REPORT

August 2016

TRANS-CANADA HIGHWAY AVALANCHE MITIGATION AT MOUNT BOSWORTH, YOHO NATIONAL PARK

Basic Impact Analysis

Submitted to:
Highway Engineering Services, Parks Canada
Government of Canada
P.O Box 900
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Golder Associates

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1.0 PROJECT TITLE AND LOCATION

Trans-Canada Highway Avalanche Mitigation – Yoho National Park – Mount (Mt.) Bosworth. The Project is located in Yoho National Park (YNP) along the Trans-Canada Highway (TCH) between kilometer (km) 83 and 85. The TCH km markers in this document are based on a station system provided by McElhanney Consulting (MCE), which is measured in km along the TCH centerline and uses the east gate of Banff National Park (BNP) as Station km 0+000.

This Basic Impact Analysis (BIA) will focus on mitigation activities for three avalanche paths on Mt. Bosworth and herein will be referred to as the Project.

2.0 PROPONENT INFORMATION

Proponent: **Parks Canada Agency**	**Gilles Lussier** **(Project Manager)**	**Phone: (403) 760-1355** **Email: Gilles.lussier@pc.gc.ca**
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3.0 PROPOSED PROJECT DATES

Planned commencement: 2017-05-01

Planned completion: 2017-09-30

4.0 INTERNAL PROJECT FILE

Lake Louise Yoho Kootenay (LLYK) Field Unit Internal Project File Number: 2016-029Y.

5.0 PROJECT DESCRIPTION

5.1 Project Justification

The Trans-Canada Highway (TCH) is a key transportation route, which facilitates use by 5 million visitors to the Mountain Parks each year, with annual average daily traffic volumes near the Project area reaching 5,762 vehicles in 2014 (BC MOTI 2014). Reliability of movement through this corridor is a priority, with a need to ensure safety and minimize delays that can lengthen travel times (Government of British Columbia 2015).

The reliability of the TCH to perform during winter is affected by avalanche risk and advance control of actual avalanches. Mt. Bosworth is located approximately 1.5 kilometers west of the boundary between Yoho and Banff National Parks on the TCH. Slide paths #3, #4 and #5 on Mt. Bosworth have historically required helicopter avalanche control work in order to maintain an acceptable level of risk for the public use of the TCH. The use of helicopters for avalanche control presents challenges, such as TCH closures when avalanche conditions are present but weather precludes helicopter flight. The objectives of the Project are to implement avalanche mitigation strategies to reduce road closures and improve winter road safety, as addressed in the *TCH Km 82 – 88 Twinning Project – Overview Avalanche Hazard Assessment* prepared by Chris Stetham & Associates Ltd in 2010, and the *TCH Avalanche Risk Management – Mount Bosworth Remote Avalanche Control System Study* prepared by McElhanney Consulting Services Ltd in 2013. Based on these studies, the appropriate course of action is to install Remote Avalanche Control Systems (RACS) on three avalanche paths on Mount Bosworth above the TCH in YNP during 2017 and to substantially reduce helicopter avalanche control work.

5.2 Project Details

The location of the three slide paths for which avalanche mitigations are proposed, as well as the staging area, are listed in Table 1. Slide paths are shown in Figure 1 (Appendix A). Footprint areas have been likely over-estimated to result in a conservative assessment. However, fine details regarding footprint locations are unknown, and will depend on the RACS system selected as well as environmental constraints identified prior to construction. Initial estimates of the distribution of RACS footprints are shown in the McElhanney (2013) Remote Avalanche Control System Study for Trans-Canada Highway Avalanche Risk Management at Mount Bosworth.

Table 1: Construction Locations along the Trans-Canada Highway

Location Description [a]	UTM Coordinates (Zone 11U)	Footprint (ha) [b]
Path 3 – North side of TCH at km 84.3	546841 E, 5701209 N	0.005
Path 4 – North side of TCH at km 84	547107 E, 5701328 N	0.005
Path 5 – North side of TCH at km 83.5	547497 E, 5701520 N	0.005
Shale Pit Staging Area at km 75.7	554782 E, 5699506 N	0.010

[a] Location of each site is approximate (mapping-level) and may be subject to change based on site conditions.

