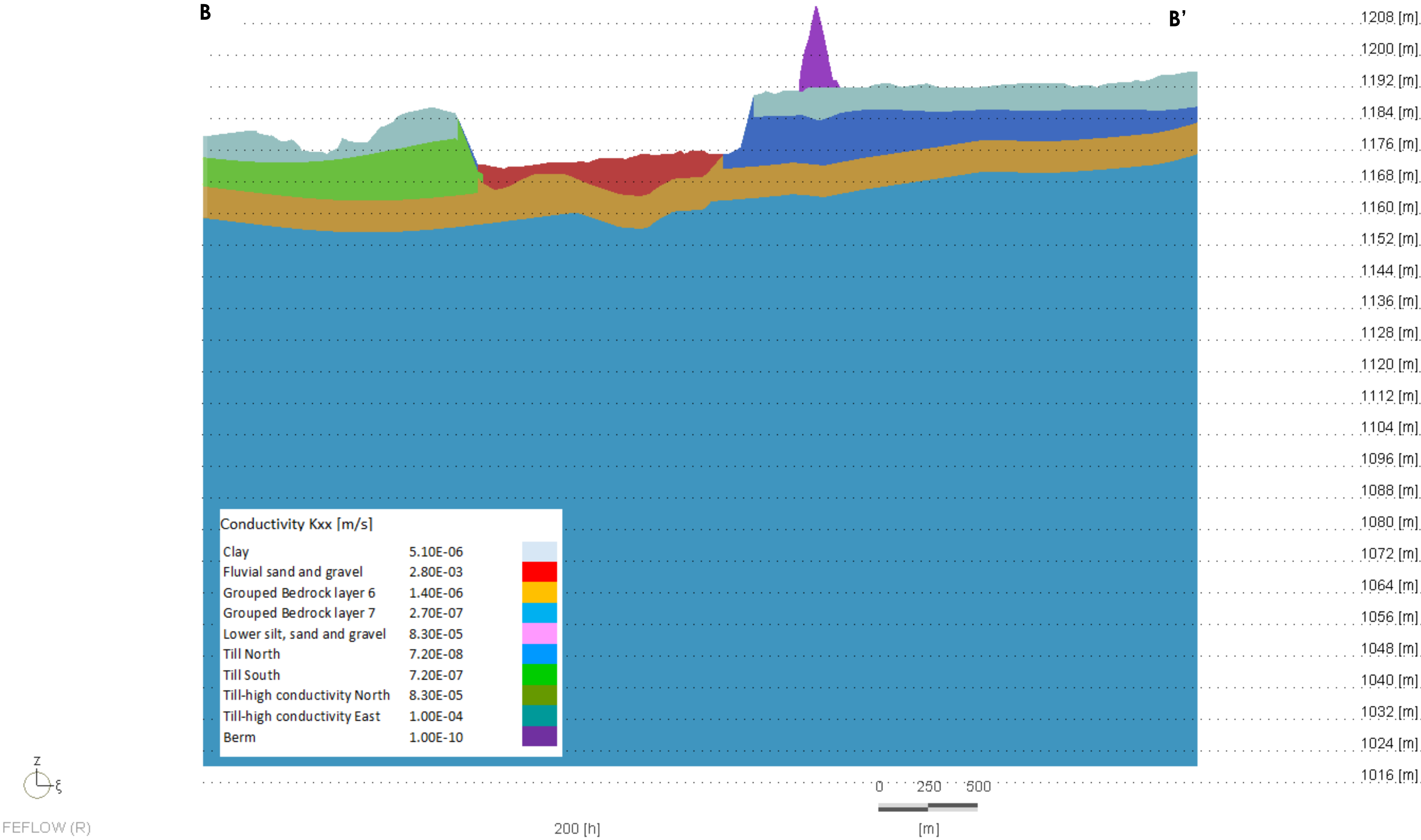


Figure 17-3 Calibrated Hydraulic Conductivity Through the Local Assessment Area, Cross Section B to B'

Conformity IR3-18

Topic: Hydrogeology – Groundwater Baseline and Model Sensitivity

Sources:

EIS Guidelines Part 2, Sections 6.1.4; 6.2.2

EIS Volume 3A, Section 5

EIS Volume 3B, Section 5

EIS Volume 4, Appendix I, Groundwater Numerical Modelling Technical Data Report

Tsuut'ina First Nation, Ermineskin Cree Nation, and Kainai First Nation – Technical Review of the EIS - Annexes – Combined

Natural Resources Canada – Comments on the EIS, June 19, 2018 (CEAR #45)

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-18

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

NRCan Round 1 IR Completeness Review Comments, July 2, 2019

Context and Rationale

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-18, the Agency required Alberta Transportation to provide additional details on the groundwater baseline studies and hydrogeological modelling.

In Alberta Transportation's response to IR3-18, Alberta Transportation notes that Appendix IR14-1 provides an updated Hydrogeology Technical Data Report. Alberta Transportation's responses to IR3-18 refer to this report. However, it is not clear whether the concerns noted in IR3-18 still exist within the new model, are no longer applicable, or have been responded to in the report.

In IR3-18 b), the Agency required Alberta Transportation to identify all water level measurement locations used to map the potentiometric surface of unconsolidated deposits and clearly identify areas where the water table is below the unconsolidated deposits. It appears that a response to this IR is not provided.

As noted in the context and rationale, NRCan noted that the cross section figures in the EIS indicate that the unconsolidated deposits may be unsaturated along many ridges and hillslopes. The potentiometric maps for unconsolidated deposits should only indicate contours for areas where unconsolidated deposits are saturated. Areas where the water table is below the unconsolidated deposits should be clearly indicated.

As noted in the information request, the EIS Guidelines require the proponent to present information regarding groundwater, including baseline information and changes to groundwater quality and quantity resulting from the Project, and to carry out modelling as required to present and substantiate anticipated changes. Additional information is required to understand the potential changes to groundwater and the effects of those changes, including effects on federal lands and on Indigenous peoples.

Information Requests:

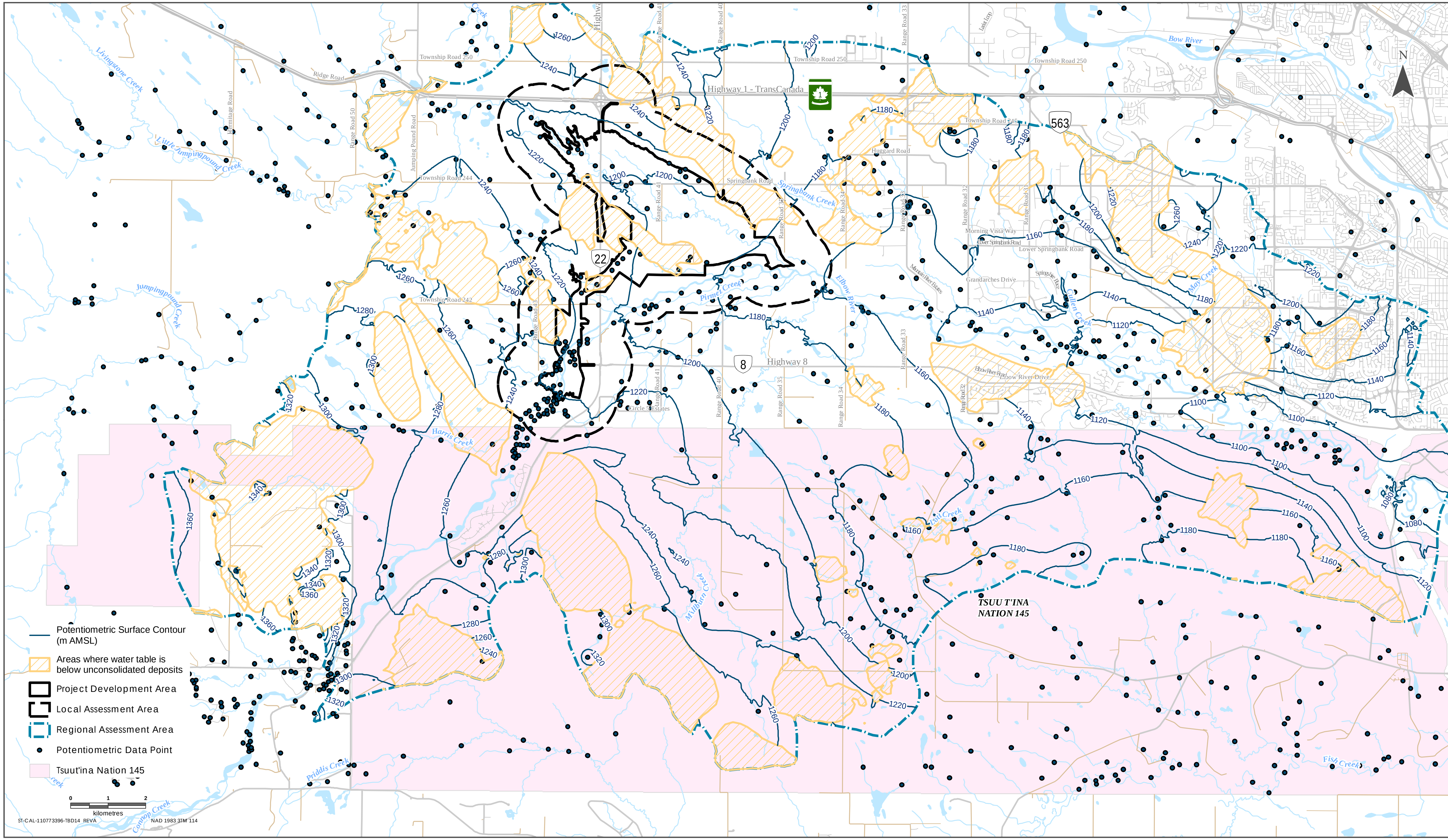
a) Considering the updated hydrogeology model, discuss each request below and indicate if the concerns still exist within the new model, if they are no longer applicable, or if a response has been provided. If the concerns still exist and a response has not been provided, respond or provide a rationale for not responding.

