COUGAR CREEK
DEBRIS FLOOD RETENTION STRUCTURE

Project Update

ADDENDUM

SUBMITTED TO:
Alberta Environment and Parks
and Natural Resources Conservation Board

SUBMITTED BY:
Town of Canmore

September 2019

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AEP	Alberta Environment and Parks
CDA	Canadian Dam Association
CPL	Canadian Projects Limited
EIA	Environmental impact assessment
IDF	Inflow Design Flood
NRCB	Natural Resources Conservation Board
SIR	Supplemental information requests
TEK	Traditional Ecological Knowledge
TLU	Traditional Land Use

1 INTRODUCTION

The Town of Canmore submitted a Project Update on the Cougar Creek Debris Flood Retention Structure to the Natural Resources Conservation Board (NRCB) and Alberta Environment and Parks (AEP) in February 2019. The February 2019 Project Update described design changes identified during a constructability and optimization review that was completed in December 2018. Upon review of the Project Update, the NRCB has requested additional information to support their assessment of project design changes. Project planning has progressed since February 2019 and the revised project design included in this Project Update Addendum represents the final design that will be used for permitting and procurement. The basic design, function, and location of the Structure has not changed, and the information provided in this Addendum is intended as a supplement the original 2016 Application (NRCB Application No. 1601) and the February 2019 Project Update.

This Addendum to the Project Update includes an updated description of the project design and information requested by the NRCB in a letter to the Town of Canmore dated February 28, 2019, and during conversations between NRCB and Town of Canmore staff. The following information is included in this Addendum:

- an updated project design that supersedes the description provided in February 2019 (Section 2);
- details regarding the following specific aspects of project design as requested by the NRCB (Section 3):
    - review of the applicability of previous breach analysis (environmental impact assessment [EIA] Section 10.3.3) and any additional work required to validate the results;
    - review of the applicability of previous physical scale modelling (SIR 162, Round 1) to inform the design of the rock-cut spillway and any additional work required to validate the results;
    - discussion of the effects of a probable maximum flood on the revised Structure and spillway design; and
    - results of technical reviews from third-party expert;
- details regarding the project costs and schedule (Section 4);
- additional details regarding a review of implications for the findings of the environmental assessment (Section 5); and
- an update on Indigenous consultation (Section 6).

2 FINAL PROJECT DESIGN

2.1 Background

The Town of Canmore submitted an EIA report and NRCB application summary for the Cougar Creek Debris Flood Retention Structure (the Structure) and access road (together the Project) in July 2016 (NRCB Application No. 1601). The EIA was deemed complete by AEP in March 2018 and the NRCB concluded that the Project was in the public interest in November 2018 (Decision NR 2018-01).

After the EIA was submitted, the Town of Canmore continued progressing the design in preparation for construction should the Project be approved. As part of this work, the Town engaged Canadian Projects Limited (CPL) in 2018 to complete a constructability review. CPL also identified opportunities to address input provided by AEP Dam Safety and third-party reviewers and to reduce construction and operating costs. The review resulted in proposed design changes aimed at reducing Project complexity and improving the long-term serviceability of the Structure. These changes shorten the construction schedule and reduce construction costs to ensure that the Project can be completed within budget. Proposed changes were presented to the AEP Dam Safety branch and third-party reviewers in December 2018, prior to the Town of Canmore making any decisions regarding the incorporation of changes.

Based on input from Dam Safety and third-party reviewers, the Town of Canmore decided to incorporate a number of design changes that were then presented to NRCB staff, the AEP EIA manager, EIA coordinator, and Water Act regional approvals technologist assigned to the Project in January 2019. The design changes were also presented to Alberta Parks staff in January 2019. In February 2019, the Town of Canmore submitted a Project Update describing changes to the Project since the EIA was submitted. This update included information related to implications for EIA findings in relation to the proposed changes.

Upon review of the February 2019 Project Update, the NRCB issued a letter on February 28, 2019, requesting additional information to support their review of the design changes. Between February and August 2019, the Town has worked with its engineering consultants, third-party reviewer, Dam Safety staff and Alberta Parks staff to progress the design to its final stage prior to issuing this Addendum. The Project design described in this Addendum supersedes that provided in the February 2019 Project Update.

2.2 Summary of Design Changes (Post EIA Submission)

The basic design, function, and location of the Structure has not changed; but some of the design elements, particularly the approach to spillway design and flow control, have been optimized. Figure 1 compares the footprint of both the original and revised design. Figure 2 presents a plan view of the revised Structure and spillway design.

In this document, Structure refers to the debris flood retention structure itself; the spillway is now a separate component. Together, the Structure, spillway and access road comprise the Project.

It is important to note that the design changes described in this document do not affect the following:

- the design intent of the Project is the same and the risk reduction for residents and infrastructure downstream does not change;
- the Structure is designed to the same Canadian Dam Association (CDA) Dam Safety Guidelines "Very High consequence dam" classification;
- the location of the Structure does not change;
- the maximum outflow rate of the Structure has not changed;
- the flow control inlet and outlet designs have not materially changed;
- the inflow design flood (IDF) used to determine height and freeboard of the Structure, as well as to determine the size of the spillway and outlet works, has not changed;
- the spillway capacity is the same;
- the spillway crest elevation is the same, producing a very similar inundation area;
- all the geotechnical investigation data and results are valid, and additional site investigation information for the new spillway location has been collected;
- mitigation identified in the EIA for construction activities (e.g., dust control, erosion control, blasting) do not change;
- backcountry access to Cougar Creek canyon will be maintained over the Structure; and
- all of the conditions listed in the draft NRCB approval (Approval No NR 2018-01) as issued in November 2018 with the NRCB decision will be met.

There are four changes from the design considered in the EIA and the NRCB decision:

1. **Flow Control (Low Level Outlet):** The original design included a diversion tunnel and associated emergency bypass pipes through the east abutment. The revised design includes a concrete encased large diameter steel conduit and associated emergency bypass pipes built into the embankment of the Structure at creek level on a rock bench at the west abutment. There is no functional change between these two design options as they provide the same outflow rate, and the general design of the inlet and outlet structures has been retained. Minor modifications of the inlet and outlet structures were required to ensure compatibility with the new configuration.

2. **Spillway:** The original design incorporated a concrete spillway on the downstream face of the Structure. The revised design includes a rock-cut spillway located on the east abutment. The excavation of the rock-cut spillway provides rock for the embankment fill. The rock-cut spillway eliminates the need to accommodate flood waters over the crest of the Structure, resulting in reduced design complexity, reduced Project-related traffic to haul fill materials, and reduced construction costs. There is no functional change between these two design options as they both provide the same capacity and are designed to the same standard (Section 2.4).

3. **Seal Wall (Sheet Pile Wall):** A sheet pile core wall will be used instead of the concrete seal wall of the original design. A sheet pile core wall provides the same impervious function as the original seal wall design; however, it is less expensive to construct, faster to erect and easier to inspect during construction (Section 2.5).

4. **Access Road:** Changing the spillway location allows for the access road to be mostly incorporated into the downstream face of the Structure, rather than on the west abutment as originally proposed (Section 2.6).

In addition to these four changes, the Town plans to source existing alluvium from the creek bed, upstream of the Structure, to be used as supplemental source of fill material for the embankment. The use of rock from the spillway excavation and material from the creek bed will significantly reduce the required quantity of imported fill material, resulting in reduced construction costs and construction traffic through Town. Sourcing alluvium material from the creek bed will result in re-contouring of the creek bed but will not result in any permanently impounded water and will not impede human or wildlife movement in Cougar Creek. Removal of this material will reduce maintenance requirements at the Structure by allowing additional space for deposition of materials in the creek bed before they reach the Structure, thereby increasing the time to initial clean-out.

In the revised design, since the Structure does not include the spillway, the entire crest of the Structure will be brought to approximately the same level of the sidewall height of the original design. The spillway crest elevation remains unchanged. The dam crest elevation accommodates the required wave run-up and freeboard for the IDF. The footprint of the Structure does not materially change since the slope of the downstream face of the Structure is now slightly steeper and includes the benches for the access road. The slope change is possible due to the removal of the spillway from the downstream face of the Structure.

The size of the Structure is similar to the original design and no additional work is required to validate the results of the dam breach analysis that was conducted for the EIA (Section 3.1). The rock-cut spillway is designed with the same performance requirements as the original spillway. The revised design uses the same IDF, has the same weir crest elevation, has a similar chute and stilling basin configuration, and has the same predicted inundation area (Section 2.4)

The Project will incorporate reclamation and landscaping elements similar to the original design. Reclamation in No Man's Land will be conducted in accordance with AEP guidance (SIR 108, Round 1). Changes to the location and orientation of the flow control outlet and spillway have been considered in the preliminary reclamation plan that will be subject to field optimization near the end of construction.

With respect to the socio-economic assessment of the Project, the revised design results in reduced overall costs for construction and operation, improving the economic viability of the Project. The Structure will still allow recreational access to Cougar Creek canyon; however, human access will be restricted in a designated area around the rock-cut spillway both for safety and to support wildlife habitat connectivity (see Section 2.4).

The design changes are described in more detail below, along with key implications for EIA findings associated with each design change.

2.3 Flow Control (Low Level Outlet)

The revised low level outlet (LLO) design includes a 3.1 m diameter concrete encased steel conduit and two 36-inch (0.91 m) diameter emergency bypass pipes, located at creek level on a rock-cut bench on the west abutment (Figure 2).

The original 4.5 m diameter tunnel was sized for tunnel constructability purposes. The original tunnel had large flow capacity, but its design flow was restricted to the current downstream channel capacity of 45 m^3/s. The conduit of the revised design is also capable of handling more than 100 m^3/s but it will also be restricted to 45 m^3/s by a throttle, in a similar way as the original tunnel was. The 3.1 m diameter steel conduit has been sized to allow for creek diversion during construction, to reduce potential blockage by debris, and to provide access for equipment and workers for clean-out and maintenance[1].

The design of the inlet and outlet of the LLO flow control system has not functionally changed. The inlet and outlet of the flow control system, including the debris rake, have been extensively studied through numerical modelling and physical scale modelling. Studies confirmed that the orientation of the inlet does not affect its hydraulics. The original inlet was sized relative to the tunnel diameter and the size of the revised inlet has been proportionally reduced according to the smaller diameter of the steel conduit.

The LLO conduit will allow for similar performance as the original design. Sediment transport and self-cleaning of the LLO conduit will be equal or superior to the original tunnel and its steel lined invert.

Rationale - This design change reduces construction risks associated with geological and technical challenges typically associated with tunneling, therefore reducing construction risk and cost. Moreover, the conduit construction requires less specialized equipment and workers, and requires only a limited amount of enclosed or confined space work. The LLO structures and conduit are entirely constructed on a rock-cut bench, eliminating long-term risks of differential settlement or movement. Long-term maintenance requirements are reduced since steel conduits are easy to inspect with non-destructive testing equipment and their rehabilitation are also commonly done. The concrete encasement of the conduit and pipes provides long-term durability and safety redundancy. The conduit will allow for the same Structure performance as the original design. Finally, the emergency bypass pipe inlets are situated at the same elevation as the original design and the bypass pipes will function in the same manner.

Review of EIA Findings – The maximum flow through the Structure has not changed and the inlet and outlet designs have not materially changed. The revised outlet orientation is better aligned with the existing creek channel and maintains the same flow as the original design.

The revised flow control system is still designed to allow regular flow and sediment to pass through the Structure during normal operations; therefore, the revised design does not alter the findings of the hydrogeology assessment that impacts to groundwater levels are low and impacts to groundwater quality are negligible in the local (LSA) and regional (RSA) study areas.

The revised design does not change the volume or rate of water passing/withheld by the Structure, nor the volume or sizes of sediment passing/withheld by the Structure during any of the design flood events. Therefore, the revised design does not change the findings of the hydrology assessment of moderate to low impacts on peak flow, peak water level, geomorphology, river hydraulics, or surface water/groundwater interactions in the LSA and RSA.

1. This conduit was sized at 2.7 m in the February 2019 Project Update and has been increased to 3.1 m to provide improved access for maintenance equipment and to further reduce the risk of debris blockage.

The rock removed from the west abutment to construct the rock bench for the conduit will be re-used onsite as rockfill material for the Structure. Mitigation identified in the EIA specific to blasting activities has not changed.

There are no implications of this design change on how the Project interacts with environmental indicators and no further environmental impact analysis is required as a result of the revised flow control design. As required in the NRCB decision, the Town will conduct surface and groundwater quality and quantity monitoring through construction and operation.