[b] Footprint area is based on information provided by McElhanney. These areas reflect full footprint extent proposed for RAC installation and not final footprint for 2017 work. Exact numbers subject to change with design finalization.

The Project is set to begin in May 2017 and be completed by October 2017. The Project schedule will be modified as required to accommodate field fitting and possible construction delays. Specific Project details broken down by Project phase are included in Table 2. A summary of Project activities is provided below.

Table 2: Summary of Project Phases and Activities

	Phases	Examples of Associated Activities	Details
Project Components	Construction / Site Preparation	Preparation of Environmental Protection Plan (EPP)	Successful contractor to prepare EPP in collaboration with Lake Louise Yoho Kootenay Field Unit (LLYK Field Unit) (which includes but is not limited to: Pollution Management, Erosion and Sediment Control, Waste Management, Equipment Maintenance and Fuel Management, Relics and Antiques, Noxious Weed Control, Protection of work limits) at least one week prior to the start of work. Vegetated buffers (i.e. around Whitebark Pine trees or stands) must be flagged prior to the start of work.
		Mobilize Equipment	Mobilize equipment to site.
		Temporary facilities	Temporary construction management facilities and staging areas (including helicopter staging) will be established in Shale Pit (km 75.7) and at the installation sites, as required.
		Supply and storage of materials	RACS will need to be designed, fabricated and shipped under tight timeframes commencing immediately after Contract Award. Based on the tight project timeline, RACS storage times will be minimal, but systems will need to be temporarily stored at the Shale Pit staging area until installation in June 2017.
		Clearing	Possible, depending on RACS installation site.
		Waste Disposal	Outside of Park
		Blasting/ Drilling	Depending on the system, the depth of bedrock and the rock quality in the slide paths, blasting may be required for foundation installation, and drilling will be required for anchors. If required, this will take place in July – August 2017.
		Excavation	Some excavation will be required for foundation installation, and will take place in June – July 2017.
		Backfilling	Minimal backfilling once concrete foundations installed with local material only.
		Use of machinery	Materials, workers and equipment will be flown in by helicopter. The use of other machinery will be at the discretion of the selected bidder and as accepted by the Departmental Representative, TBD.
		Transport of materials/ equipment	Materials, workers and equipment will be taken to the staging areas in YNP via truck, and to the work sites by helicopter.
	Operation/ Implementation Decommissioning	Waste Disposal	There will be no waste produced during the operation of the RACS, with the exception of some explosives shrapnel. The RACS will likely be replaced at the end of their design life rather than decommissioned.
		Maintenance	Occasional maintenance will be required in the off-season, and will be performed in the slide path or at highway level depending on the type of RACS. Maintenance will be performed by Parks Canada Agency (PCA) staff unless a maintenance contract is negotiated with the supplier.
		Use	During the design life of the RACS, each RACS will be controlled remotely and will provide explosions in specified locations on command in order to trigger controlled snow avalanches when the TCH is closed, and avoid sudden uncontrolled snow avalanches onto the open highway.
		Use/Removal of temporary facilities	Upon completion of the construction (September 30, 2017), the temporary facility at highway level and at the installation sites will be removed by the Contractor.

Preparation of staging areas will be minimal, with use of existing cleared areas within Shale Pit at km 75.7 proposed for the highway level staging of materials and equipment. The staging area at ridgeline is in alpine terrain and is not anticipated to require tree or vegetation clearing. At most, some minor leveling may occur to prepare a safe helicopter landing area. A survey for unexploded ordinances in the Project area must occur to ensure a safe work environment. The slide paths themselves may require some scaling to mitigate overhead rock fall hazard for workers prior to commencing the work. Depending on which RACS system is selected, different depths and extents of excavation, drilling, anchor installation, rock bolting, rock grouting, and forming and pouring reinforced concrete foundations will be required prior to installation.