- **Identify all water level measurement locations used to map the potentiometric surface of unconsolidated deposits.**
- **Clearly identify areas where the water table is below the unconsolidated deposits.**

Response

a) Concerns related to water level measurement locations are provided in the TDR Update, Section 3.2.2. All water level measurement locations used to map the potentiometric surface of the unconsolidated deposits are presented in the TDR Update in Figure 3-19. Figure 18-1 (modified from Figure 3-19 of the TDR Update) is provided here.

   Figure 18-1 identifies areas where the water table is below the unconsolidated deposits. The potentiometric contours have been removed from unsaturated areas of the unconsolidated deposits. The graphical representation of this information is not a concern for the new model.



Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.

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ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Water Table Elevation in the Unconsolidated Deposits

Conformity Response 3

Figure 18-1

Conformity IR3-23

Topic: Fish and Fish Habitat – Effects of Noise

Sources:

EIS Guidelines Part 2, Sections 6.1.5; 6.2.1; 6.3.1

EIS Volume 3A, Section 4; 11

EIS Volume 3B, Section 4; 11

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-23

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

DFO Round 1 IR Completeness Review Comments, June 28, 2019

Context and Rationale

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-23, the Agency required the proponent to provide an assessment of the effects of noise and vibration to fish and fish habitat from construction and to describe associated mitigation measures. As noted in the information request, the EIS Guidelines require the proponent to provide baseline information on and assess the effects of changes to the environment on fish and fish habitat.

Alberta Transportation's response to IR3-23 notes that construction will not occur instream. Alberta Transportation identifies that the references cited in the Agency's information request primarily consider the effects of construction within aquatic environments. An assessment of effects of noise and vibration from dry construction adjacent to fish habitat is not provided. The response does not present alternative studies or information as rationale for not conducting an effects assessment.

Information Request:

a) Provide an assessment of the effects of noise and vibration to fish and fish habitat during construction.

b) Describe mitigation measures to reduce or eliminate the effects of noise and vibration on fish and fish habitat.

Response

a) The effects of noise and vibration on fish can be physiological or behavioural. Physiological effects can include injury or lead to fish mortality. Behavioural effects typically include avoidance, startle responses, and acoustic masking. The Project effects of noise and vibration during construction are predicted to be of low magnitude, as discussed below.

VIBRATIONS

Vibrations in the underwater environment are measured by particle velocity. Harmful physiological effects on fish generally result from the use of explosives or pile driving in or near water. These activities create elevated overpressures or high peak particle velocities. Neither of these types of activities are planned during the construction.

Vibrations in the water column from the Project will mainly occur from the use of heavy equipment with vibrations moving from the ground into the water column. Vibration attenuation, which is the process by which the magnitude of the vibration is reduced from the sources, is affected by two factors; geometric spreading and material dampening (Hiller and Crabb 2000). Vibrations caused by the use of heavy equipment spreads in all directions, decreasing in magnitude as it passes through larger volumes of material. Vibration attenuation increases by dampening caused by the material the vibrations pass through. Soft materials such as the soil found within the PDA (Chernozem, Greysolic and Regosolic soils) will dampen vibrations (greater than if the vibrations passed through hard material such as bedrock) before entering the water column, thereby, reducing behavioral effects on fish. Ports North (2015) expected vibration levels to be below 0.1mm/s from excavation activities due to the soft soils present (sand and clay). Fisheries and Oceans Canada recommends 13 mm/sec to protect spawning areas (Wright and Hopky 1998) which is approximately 100 times higher than the expected vibrations levels for the Ports North Project. Vibrations from construction for the Project would be expected to be similar in magnitude to those found by Ports North as both areas have soft soil material which would dampen vibrations

As described in the above paragraph, soils within the PDA would dampen vibrations entering the water column and would not exceed values which would cause injury or death to fish. Vibrations from construction activities would be expected to be similar to vibrations caused by traffic on roadways adjacent to waterbodies or bridges and of which there have been no observed harmful effects on fish identified in the literature. Vibrations from construction are predicted to be of a low magnitude and reversible, and they would not be sufficient to cause harm to fish because they would be well below the threshold value of 13 mm/sec, as recommended by Wright and Hopky (1998) and Fisheries and Oceans Canada pathways of effects (DFO 2014). As the potential for harmful effects on fish due to vibrations caused by the use of heavy equipment is not anticipated, no vibration monitoring is proposed.

NOISE

Behavioral effects may be anticipated during the construction phase as a result of the input of noise into the water column. Behavioral effects may include startle response by fish, that can last from a few seconds to minutes; or sound masking which can affect feeding behavior of fish. Although water is an excellent medium for conducting sound, the amplitude of sound to which an animal (e.g., fish) is exposed will always be lower relative to the source level, due to transmission losses between the source of the sound and the animal receiving the sound (Olesiuk et al. 2012). Air borne noise generated by land-based or dry construction activities will be partially reflected off the surface of the water back into the air. This will reduce the amount of noise from construction entering the water column.

It is predicted that the effect of construction noise on the aquatic environment would be of low magnitude, for the duration of Project construction and reversible. Noise from construction will be mainly related to the use of heavy equipment and will be on a continuous basis during construction and not pulsed as occurs with explosives or pile driving. Sound (noise) input on a continuous basis allows for the potential for fish to acclimatize to the sound, thus reducing the effects of the additional noise. Sound studies conducted in an aquarium setting on zebra fish (*Danio rerio*), which have a high hearing capacity, observed these fish experienced behavioural responses lasting only a few minutes due to the input of noise (Neo et al. 2015). Masking of sound through Project generated noise would be localized and similar fish habitat is widely available both downstream and upstream of the PDA.

b) Project mitigation includes building a temporary diversion channel to convey river flows around the construction area. This will create a dry working space for constructing Project components. Therefore, activities will be at a distance from the water and noise effects reduced, as discussed in the response to part a). No mitigation is proposed for vibration as vibration is anticipated to be below thresholds to cause harm to fish. Potential Project effects due to noise and vibration are not predicted to adversely effect fish; therefore, no additional mitigation is recommended.

REFERENCES

DFO. 2014. Pathways of Effects. Available at: http://www.dfo-mpo.gc.ca/pnw-ppe/pathways-sequences/index-eng.html.

Hiller, D & Crabb, 2000, *Groundborne Vibration Caused by Mechanised Construction Works*, Transportation Research Laboratory, England.

Neo, Y.Y., L. Parie, F. Bakker, P. Snelderwaard, C. Tudorache, M. Schaaf, and H. Slabbekoorn. 2015. Behavioral changes in response to sound exposure and no spatial avoidance of noisy conditions in captive zebrafish. Front Behav Neurosci. 2015; 9:28.

Olesiuk, P.F., J.W. Lawson, and E.A. Trippel. 2012. Pathways of effects of noise associated with aquaculture on natural marine ecosystems in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/025. vi + 64 p.

Ports North. 2015. Cairns Shipping Development Project Environmental Impact Statement. Chapter B10: Noise and Vibration.

Wright, D.G., and G.E. Hopky. 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. Can. Tech. Rep. Fish. Aquat. Sci. 2107: iv + 34p.