2.4 Spillway

The original design incorporated a spillway on the downstream face of the Structure that is replaced by a rock-cut spillway located on the east abutment (Figure 2). The rock-cut spillway is deeply incised into bedrock. It is approximately 250 m long, 35 m wide at the weir crest, 20 m wide at the chute, with a maximum depth of 30 m at the Structure crest. The steep internal spillway walls are terraced in 8 m high steps. The rock-cut spillway and stilling basin are designed with the same performance requirements as the original design. The chute slope angle, of approximately 36 degrees, follows the natural bedding plane of the bedrock in the spillway location. The revised design uses the same IDF for design; has the same weir crest elevation; and has a similar chute, stilling basin design and predicted inundation area.

Rationale - Design and construction of a steep concrete spillway chute on a new embankment, as per the original design, is technically challenging. The rock-cut spillway therefore reduces the technical complexity of the Project and reduces construction risk and cost. The rock-cut spillway solution greatly simplifies construction methods and logistics of both the embankment and the spillway, while providing the same function. Moreover, the rock-cut spillway is intrinsically stable and not prone to erosion or uplift stability issues since it is founded on native bedrock.

The original Structure design relied on significant volumes of rock and aggregate being hauled by trucks to the site from local quarries to construct the embankment. The construction of the rock-cut spillway on the east abutment will generate large quantities of high quality angular rock fill, specifically well-suited for the embankment construction. This local source of material will reduce the need to truck materials from off-site to the Project location. This offset in material sourcing will therefore significantly reduce imported fill quantities and associated trucking costs. Moreover, the reduced trucking will result in a substantial benefit to residents affected by construction traffic.

The long-term inspection of the rock-cut spillway is simpler and its maintenance requirements will be substantively simplified and reduced compared to a concrete structure.

Implications for EIA Findings - The revised spillway is designed with the same parameters as the original spillway; therefore, the findings of the hydrology and hydrogeology assessments do not change. As further discussed in Section 2.6, removing the spillway from the Structure allows for the access road to be located primarily on the downstream face of the Structure rather than in the designated wildlife corridor to the west. The portions of the Structure that are not used by the access road will be vegetated, except for a nominal height of riprap at the toes of the embankment.

The revised spillway design does change the footprint of the Project and the potential effects of this change on terrestrial components were assessed. As described in Section 5.4, the assessment of effects on vegetation, soils and terrain do not change as a result of the design changes described in this Addendum; however, the findings of the EIA with respect to habitat connectivity have changed from low to moderate environmental consequence as a result of the revised spillway design. Details on the assessment of potential effects of this design change on wildlife habitat availability, habitat connectivity and mortality are presented in Section 5.4.2.

The rock-cut spillway is located between a wildlife corridor to the west and a habitat patch to the east and will create a low-permeable barrier to wildlife movement. Preliminary data from cameras at and around the Structure location do show some movement but do not indicate that the site is a major point of cross-canyon movement. Due to the steep terrain at the Structure location, movement across Cougar Creek at that specific location is likely small, relative to shallower slopes further downstream. However, there is some uncertainty in the amount of movement up the steep slopes and additional mitigation is required to adequately address wildlife connectivity and mortality concerns. The revised spillway design includes egress points at the entrance and exit to facilitate wildlife movement in and out of the spillway to reduce the possibility of animals being trapped (Figure 2). The Town of Canmore met with AEP staff on January 11 and 30, 2019, to identify additional mitigation to address wildlife connectivity. The Town of Canmore agreed to further investigate the possibility of adding wildlife egress along the spillway in addition to that at the entrance and exit. A site visit was held on February 14, 2019, with AEP staff and CPL to consider design options. Upon review by the Project engineering team, AEP Dam Safety and third-party reviewers, it was determined that egress points along the spillway would compromise the engineering performance of the spillway and could not be included in the design. The Town of Canmore met with AEP staff on July 30, 2019 to further discuss potential effects of the Project on habitat connectivity. Without egress points along the spillway, mitigation related to limiting human access above the spillway and additional habitat enhancement is required. Implementation of additional mitigation will be a joint effort between AEP and the Town of Canmore. Additional mitigation includes:

1. **Access Management** - Human access will be restricted above the spillway between the Project and the existing Horseshoe Trail. The Town of Canmore will use signage, remote cameras and public communication to restrict access in the area that is included within their Project disposition. AEP will consider mechanisms to manage access outside of the Town of Canmore disposition and may also work to consolidate existing trails in the area.

   The use of fencing or slash piles to discourage human access and to direct wildlife around the spillway is also being considered. AEP will decide on the best approach once the spillway has been constructed. Signage will be used to encourage users of Cougar Creek to move quickly through the Project area to minimize human disturbance in the areas around the Structure where wildlife movement occurs.

2. **Habitat Enhancement** - The Town of Canmore will support AEP efforts to enhance habitat above the spillway and will provide equipment for this work during the construction phase, if requested by AEP.

These mitigation measures are in addition to the habitat enhancement in No Man's Land that the Town of Canmore has already committed to, and confirms and expands the human access

restrictions near the spillway proposed in the February 2019 Project Update. The Town of Canmore commits to working with AEP in the construction planning and implementation stages to further define and improve mitigation options for habitat connectivity. As recommended in the NRCB decision, the Town of Canmore will continue to support AEP efforts to understand the use of corridors and habitat patches, and to monitor the long-term effects of the Project and revegetation of No Man's Land on wildlife distribution and movement.

The rock-cut spillway also has implications for public safety as it creates a potential fall hazard. Details on the potential effects of this design change on public safety are presented in Section 5.4.8.

2.5 Seal Wall (Sheet Pile Wall)

The concrete seal wall has been replaced with a sheet pile wall that will be faster and easier to construct, while providing the same impervious function as the original design. The sheet piles will be erected on a concrete foundation on the creek bottom, and in a concrete filled cut-off trench on the abutments.

Foundation for the sheet pile core wall consists of a concrete plinth cast on bedrock in a three-meter wide trench at the creek bottom, along the centre of the Structure. Any weathered rock will also be removed to ensure that the foundation is on solid rock. Rock dowels will securely anchor the plinth to the bedrock. The sheet pile will be erected on the plinth and the remaining trench will be backfilled with cast-in-place concrete to complete the sheet pile core wall foundation. The sheet pile core wall will then be erected to the top of the Structure. Rockfill material from the spillway excavation will be used to construct the embankment while providing support for the sheet pile core wall on both sides. During construction, the entire erected sheet pile wall is easy to inspect for quality assurance and quality control purposes.

A grout curtain will be established between the sheet pile core wall and the bedrock to minimize the risk of seepage and possible instabilities associated with poor rock conditions. The grout curtain will be constructed using a series of pressure-grouted holes. A set of primary holes will be grouted 10 meters apart. Secondary grout holes may also be required until the target water permeability is achieved.

Temporary dewatering is required to facilitate construction of the plinth and the lower portion of the sheet pile core wall. At a location 250 m upstream of the Structure, water will be forced to surface using a lined partial cut-off trench. The flow will then be conveyed in a lined drainage channel to the Structure and through the constructed LLO conduit. Any further dewatering required at the construction site will be achieved with localized pumping.

Rationale – This design change lowers construction risk, cost and duration. Construction of a sheet pile wall does not require any special materials or construction methods and sheet piles are easily sourced.

Implications for EIA Findings – This modification does not result in any functional or operational changes and does not result in a change to the Project footprint. There are no implications of this design change on how the Project interacts with environmental indicators and no further environmental impact analysis is required as a result of the revised seal wall design.

2.6 Access Road

As discussed in Section 2.2, removing the spillway from the Structure allows for the majority of the access road to be located on the downstream face of the Structure rather than in the designated wildlife corridor to the west (Figure 1).

Rationale **-** Incorporating the access road on the Structure, rather than building an independent road on the abutment, reduces tree removal quantities and rock blasting required. Therefore, the road construction risk is reduced, duration is shortened and costs are lowered. The road also provides access to intermediate levels of the downstream embankment for monitoring and inspection during operation.

Implications for EIA Findings **-** Locating the access road on the Structure reduces the road footprint within the designated wildlife corridor to the west of the Structure. This change reduces the amount of high quality habitat that is lost within the corridor compared to the original design. Eliminating road construction on the west abutment also reduces interference with established, high-use hiking trails. Changes to the Project footprint were considered in the assessment of terrestrial components as described in Section 2.4 and below in Section 5.4.

3 RESPONSES TO SPECIFIC NRCB QUESTIONS

3.1 Breach Analysis

NRCB Question:

The Project Update (page 3) states that "the Town of Canmore is currently working with its consulting team to confirm if the results of the dam breach analysis completed for the original design can be used for the updated design and, if required, to determine what additional work is required to validate the results." The results of this analysis and work, including the revised dam breach analysis, have not been provided to the NRCB and are outstanding.

Town of Canmore Response:

For flood induced failure (dam breach analysis), the same assumptions for a breach scenario are applicable to the updated design since the embankment designs are very similar. Some of the assumptions of the breach modelling are likely conservative due to the higher tensile capacity of the sheet pile, as compared to concrete for the core wall. Moreover, the embankment fill material is slightly coarser, as compared to the original specifications, reducing its erodibility.

Therefore, the results from the dam breach analysis from the original design are still valid and no additional work is required to validate the results.

3.2 Physical Scale Modelling

NRCB Question:

The Project Update (page 4) states "The Town of Canmore is currently working with its consulting team to confirm that the results of the physical scale modelling can be used to inform the design [of] the rock-cut spillway and, if required, to determine what additional work is required to validate the model results." This information has not been provided to the NRCB and is outstanding.

Town of Canmore Response:

The consulting team has considered the spillway physical scale model results in the design of the rock cut spillway, which includes the weir overflow, chute flow, and the stilling basin. Although the maximum unit discharge per width of the rock-cut spillway is higher than that represented by the model test, this is still considered hydraulically similar. More importantly, the head, or drop to the stilling basin, is very similar, which increases the applicability of the modelled stilling basin design and performance to the rock-cut spillway design. Additional work is not required to validate the model results.

3.3 Probable Maximum Flood

NRCB Question:

The Town previously stated that the original Structure could withstand overtopping events, up to and including a probable maximum flood. The Project Update should include an assessment of the effects of a probable maximum flood on the updated Structure and Spillway design.

Town of Canmore Response:

The updated design has been assessed regarding the potential effects of overtopping in the case of a probable maximum flood (PMF). To ensure common understanding of terms, the following definitions are presented:

- The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation.
- The IDF is the flood used to design and/or modify a specific dam and its appurtenant works; particularly for sizing the spillway and outlet works, and for determining surcharge storage and height of dam requirements. It is the flood used for design of structures.

Design of a dam and water retention structure in Alberta follows the 2007 CDA Guidelines (2013 Edition) to select the appropriate IDF. It is based on the consequence classification of the structure or risk assessment.

As per SIR 164 Round 1, the Cougar Creek Structure is classified as a "Very High Consequence" structure. According to the 2007 CDA Guidelines (2013 Edition), for a very high consequence dam, the IDF to be used for design of the spillway and all flow control structures shall be 2/3 between 1/1,000 and the PMF. Northwest Hydraulic Consultants (NHC) completed the Cougar Creek PMF study in June of 2017. The calculated IDF is 370 m^3/s. This IDF was used in the original design, including the required freeboard, and designs for the spillway, stilling basin, and all flow control structures. The same IDF of 370 m^3/s is being used for the revised design.

The original design could resist overtopping events since its spillway was located on its downstream face. The revised design follows a more traditional dam design where the spillway is not located on the main embankment. However, the spillway location does not change the requirement to be able to safely pass the IDF. Both designs are therefore able to withstand the IDF, only the IDF routing is slightly different (over the spillway on the downstream face of the Structure versus over the spillway on the east abutment). The revised design includes the required freeboard to minimize the probability of the Structure overtopping by waves, at full impoundment level.

Based on the PMF hydrograph developed by NHC, the updated Structure would be overtopped if exposed to such a flood event. However, the overtopping would last for less than an hour, would have a maximum peak flow of 10 m^3/s, and a maximum flow depth of 0.2 m over the crest. Based on empirical relationships developed by the United States Bureau of Reclamation (USBR), the embankment rockfill is not expected to erode under those conditions. The Structure is therefore expected to remain stable if exposed to a PMF.

3.4 Third-party Reviews

As part of the Town's design process, Dr. Norbert Morgenstern has been engaged as a third-party reviewer throughout Project development. Dr. Morgenstern is a Professor Emeritus of Civil Engineering at the University of Alberta and an internationally recognized authority in the field of geotechnical engineering and dam safety reviews. Dr. Morgenstern has reviewed the revised

design on three separate occasions, including the final version presented in this Addendum. Supporting documentation from Dr. Morgenstern's review is included in Appendix A.