The dimensions of structures, size of excavation, area of disturbance, and fill requirements will depend on the selected RACS, and the geotechnical conditions of each location. However, the maximum extent of the footprint for each unit of an RACS system is estimated to be no more than 50 m2 or 0.005 ha, per structure which includes temporary workspace (Table 1). The potential RACS systems and associated footprints are outlined below.

Gazex

- Anchors will be drilled approximately 2.0 m deep in sound rock.
- Each exploder has two reinforced concrete foundations (total footprint is approximately 5 m^2) and the exploder is attached to both.
- Each exploder has gas lines running to it from a shelter which is built above the slide path on even ground free of rock fall hazard.
- Each shelter can service multiple exploders.
- A central gas shelter provides propane and oxygen by pipeline to Gazex exploders, which detonate the mixture of propane and oxygen gasses in a galvanized steel cylinder.

Wyssen Towers and Avalanche Guard

- Anchor depths and extents of excavation will depend on rock quality.
- The footprint of base plate is approximately 1 m x 1 m for one tower.
- Wyssen Towers and Avalanche Guard are pre-armed, secure explosive magazine systems.

Given the remote setting, all workers, equipment and materials will be flown in by helicopter. The number of helicopter flights required for construction will vary depending on the selected RACS system, but are estimated to be between 70 and 90 flights. All installations will take place on steep, rocky slopes, so the use of equipment will be limited, and hand methods will be employed wherever possible. Each system is powered by a solar panel and battery system. No system will require changes to existing utilities or drainage directions.

All loading and maintenance is to take place once per year prior to the start of the avalanche season. None of the systems require road closures during seasonal maintenance and only Wyssen has a seasonal installation component. This involves reloading the deployment box at or near highway level, and long-lining the deployment box back to the permanently installed tower. Short road closures may be required when long-lining the deployment box back to the tower in the fall before avalanche season begins as the explosives within the box are armed prior to flying. Each system shall be loaded with sufficient consumables to perform the necessary avalanche control for an entire season. Systems will be unloaded at the end of the season. Suppliers are required to train PCA staff to monitor, maintain and reload the systems. The TCH will be closed when RACS are detonated but the closures will be short as planned control work will result in small avalanches that should not reach the highway. Over the longer term, better avalanche control and more timely detonation should reduce demands on staff and highway infrastructure.

6.0 VALUED COMPONENTS LIKELY TO BE AFFECTED

Golder conducted desktop searches for background information pertaining to components that have the potential to be directly or indirectly affected by the Project and associated activities. Sources searched include the following:

- BIA Trans-Canada Highway Rock Slope Reprofiling 2015 Works (PCA 2015a);
- BIA Vegetation Removal for 2015 Trans-Canada Highway Rock Reprofiling (PCA 2015b);
- BC Conservation Data Centre Species and Ecosystems Explorer (BC CDC 2015);
- Parks Canada Agency Biotics Web Explorer (PCA 2013);
- BC Ministry of Environment Habitat Wizard (BC MOE 2012);
- BC Ministry of the Environment Fisheries Information Summary System (FISS) database (BC MOE 2009);
- Government of Canada Species at Risk (SAR) Public Registry (Environment Canada 2016); and
- Data provided by the LLYK Field Unit.

Information obtained during the background search was used to identify valued components (VCs) with potential to be affected by the Project, and that would therefore be carried forward in the BIA for further analysis. Rationale for the inclusion or exclusion of an environmental component as a VC is provided in the sections below.