Conformity IR3-24

Topic: Fish and Fish Habitat – Habitat Destruction

Sources:

EIS Guidelines Part 2, Sections 6.1.4; 6.1.5; 6.2.2; 6.3.1

EIS Volume 3A, Sections 8.3; 8.4; 8.7

EIS Volume 3B, Section 8.2.5

Fisheries and Oceans Canada – Comments on the EIS, June 19, 2018 (CEAR #28)

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-24

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

DFO Round 1 IR Completeness Review Comments, June 28, 2019

Context and Rationale

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-24, the Agency required the proponent to provide a detailed breakdown of areas of fish habitat to be affected by the Project, areas of each temporary or permanent structure, and a rationale for the characterization of residual effects from the destruction of fish habitat. As noted in the information request, the EIS Guidelines require the proponent to provide baseline information on and assess the effects of changes to the environment on fish and fish habitat.

Alberta Transportation's response to IR3-24 states that an analysis of the habitat footprint associated with the planned diversion structure and Highway 22 bridge has not been completed and will be generated for an application for authorization to Fisheries and Oceans Canada (DFO). The response quotes the EIS and does not offer additional rationale for the characterization of residual effects. Sufficient information is required within the environmental

assessment process to support a full understanding of potential effects of the Project to fish and fish habitat.

Alberta Transportation's response identifies, to the extent possible given the design completed to date, an overview of the habitat types that overlap with project components and physical activities and the associated permanent alteration or destruction of fish habitat. The response does provide not an equivalent breakdown of areas to be affected by Project operations or describe the interconnection between the placement of temporary or permanent structures, the operations of these structures, and effects to fish and fish habitat. For example, the response states that the diversion structure will affect Class 3 run and riffle habitats within the thalweg of the Elbow river; however, the response does not explain how the operation of the diversion structure, specifically the obermeyer gates, and the design of fish passage mitigation measures to constrict flow to the thalweg on the north bank of the river may affect potential spawning riffle downstream of the diversion structure.

Understanding the destruction and permanent alteration of fish habitat from project components and project operations is necessary to support a full understanding of potential effects to fish and fish habitat.

Information Request:

a) **Provide table summarizing all destruction and permanent alternation to fish habitat resulting from all project components and project operations.**

b) **Explain potential effects of operation of the obermeyer gates and design of fish passage mitigation measures to constrict flow to the thalweg on the north bank of the river on the potential spawning riffle downstream of the diversion structure.**

Response

a) Project components and associated aquatic habitat in the footprint area are listed in Table 24-1. The information relevant to the footprint area in Elbow River is also illustrated in Figure 24-1. The relationship (i.e., interconnection) between the placement of temporary and permanent structures, the river channel morphology, and fish habitat is dependant on dynamic river processes. Instream changes due to Project infrastructure will affect stream flows that rearrange mobile substrates, thus redistributing or changing the nature of channel units and effects on fish habitat.

   Table 24-1 identifies the different types of channel units and potential habitat altered and lost to Project footprint components. However, the table does not differentiate between potential quality of habitat, nor does it differentiate between habitat types to support different fish life stages. Habitat is defined in the broadest terms which leads to a conservative assessment. In actuality, much of the area within the footprint and downstream of the Project infrastructure has low potential to support many fish life stages. For instance, the bed structures within the channel includes areas considered bar habitat and unavailable for much of the year and therefore, potential footprint related effects are low. Figure 24-1a illustrates the habitat types in relation to Project footprint components.

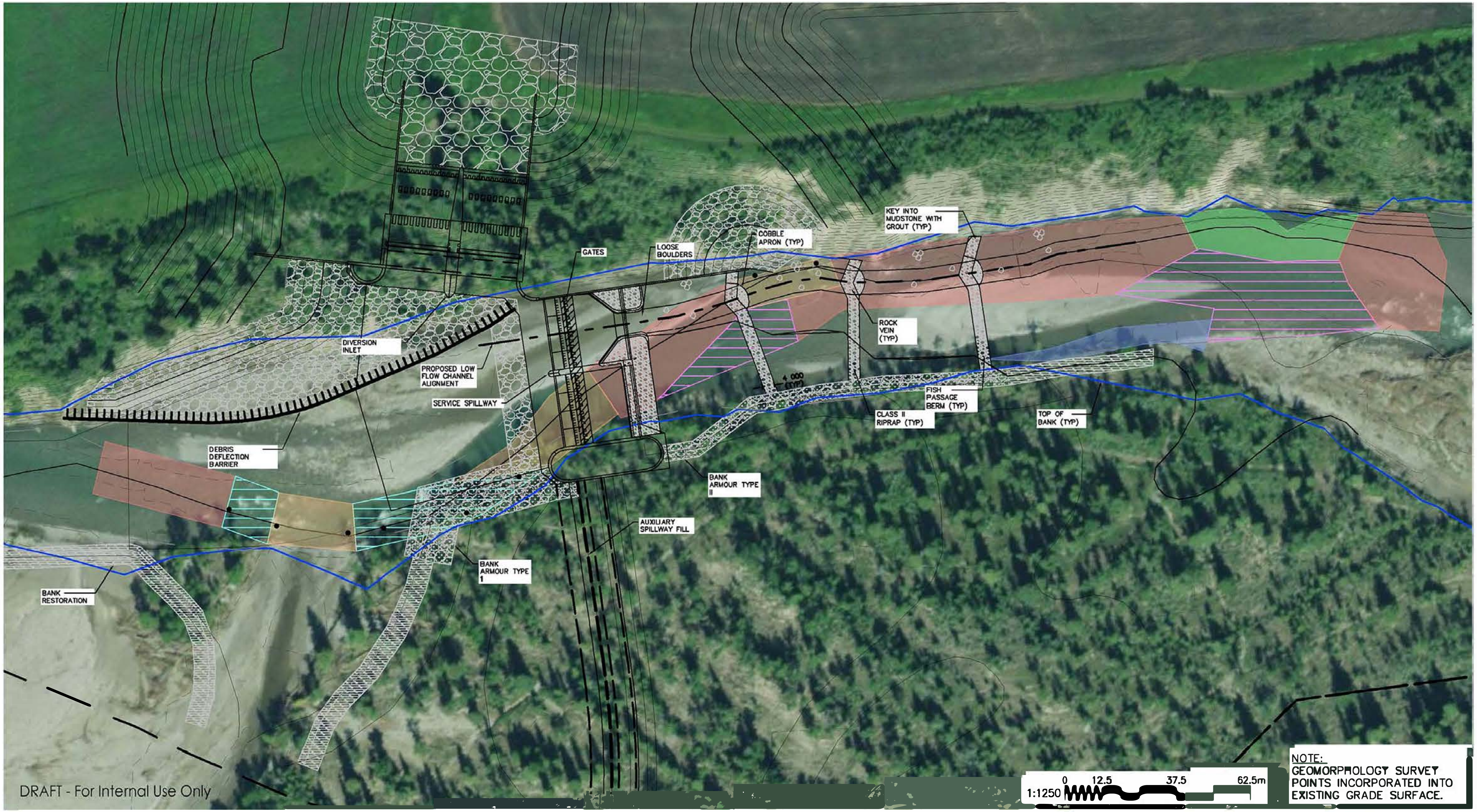
Table 24-1 Project Component, Aquatic Habitat Types and Areas within the Footprint

Project Component	Habitat Area (m^2)	Habitat Type[2]
Temporary Habitat Alteration		
Berms to isolate channel	4,744	• riffle, run (R2 and R3) and gravel bar units • potential rearing habitat
Dry working space within the channel[1]	15,002	• riffle, rapid, channel snye, and gravel bar units • potential rearing, spawning habitat
sub-total	*19,746*	
Permanent Habitat Alteration		
V-weir fish passage structures	598	• run (R2 and R3) and riffle units • potential Spawning gravel habitat
Bank armour	1,458	• gravel bar, bank, run (R2) units • potential limited bank cover and feeding habitat
sub-total	*2,056*	
Habitat Destruction		
Debris deflector	2,766	• gravel bar and bank units • minimal habitat only during freshet
Service spillway (with Obermeyer gates), stilling basin and bank modification	2,970	• run (R2 and R3); gravel bar and bank units • potential rearing habitat • gravel bar and bank habitat provide minimal high-water habitat
Cut-off of unnamed channel to construct the diversion channel	300	• shallow riffle, run, pool units • temporary habitat and generally poor for all life stages
sub-total	*6,036*	

NOTES:

1 A diversion channel around the workspace of approximately 19,080 m^2 will be constructed to maintain Elbow River flows and fish passage; this area is not included in the habitat area calculations

2 Habitat types reflect water flows during late summer air photos



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Legend

Boulder	●
Fish Habitat Unit and Feature	
Class 2 Run	
Class 3 Pool	
Class 3 Run	
Rapid	
Riffle	
Snye	
High Water Mark	
Bank Restoration / Bank Armor	
Infrastructure Footprint	

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ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT
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Project Component, Aquatic Habitat Types, and Areas within the Footprint

Conformity Response 3

Figure 24-1

b) During times of low baseflow in the river, the right downstream gate will be raised to channel all river flow through the left bay of the service spillway and maintain sufficient flow depth for fish passage. This will result in a thalweg developing along the north side of the channel and through a small rapid downstream of the diversion structure. This will modify channel configuration and rearrange the bed sediment distribution. Because the thalweg and most of the stream flow will be directed to the left side of the channel, the riffle channel unit in the middle of the channel will likely be isolated from the main flow in the river. Bedload sediment aggradation during freshet may cause the head of the gravel bar to migrate upstream and cover the riffle. Gravel will sort according to size based on flow velocities at each v-weir; however, riffle habitat and suitable spawning gravel beds are unlikely to re-develop at this location.