4 PROJECT COST AND SCHEDULE

4.1 Project Cost Estimates

The Town of Canmore is carrying $36.4 million (CAD) as its current cost estimate for the Project. This cost estimate is broken down as shown in Table 1. This cost estimate is based on the following inputs:

- CPL prepared a Preliminary American Association of Cost Engineering (AACE) Class 4 Cost Estimate on August 21, 2018, based on the initial concept for the revised design that CPL was proposing. A Class 4 estimate is typically used at the concept or feasibility stage of Project development and for preliminary budget approval.
- To further refine the preliminary cost estimate, Budgetary Quote Requests (BQR) were sent to five contractors on November 9, 2018. The BQRs included several drawings and descriptions of the required work. Budgetary quotes were received from four contractors.
- CPL conducted a Cost Estimate Verification on November 30, 2018. The BQRs were used to verify the preliminary cost estimates. The BQR process provided key cost and schedule information required to increase cost estimate certainty and allows for comparison between the quotes received and the preliminary cost estimate prepared by CPL.
- CPL prepared detailed AACE Class 3 Cost Estimate on August 29, 2019, based on the final design.

Table 1 Cost Estimate

Item	Cost Estimate by Item (million CAD)
Embankment Structure and Spillway	$15.5
Low Level Outlet	$7.4
Instrumentation	$0.7
Site Services & Safety	$2.8
Engineering	$4.7
Contingency + Allowances	$5.3
Total Project Cost Estimate	**$36.4**

4.2 Project Schedule

Once NRCB approval and required permits are secured, Project construction is anticipated to occur over approximately two years with the following schedule:

- Winter 2019/2020: Site preparation work is planned for the winter months. In February and March, the access road will be established and tree clearing will be undertaken. Temporary site offices and laydown areas will also be established and the contractor will mobilize to site. A temporary creek realignment, within the boundaries of the existing channel, will be established to ensure that surface water flows on the east side of the channel.

- Spring 2020: The rock-cut bench for the LLO will be excavated and the work on the LLO, intake and outlet will start. This work will take place from March to August. Once the LLO is complete, Cougar Creek will be permanently diverted through the LLO. The LLO will also serve as the flood diversion for the remainder of the construction work.

- Summer and Autumn 2020: The construction of the embankment foundation will begin once the water has been diverted through the LLO. The intent is to build the foundation and lower section of sheet pile core wall to a level slightly above creek bed.

- Winter 2020/2021: No construction is planned for the winter of 2020/2021. During this time there will be no open excavations and no equipment on site. Some material, such as rock and soil, could be stockpiled. Site security requirements will be determined by the construction contractor and the Town of Canmore but are expected to be limited (e.g., signage).

- Spring, Summer and Autumn 2021: The next phase of work will include the construction of the rock-cut spillway, upper sheet pile core wall and the embankment. This work is expected to take 24 to 30 weeks to complete. The months of April to October are currently earmarked for this work. Furthermore, landscaping rehabilitation will be initiated during this construction season.

- Summer 2022: Commissioning of the Structure can be done following the substantial completion of the construction. Landscaping maintenance, deficiency correction and general maintenance of the Structure will also be undertaken as necessary.

5 ENVIRONMENTAL ASSESSMENT REVIEW

5.1 Approach

The purpose of an EIA is to evaluate the potential environmental and socio-economic consequences of a project or activity. This evaluation is completed by identifying project activities that can interact with the human or natural environment, considering potential effects that may arise from those interactions, selecting appropriate mitigation measures to reduce potential environmental effects, and then assessing the residual effects remaining after mitigation. Effects are assessed for activities that occur for all stages of a project within defined local and regional spatial boundaries.

After mitigation is applied, resulting residual effects are rated in terms of standard effects assessment criteria (direction, magnitude, geographic extent, duration, frequency, and permanence). Effects criteria were defined in the EIA for each discipline to reflect discipline and indicator specific considerations. Professional judgment is used to synthesize the individual effects assessment criteria ratings and describe an overall environmental consequence for the effect being evaluated.

As described in Section 2, the design changes do not alter the basic design, function or location of the Structure. However, they do result in the following key changes that have implications for the environmental assessment:

- changes to the Project footprint resulting from the removal of the access road on the west abutment and addition of the rock-cut spillway on the east abutment;
- reduction in construction duration and cost;
- reduction in construction traffic; and
- changes to blasting requirements and timing.

Design changes were reviewed for each EIA component (as defined in the Project EIA Terms of Reference) to determine if the revised Project design and associated activities alter how the Project interacts with ecological or socio-economic indicators during construction or operation. If no changes in how the Project interacts with indicators was identified, no further assessment work was undertaken (Section 5.3).

For environmental and socio-economic indicators where further assessment review was warranted, design changes were reviewed (Section 5.4) to:

- identify any additional mitigation that may be required;
- re-assess the potential Project effects associated with the revised design based on the effects criteria as described in Section 5.2.7 of the EIA report and defined specifically for each indicator; and
- identify any additional monitoring that may be required.

5.2 Summary of Assessment Review

The results of this review are that for all environmental and socio-economic components, other than wildlife, the findings of the original EIA do not change. Appendix B summarizes this review by EIA component. Additional detail is provided in Section 5.3 for components not affected by design changes, and Section 5.4 for components that are affected by the design changes. Changes to the wildlife assessment are presented in Section 5.4.1.

5.3 Component Assessments Not Affected by Design Changes

As described in Section 5.1, if no changes in how the Project interacts with indicators was identified, no further assessment work was undertaken. Environmental and socio-economic components for which no further assessment was required are listed in Table 2.

Table 2 EIA Components for which No Further Assessment is Required

EIA Component	Rationale
Project Description	
Conservation and Reclamation	The Structure will incorporate reclamation and landscaping elements similar to the original design. Reclamation in No Man's Land will be conducted in accordance with AEP guidance and changes to the location and orientation of the flow control outlet and spillway have been considered in the preliminary reclamation plan.
Aquatic Environment	
Hydrogeology	The EIA findings were that groundwater levels near the Structure would be locally altered in the immediate vicinity of the Structure footprint, but that downgradient water levels and groundwater flux would re-equilibrate to pre-development conditions shortly after construction. Impacts to groundwater quality were not expected unless any upset conditions occur during Project construction (e.g. spills). The revised flow control system is still designed to allow regular flow and sediments through the Structure during normal operations; therefore, the revised design does not alter the EIA findings that the impacts to groundwater levels are low and groundwater quality are negligible in the LSA and RSA.
Hydrology	The revised design does not change the volume or rate of water passing/withheld by the Structure, nor the volume or sizes of sediment passing/withheld by the Structure, during any of the design flood events. The revised outlet orientation is also better aligned with the existing creek channel. Thus, the revised design does not change the findings of the hydrology assessment of moderate to low impacts on peak flow, peak water level, geomorphology, river hydraulics, or surface water/groundwater interactions in the LSA and RSA.
Surface Water Quality and Aquatic Ecology	The revised design does not alter any water quality parameters. The findings of the surface water quality assessment do not change. The revised design does not alter downstream sport fish habitat, sediment load, or woody debris contribution. The findings of the aquatic ecology assessment do not change.
Human Environment	
Land Use and Management	The design change does not alter the Project land use. The boundary of the disposition issued by AEP for the Project will include the final design footprint.
Traditional Land Use (TLU) and Traditional Ecological Knowledge (TEK)	No specific TEK was provided by any of the First Nations consulted on the Project and none of the First Nations who conducted TLU site visits identified any specific cultural, historical, or TLU areas associated with the Project site. The proposed footprint changes do not alter the assessment of potential effects on TLU.
Socio-Economics (other than viewshed)	The design changes reduce construction costs and increase the viability of the Project. Economic effects will be altered as less truck contracting will be required and less aggregate will be sourced from local quarries. Reduced traffic is expected to be less disruptive for local residents and recreational users. While the design changes do have an effect on socio-economic considerations, the changes are not material enough to alter the findings of the assessment.
Incidents and Malfunctions	The design intent of the Structure is the same and the risk reduction for residents and infrastructure downstream does not change. The Structure is designed to the same high standard of the CDA Guidelines for a "very high consequence dam" classification and the expected performance of the Structure does not change.

5.4 Component Assessments Potentially Affected by Design Changes

As described in Section 5.1, if potential changes in how the Project interacts with indicators was identified, further assessment work was completed to determine if the findings of the EIA have changed. Components for which further assessment was required are listed in Table 3 and described in Sections 5.4.1 to 5.4.8.

Table 3 Component for which Further Assessment was Conducted

Component	Rationale	Changes to EIA Findings
Terrestrial Environment		
Terrain and Soils	Project footprint has changed	No
Vegetation	Project footprint has changed	No
Wildlife	Project footprint has changed	**Yes**
Biodiversity	Reviewed for changes to other terrestrial disciplines	No
Human Environment		
Air Quality	Reduction in construction traffic Increase in Project blasting	No
Noise	Reduction in construction traffic Increase in Project blasting	No
Socio-Economics (viewshed)	Project footprint has changed	No
Historical Resources	Project footprint has changed	No (pending *Historical Resource Act* clearance)
Public Health and Safety	Spillway fall hazard and human access	No

5.4.1 Terrain, Soils, and Vegetation

The revised Project footprint is entirely located within the LSA used for the terrain, soils and vegetation assessments. The design changes described in this Addendum result in an increase in disturbance to vegetation and soils of less than 0.8 ha in the LSA. Upon review of the mitigation measures and assessment criteria presented in the EIA, the assessment of effects on vegetation, soils and terrain do not change as a result of the design changes described in this Addendum (EIA Tables 7.4-8, 7.4-9, and 7.4-17). Regulators expressed concerns about impacts to whitebark pine (*Pinus albicaulis*) resulting from the revised spillway location. The revised footprint remains within the boundaries of the LSA of the EIA where whitebark pine was not reported.

5.4.2 Wildlife

Potential Project effects on wildlife indicators were re-assessed as the revised design results in an increased footprint and the addition of the rock-cut spillway creates a low-permeable barrier to wildlife movement and increases the amount of blasting associated with the Project.

Wildlife Habitat Availability – The revised design will alter habitat availability relative to the original EIA with an increase in footprint of 1.38 ha for a total of 8.47 ha. The increase in footprint and change in disturbance areas will result in a small increase in high quality habitat loss for deer (-0.03 ha) and game trails (-0.53 ha) relative to the EIA findings; as well as an increase in medium

quality habitat loss for elk (-0.15 ha), deer (-0.44 ha), and game trails (-0.46 ha). High quality habitat loss will decrease for elk relative to the EIA footprint (+0.04 ha). The final ratings for habitat loss from the original EIA do not change and remains negligible as no effect on wildlife is anticipated to be discernable and no species are anticipated to lose substantial habitat (Table 4). Loss of habitat availability tables for elk, deer and game trails are included in Appendix C.

Wildlife Habitat Connectivity - The revised spillway will alter habitat connectivity by creating a low-permeable barrier to wildlife movement between the wildlife corridor and the adjacent habitat patch that is approximately 250 m long. Wildlife will be able to cross Cougar Creek upstream and downstream of the spillway but will be unable to enter or exit the spillway at any other location due to the steep slopes of the spillway walls. Due to the natural steep terrain, current movement across Cougar Creek at that location is likely low relative to the shallower slopes downstream of the spillway; however, there is uncertainty in the amount of movement on those steep slopes. The magnitude for habitat connectivity, rated as low in the EIA, is increased to medium for the LSA and RSA as there may be a detectable change in movement greater than that observed in natural variation. There is potential for habitat connectivity to be impacted greater than levels seen in natural variability and have a measurable change on movement of regional wildlife populations.

The environmental consequence rating defined in the EIA is determined by the predicted impacts of a project on the size of a regional wildlife population. With consideration for increased uncertainty and magnitude within the LSA, mitigation measures identified in the EIA and proposed mitigation associated with spillway design, the environmental consequence rating for habitat connectivity therefore increases from low to moderate within the LSA and RSA because the size of the regional populations have potential to measurably change over the life of the Project. The increase to a moderate rating is a conservative approach that takes into account the uncertainty of impacts to animal movement across the steep sloped area of Cougar Creek, which is a connection between the wildlife corridor and adjacent habitat patch.

As described in Section 2.4, without egress points along the spillway, additional mitigation related to limiting human access above the spillway and habitat enhancement is required to support habitat connectivity. Implementation of additional mitigation will be a joint effort between AEP and the Town of Canmore.