Valued Components with potential to be affected by the Project were identified through the Effects Identification Matrix (Appendix B). The selection of VCs was based on the following criteria:

- the sensitivity or vulnerability of the VC;
- the uniqueness or rarity of the VC;
- the value attributed to the VC by stakeholders and Aboriginal communities;
- recognition of the importance of a VC by a statute, policy, regulation, or court;
- risks to the health, safety or well-being of people;
- the likelihood to affect visitor experience; and
- the likelihood of an indirect effect on an associated VC (i.e., a link exists between the affected VC and another VC, such as water quality affecting fish habitat).

Those VCs that met a minimum of one of these criteria were carried forward through the impact analysis for the Project. A summary of VCs and the rationale for their selection is presented in Table 3 and discussed in the following section.

Table 3: Valued Components and Selection Rationale

Valued Component		Rationale for Selection
Vegetation	Whitebark Pine	■ Regulatory requirement: potential adverse effect on federally listed (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] [Environment Canada 2016]; *Species at Risk Act* [SARA] [Environment Canada 2016]) or provincially listed plant species of management concern (BC CDC 2015). ■ Potential implications to species and community level biodiversity.
Wildlife	Migratory Birds	■ Federal Regulation - *Migratory Birds Convention Act* (GoC 1994). ■ Project activities may occur during the nesting period for migratory birds, and may result in incidental take. The LSA is within migratory bird nesting zone A3, in which the general nesting period is April 14 to August 19 (ECCC 2016a). ■ Project has the potential to alter habitat. ■ Potential implications to species and community level biodiversity.
	Grizzly Bear	■ Adaptable and tolerant of anthropogenic disturbance; potential for habituation and human-wildlife conflict (e.g., encounters and human-caused mortality). ■ Locally abundant with regular occurrence in YNP.
	Wolverine	■ Sensitive to anthropogenic disturbance. ■ Likely to occur regularly in low densities in YNP.
	Mountain Goat	■ Regular occurrence in YNP. High density of historical observations between km 85 and km 85.5, which overlaps with the mineral licks at km 85.4 and 85.4 in the Mount Bosworth area. ■ Likely to be present in the high alpine where construction activities will occur.
Terrain and Soils	General	■ Ecosystem conservation concern; importance to ecosystem diversity and interrelation with other components (e.g., effects of sedimentation on surface or groundwater, fisheries, vegetation).
Cultural Resources	General	■ Potential for impacts on the Kicking Horse Pass National Historic Site. ■ Historical resources may exist in the Project area and may be disrupted by construction activities. ■ Consideration of potential Aboriginal and public concern.
Visitor Experience	General	■ Potential to improve reliability of traffic movement along the TCH. ■ Natural aesthetics and overall visitor experience may be affected by the Project. Potential to improve visitor safety.

Spatial boundaries define the geographic extents within which the potential environmental effects of the Project are considered and are used to define the study areas for the BIA. The description of environmental setting and assessment of potential Project effects on the VCs considers the following defined study areas:

- Project footprint: 0.025 ha or 250 m^2
- Local Study Area: 358 ha

The Project footprint, associated with construction and operation of the Project, assesses the potential direct effects of the Project on the local environment while the Local Study Area (LSA) was established to assess the potential, largely indirect effects of the Project within the broader, regional context. The LSA is composed of slide paths 3, 4 and 5 plus a 500 m buffer extending east and west along the slope (Figure 1).

6.1 Aquatic Resources

The water features within the LSA include Sink Lake and tributaries to Sink Lake that range in size from small, undefined drainages, to defined watercourses. Sink Lake is located on the south side of TCH at the bottom of the avalanche slide paths. Because of a lack of watercourses or other water features in proximity to the RACS installation locations and the use of an existing disturbed area for the staging area, there are no anticipated direct effects to aquatic resources as a result of the Project; therefore, aquatic resources have not been selected as a VC for the impact analysis.

6.2 Vegetation

On June 23, 2016, Golder conducted a helicopter reconnaissance visit to document site conditions within the LSA with a focus on high-elevation sites where construction is likely to occur. A detailed vegetation inventory focusing on RACS installation locations, helicopter landing sites, and on-site staging locations was not possible because these sites will not be determined until final Project design, and safety issues associated with the steep terrain made access difficult at proposed Project footprint areas. Vegetation species were documented to the extent possible from the helicopter and during limited ground surveys.