Conformity IR3-25

<u>Topic:</u> Fish and Fish Habitat – Mapping

<u>Sources:</u>

EIS Guidelines Part 2, Sections 6.1.5; 6.3.1.

EIS Volume 3A Section 8, Figure 8.2-2; Table 8-5

Louis Bull Tribe – EIS Review Submission, July 18, 2018 (CEAR #49)

Fisheries and Oceans Canada – Comments on the EIS, June 19, 2018 (CEAR #28)

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-25

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

DFO Round 1 IR Completeness Review Comments, June 28, 2019

<u>Context and Rationale</u>

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-25, the Agency required maps of fish habitat that is consistent with the definition of fish habitat provided in the EIS and the requirements in the EIS Guidelines. As noted in the information request, the EIS Guidelines require maps indicating the surface area of potential or confirmed fish habitat for spawning, nursery, feeding, overwintering, migration routes, etc.

Alberta Transportation's response to IR3-25 presents maps using the habitat features as defined in Alberta Transportation's 2009 Fish Habitat Manual Guidelines and Procedures for Watercourse Crossings in Alberta, stating this approach is most efficient. It is unclear from the response

provided how the approach used supports an equivalent understanding of effects to fish and fish habitat as would be achieved my mapping consistent with the definition of fish and fish habitat in the EIS and the requirements of the EIS Guidelines.

Information Request:

a) Present a comparison of the fish habitat features as defined in Alberta Transportation's 2009 Fish Habitat Manual Guidelines and Procedures for Watercourse Crossings in Alberta and fish habitat as defined in the EIS and requirements of the EIS Guidelines. Explain how the mapping approach taken supports a full understanding of potential effects on fish habitat as described in the EIS Guidelines.

Response

a) The EIS Guidelines (page 25) provided by the Agency for the Project required the inclusion of "*maps, at a suitable scale, indicating the surface area of potential or confirmed fish habitat for spawning, nursery, feeding, overwintering, migration routes, etc. This information should be linked to water depths (bathymetry) to identify the extent of a water body's littoral zone*."

However, the EIS Guidelines did not include specific direction on the method to produce the requested maps. As a result, Alberta Transportation used their 2009 Fish Habitat Manual Guidelines and Procedures for Watercourse Crossings in Alberta (Alberta Transportation 2001). These methods have been previously accepted by provincial (Alberta Environment and Parks [AEP]) and federal regulators (Fisheries and Oceans Canada [DFO) for major transportation and other projects (e.g., Calgary Green Line Light Rail Transit, Bonny Brook Water Treatment Plant Outfall, Nova Gas Transmission Ltd. pipeline expansion) in Alberta. These methods include regulator acceptable procedures for habitat mapping of confirmed and potential fish habitat for spawning, nursery, feeding, overwintering and migration for sport, coarse and forage fish. There were some assessment guidelines required under the EIS Guidelines (e.g., benthic and aquatic invertebrates and bank stability) not covered under Alberta Transportation's 2009 Fish Habitat Manual Guidelines and Procedures for Watercourse Crossings in Alberta (Alberta Transportation 2001). However, these additional parameters were collected as part of baseline field studies for the environmental impact assessment completed in 2016.

Table 25-1 provides a comparison of the assessment parameters for the EIS Guidelines and Alberta Transportation's 2009 Fish Habitat Manual Guidelines and Procedures for Watercourse Crossings in Alberta (Alberta Transportation 2001).

Table 25-1 Comparison of EIS Guidelines and Alberta Transportation Guidelines (2009; Alberta Transportation 2001) with 2016 Project Baseline Field Studies

Parameter	EIS Guidelines	Alberta Transportation Guidelines	2016 Project Baseline Field Studies
Surface area	✓	✓	✓
Depth	✓	✓	✓
Water quality	✓	✓	✓
Water flow	✓	✓	✓
Substrate	✓	✓	✓
Bank stability	-	-	✓
Riparian area	-	✓	✓
Barriers to fish	✓	✓	✓
Aquatic plants	✓	✓	✓
Benthos	✓	-	✓
Aquatic invertebrates	✓	-	✓
Spawning (all fish species)	✓	✓	✓
Rearing/Nursery (all fish species)	✓	✓	✓
Feeding (all fish species)	✓	✓	✓
Overwintering (all fish species)	✓	✓	✓
Migration (all fish species)	✓	✓	✓
Species at risk	✓	✓	✓
NOTE: "-" indicates no mention in the referenced document			

The fish habitat mapping approach used in the EIA meets the objectives for mapping outlined in the EIS Guidelines (i.e., characterize and describe fish habitat that will be modified or changed from Project related effects). The mapping provides details and understanding of existing habitat and resulting changes from Project related effects (e.g., the location and extent of the service spillway structure, the fish passage v-weir structures, bank armoring, etc.). The response to CEAA Conformity IR3-24 provides an example of fish habitat mapping and how effects from the Project are assessed.

REFERENCES

Alberta Transportation. 2001. Fish Habitat Manual: Guidelines and Procedures for Watercourse Crossings in Alberta (revised 2009). Edmonton. 93 pages + appendices.

Conformity IR3-31

Topic: Fish and Fish Habitat – Assessment of Effects

Sources:

EIS Guidelines Part 2, Sections 6.1.5; 6.3.1; 6.6.3

EIS Volume 3C, Section 1.3.5.1

EIS Volume 4, Appendix M, Section 2.2.2

Fisheries and Oceans Canada – Comments on the EIS, June 19, 2018 (CEAR #28)

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-31

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

DFO Round 1 IR Completeness Review Comments, June 28, 2019

Context and Rationale

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-31, the Agency required the proponent to describe potential effects to fish that support CRA fisheries and to revise the cumulative effects assessment for fish and fish habitat. The information request identifies that there is fish spawning habitat that has not been considered in the cumulative effects assessment. As noted in the information request, the EIS Guidelines require the proponent to provide baseline information on and assess the effects of changes to the environment on fish and fish habitat, and identify and assess the Project's cumulative effects.

Alberta Transportation's response does not demonstrate consideration of fish species that contribute to the productivity of CRA fisheries. The response lists pathways of effects associated with proposed works and lists supporting CRA fish species. However, pathways of effects specific to species that support the productivity of CRA fisheries, and related mitigation measures, are not identified or discussed.

Alberta Transportation's response does not present a revised cumulative effects assessment. The response states that the assessment includes all life stages (e.g. spawning) but does not explain how all fish spawning habitat, including fish spawning habitat downstream of the low level outlet channel, was considered in the cumulative effects assessment.

Information Request:

a) Describe potential effects to fish that support CRA fisheries considering fish species that contribute to the productivity of CRA fisheries.

b) Revise the cumulative effects assessment for effects to fish and fish habitat to:

- **Demonstrate how fish spawning habitat has been considered in the cumulative effects assessment;**
- **Specifically account for potential effects identified in part a).**

Response

a) For the purpose of this response, the fish that support commercial, recreational or Aboriginal (CRA) fisheries are considered fish species that contribute to the productivity of CRA fisheries. In Elbow River these are the seven species of forage fish discussed below. Effects on prey species and their habitat was implied in the EIA, the following response provides additional information on the assessment of prey species.

POTENTIAL EFFECTS ON FORAGE FISH

Seven species of resident forage fish (i.e., small bodied prey species that support CRA fish populations) are identified in Elbow River (EIA, Volume 4, Appendix M, Section 3.1.1) and summarized in Table 31-1. Effects on forage fish from components associated with the Project are discussed in the following the table.