Wildlife Mortality Risk - The design change will potentially alter wildlife mortality by increasing the amount of blasting necessary to create the spillway and by potentially creating an increase in predation, or an increase in predation success at the spillway. Standard mitigation identified in the EIA will address mortality associated with blasting. The potential change in predation associated with the spillway is mitigated by preventing traps and dead ends in the design. The decrease in traffic associated with sourcing rock from the spillway will reduce potential mortality along the access road. These minor changes to mortality risk and the associated mitigation measures do not present a material change in the assessment of mortality compared to the original design. Therefore, the environmental consequence rating remains negligible for all mortality indicators and effects.

Table 4 below supersedes the EIA Wildlife Assessment Summary table (EIA Table 7.4-23).

Table 4 Revised Wildlife Assessment Summary

Environmental Indicator and Effect	Direction	Geographic Extent	Magnitude	Duration	Frequency of Occurrence	Permanence	Confidence	Environmental Consequence Rating
Habitat Availability								
Habitat Availability- LSA	Negative	Local	Negligible	Long-term	Continuous	Irreversible	Low	Negligible
Habitat Availability- RSA	Negative	Local	Negligible	Long-term	Continuous	Irreversible	Low	No impact
Habitat Connectivity								
Habitat Connectivity- LSA	Negative	Regional	**Medium**	Long-term	Continuous	Irreversible	Medium	**Moderate**
Habitat Connectivity- RSA	Negative	Regional	**Medium**	Long-term	Continuous	Irreversible	Medium	**Moderate**
Mortality Risk								
Site Clearing and Blasting	Negative	Local	Negligible	Short-term	Isolated	Irreversible	Medium	Negligible
Removal of Nuisance Wildlife	Negative	Local	Negligible	Short-term	Isolated	Irreversible	High	Negligible
Collisions with Project Vehicles	Negative	Local	Negligible	Long-term	Occasional	Irreversible	Medium	Negligible
Indirect Mortality Risk	Negative	Subregional	Negligible	Long-term	Occasional	Irreversible	Medium	Negligible

5.4.3 Biodiversity

Potential Project effects on biodiversity were re-assessed as the revised design results in an increased footprint. Indirect effects were not re-assessed as the inundation area does not change. Biodiversity indicators include both species- and ecosystem-level indicators related to vegetation and wildlife. While there may be impacts to some regional wildlife species due to the additional barrier to wildlife movement, this effect is more likely to impact species that are likely to cross Cougar Creek on the steep slopes of the canyon at the site of the spillway and have large home ranges (i.e., ungulates and carnivores).

Species Richness

The three ecosites that will be impacted by the spillway construction (ecosites b3, c2, and d1) have average-to-low species richness relative to other ecosites. There may be decreases in wildlife populations at a regional level as a result of an impact of the spillway on wildlife movement as described in Section 5.4.2. However, the areas with the highest species richness (shrubland, g2, and fen ecosites or microsites) are not anticipated to be impacted by the change in Project footprint. Additionally, the proportion of terrestrial habitat that will be disturbed will remain <0.2% of the LSA. The wildlife species likely to have movement impacted by the Project are still expected to be found in the LSA. Based on the information above, the findings of the EIA assessment of direct effects on species richness do not change (EIA Tables 7.4-31).

Rare Species or Species at Risk

No rare plant species are expected to be affected by the change in footprint. Of the ungulates and carnivores that may be impacted, only grizzly bears are listed as a species at risk (listed as Threatened in Alberta). Almost all of the natural ecosystems in the Bow Valley qualify as grizzly bear habitat. Grizzly bears are a species of management and conservation concern in the Bow River Valley and their habitat use has been tracked using telemetry data from collared individuals. Historical habitat use data indicate that grizzly bear activity is greater on the southern side of the TransCanada Highway than on the northern side coincident with the Project footprint. Grizzly bears are likely to continue using the Bow Corridor and Cougar Creek at the current low level of use. Based on the information available, the findings of the EIA assessment of direct effects on rare species or species at risk do not change (EIA Tables 7.4-31).

Habitat Area and Relative Abundance; Habitat Richness; and Habitat Diversity

Direct Project disturbances, related to the revised design, impact a small proportion of the b3, c2, and d1 ecosites and these habitats are not considered rare or species diverse (EIA Tables 7F-2, 7F-3); therefore, the findings of the EIA assessment of direct effects on habitat area, abundance, richness or diversity do not change (EIA Tables 7.4-31).

Habitat Fragmentation

The addition of the spillway will not appreciably change the number of patches or the patch size within the LSA or RSA. However, the addition of the spillway introduces a low-permeable barrier to wildlife which increases fragmentation of the landscape compared to the original design. While there may be changes to habitat connectivity, as discussed in Section 5.4.2, it is not anticipated that any of the species that currently use the RSA would stop using the area due to the addition

of the spillway; therefore, the findings of the EIA assessment of direct effects on habitat fragmentation do not change Table 7.4-31).

5.4.4 Air Quality

Project design changes alter the emission profile of the Project. Construction of the rock-cut spillway will increase the amount of blasting required for the Project; however, it will also generate large quantities of high-quality angular rock fill specifically well-suited for embankment construction. This local source of material will reduce the need to truck materials from off-site to the Project location. The amount of Criteria Air Contaminant (CAC) generated during construction of the Project was recalculated for comparison with values presented in the EIA. Operation (maintenance) phase emissions do not change. A summary of changes to the air quality assessment are provided below and details can be found in Appendix D.

Construction Equipment Emissions

CAC emissions were calculated based on the types of equipment used for construction activities and their operating durations. The original Structure design relied on significant volumes of rock and aggregate being hauled by trucks to the site from local quarries to construct the embankment. The construction of the rock-cut spillway on the east abutment will generate rock fill for the embankment and will reduce the need to truck material from off-site to the Project location.

Emissions of NO_x and $PM_{2.5}$ from construction equipment and trucks were calculated using the same approach as in the EIA (EIA Section 8.2). Total emissions were based on the type and operating durations of the construction equipment and trucks required to haul fill material to the site. As shown in Table 5, construction equipment emissions of NO_x and $PM_{2.5}$ are predicted to be lower than for the original design and construction plan.

Table 5 Emissions from Construction Equipment

Scenario	NOx Emissions	$PM_{2.5}$ Emissions
Original Design (EIA)	174,600 kg	1,843 kg
Revised Design	152,200 kg	875 kg
Difference	23,400 kg (13% reduction)	968 kg (52% reduction)

Blasting Emissions

Blasting will be required for construction of the LLO and the rock-cut spillway. For the EIA it was assumed that ammonium nitrate with 5.8% to 8% fuel oil (ANFO) would be used for blasting. However, concerns around blasting in proximity to a watercourse has resulted in changing the explosive to Powerfrac, an ammonia gelatin dynamite. ANFO has more significant NO_x emissions, while Powerfrac's NO_x emission are negligible and only $PM_{2.5}$ emissions were re-assessed. Particulate emissions were calculated using blasting emission factors from Environment Canada's *Pits and Quarries Guidance* (ECCC 2017) and blasting reference data from the *Blasting and Explosives Quick Reference Guide 2010* (Dyno Nobel 2010) as described in Section 8.2.6.4 of the EIA.

The rock-cut spillway will be the most significant blasting event resulting from the revised design and it will occur over a period of 16 weeks. Blast mats will be used for all blasts to reduce projectiles and dust. The blast engineer will minimize blast fumes using good engineering practices.

Total $PM_{2.5}$ emissions from blasting calculated for the EIA were 68 kg to clear 2,350 m^3 of rock. Total $PM_{2.5}$ emissions for the revised blasting plan are estimated to be 1,973 kg to clear 141,234 m^3 of rock. The Project blasting engineer considers this volume of blasting to be relatively small; approximately the same volume of rock, and hence a similar scale of $PM_{2.5}$ emission, as one month of blasting at the Lafarge quarry in Exshaw.

Road Dust

There will be a reduction in construction equipment (Appendix D, Table 2) required for the revised design, resulting in an overall reduction in road dust related particulate matter. As indicated in Section 6.6.4.2 of the EIA, dust will be controlled along the access road with water spraying up to four times per day. Therefore, a revised road dust assessment was not conducted.

Summary

The total NO_x emissions will decrease for the revised design over the construction phase; however, the total $PM_{2.5}$ generated by Project construction will increase due to the revised blasting plan. The findings of the EIA do not change as a result of this re-assessment of air emissions from the Project (EIA Section 8.2.10).

5.4.5 Noise

Project design changes result in a reduction of equipment use during the construction phase of the Project. Acoustical Consultants Inc. (ACI) conducted a noise impact assessment (NIA) in 2016 that used the conservative assumption of all equipment was operating at the same time. The findings of the 2016 NIA were that most receptors would only see an increase of less than 1.0 dBA from the baseline case. ACI has reviewed the revised construction plan and concluded that there should be an overall reduction in construction related noise associated with the revised design compared to the original design (Appendix E). The maintenance phase noise assessment does not change.

ACI notes in their review that while there is additional blasting associated with the revised design, the noise associated with blasting is too random and variable to accurately predict in a noise model. For this reason, blasting noise was not included as part of the 2016 NIA. Blasting procedures outlined in the EIA will minimize potential noise and vibration impacts associated with blasting.

It should also be noted that noise assessments from construction activities are not typically conducted in Alberta and there are no prescribed methods or assessment criteria within the Province. The Alberta Energy Regulator does not have blasting related noise criteria and blasting noise assessments are not typically done even for mine development with blasting occurring throughout the life of a project.

5.4.6 Socio-Economics - Viewshed

The EIA considered changes to viewshed for residents and recreational users. Since the revised design has moved the access road from the west abutment onto the Structure and now includes a rock-cut spillway separate from the Structure, the viewshed analysis has been updated. Viewsheds are the extent of the total visible area calculated from a particular location or linear feature. The updated viewshed modeling for the Project consisted of the following steps:

- CPL provided a set of contours modelling the ground surface with the surface topography of the Project.
- These contours were converted to a topography surface representative of a "bare earth" topographical model that does not include trees or buildings.
- Light Detection and Ranging (LiDAR) data was used to model trees and buildings that were then added to the "bare earth" topography.
- To create a real-world post-construction topographic model, a 2 m buffer was added to the Project footprint as a construction buffer.
- Viewsheds were calculated in ArcGIS for five receptors: three representative houses, one road and one pathway. House viewsheds were modeled at existing roof height to represent a conservative calculation. The road and pathway features were modeled at a height of 1.7 m, representing the average height of an adult (Shields et al. 2011)

This modelling technique does not take into account: climatic conditions such as cloud cover, rain, mist or fog; individual observer techniques; variations in vegetative density; or seasonal variations in vegetative cover.

Figure 3 presents the results of the viewshed analysis. The Project cannot be seen from the residential receptors on Eagle Terrace Road East or Eagle Landing East; however, a portion of the Structure and stilling basin can be seen from the residential receptor on Canyon Road North (from roof height). A small portion of the Structure can be seen from the selected pathway receptor. The Project cannot be seen from Elk Run Boulevard.

5.4.7 Historical Resources

The Project archaeologist (Lifeways of Canada Limited) reviewed the revised footprint and has recommended that no additional Historical Resource Impact Assessment work is required. In order to gain clearance for the revised footprint, Lifeways submitted a Historical Resources Application through the Historical Resource Management Branch's (HRMB) Online Permitting and Clearance system on September 6, 2019. As required by the HRMB, this application includes information on the proponent, size of the ground disturbance footprint including GIS shapefiles, maximum depth of disturbance, Project construction scheduling, and figures illustrating the area to be disturbed. Lifeways' recommendation for clearance was provided with the application along with the necessary detail describing Project components.

After review of the Historical Resources Application, the HRMB will issue correspondence either granting *Historical Resources Act* clearance outright or requiring that additional Historical

Resources Impact Assessment (HRIA) work be undertaken prior to development. Given the previous HRIA work undertaken, the clearance previously granted, and the nature of the proposed footprint revisions, Lifeways believes it most likely that the HRMB will issue *Historical Resources Act* approval for the Project to proceed without further HRIA work. The Town of Canmore will provide the NRCB with the HRMB response to the Historical Resources Application when available.

5.4.8 Public Health and Safety

The design intent of the Structure is the same and the reduction of risk for residents and infrastructure downstream does not change. The Structure is designed to the same high standard of the CDA Guidelines for a "very high consequence dam" classification.

The human health risk assessment found that over the life of the Project, air emissions from mobile equipment included in the air quality assessment are not considered to have a valid linkage to human health. Design changes result in reduced construction traffic and lower emissions than were included in the human health risk assessment; therefore, the findings of the human health risk assessment remain valid.