Vegetation Communities

The LSA is located primarily in the in the Engelmann Spruce Subalpine Fir (ESSF) biogeoclimatic zone (312 ha or 87% of the LSA), with a small portion in the Interior Mountain-heather Alpine (IMA) biogeoclimatic zone (46 ha or 13% of the LSA) (BC MOFR 2011) (Figure 1).

The ESSF biogeoclimatic zone is generally located in elevations above the MS biogeoclimatic zone at elevations from about 1,500 to 2,300 masl in southeast BC. Topography is mountainous, often steep, and rugged. Vegetation of the biogeoclimatic ESSF zone is typically dominated by Engelmann Spruce (*Picea engelmannii*) and Subalpine Fir (*Abies lasiocarpa*). At lower elevations, trees such as Western White Pine (*Pinus monticola*), Douglas Fir (*Pseudotseuga menziesii*), Western Hemlock (*Tsuga heterophylla*) and Western Red Cedar (*Thuja plicata*) occur occasionally. The understory vegetation of the ESSF biogeoclimatic zone consists of species such as White-flowered Rhododendron (*Rhododendron albiflorum*), Black Huckleberry (*Vaccinium membranaceum*) and Oval-leaved Blueberry (*Vaccinium ovalifolium*) (Steen and Coupé 1997). On less productive sites, low-growing shrubs such as Crowberry (*Empetrum nigrum*) and Dwarf Blueberry (*Vaccinium caespitosum*) are common (Steen and Coupé 1997). Within the LSA, the ESSF biogeoclimatic zone transitions from sparsely vegetated areas with dwarf and low-species observed in the IMA biogeoclimatic zone, to forested stands dominated by Engelmann spruce and Subalpine Fir.

The IMA zone is found at high-elevations beginning at 1,800 in the north of BC and 2,500 m in the dry south (BC MOFR 2006). The IMA portion of the LSA includes vegetation typical of the IMA biogeoclimatic zone and includes patches of spruce (*Picea* sp.), Subalpine Fir and Whitebark Pine (*Pinus albicaulis*) in lower elevations. Higher elevation areas are sparsely vegetated with patches of dwarf and low-growing species such as White Mountain Avens (*Dryas octapetala*), sedge species (*Carex* sp.) and lichen species.

Invasive plant species (weeds) were not observed during the field visit in high-elevation areas. Parks Canada has documented three occurrences of invasive plant species (weeds) within the LSA in low-elevation disturbed areas along the TCH. These include two occurrences of Common Tansy (*Tanacetum vulgare*) and one of Hound's Tongue (*Cynoglossum officinale*) (Figure 1). Invasive plant species can out-compete native species and reduce biodiversity (Dukes and Mooney 2004). Invasive plant species may be spread by construction equipment and other vehicles carrying seeds or plant propagules from other work sites.

There may be losses of vegetation communities associated with RACS construction, which would result in a reduction of terrestrial vegetation communities. The Project also has the potential to affect the successional stage of vegetation communities along the three avalanche paths within the LSA. Plant species present in avalanche paths are often similar to those found in the surrounding landscape, but the communities differ in composition and structure because succession is continuously stalled by the disturbance regime and soil moisture is higher, favoring shade-intolerant species and shrubs and herbs over trees (Bebi et al. 2009; Quinn and Phillips 2000). The Project is not anticipated to have a substantive effect on vegetation communities. Spatially, the RACS footprints are anticipated to be small (i.e., 0.005 ha each; Table 1), will occur in sparsely or un-vegetated areas and will require no or very limited amounts of vegetation removal. Avalanche control for the three avalanche paths within the LSA is currently conducted by helicopter. Although operations of the Project will increase the frequency of avalanche control, this is not anticipated to result in changes to the successional stage of avalanche path vegetation communities.