Table 31-1 Forage Fish Species and Conservation Status

Family[1]	Common Name[1]	Scientific Name[1]	Species Code	*SARA*[2] (Federal)	*Wildlife Act*[3] (Provincial)	COSEWIC[4] (Federal)	General Status[5] (Provincial)
Cyprinidae (carps and minnows)	fathead minnow	*Pimephales promelas*	FTMN	No status	Not listed	Not assessed	secure
	lake chub	*Couesius plumbeus*	LKCH	No status	Not listed	Not assessed	secure
	longnose dace	*Rhinichthys cataractae*	LNDC	No status	Not listed	Not assessed	secure
	pearl dace	*Margariscus margarita*	PRDC	No status	Not listed	Not assessed	undetermined[6]
	spottail shiner	*Notropis hudsonius*	SPSH	No status	Not listed	Not assessed	secure
Gasterosteidae (sticklebacks)	brook stickleback	*Culaea inconstans*	BRST	No status	Not listed	Not assessed	secure
Percopsidae (trout-perches)	trout-perch	*Percopsis omiscomaycus*	TRPR	No status	Not listed	Not assessed	secure

NOTES:
[1] Common and Scientific Names of Fishes from the United States, Canada, and Mexico (Page et al. 2013)
[2] *Species at Risk Act* (SARA 2002) (GoC 2017a)
[3] *Wildlife Act* Wildlife Regulation (1997)
[4] Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (GoC 2017b)
[5] General Status of Alberta Wild Species (ESRD 2012)
[6] Has not been assessed yet

CONSTRUCTION

During construction, the following mitigation will be followed to protect resident forage fish species.

- A temporary construction diversion channel will convey river flows around the construction area and permit instream activities (i.e., construction of service spillway, diversion inlet, debris deflector and v-weirs) to be completed in an isolated, dry working area. Migration and/or movement of forage fish will be maintained upstream and downstream of the PDA.
- The berms constructed to isolate the work area will temporarily alter fish habitat in the river. Berm materials will be clean to reduce sediment inputs to the river. Berm materials will be placed to reduce impacts to small fish in the interstitial bed substrates.
- Fish monitoring and rescue work will be done to capture and remove fish in the isolated work area as the construction area is dewatered. Fish habitat within the isolated area will temporarily be affected for the period of time it is dry and unavailable for resident fish.

The isolation of the construction site will temporarily alter available river habitat for forage species and temporarily reduce available benthic prey items in the immediate vicinity of the construction area.

The effects of construction on resident fish will be limited to those fish displaced to areas outside the PDA. Some resident forage fish are expected to be lost due to construction related mortality; however, due to the abundance of available habitat in Elbow River, will not affect the sustainability of resident forage fish populations.

Some habitat within the component footprints will be permanently altered or destroyed (for further discussion on footprints and habitat alteration and loss see the response to CEAA Conformity IR3-24). A small unnamed tributary with ephemeral flow will be intersected by the permanent diversion channel (that diverts some of Elbow River flood waters into the off-stream reservoir) and approximately 300 m of stream channel will be isolated from Elbow River.

FLOOD OPERATIONS

Potential effects on forage fish may occur during flood operations. Fish may be displaced and swept into the diversion inlet and entrained in the off-stream reservoir.

ENTRAINMENT

Some forage fish will become entrained within the reservoir when flood waters are partially diverted from Elbow River during a flood. Even though some fish will be displaced during flooding, fish generally respond to environmental cues (e.g., rising flows and velocities, changes in temperature) that trigger a behavioral response to avoid effects from flooding, including searching out refuge (e.g., moving to channel margin habitat; floodplain habitats' point bars; concave-bank benches; deflection eddies; and expansion eddies) (Schwartz and Harricks 2005; Bolland et al. 2015; Lytle and Poff 2004). Franssen et al. (2006) reported that rather than downstream displacement of fish, flooding resulted in upstream dispersal into local refugia habitats. However, small-sized fish such as minnows, shiners and salmonid fry are at the highest risk of displacement during high water events (George et al. 2015). Weaker swimming capabilities of small-sized fish may make these fish more susceptible to displacement during higher flows, in channelized watercourses (Bolland et al. 2015).

Fish entrained in the reservoir will have to contend with the following:

- Suspended sediment in the water entering the reservoir will be elevated and the same concentration as existing in Elbow River during the flood. This sediment will begin to settle within the reservoir once water ceases to be diverted into the reservoir. Suspended sediment levels will cause physiological stress and potentially result in some fish mortality.
- Water temperatures may increase within the reservoir during the water holding period. Based on the Alberta Transportation's response to Round 1 CEAA Package 1, IR1-05, water temperatures in the reservoir could rise to levels above 22˚C. This may result in physiological stress to riverine forage fish (e.g., longnose dace) adapted to cooler river water.
- Dissolved oxygen will remain at viable levels in the water column because the reservoir will be exposed to winds that produce wave action. No significant effects on forage fish is expected while being entrained in the reservoir.
- Predation will likely occur because entrained forage fish will be sharing the reservoir with larger predatory fish also entrained in the reservoir. Predation in the reservoir may deplete forage fish populations depending on available cover and density of predator fish. However, larger fish are less likely to be entrained in the reservoir, mitigating predation levels to some degree.

REDUCTION IN PEAK FLOWS

Elbow river flood flows between 160 m^3/s (1:7 year flood flow) and the 760 m^3/s (design flood flow) will have a portion diverted into the off-stream reservoir (e.g., for a 760 m^3/s flow, 600 m^3/s would be diverted into the reservoir and 160 m^3/s would continue in Elbow River). Removing peak flows from the flow regime has the potential to affect stream channel geomorphology and the nature of associated habitat.

The effect on fish habitat associated with eliminating the peak flows greater than 160 m^3/s will be reduced mobilization of substrates on gravel bar heads and subsequent decrease in the magnitude of degradation and aggradation of those gravel bars. Most (i.e., 99%) of the changes in aggradation and degradation will be less than 20 cm. Changes to species-specific habitat of this small magnitude on bar heads is not possible to determine. Effects on spawning habitat are expected to be minimal and not affect the sustainability of resident forage fish populations.

POST-FLOOD OPERATIONS

During post-flood operations, effects on forage fish include stranding of entrained fish in the reservoir during drawdown and in Elbow River from reservoir water mixing in the river.

STRANDING

The reservoir drawdown may lead to some forage fish being stranded within temporary, isolated pools as the reservoir water levels decrease. Fish rescues will be conducted for all fish including forge fish as water levels drop within the reservoir, thereby reducing the risk of mortality to forage fish through stranding.

Fish entrained in the reservoir (including forage fish) will be captured and carefully returned to Elbow River to mitigate the effects of stranding. This is further discussed in Alberta Transportation's response to Round 1 CEAA Package 3, IR3-29. The effect of stranding on resident forage fish populations will be limited; fish rescue activities will reduce mortality. The sustainability of resident forage fish populations is not predicted.

RESERVOIR WATER RELEASE TO ELBOW RIVER

Reservoir drawdown will lead to a temporary increase in water temperature in Elbow River; however, oxygen levels are predicted to remain suitable for forage fish. Rapid aeration of water released through the outlet gates will re-oxygenate water prior to entering the river. Temperature and dissolved oxygen levels are predicted normalize quickly as waters mix between the released reservoir water and Elbow River.

During drawdown, suspended sediments will be released from the reservoir and concentrations will increase during the end of the release period (EIA, Volume 3B, Section 7.4.2, Page 7.21). Effects of suspended sediments on fish are discussed in Alberta Transportation's response to Round 1 CEAA Package 1, IR1-05. Estimated suspended sediment concentrations are predicted to be elevated and at levels to potentially cause sublethal and lethal effects to fish. However, during this period, fish are expected to move and seek out refuge from elevated suspended sediments. Where reservoir water is fully mixed in river water and refuge areas are limited, forage fish may experience physiological stress.