The rock-cut spillway creates potential fall hazard that could be accessed by the public. As noted in Section 2.4, human access will be restricted above the spillway between the Project and the existing Horseshoe Trail. The Town of Canmore will use signage, remote cameras and public communication to restrict access in the area that is included within their Project disposition. AEP will consider mechanisms to manage access outside of the Town of Canmore disposition and may also work to consolidate existing trails in the area. The Canadian Dam Association publication *Guidelines for Public Safety Around Dams* (CDA 2011) describes industry best practices, including signage requirements that the Town of Canmore will incorporate into Project operation.

6 INDIGENOUS CONSULTATION

6.1 Government of Alberta Consultation

As a mandatory activity listed in the *Environmental Assessment (Mandatory and Exempted Activities) Regulation,* the Project required an EIA pursuant to the *Environmental Protection and Enhancement Act*. Mandatory activities that require an EIA also require extensive Level 3 First Nations consultation to be completed before any Government of Alberta decisions can be made on the Project.

In accordance with *The Government of Alberta's Policy on Consultation with First Nations on Land and Natural Resource Management* (GoA 2013), procedural aspects of consultation were delegated to the Town of Canmore as the proponent of the Project. The Town has been working with the Aboriginal Consultation Office (ACO) since March 2015 to fulfill Government of Alberta consultation requirements. A Pre-Consultation Assessment, provided by the ACO on August 11, 2015, informed the Town of Canmore that all Treaty 7 First Nations were to be consulted on the Project:

- Stoney Nation (Bearspaw, Chiniki, and Wesley Bands);
- Blood Tribe;
- Piikani Nation;
- Siksika Nation; and
- Tsuut'ina Nation.

On October 1, 2015, the ACO approved the Town of Canmore Cougar Creek Debris Flood Retention Structure Project Aboriginal Consultation Plan (the Consultation Plan). This approval confirmed that the Town's Consultation Plan was consistent with the requirements outlined in The Government of Alberta's *Guidelines on Consultation with First Nations on Land and Natural Resource Management* for projects requiring an EIA. The Town of Canmore has been undertaking consultation activities in accordance with the Consultation Plan and Government of Alberta First Nation Consultation Policy and Guidelines and have provided Treaty 7 First Nations with bimonthly consultation reports for their review since November 2015 and will continue to do so until the regulatory process is complete.

The Town of Canmore continues to inform Treaty 7 First Nations regarding Project milestones, including the February 2019 Project Update. The Town of Canmore informed Treaty 7 First Nations in January 2019 that, as a result of the 2018 constructability review, design changes had been made and that a Project Update package would be forthcoming. A Project Update was sent to Treaty 7 First Nations in February by email and registered mail. To date, no Treaty 7 First Nations have expressed interest in further discussions with the Town of Canmore regarding the Project Update. This Addendum will also be circulated to all Treaty 7 First Nations, along with an offer from the Town of Canmore to answer any questions or concerns. All correspondence regarding the Project has been documented with delivery verification and will form part of the Record of Consultation that will be sent to the ACO.

6.2 Government of Canada Consultation

The Town of Canmore received confirmation from the Canadian Environmental Assessment Agency on April 21, 2015, that the Project was not a designated activity pursuant to the *Canadian Environmental Assessment Act,* 2012 and that a federal environmental assessment was not required. As a result, no federal consultation was required in relation to the provincial environmental assessment.

In October 2016 Infrastructure Canada (INFC) announced that it would provide funding for the Project and that this funding triggered a duty to consult on the Project. The INFC notification confirmed that INFC would rely to the extent possible on consultation undertaken by the proponent as directed by the GOA. After reviewing the Town of Canmore Consultation Plan that included all Treaty 7 First Nations, INFC requested that the Town of Canmore also notify the Metis Nation of Alberta and the Ktunaxa Nation.

In accordance with guidance provided by INFC on Government of Canada notification requirements, the Town of Canmore submitted notification letters in November 2016 to the Metis Nation of Alberta and to the Ktunaxa Nation through the Akisq'nuk First Nation of Windermere British Columbia and the Shuswap First Nation of Invermere British Columbia. No further action by the Town of Canmore was required by INFC. The Town of Canmore has provided INFC with consultation records for Treaty 7 First Nations up to March 2017 and will provide INFC with the final Record of Consultation when it is complete.

The Town of Canmore informed the Metis Nation of Alberta, the Akisq'nuk First Nation and the Shuswap First Nation in January 2019 that, as a result of the 2018 constructability review, design changes had been made and that additional information would be forthcoming. The Metis Nation of Alberta has updated their consultation procedures since the original Project notification was sent in November 2016 and the Town of Canmore met with the Region 3 Consultation Coordinator in February 2019 to discuss the Project. The Town of Canmore prepared a letter describing the Project status and design changes that was sent to these communities in February by email and registered mail. Correspondence regarding the Project Update has been documented with delivery verification and will form part of the Record of Consultation that will be sent to INFC.

7 REFERENCES

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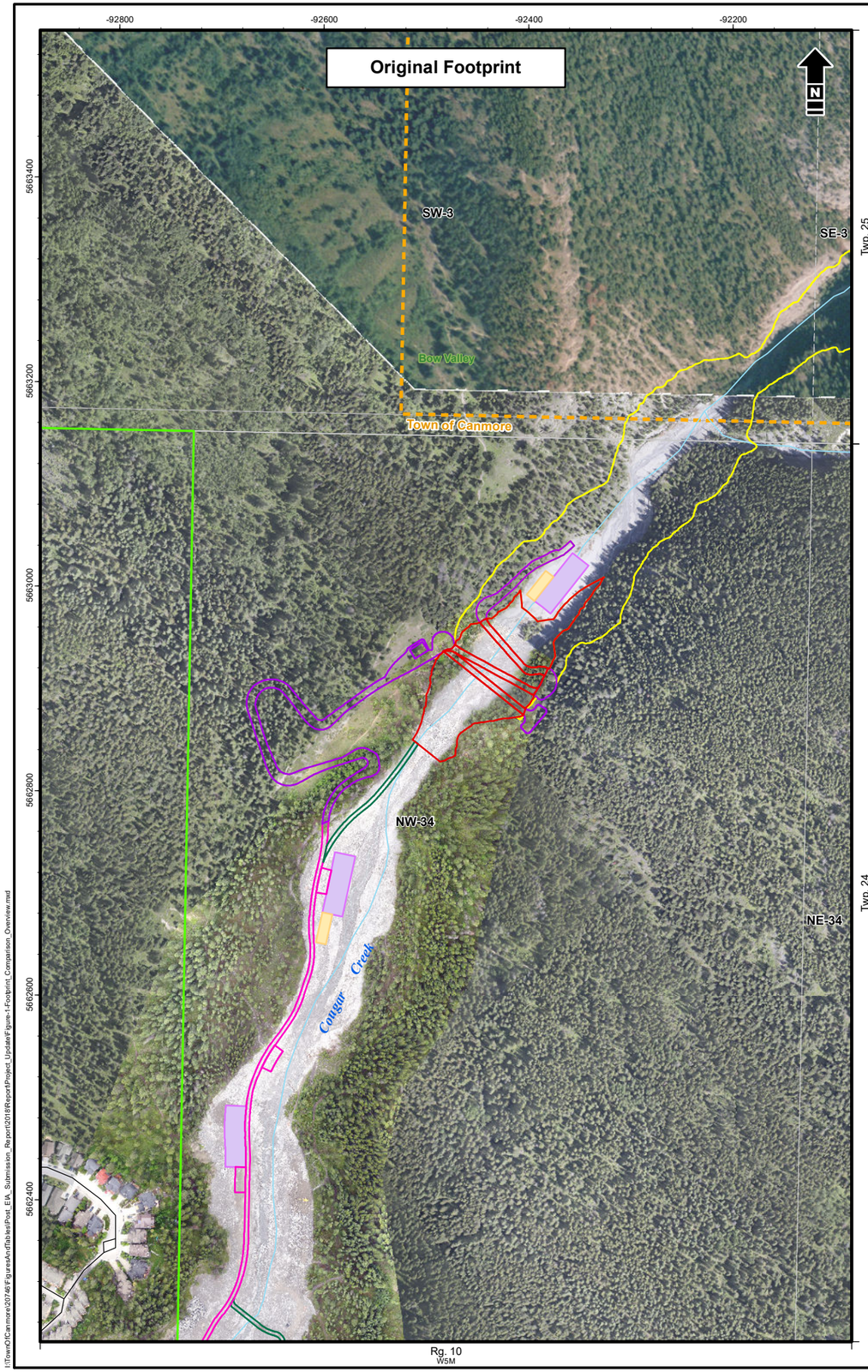

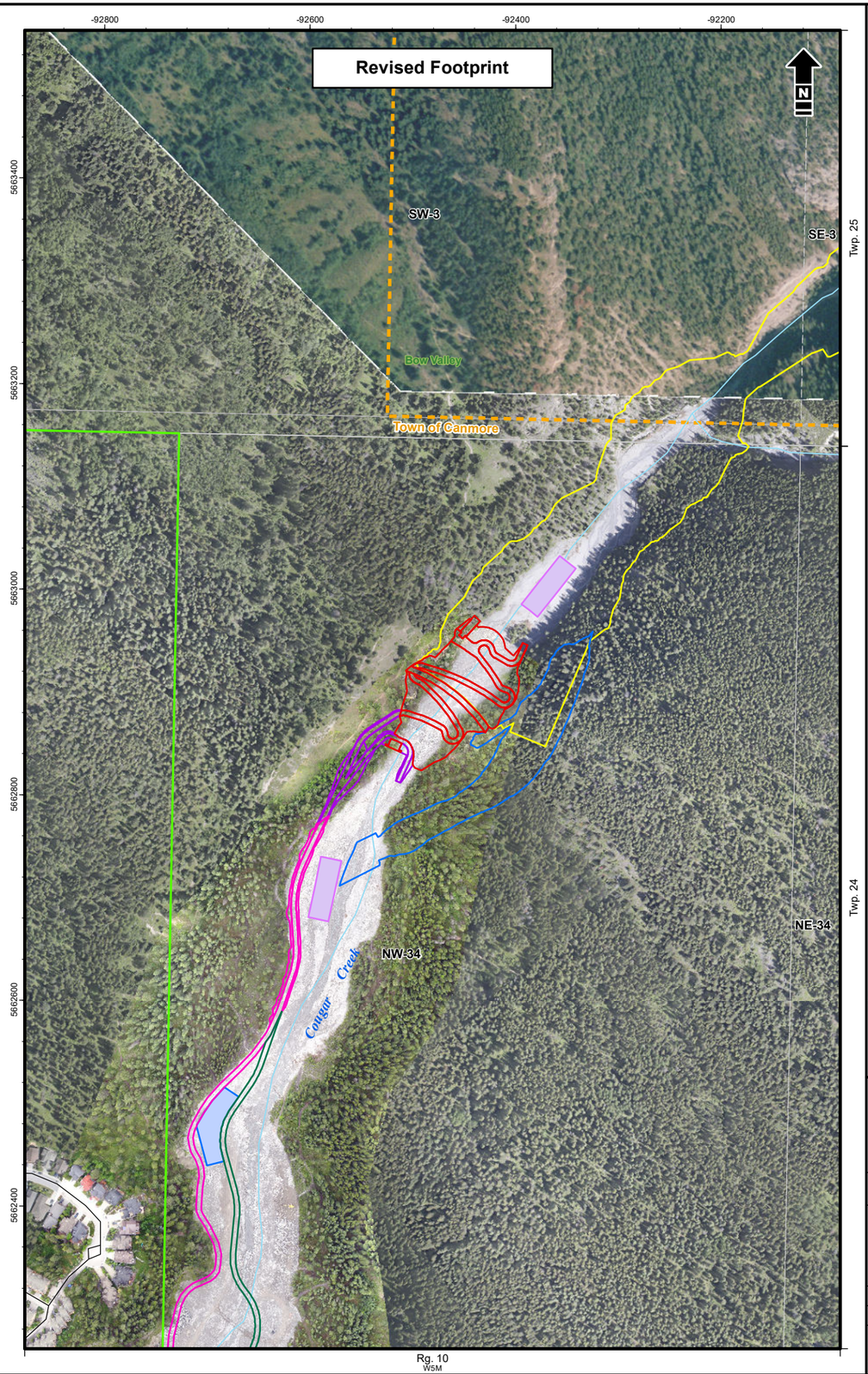

Town of Canmore Municipal Boundary
Wildland Provincial Park
Watercourse
Road

Footprint
Debris Flood Retention Structure
Access Road
Inundation Area
Spillway

Construction Footprint Areas
Stockpile
Laydown
Construction Office

Site Access
Construction
Operations and Construction

Reference: Data obtained from AltaLIS © Government of Alberta used under license. GDM transportation infrastructure data provided by IHS © 2015 used under license. Imagery (2009, 2013 and 2014) obtained from client used under license.