Listed Plant Species

Golder queried the Parks Canada Biotics Explorer (PCA 2013) and the BC Species and Ecosystems Explorer (BC CDC 2015) to identify listed ecological communities or plants species that have been previously identified or have the potential to occur in the LSA. Listed plants and ecological communities are defined as meeting one or more of the following criteria:

- listed on the BC Red or Blue List (BC CDC 2015);
- assessed as 'Special Concern', 'Threatened', or 'Endangered' by COSEWIC (Environment Canada 2016); or
- listed as 'Special Concern', 'Threatened', or 'Endangered' under SARA (Environment Canada 2016).

Occurrences of Red- or Blue-listed ecological communities have not been previously identified in the LSA (BC CDC 2015). Two federally listed species, Whitebark Pine and Limber Pine (*Pinus flexilis*), are known to occur within YNP (Table 4). However, the LSA is located above the Limber Pine elevation range and there have been no documented occurrences of these species within the Project area. This species was not selected as a VC.

Prior to the June 23, 2016 reconnaissance survey, Whitebark Pine had only been documented to the west of the LSA (BC CDC 2014) but was expected to occur within the LSA. The presence of this species was confirmed in and around the LSA during the reconnaissance survey. From the helicopter, Whitebark Pine was observed in patches with other tree and shrub species along the tree line (Figure 1) but could not be confidently distinguished from other tree species below the tree line. Although the high-elevation, exposed areas above the tree line were generally un-vegetated and had poorly developed soil (i.e., low-quality habitat conditions), there is the potential for individual Whitebark Pine trees to occur in these areas. A single seedling was observed at the edge of a proposed helicopter landing site at the summit of Path 5 (Figure 1). Because of the potential for Whitebark Pine to be within the Project footprint, this species was selected as a VC and carried forward to the effects analysis.

Critical Habitat (CH) is an area that is important for the conservation of listed species and contains habitat features that may require special management or protection. At the time of writing, a federal recovery strategy for Whitebark Pine is in development, but the definition of CH for this species has not yet been finalized. Habitat that will be affected by the Project is low suitability for Whitebark Pine, as RACS installation will occur above the elevational range of Whitebark Pine, and staging will occur below the elevational range in areas that are already disturbed.

The RACS footprint locations in and around slide paths 3, 4 and 5 are outside of areas where Ecological Land Classification (ELC) data (Appendix A, Figure 1) identify Whitebark Pine as a forest stand component. However, Whitebark Pine may sporadically occur. Therefore, Whitebark Pine was selected as a VC and carried forward to the effects analysis.

Table 4: Federally Listed Plant Species in Yoho National Park

Common Name	Scientific Name	COSEWIC Status [a]	SARA [a]	Habitat [b]	Potential for Presence in Project Footprint
Limber Pine	*Pinus flexilis*	Endangered	Endangered	Warm, dry sites on the lower portions of the mountains and foothills at elevations approximately 850 to 1900 masl. They generally exist on southerly or westerly aspects and gentle to steep slopes.	Nil – poor quality habitat within the LSA and not observed during field reconnaissance.
Whitebark Pine	*Pinus albicaulis*	Endangered	Endangered, Schedule 1	From high-elevation krummholz forests to lower elevations as part of mixed and/or closed subalpine forests. Present at elevations ranging from approximately 1,950 to 2,250 masl, and occasionally at lower elevations.	Low- Project RACS footprints will be above the tree line and above upper elevational limit of Whitebark Pine, although individual trees may occur. Shale Pit staging area will be below the lower elevational limit of Whitebark Pine in an area that is already disturbed and the footprint will not result in additional vegetation disturbance.