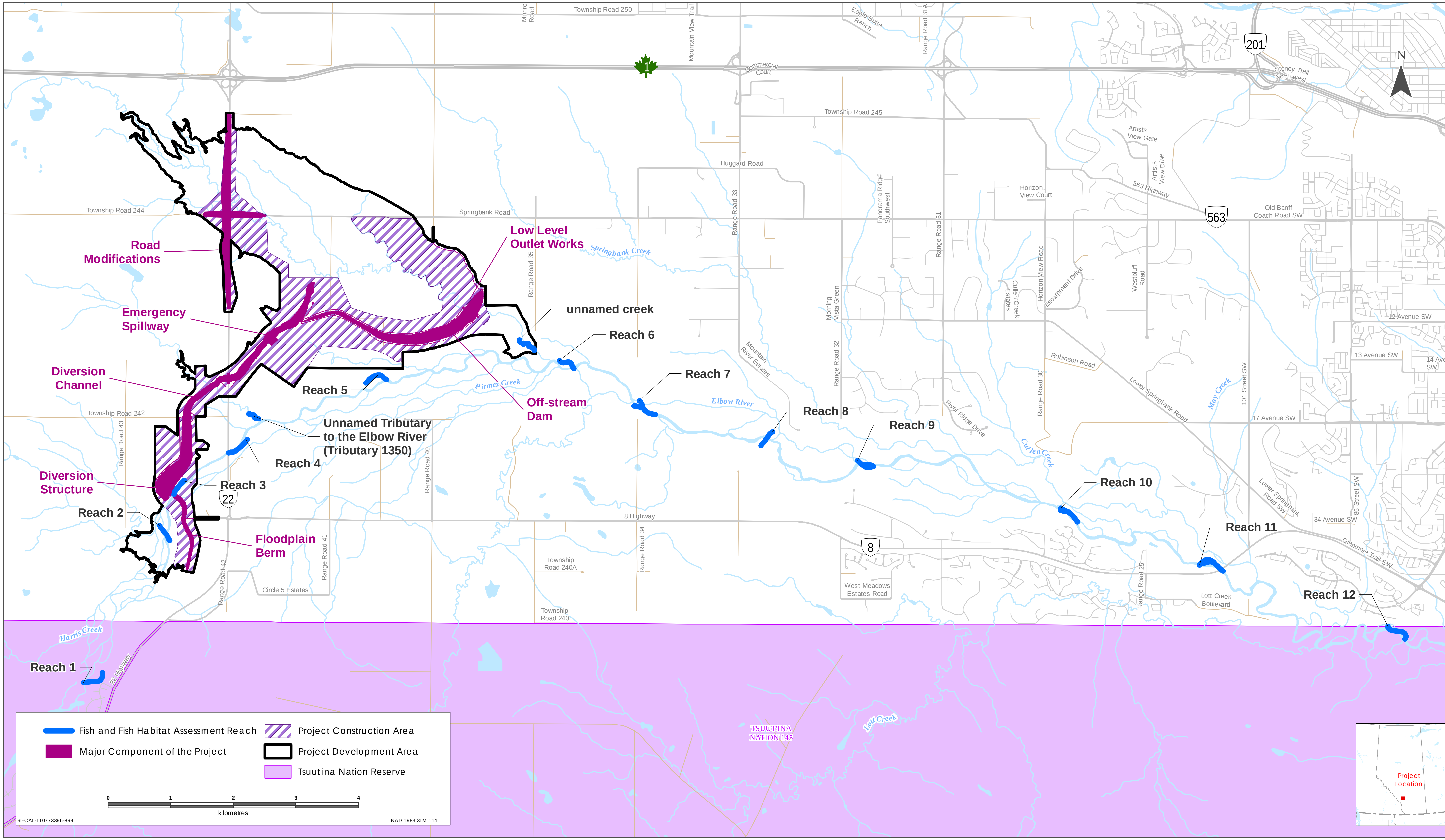
Forage fish spawning mainly occurs from May or June and, depending on the species, may extend into August with eggs typically hatching within a few weeks. Elevated suspended sediments released into Elbow River during drawdown are expected to begin in late July or August. Therefore, fish spawning later may be affected by reservoir drawdown. Sediment released from the reservoir is predicted to affect a small portion of forage fish spawning in Elbow River and is not expected to affect the sustainability of resident populations.

Water released from the reservoir will be conveyed to Elbow River through the unnamed creek (ID 22259). Depending on the rate and volumes released during reservoir drawdown, erosion of substrates may occur. This will result in temporary changes and alterations to habitat in the creek. Habitat in the creek is limited because the channel is narrow and flows are ephemeral (EIA, Volume 4, Appendix M, Section 3.1, page 3.31). Available habitat is limited to periods of time when runoff is available and groundwater is suitable to support pools in the lower sections of the creek close to the river. Habitat in the creek is poor for forage fish species.

In conclusion, construction and operations will have limited effects on resident forage fish populations. Some habitat will be altered or lost in the unnamed tributary (ID 1350) and unnamed creek (ID 22259). Some forage fish mortality is expected in the reservoir due to physiological stress from suspended sediments and predation. Suspended sediments released from the reservoir may also have a short-term effect on forage fish between the confluence of the unnamed creek with Elbow River and the Glenmore Reservoir. However, resident forage fish species are commonly found throughout Elbow River and Project-related effects are not expected to affect the sustainability of resident populations.

b) ***CUMULATIVE EFFECTS ON SPAWNING AND SPAWNING HABITAT***

Habitat descriptions for resident forage fish species in Elbow River are discussed in the EIA, Volume 4, Appendix M, Aquatic Technical Data Report and summarized in Table 31-2. Habitat ratings for forage fish are based on flow, water quality, substrate, instream and overhead cover. The location for each habitat assessment reach in Elbow River are illustrated in Figure 31-1. Detailed habitat information in Elbow River used to assess effects on forage fish species is limited. Field work is currently being planned for fall 2019 to map fish habitat in Elbow River in the vicinity of, upstream, and downstream of the PDA. The mapping will be used to delineate habitat types in Elbow River as per the EIS Guidelines. The resulting fish habitat maps will be available for responses to Round 2 CEAA IRs.



Sources: Base Data - Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Fish and Fish Habitat Assessment Reaches

Conformity Response 3

Figure 31-1

Table 31-2 General Habitat Rating by Reach for Forage Fish

Habitat Assessment Reach	Spawning	Overwintering	Rearing	Migration
1	P	M	P-M	G
2	P	M	M	G
3	M	M	G	G
4	G	G	G	G
5	G	G	G	G
6	G	G	G	G
7	M-G	M-G	M	G
8	M-G	G	M-G	G
9	P-M	P-M	M	G
10	P-M	P-M	P-M	G
11	M	M-G	M	G
12	M	G	G	G
NOTES: P = poor M = moderate G = good				

Forage fish spawning habitat potential in Elbow River is variable and ranges from poor to good. Most forage fish spawning is triggered by warming water temperatures in spring and early summer, and mainly begins in May or June (depending on the species) and may extend into August. Brook stickleback spawn earlier than cyprinids (i.e., minnows and shiners) and may begin spawning in April if conditions are suitable. Forage fish resident to erosional rivers (i.e., rivers with cobble and gravel substrates) spawn over sand or gravel habitats. However, brook stickleback build spawning nests in weedy areas of calm tributaries.

Project-related effects on spawning habitat include:

- construction related activities
- altered or lost habitat to Project footprint
- changes in water quality (temperature and dissolved oxygen)
- suspended sediment deposition
- downstream changes to channel morphology

The cumulative effect of these habitat changes to the forage fish community is not expected to affect the sustainability of these resident populations, nor are they expected to affect resident CRA fisheries that depend on these species.

- Construction related activities will be medium term in duration over several months (EIA, Volume 3A, Section 8.1.5, Table 8-2, page 8.14); however, the activities will be limited to the construction area. Flows and temporary habitat will be maintained during construction of the diversion channel.
- Permanently altered or lost habitat in the Project footprint will affect local resident fish in the long term. Forage fish have smaller home ranges than large bodied fish and residents will be permanently displaced. However, due to the abundance of habitat, productivity in Elbow River is not predicted to be affected. A *Fisheries Act* Authorization and associated offset to compensate for lost habitat and potential productivity will be required prior to construction.
- Temporary altered habitat may occur in the unnamed creek if elevated volumes of water are released from the reservoir, which will temporarily affect habitat. Spawning habitat in the creek is likely limited to brook stickleback that spawn earlier than other species and may be able to take advantage of early ephemeral flows.
- Changes in water quality due to temperature and dissolved oxygen are predicted to be localized and short-term in duration. These conditions will be ameliorated when water released from the reservoir is aerated through turbulence and temperature levels will naturalize during mixing.
- Increased suspended sediment concentrations in water released from the reservoir will occur over a few weeks and affect habitat in Elbow River from confluence of the unnamed creek with Elbow River and downstream potentially to Glenmore Reservoir. Heavier sediments are expected to largely deposit in Elbow River within a short distance from the confluence. Most sediments, however, are expected to remain in the water column and be diluted as mixing occurs in the river. Deposited sediments will accumulate on riverbed substrates and cover spawning habitat. These conditions will persist until flow velocities in Elbow River increase and flush sediments downstream (e.g., during spring freshet the following year). Elevated fine suspended sediments will affect water quality in the river downstream to the Glenmore Reservoir.
- Downstream changes in channel morphology are predicted to result in change of less than 20 cm to aggradation and degradation of bar heads. As water levels recede in Elbow River, bar heads are expected to have limited habitat value. This effect is predicted for the river between the confluence and Glenmore Reservoir and persist until the next channel forming flow (i.e., bankfull discharge occurs approximately 1:2 years).