1:5,000

150 0 150
Metres

NAD 1983 3TM 114

Town of CANMORE

Cougar Creek Debris Flood Retention Structure

Footprint Comparison - Overview

Date: 26 Aug 2019		Project: 20746-514	
Technical: I. Trimble	Reviewer: R. Labbe		Drawn: M. Pfeifer

Disclaimer: Prepared solely for the use of the Town of Canmore as specified in the accompanying report. No representation of any kind is made to other parties with which the Town of Canmore has not entered into contract.

Figure 1

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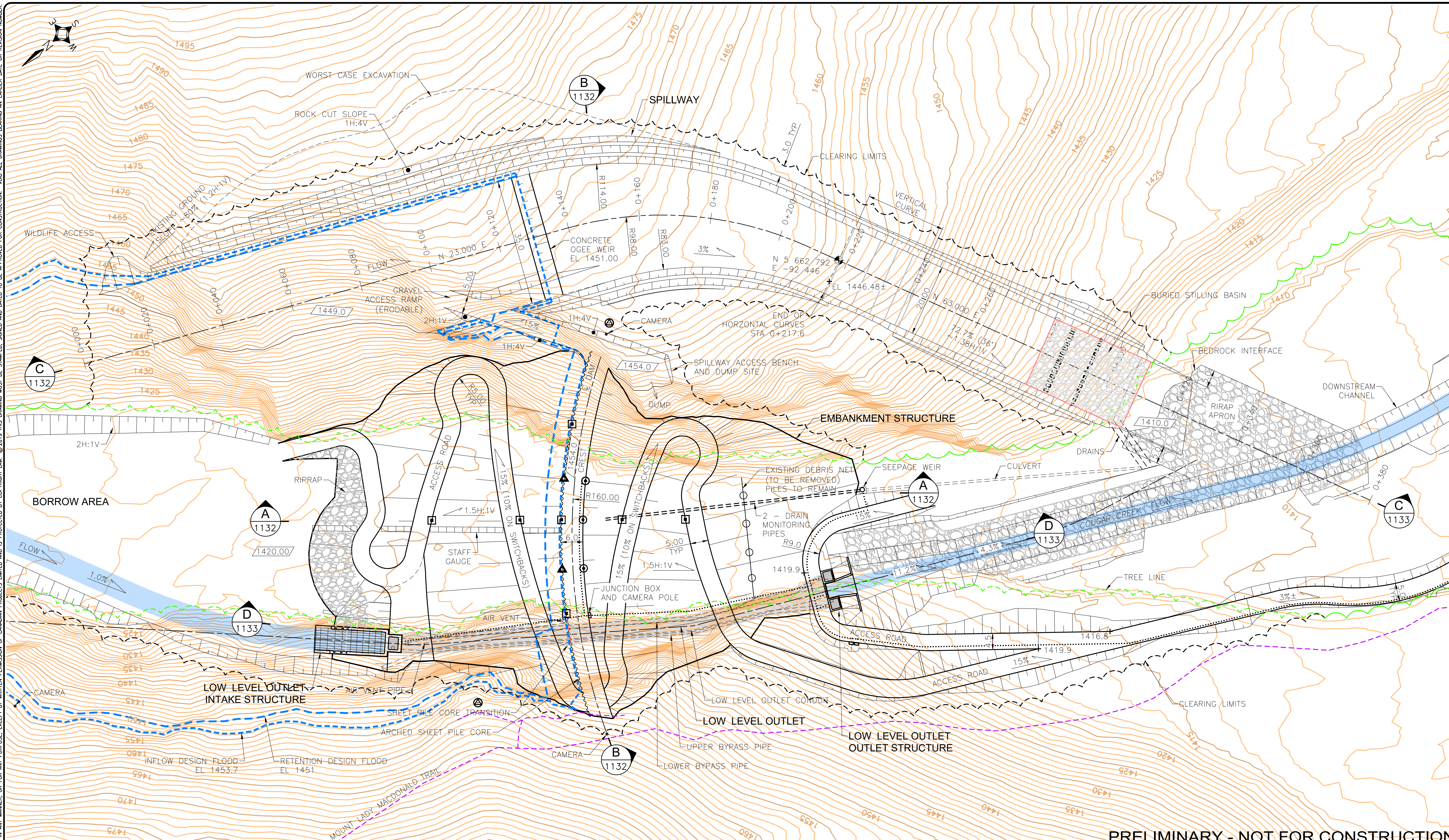


PRELIMINARY - NOT FOR CONSTRUCTION

NOTES

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. 1m INTERVAL CONTOURS CREATED BY CPL FROM DEM DATA PROVIDED BY THE TOWN OF CANMORE MAY 2018.
3. HORIZONTAL DATUM: ALBERTA NAD83; 3TM, 114°.
4. VERTICAL DATUM: CGVD28.

LEGEND

- HIKING TRAILS
- POWER/COMMUNICATION CABLES
- ELECTRIC PIEZOMETER
- SURVEY POINT
- INCLINOMETER
- SURVEY INSTRUMENT POST

SCALE 1:1 000

0 10 20 30 40 50 METRES

REV	Y	M	D	REVISION DESCRIPTION	DES	CHK	DRN	CHK
1	19	07	25	REVISED ROADS, LLO ALIGNMENT	CJW	CJW	AB	CPB

Canadian Projects Limited
A TETRA TECH COMPANY

Town of CANMORE

TOWN OF CANMORE

FIGURE 2

STRUCTURE AND SPILLWAY PLAN VIEW

PROJECT NUMBER 1093-001

CADD NUMBER 4.3.043

DRAWING NUMBER 1131

Town of Canmore Municipal Boundary
Wildland Provincial Park
Water Body
Watercourse
Road

Proposed Structure
Debris Flood Retention Structure
Access Road
Spillway
Inundation Area

Construction Footprint Area
Construction Footprint Area

Site Access
Construction
Operations and Construction
Pathway

Visible Area Of Proposed Structure
Canyon Road North
Pathway

Receptor Name
Canyon Road North
Eagle Landing East
Eagle Terrace Road East
Elk Run Boulevard
Pathway

Reference: Data obtained from AltaLIS © Government of Alberta used under license. GDM transportation infrastructure data provided by IHS © 2015 used under license. Imagery (2009, 2013 and 2014) obtained from client used under license.

1:5,000

100 0 100
Metres

NAD 1983 3TM 114

Town of CANMORE

Cougar Creek Debris Flood Retention Structure

Viewshed From Receptors

Date: 05 Sep 2019		Project: 20746-514	
Technical: I. Trimble	Reviewer: R. Labbe	Drawn: M. Pfeifer	

Disclaimer: Prepared solely for the use of the Town of Canmore as specified in the accompanying report. No representation of any kind is made to other parties with which the Town of Canmore has not entered into contract.

Figure 3

I:\Town Of\Canmore\20746\Figures And Tables\Post_EIA_Submission_Report\2018\Report\Proj ect_Update\Figure-3-Viewshed_From_Receptors.mxd

Appendix A

Third-party Review

From: Norbert Morgenstern <norbertm@ualberta.ca>
Sent: September 1, 2019 15:29
To: Felix Camire <felix.camire@canmore.ca>
Subject: Cougar Creek Project

Dear Mr. Camire,

This is to advise you that I have completed my review of the final design drawings and accompanying notes submitted by Canadian Projects Limited(CPL). I have also inspected the latest draft of the Design Basis Memorandum(DBM), recognizing that it is a work in progress. It is my understanding that an As-Built Report an OMS Manual and an EPP will also be prepared in due course.

I have assisted the Town of Canmore in a review capacity since the 2013 flood event and have been involved primarily with the following:

- review of debris flood hazard characterization
- review of Cougar Creek risk assessment
- advised on development of risk-based design criteria
- review of early structural designs
- review of dam-site characterization
- review of most recent design developed by CPL

My perspective has been from a geotechnical and related construction point of view.

Based on this background and review I support the design as presented.

I note however that the design is presented as suitable for more than 100 years. This is an acceptable statement for the DBM. However, given the function of the Project to protect a community for much longer than 100 years, it is important that the OMS Manual consider how this is to be achieved by including milestones for durability assessment and future life of facility forecasting.

I trust that this note meets your current needs.

Sincerely yours,
Norbert Morgenstern P.Eng.

--

_____
Norbert R. Morgenstern

Appendix B

Summary of Assessment Review

Appendix B Summary of Assessment Review

As described in Section 5.1 of this Addendum, design changes were reviewed for each EIA component to determine if the revised Project design and associated activities alter how the Project interacts with ecological or socio-economic indicators during construction or operation. The following table lists each EIA component and associated indicators and provides a rationale for whether or not further assessment was required. The intent of this table is to summarize the approach taken to update the EIA findings.

Component	EIA Indicators	Implications of Revised Design on Interactions with the EIA Indicators	Further Assessment Required	Rationale	Additional Mitigation Required	Changes to EIA Findings	Additional Monitoring Required
Aquatic Environment							
Hydrology	• Peak flow and water level • Geomorphology • Surface water and ground water interactions	None	No	The revised design does not change the volume or rate of water passing/withheld by the Structure, nor the volume or sizes of sediment passing/withheld by the Structure, during any of the design flood events. The revised outlet orientation is also better aligned with the existing creek channel. Thus, the revised design does not change the hydrology assessment of impacts on peak flow, water level, geomorphology, river hydraulics, or surface water/groundwater interactions in the LSA and RSA.	N/A	N/A	N/A
Surface Water Quality	• Key water quality parameters	None	No	The revised design does not alter any water quality parameters. The findings of the surface water quality assessment do not change.	N/A	N/A	N/A
Aquatic Ecology	• Sport fish habitat • Sediment load and woody debris contribution	None	No	The revised design does not alter downstream sport fish habitat, sediment load, or woody debris contribution. The findings of the aquatic ecology assessment do not change.	N/A	N/A	N/A
Hydrogeology	• Groundwater levels in Valley/Fan Aquifer • Groundwater quality in Valley/Fan Aquifer	None	No	The EIA findings were that groundwater levels near the Structure would be locally altered in the immediate vicinity of the Structure footprint, but that downgradient water levels and groundwater flux would re-equilibrate to pre-development conditions shortly after construction. Impacts to groundwater quality were not expected unless any upset conditions occur during Project construction (e.g. spills). The revised flow control system is still designed to allow regular flow and sediments through the Structure during normal operations; therefore, the revised design does not alter the EIA findings that impacts to groundwater levels are low and groundwater quality are negligible.	N/A	N/A	N/A
Terrestrial Environment							
Soils and Terrain	• Terrain • Soil quantity • Soil quality • Land capability	Project footprint has changed	Yes	The revised Project footprint is entirely located within the LSA used for the terrain, soils and vegetation assessments. The design changes described in this Addendum result in an increase in disturbance to vegetation and soils of less than 0.8 ha in the LSA. Upon review of the mitigation measures and assessment criteria presented in the EIA, the assessment of effects on vegetation, soils and terrain do not change as a result of the design changes described in this Addendum.	No	No	No
Vegetation	• Terrestrial vegetation communities • Wetlands • Riparian communities • Old-growth forests • Rare plants • Ecological communities of concern • Weeds and non-native invasive species	Project footprint has changed	Yes		No	No	No
Wildlife	• Wildlife habitat availability • Wildlife habitat connectivity • Wildlife mortality risk	Project footprint has changed Rock-cut spillway	Yes	The revised design results in an increased footprint. The addition of the rock-cut spillway creates a low-permeable barrier to wildlife movement and increases the amount of blasting associated with the Project.	Yes, As described in Section 2.4	Yes, as described in Section 5.4.2	No (already committed to in EIA)