The periodicity of flood and post-flood effects (i.e., reservoir drawdown) are predicted to have a frequency of less than once every 7 years (related to a river flow rate of 160 m^3/s; the 1:10 year flood is associated with a river flow of 200 m^3/s).

In conclusion, construction and footprint related habitat changes and loss will result in permanent, local effects on forage fish spawning habitat. Because forage fish habitat is common throughout the river, altered or lost habitat as described for the Project footprint is not anticipated to affect the sustainability of forage fish in Elbow River.

Flood and post-flood operations (i.e., reservoir drawdown) will result in changes in water quality, sediment release and changes in river flow and will subsequently have a temporary effect on habitat over a larger area (i.e., from the unnamed creek confluence to Glenmore Reservoir). Reservoir drawdown and post-flood operations will occur as conditions permit (i.e., flows in Elbow River drop to level of approximately 20 m^3/s) which is expected in late August, after forage fish spawning has concluded. Sediment deposition in the river may affect spawning habitat in Elbow River for a short distance downstream of the confluence of the unnamed creek for the following season (i.e., the next year); however, the spring runoff and freshet flows are expected to flush sediments from bed substrates thus rejuvenating forage fish habitat.

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Conformity IR3-45

Topic: Alternative Means

Sources:

EIS Guidelines Part 2, Section 2.2

EIS Volume 1, Section 1.0; 2.2.1.1; 2.2.1.3,

Rocky View County – Comments on the EIS, June 15, 2018 (CEAR #571)

CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-45

Alberta Transportation Responses to IR Round 1, SR1 CEAA IR Package 3, June 14, 2019

Context and Rationale

In CEAA Information Requests Related to the Environmental Impact Statement Round 1 Part 3, IR3-45, the Agency required Alberta Transportation to evaluate whether the Micro-Watershed Impounding Concept is a feasible alternative means of meeting the Project's purpose and to consider potential environmental effects in this evaluation. As noted in the information request, the EIS Guidelines require the proponent to identify and consider the effects of alternative means of carrying out the project, and to provide an analysis of alternative means of meeting the project purposes or objectives that considers environmental effects as per CEAA 2012.

In Alberta Transportation's response to IR3-45, Alberta Transportation notes that details on the Micro-Watershed Impounding scheme have not been provided and the only available information that Alberta Transportation is aware of is on the TRJR website. Additionally, the response indicates that Alberta Transportation does not know who its proponent is, nor does Alberta Transportation have any details to evaluate its merit, or feasibility. However, Alberta Transportation does note that the Micro-Watershed Impounding scheme refers to a series of low-

head dams or weirs placed throughout Elbow River and its tributaries which would require significant disruption to the Elbow River system as a whole with the installation of multiple low-head dams that would be required to meet the active flood storage capacity requirements for flood control on Elbow River.

Alberta Transportation's response does not provide an understanding of the Micro-Watershed Impounding concept, accurately evaluate the concept, or provide a consideration of potential environmental effects.

As referenced in the information request, CEAR 1037 refers to the Micro-Watershed Impounding Concept. Additional references include CEAR 1237, 1236, and 1139. Additionally, Mr. Charles Hansen (the proponent - as noted in the referenced submission), has confirmed that he has been in contact with both Alberta Transportation and Stantec regarding this concept since 2013, with presentations to the Flood Mitigation Advisory Panel, direct communication with Stantec, and direct submissions regarding the concept to Alberta Transportation through open houses and online submissions.

Alberta Transportation's response to IR3-45 further notes that potential concerns regarding the Micro Watershed Impounding Concept include limited flood storage, barriers to fish, impassibility of the river, and disruptions from road and utility access to each of the micro-impoundment facilities. However, Mr. Hansen notes that the flood storage capacity of the concept was estimated to accommodate the 2013 flood amount and is demonstrated in numerous submissions (for example, CEAR 1237). Additionally, he indicates that the concept requires no new roads. Existing roads allow equipment access to dry riverbeds to allow access to dams.

<u>Information Requests:</u>

a) Re-evaluate whether the Micro-Watershed Impounding Concept is a feasible alternative means of meeting the Project's purpose and consider potential environmental effects in this evaluation.

Response

a) Alberta Transportation has been corresponding with Mr. Hansen in an effort to set up a meeting for Mr. Hansen to provide additional information on the Micro-Watershed Impounding Concept. These efforts are ongoing, and Alberta Transportation is open to meeting with Mr. Hansen once a suitable date can be found. If the proposed meeting with Mr. Hansen results in additional information to inform this response, Alberta Transportation will provide this information to the Impact Assessment Agency.

Prior to a meeting with Mr. Hansen, CEAR 1037,1237, 1236, 1139 and 21 other submissions to CEAA by Mr. Hansen have been reviewed. The following response evaluates the Micro-Watershed Impounding Concept based on the information presented in these submissions.

From the information that has been provided, Alberta Transportation's understanding of the Micro Watershed Impounding Concept that has been put forward by its proponent involves:

- locating a series of impounding structures at 40 to 80 locations, and spaced at 1 km intervals across 17 micro watersheds along Elbow River, Canyon Creek and Little Elbow River stream beds to control flooding on Elbow River (Figures 45-1 and 45-2 from CEAR 1037 illustrate the concept)
- dredging Glenmore Reservoir so it provides 22,000 dam^3 flood storage capacity (the current active flood storage allocation is 10,000 dam^3)
- including both wet dams and dry dams, with the wet dams being retained for drought and irrigation purposes
- constructing the impounding structures using the existing riverbed materials, ploughed up to a height of two or three metres
- including Bauer Foundation type soil cement within the berm core of wet dams
- integrating fish spawning migration ladders on all impounding structures
- installing supervisory control and data acquisition (SCADA) Wi-Fi controlled release steel gates on each impounding structure to release the impounded water
- the system requires no new roads for construction or access to the impounding structures

The filed material from Mr. Hansen states that a feasibility study is needed to test this proposal for addressing the Elbow River flood concerns. Alberta Transportation is not conducting further feasibility studies for Project alternatives at this stage of Project development.

Alberta Transportation has reviewed the filed material on the Micro Watershed Impounding Concept, and re-evaluated whether the Micro-Watershed Impounding Concept is a suitable alternative means of meeting the Project's purpose. The re-evaluation had the following findings:

- Variations of the Micro Watershed Impounding Concept has been proposed for hydroelectric power generation and water supply, but there was no information provided by the proponent indicating where this concept has been used for flood control, and at the scale of the 2013 flood.
- Dredging of Glenmore Reservoir was reviewed by the Province's Flood Recovery Task Force and it was deemed to not be a feasible means of providing more active flood storage, because the silt and debris only comprise 10% of its volume. Dredging was also deemed to be not appropriate in the City's drinking water reservoir (City of Calgary 2019).

- The ploughing up of impoundment structures two or three metres high to provide a total storage of approximately 80 million m^3 required to mitigate the 2013 equivalent flood on Elbow River. CEAR 1037 states that 40 to 80 instream structures are required. The following comments are provided by Alberta Transportation:
  - Figure 45-1 (provided in this response) shows the structures located on the apex of the colluvial (or talus) slopes. These locations are not suitable for impoundment structures, primarily because the topography of the terrain at the apex of these colluvial fans does not contain any depressions or channels upon which to begin impounding water. Even if water could be impounded there, the slopes are so steep (approximately 30^0) that the volume impounded would be so small (less than 200 m^3) that the number of structures required would vastly exceed the number estimated in the more reasonable example below.
  - The Elbow River headwater creeks slope at an average 2% or steeper. At a 2% slope, a 3 m high dam will back flood approximately 85 m up the watercourse. If a single micro-dam impoundment blocked-off a 200 m wide tributary creek valley, the resulting impoundment would hold approximately 25,500 m^3. Even with a dredged Glenmore Reservoir providing 22,000 dam^3 flood storage, the Elbow River watershed would still need more than 2,200 of these impoundments across the basin, more than the 40 to 80 estimated in the submissions, to mitigate the same flood risk as the Project. This number of facilities is costly to construct, maintain and operate, and the disturbance to the watershed would be extensive.
- The micro-dam structures, as described, would not be sufficiently resilient to floods. While each structure retains some flood water, the flow rates in the tributaries will increase the farther downstream the watersheds that each micro-dam is placed. Each gated conduit will need to be progressively larger from upstream to downstream, increasing the cost and complexity of the system. The conduits described are susceptible to debris blockages that would reduce the conveyance capacity of the conduit and increase the risk of overtopping the micro-dam. If overtopped, the micro-dam as described would wash-out, releasing its headpond. The wash-out of a micro-dam would make it ineffective in its contribution to the storage in the system and would likely cause the cascade failure of the series of micro-dams that are downstream of it. This would create considerable amount of damage to fish habitat and render the system ineffective on that respective tributary.
- The assumption above that the micro-dams are each impounding 25,500 m^3 is very close to the 30,000 m^3 volume (and 2.5 m height) that classifies the impoundments as 'dams' under the Canadian Dam Safety Guidelines and the Alberta Dam and Canal Safety Directive. Each micro-dam will have varying geometries governed by the topography and it is likely that many of these structures will meet these criteria and be classified as 'dams'. This will require dedicated emergency spillways and more onerous inspection, monitoring and maintenance activities at each of the micro-dams that receive this classification. Even a small percentage of the 2,200 micro-dams receiving this

classification as dams will greatly increase the capital, maintenance and operation costs and operational complexity of the system.