Component	EIA Indicators	Implications of Revised Design on Interactions with the EIA Indicators	Further Assessment Required	Rationale	Additional Mitigation Required	Changes to EIA Findings	Additional Monitoring Required
Biodiversity	• Species richness • Rare species or species at risk • Habitat area and relative abundance • Habitat richness • Habitat diversity • Habitat fragmentation	Project footprint has changed Rock-cut spillway	Yes	The three ecosites that will be impacted by the spillway construction have average-to-low species richness relative to other ecosites. There may be decreases in wildlife populations at a regional level as a result of an impact of the spillway on wildlife movement. However, the areas with the highest species richness are not anticipated to be impacted by the change in Project footprint. The wildlife species likely to have movement impacted by the Project are still expected to be found in the LSA. The findings of the EIA assessment of direct effects on species richness do not change. No rare plant species are expected to be affected by the change in footprint. Direct Project disturbances, related to the revised design, impact a small proportion of ecosites and these habitats are not considered rare or species diverse; therefore, the findings of the EIA assessment of direct effects on habitat area, relative abundance, richness or diversity do not change. The addition of the spillway will not appreciably change the number of patches or the patch size within the local or regional study area. While there may be changes to habitat connectivity, it is not anticipated that any of the species that currently use the area would stop using the area due to the addition of the spillway; therefore, the findings of the EIA assessment on habitat fragmentation do not change.	No	No	No
Human Environment							
Air Quality	• Air quality	Reduction in construction traffic Increased blasting	Yes	Project design changes alter the emission profile of the Project. Construction of the rock-cut spillway will increase the amount of blasting required for the Project; however, it will also generate large quantities of high quality angular rock fill specifically well-suited for the embankment construction. This local source of material will reduce the need to truck materials from offsite to the Project location.	No	No	No
Noise	• Noise levels	Reduction in construction traffic Increased blasting	Yes	Project design changes result in a reduction of equipment use and an increase in blasting during the construction phase of the Project.	No	No	No
Land Use and Management	• Integration with land and resource use policies and management initiatives • Unique sites and special features • Surface interests • Aggregate resources • Recreation and access	None	No	The design change does not alter the Project land use. The boundary of the disposition issued by AEP for the Project will include the final design footprint.	No	No	No

Component	EIA Indicators	Implications of Revised Design on Interactions with the EIA Indicators	Further Assessment Required	Rationale	Additional Mitigation Required	Changes to EIA Findings	Additional Monitoring Required
Socio-Economics	• Regional economic context and labour force characteristics • Population in the RSA • Landowners adjacent to the Project • Housing and accommodation • Medical facilities and emergency services • Infrastructure and community services • Recreation and tourism • Traffic and transportation	Rock-cut spillway (visual resources)	Yes	There will be a view shed change resulting from removal of the road on the west abutment and the addition of a spillway independent from the Structure on the east abutment.	No	No	No
Historical Resources	Not applicable	Project footprint has changed	Yes	Revised clearance application is required for changes to the Project footprint.	Not anticipated	No	No

Appendix C

Habitat Availability Update

TABLE C1 Loss of Habitat Availability for Elk in the Local Study Area

	Habitat Area (ha)				
	Very Low	**Low**	**Medium**	**High**	**Total**
Original Footprint	5.97	0.91	0.17	0.04	7.09
Revised Footprint	7.17	0.99	0.32	0.00	8.47
Difference in Habitat Loss	-1.20	-0.08	-0.15	0.04	-1.38

TABLE C2 Loss of Habitat Availability for Deer in the Local Study Area

	Habitat Area (ha)				
	Very Low	**Low**	**Medium**	**High**	**Total**
Original Footprint	4.58	2.09	0.39	0.03	7.09
Revised Footprint	5.03	2.55	0.83	0.06	8.47
Difference in Habitat Loss	-0.45	-0.46	-0.44	-0.03	-1.38

TABLE C3 Loss of Habitat Availability for Game Trails in the Local Study Area

	Habitat Area (ha)				
	Very Low	**Low**	**Medium**	**High**	**Total**
Original Footprint	0.78	2.3	2.77	1.24	7.09
Revised Footprint	0.90	2.57	3.23	1.77	8.47
Difference in Habitat Loss	-0.12	-0.27	-0.46	-0.53	-1.38

Appendix D

Air Quality Assessment Update

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Version 1.0
September 4, 2019 Matrix 20746-514

Mr. Félix Camiré
TOWN OF CANMORE
Engineering Services
902 – 7 Ave.
Canmore, AB T1W 3K1

Subject: Cougar Creek Debris Flood Retention Structure Air Quality Assessment Update

Dear Mr. Camiré:

1 BACKGROUND

In 2016, Matrix Solutions Inc. conducted an air quality assessment in support of the environmental impact assessment (EIA) for the proposed Cougar Creek Debris Flood Retention Structure (the Project). As described in the February 2019 Project Update submitted to Alberta Environment and Parks and the Natural Resources Conservation Board, a number of design changes have been proposed to reduce Project complexity and improve the long-term serviceability of the Project. These changes to the overall design of the Project have prompted a review of the air quality assessment to understand the implications of these changes on the findings of the EIA.

2 DESIGN CHANGES RELEVENT TO THE AIR QUALITY ASSESSMENT

The revised design includes a rock-cut spillway located on the east abutment and a rock bench for the low-level outlet pipe. Construction of the rock-cut spillway will increase the amount of blasting required for the Project; however, it will also generate excavated rock for Project fill and reduce the number of trucks required to bring material from offsite. Matrix has recalculated the amount of criteria air contaminant (CAC) generated during construction of the Project for comparison with values presented in the EIA. Operation (maintenance) phase emissions do not change.

Construction timelines remain the same. This includes 12-hour shifts Monday to Friday and a 10-hour shift on Saturday (i.e., no construction on Sunday and no night-time construction). Construction will last between 2 and 2.5 years from site preparation to reclamation. In year one of construction the rock bench of the low-level outlet pipe will require blasting. Year two will include blasting of the rock-cut spillway.

3 CRITERIA AIR CONTAMINANT EMISSIONS

Construction emissions will be generated by diesel-powered equipment, rock blasting, and road dust generated on the gravel section of the road between the Bow Valley Wildland Provincial Park boundary

and the Project site (Section 4.5 of the EIA). Construction activities will be the primary sources of Project air emissions.

CAC emissions were calculated based on the types of equipment used for construction activities, their operating durations, and for blasting operations. The EIA focused on the primary emissions from construction equipment, which include oxides of nitrogen (NO_X) and fine particulate matter less than 2.5 µg ($PM_{2.5}$), and from blasting, which included $PM_{2.5}$.

3.1 Construction Equipment

The revised list of equipment needed for Project construction and material movement including estimates of the number of trips required to move materials on and off the Project site have been reduced and therefore construction phase emissions will be reduced. A comparison of the equipment included in the EIA and the equipment to be used for the design update is provided in Table 1, the main difference being the addition of an air track drill and wheel loaders.

TABLE 1 Equipment Comparison

Equipment Considered in the EIA	Equipment Considered in the 2019 Air Quality Assessment Update
Articulated trucks (CAT 730) moving material within Cougar Creek	Articulated trucks (Volvo A40) moving material within Cougar Creek
Tandem trucks bringing material from Exshaw	Tandem trucks bringing material from Exshaw
Flatbed trucks brining material from Exshaw	Flatbed trucks brining material from Exshaw
Concrete trucks bringing concrete from Exshaw	Concrete trucks bringing concrete from Exshaw
Water trucks used for dust control on the gravel road within Bow Valley Wildland Provincial Park	Water trucks used for dust control on the gravel road within Bow Valley Wildland Provincial Park
Pickup trucks transporting workers to the site	Pickup trucks transporting workers to the site
Excavators (John Deere 470 or equivalent) working at the site	Excavators (John Deere 470 or equivalent) working at the site
Excavators (John Deere 350 or equivalent) working at the site	Excavators (John Deere 350 or equivalent) working at the site
Rollers/compactors (Cat CP74B or equivalent) working at the site	Rollers/compactors working at the site
Dozers (Cat D9 or equivalent) working at the site	Dozers working at the site
Crane working at the site	Crane working at the site
Portable electric generators working at the site	Generators working at the site
Graders for constructing access roads	Graders for constructing access roads
Drill rig for preparing holes for blasting	Drill rig for preparing holes for blasting
Logging trucks for tree removal	Logging trucks for tree removal
Chainsaws for tree removal	Chainsaws for tree removal
	Air track drill (air operated) at the site
	Wheel loaders (980) working at the site

The type and duration of construction activities will vary over the construction period. This variation is accounted for as shown in Table 2, which considers power ratings and the number of 12-hour days of use of the equipment over the entire construction period. Chainsaws are a small emission source and used for a short duration.

TABLE 2 Construction Equipment, Power Ratings, and Time Period of Equipment Use Comparison

Equipment *	EIA				2019 Air Quality Assessment Update			
	Number of Units	Time (days)	Power Rating (kW)	Power Rating (hp)	Number of Units	Time (days)	Power Rating (kW)	Power Rating (hp)
Articulated Truck (Volvo A40)	4	240	242	325	4	282	350	469
Tandem Trucks	30	360	261	350	10	20	261	350
Flatbed Trucks	3	60	261	350	20	30	261	350
Concrete Trucks	10	60	302	405	5	20	302	405
Water Trucks	1	540	242	325	1	384	242	325
Pickup trucks	20	540	242	325	20	384	242	325
470 Excavator	6	360	272	365	2	282	272	365
350 Excavator	4	360	201	270	2	282	201	270
980 Wheel Loader	0	0	0	0	1	282	278	373
Rollers/Compactors	4	120	127	170	2	282	127	170
Medium Dozer	5	240	112	150	3	282	112	150
Crane	2	192	298	400	2	207	298	400
Generator	2	432	500	671	2	384	500	671
Grader	2	6	108	145	2	6	108	145
Drilling Rig	1	5	1,101	1,476	1	5	1,101	1,476
Logging Trucks	3	3	410	550	3	3	410	550
Air Track Drill (Air Operated)	0	0	0	0	2	282	201	269

* It is assumed that all equipment will run on diesel fuel.

Construction emissions for NO_X and $PM_{2.5}$ resulting from heavy equipment (Table 3) were calculated using the same approach as in the EIA. Total emissions were based on the type and operating durations of the construction equipment. United States Environmental Protection Agency (U.S. EPA) Tier 4 emission[1] factors for particulate matter and a transitional Tier 4 standard for NO_X (U.S. EPA 2017) were used. The EIA had used a transitional Tier 4 standard for NO_X emission factor of 1.9 g/kWh, this factor has been subsequently corrected to the updated value of 3.5 g/kWh.

TABLE 3 Total Estimated Criteria Air Contaminant Emissions for Equipment During the Construction Phase

Potential Equipment	Time (days)	Emission Factors[1,2] (g/kWh)		2019 Air Quality Assessment Update Emissions[3] (kg)	
		NO_X	$PM_{2.5}$	NO_X	$PM_{2.5}$
Articulated Truck (Volvo A40)	282	3.5	0.02	16,121.00	92.12
Tandem Trucks	20	3.5	0.02	2,131.50	12.18
Flatbed Trucks	30	3.5	0.02	6,394.50	36.54
Concrete Trucks	20	3.5	0.02	1,233.17	7.05
Water Trucks	384	3.5	0.02	3,794.56	21.68

[1] A set of emission requirements established by the EPA to reduce particulate matter, NO_X, and other pollutants from new, non-road diesel engines.

Potential Equipment	Time (days)	Emission Factors[1,2] (g/kWh)		2019 Air Quality Assessment Update Emissions[3] (kg)	
		NO_X	$PM_{2.5}$	NO_X	$PM_{2.5}$
Pickup trucks	384	3.5	0.02	75,891.20	433.66
470 Excavator	282	3.5	0.02	6,264.16	35.80
350 Excavator	282	3.5	0.02	4,629.03	26.45
980 Wheel Loader	282	3.5	0.02	3,201.17	18.29
Rollers/Compactors	282	3.5	0.02	2,924.81	16.71
Medium Dozer	282	3.5	0.02	3,869.04	22.11
Crane	207	3.5	0.02	5,037.69	28.79
Generator	384	3.5	0.02	15,680.00	89.60
Grader	6	3.5	0.02	52.92	0.30
Drilling Rig	5	3.5	0.1	224.79	6.42
Logging Trucks	3	3.5	0.02	150.68	0.86
Air Track Drill (Air Operated)	282	3.5	0.02	4,629.03	26.45
TOTAL		**152,229.24**		**875.02**	

1. It is assumed that all equipment will run on diesel fuel.
2. U.S. EPA 2016.
3. These are total emissions for all units of each type of equipment.

Construction emissions from the EIA were 174,600 kg and 1,843 kg for NO_X and $PM_{2.5}$, respectively.