- The filed material by Mr. Hanson states that additional roads would not be required but many of these dams would have to be placed in areas inaccessible by road. Without roads, heavy equipment for construction, including compaction equipment, would presumably have to use the river/stream bed as access. Furthermore, dam access for operations and maintenance may be rendered impossible during high flow conditions.
- The evaluation considered the potential environmental effects and found the following:
  - The micro-dams would permanently alter the hydrologic flow regime of Elbow River and the various tributaries during all flow conditions, as opposed to the Project which would only impact the flow regime on Elbow River during flood operations.
  - The instream footprint from over 2,200 micro-dams would destroy considerable amounts of existing fish habitat. Assuming the 3 m high micro-dams have a crest width of 3 m and side-slopes of 3:1 H:V; and assuming the average tributary channel is 5 m wide, then each micro-dam would have a footprint in the channel bed of 105 m^2. The total area of channel bed in the watershed (fish habitat) that would be covered by the footprints of 2,200 micro dams would be 231,000 m^2. This estimate does not include the alteration of fish habitat created by the micro-dams' headponds, nor does it include the permanent disturbance to the creek bottoms by pushing up the 'glacio-fluvio' to create the micro dam. The total permanent channel bed footprint of the Springbank Project is 8,092 m^2, as detailed in the response to CEAA Conformity IR3-24.
  - The tributaries of Elbow River can run dry, or sub-surface, in dry periods and seasonally on select tributaries. Fish mortality could be high from the micro-dam arrangement because there would be small permanent pools at many of the structures, either intentionally for water supply, or unintentionally from local scour. As flows drop, the fish will tend to migrate to these pools, rather than downstream and through the system to the tributary's confluence with the main channels. The pools at the micro-dams' impoundments will ultimately become hydraulically isolated on many of the tributaries because there will be insufficient flow to maintain the fishway and connect the pools with the others, and down to its confluence. The shallow, ponded water behind the micro-dams, with the loss of hydraulic connectivity, will create 'fish traps' where fish cannot escape and leading to fish mortality due to changes in water quality and water temperature (either heating or freezing)
  - Fishways ('fish spawning migration ladders") are mitigation structures that are used at barriers to facilitate fish passage. They are not 100% successful and there are many cases of well-designed fishways not successfully passing fish because of fish behavioral issues. While the likelihood of fishway success is dependent on many factors, and there are no details provided on the fishways proposed at the micro-impoundments, it is anticipated that fish passage in the basin would be severely

affected due to the number of structures that fish would need to pass in their migrations.

- Vegetation behind the more than 2,200 impoundment areas would be destroyed or altered during floods. This would affect more than 3,740 ha (9,242 acres) of land. The impoundment area of the Springbank Project, when full, is 789 ha (1,950 acres).
- The disturbance to wildlife during construction, and during floods, will occur over a wide area, given the number of dams required for this micro watershed impounding concept.
- The use of the stream bed for access would have a detrimental impact on the water quality, fish habitat and local fish species and may require bed modification to overcome impassible reaches.

Alberta Transportation has re-evaluated the feasibility of the Micro Watershed Impounding Concept using the information presented in CEAR submissions. It is found that constructing, maintaining and operating a network of approximately 2,200 micro-dams would be too costly; have low flood resiliency and reliability; and would have too large a disturbance footprint and environmental impacts. Alberta Transportation has deemed the Micro Watershed Impounding Concept to not be a suitable solution for flood mitigation on Elbow River.

REFERENCES

City of Calgary. 2019. Elbow River Flood Mitigation Alternatives Evaluated. Newsletter issued, Calgary, Alberta. January 2019

Figure 45-1 Micro-Watershed Impounding Concept Illustration 1 (From CEAR 1037)

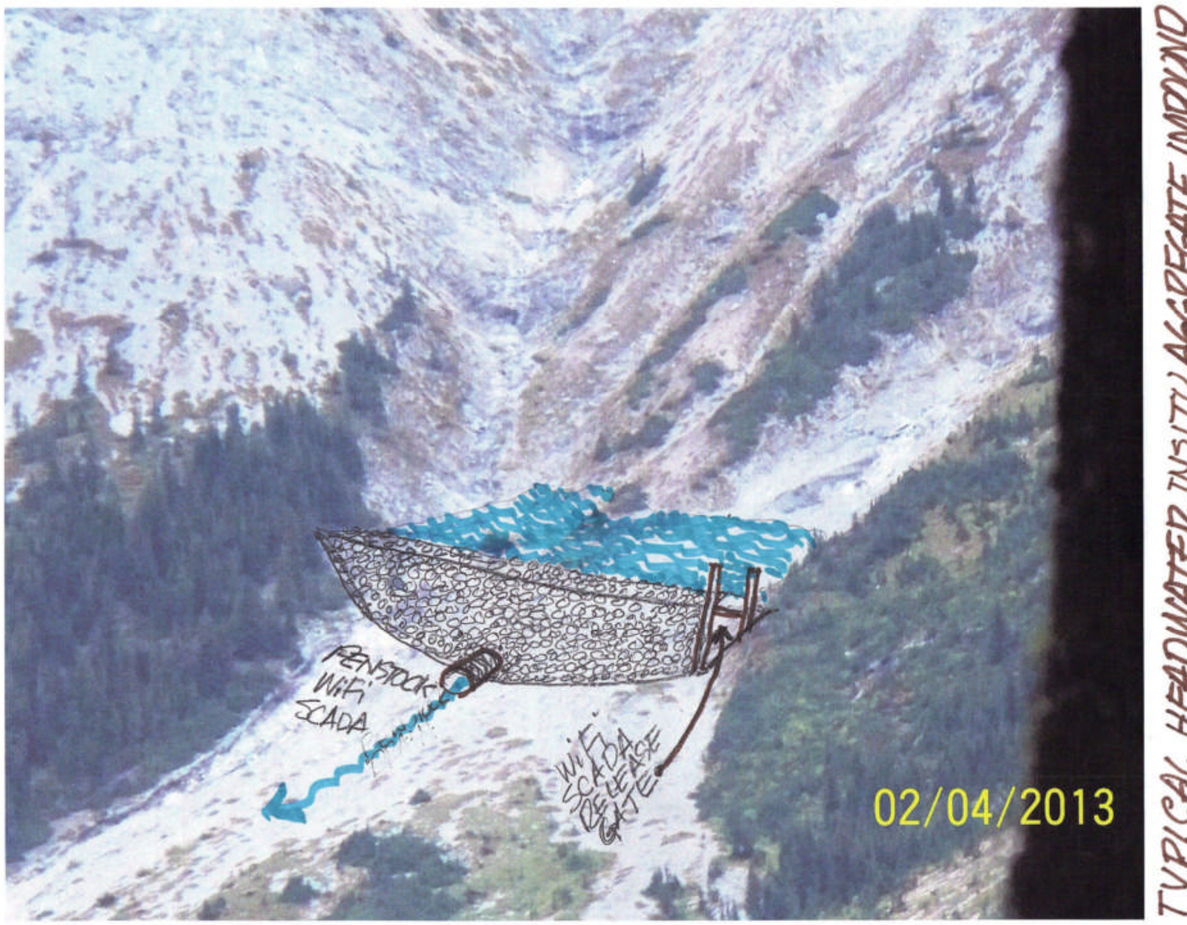

Figure 45-2 Micro-Watershed Impounding Concept Illustration 2 (From CEAR 1037)