3.2 Blasting

Blasting will be required for construction of the low-level outlet pipe and the rock-cut spillway. For the EIA it was assumed that ammonium nitrate with 5.8% to 8% fuel oil (ANFO) would be used for blasting. However, concerns around blasting in proximity to a watercourse has resulted in changing the explosive to Powerfrac, an ammonia gelatin dynamite. ANFO has more significant NO_X emissions, while Powerfrac's NO_X emission are negligible hence only $PM_{2.5}$ emissions were re-assessed and the U.S. EPA has no data regarding NO_X emissions for dynamite, ammonia. Therefore, only $PM_{2.5}$ emissions were re-assessed. Particulate emissions were calculated using blasting emission factors from Environment Canada's *Pits and Quarries Guidance* (ECCC 2017) and blasting reference data from the *Blasting and Explosives Quick Reference Guide 2010* (Dyno Nobel 2010) as described in Section 8.2.6.4 of the EIA.

The rock-cut spillway will be the most significant blasting event resulting from the revised design and it will occur over a period of 16 weeks. Blast mats will be used for all blasts to reduce projectiles and dust. The blast engineer will minimize blast fumes using good engineering practices.

The parameters used to calculate blasting emissions from the rock-cut spillway and rock bench for the low-level outlet pipe are provided in Table 4.

TABLE 4 Operating Parameters for Blasting Areas

Parameter	Rock Bench for the Low-level Outlet Pipe	Rock-cut Spillway
Volume of Rock (m^3)	11,080	130,000
Footprint (m^2)	1,750	8,740
Depth (m)	6.3	Max 8
Total Area (m^2)	1,750	16,250
Rock Processing Rate (m^3/hr)	40	60
Number of Blasts	24	186

The emissions resulting from blasting are shown in Table 5.

TABLE 5 $PM_{2.5}$ Emissions from Blasting

Year	Emission[1] from Blasting	Emission Factor for Wet Drilling[2] (kg/hole)	Aggregated Emission Rate per Day of Wet Drilling (kg/blast)	Amount of Material Discharged per Blast (kg/blast)	Maximum 1-hour Emission Rate (g/s)	Maximum 24-hour Emission Rate (g/s)	Volume of blasted material (m^3)	Total (kg)
1	Low-level Outlet	0.31	2.17	0.004	0.05	0.09	11,080	187.8
2	Rock-cut Spillway	0.31	1.86	0.005	0.04	0.08	130,000	1,249.1
							TOTAL	**1,972.6**

1. Difference in emission rates relates to differences in blast patterns and blast hole depths.
2. *Pits and Quarries Guidance* (ECCC 2017)

Total $PM_{2.5}$ emissions from blasting calculated for the EIA were 68 kg to clear 2,350 m^3 of rock. Total $PM_{2.5}$ emissions for the revised blasting plan are estimated to be 1,973 kg to clear 141,234 m^3 of rock. The Project blasting engineer considers this volume of blasting to be relatively small; approximately the same volume of rock, and hence a similar scale of $PM_{2.5}$ emission, as 1 month of blasting at the Lafarge quarry in Exshaw.

3.3 Road Dust

As there will be an overall reduction in construction equipment (Table 2) required for the revised design, there will also be an overall reduction in road dust related particulate matter. As indicated in Section 6.6.4.2 of the EIA, dust will be controlled along the access road with water spraying up to four times per day. Therefore, a revised road dust assessment was not conducted.

3.4 Summary and Conclusion

As a result of the design changes, the amount of equipment working onsite and trucking (measured in number of operating day) is significantly less than predicted in the original EIA; however, the design changes have resulted in additional onsite blasting. The predicted emissions from the new equipment profile are less than the EIA. With respect to blasting, the rock-cut spillway will be the most significant

blasting event and will occur over a period of 16 weeks, which includes drilling, blasting, and excavation of blasted material. The air quality was re-assessed to quantify emissions that will occur as a result of the design change.

Construction emissions for NO_X and $PM_{2.5}$ resulting from heavy equipment (Table 6) were calculated using the same approach as in the EIA. Total emissions were based on the type and operating durations of the construction equipment.

With respect to blasting, in the EIA's air quality assessment, it was assumed that ammonium nitrate (ANFO) would be used for blasting. While ANFO blasting does produce NO_X emissions, the NO_X emissions from blasting in the EIA were nominal. Based on concerns around using ANFO in proximity to a watercourse, Powerfrac (an ammonia gelatin dynamite) has been selected. Based on the chemical composition of Powerfrac, the production of NO_X emissions through blasting are negligible. The creation of $PM_{2.5}$ remains consistent with both kinds of blast materials and as such revised calculations for $PM_{2.5}$ emissions were re-assessed using the same methods as described in the EIA.

The total construction emissions, including equipment, and blasting for construction of the Project are shown in Table 3-6.

Table 3-6 Total CAC Emissions for the Construction Phase of the Project

Source	EIA Emissions		2019 Air Quality Assessment Update Emissions	
	Emissions (kg)		Emissions (kg)	
	NO_X	$PM_{2.5}$	NO_X	$PM_{2.5}$
Equipment	174,600	1,843	152,000	875
Blasting	25	68	-	1,920
TOTAL	**174,625**	**1,911**	**152,000**	**2,795**

The total NO_X emissions will decrease for the revised design by approximately 25,000 kg over the construction phase. The amount of $PM_{2.5}$ will increase by 884 kg due to the revised blasting plan. The Project is a similar magnitude of $PM_{2.5}$ emissions as 1 month of blasting at the Lafarge quarry in Exshaw.

The following mitigations, as described in the original EIA, will be implemented to reduce air quality impacts:

- blast mats will be used for all blasts to reduce projectiles and dust
- blast engineers will minimize blast fumes using good engineering practices
- road dust will be controlled with water as a dust suppression method

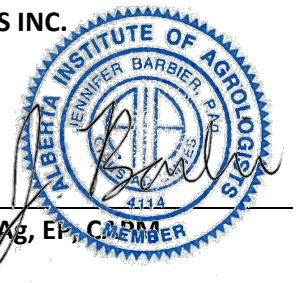
Based on the scope of the Project and duration of construction activities, the effects of emissions on the atmosphere are expected to be low in magnitude, short-term, and reversible as such there is no change to the findings of the EIA.

4 CLOSURE

We trust that this letter report suits your present requirements. If you have any questions or comments, please call either of the undersigned at 403.237.0606.

Yours truly,

MATRIX SOLUTIONS INC.



Jennifer Barbier, P.Ag, EP, CAPM
Regulatory Advisor

Reviewed by

reviewed by

Ingrid Trimble, P.Eng.
Approvals Engineer

Contributors

Colin Welburn, M.Eng., P.Eng., TSRP, Emissions Inventory Specialist, Welburn Consulting

VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V1.0	04-Sept-2019	Final	20746-514 LR 2019-09-04 final V1.0.docx	Issued to client

5 REFERENCES

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Appendix E

Noise Impact Assessment Update

aci Acoustical Consultants Inc.
5031 – 210 Street
Edmonton, Alberta, Canada T6M 0A8
Phone: (780) 414-6373
www.aciacoustical.com

To: Town of Canmore
Engineering Services
902 – 7 Avenue
Canmore, Alberta
T1W 3K1

March 20, 2019

Attn: Félix Camiré

re: Cougar Creek Debris Flood Retention Structure Noise Study Update

Dear Mr. Camiré;

In 2016, aci Acoustical Consultants Inc. (aci) conducted a noise impact assessment for the proposed Cougar Creek Debris Flood Retention Structure (the Project) and submitted a summary report (*Environmental Noise Impact Assessment For The Cougar Creek Debris Flood Retention Structure*, prepared for the Town of Canmore, July 12, 2016). Recent changes to the overall design of the Project have prompted a review of the noise impact assessment and any related changes to the assessed noise levels. It is important to note that the changes only pertain to the *Construction* phase. The *Maintenance* phase noise assessment remains the same.

In terms of the general construction activities, the timelines between the 2016 design and the 2019 design are the same with 12-hour shifts Monday-Friday and a 10-hour shift on Saturday (i.e. no construction on Sunday and no night-time construction). Relative to the 2016 design, the largest change associated with the 2019 design is the modification of the spillway and the associated additional on-site aggregate that will be available for construction of the Project. This will result in a reduction in the quantity of aggregate hauling trucks required to bring in material from off-site. Table 1 provides a comparison list between the noise sources from the 2016 design and the 2019 design. The information in the Table includes the specific noise producing equipment, the quantities proposed in the 2016 design and the 2019 design, and the relative change in noise levels associated with the change in quantity for each specific piece of equipment.

Table 1. *Construction* Phase Equipment Comparison (2016 Design vs. 2019 Design)

Equipment	2019 Design Quantity	2016 Design Quantity	Associated Noise Change (dBA)[1]
Vehicles Accessing Project Site (per day)			
Tandem Trucks	10	30	-4.8
Concrete Trucks	5	10	-3.0
Flatbed Trucks	20	20	0.0
Water Trucks	1	1	0.0
Pickup trucks	20	20	0.0
Construction Equipment At Project Site (per day)			
470 Excavator	2	6	-4.8
350 Excavator	2	4	-3.0
Rollers/Compactors	2	4	-3.0
Medium Dozer	3	5	-2.2
Articulated Truck (Volvo A40)	4	4	0.0
Generator	2	2	0.0
Grader	2	2	0.0
Logging Trucks	3	3	0.0
Crane	2	1	+3.0
Drilling Rig	1	0	N/A[2]
980 Wheel Loader	1	0	N/A
Air Track Drill (Air Operated)	2	0	N/A

With reference to Table 1, the following can be concluded when comparing the 2019 design to the 2016 design:

- There will be fewer (by a factor of 1/3) Tandem Trucks hauling aggregate to the site. These are the most dominant noise source for the residents backing onto Cougar Creek so a reduction in the quantity will result in a reduction in the associated noise impact.
- There will be fewer (by a factor of 1/2) Concrete Trucks accessing the site. These are a notable noise source for the residents backing onto Cougar Creek so a reduction in the quantity will result in a reduction in the associated noise impact.
- The other vehicles accessing the site will remain the same, resulting in no change to the associated noise levels.
- The quantities of many of the higher noise producing construction equipment at the Project site (Excavators, Rollers/Compactors, Dozers) will be reduced by factors of 1/3, 1/2, 3/5 resulting in lower associated noise levels.

[1] Note that the associated noise change values are determined based on the ratio of the 2019 design vs. the 2016 design quantities and are specific to each type of equipment. The actual differences in the overall noise levels at each receptor will also depend on other factors such as the location of the equipment relative to each residential receptor and the operating conditions, etc.

[2] A "relative" noise change from the 2016 design to the 2019 design cannot be calculated for equipment that was not part of the 2016 design. As such, the letters "N/A" are used in the table for these three specific pieces of equipment. They will, however, still result in an overall impact on the noise level as discussed in the text. Noise from these units is expected to be similar to that from excavators.

- The quantities of a number of other pieces of construction equipment (Articulated Trucks, Generators, Graders, Logging Trucks) will remain the same resulting in no change to the associated noise levels.
- There will not be an aggregate crusher on-site
- There will be two Cranes instead of one. Relative to many of the other noise sources, the Cranes are much quieter. Thus, although a second crane will add approximately +3.0 dBA to the crane related noise, overall this will have a minimal noise impact.
- There will now be one Wheel Loader, one Drilling Rig, and two Air Track Drills. Each of these items is approximately as loud as one Excavator or one Dozer. There will be eight fewer Excavators and Dozers and only four of these new items. As such, there will still be an overall decrease in noise even with the addition of the Wheel Loader, Drilling Rig, and Air Track Drills.

As a result, all other construction activities and locations being equal, there should be an overall reduction in *Construction* related noise associated with the 2019 design compared to the 2016 design.

Note also that the *Construction* phase will involve blasting at the Project location. This will generate fill material for the Project and will reduce the quantity of haul trucks accessing the site relative to the previous noise assessment. The noise associated with the blasting itself has not been quantified since such a noise source is too random and variable with too many unknowns to accurately predict in a noise model. Noise assessments from construction activities are not typically conducted in Alberta and there are no prescribed methods or assessment criteria within Alberta. The Alberta Energy Regulator does not have blasting related noise criteria and blasting noise assessments are not typically done even for coal mine blasting in Alberta (i.e. much longer duration than the blasting associated with the Project). As part of the Project, the following blasting procedures will be adhered to in order to minimize potential noise and vibration impacts associated with blasting:

- Blasting will occur only on weekdays during typical day-time hours.
- As much as reasonably possible, the blasting will be scheduled such that the blasting dates and times will be known to the area residents ahead of time in an effort to minimize the potential startle effects.
- If required, modifications to the blasting procedures can be reviewed based on residential complaints in an effort to further mitigate the impacts.

We trust the information provided is sufficient; if there are further questions, please contact us. Thank you for retaining aci for this work.

Yours very truly,
aci Acoustical Consultants Inc.,

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