[a] COSEWIC – Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2010; COSEWIC 2014); SARA = *Species at Risk Act* (ECCC 2016b)

[b] COSEWIC 2010; COSEWIC 2014

A detailed vegetation inventory was not possible because of uncertainty associated with locations of RACS as well as safety issues associated with steep terrain in the LSA. A summary of listed plants with potential to occur in the LSA was compiled based on known habitat associations (Appendix C Table C-1). This summary is not intended to be an exhaustive list of all possible listed plants that could be in the LSA, but rather was intended to help identify listed species with potential to occur in the LSA that could be affected by the Project footprints. However, the footprints of the RACS are anticipated to be small and will occur in sparsely or un-vegetated areas. Therefore, other than Whitebark Pine, listed plant species have not been selected as a VC for the impact analysis.

6.3 Wildlife and Wildlife Habitat

The LSA occurs primarily in the ESSF biogeoclimatic zone, with a small portion in the IMA biogeoclimatic zone. The ESSF and IMA biogeoclimatic zones offer a variety of habitat types that are attractive to many wildlife species. Areas disturbed by avalanches and fires often have regenerating shrubby berry crops, and dense herbaceous vegetation that attract Grizzly Bears, American Black Bears and Moose during the spring and summer months. Other ungulates such as Mountain Goat, Elk and Deer (*Odocoileus* spp.) may be found in some areas. Other mammals, including American Marten and Wolverine (*Gulo gulo*), in addition to seed-eating birds such as Red Crossbill (*Loxia curvirostra*), White-Winged Crossbill (*Loxia leucoptera*), Pine Siskin (*Carduelis pinus*) and Clark's Nutcracker (*Nucifraga columbiana*) can be found in coniferous forests in the ESSF biogeoclimatic zone (Meidinger and Pojar 1991).

Habitat within the LSA is altered by the TCH, adjacent Canadian Pacific Railroad (CPR), and the Shale Pit. With the exception of those disturbed areas, habitat is relatively intact and characterized by coniferous forests and avalanche paths in upland sites. Habitats are diverse within the LSA and include abundant denning opportunities for small mammals, and wildlife trees for nesting birds and roosting bats.

Golder compiled a list of species of management concern that have been previously identified or have the potential to occur in and around the Project footprint by querying the Parks Canada Biotics Web Explorer for regularly occurring species in YNP (PCA 2013), the BC Species and Ecosystems Explorer (BC CDC 2015), and data supplied by LLYK Field Unit staff. The background search revealed that a total of 10 species of conservation concern occur or have the potential to occur in the LSA, including one amphibian species, five bird species, and four mammalian species (Appendix C; Table C-2). Of those, the neotropical migratory birds, Common Nighthawk and Olive-Sided Flycatcher (*Contopus cooperi*), are listed as Threatened on Schedule 1 of SARA (ECCC 2016b). In addition, Little Brown Myotis (*Myotis lucifugus*) is listed as Endangered on Schedule 1 of SARA (ECCC 2016b). No other wildlife species with potential to occur in the LSA are SARA-listed as Threatened, Endangered or Extirpated. Species or species groups selected as wildlife VCs for the Project are those that are of conservation or management concern, have a moderate or high potential of occurring within the LSA and have potential to be affected by the Project (Table 5). These wildlife VCs have therefore been selected to be carried forward to the effects analysis.

Table 5: Wildlife Valued Component Species and Species Groups and their Potential to be Affected by the Project

Common Name	Scientific Name	COSEWIC Status [a]	SARA [a]	Regularity within YNP [b]	Population [c]	Potential for Project Interactions
Birds						
Migratory Birds	n/a	n/a	n/a	Regular	Breeding	High – potential habitat within the LSA, which may be impacted by the Project.
Carnivore/ Furbearer						
Grizzly Bear	*Ursus arctos*	Special Concern	No Schedule	Regular	Year-round	High – documented in LSA. Habitat is known to be present in the LSA, and may be impacted by the Project due to sensory disturbance during construction. Some small-scale vegetation clearing may occur. Potential for wildlife-human conflict associated with food sources.
Wolverine	*Gulo gulo*	Special Concern	n/a	Regular	Year-round	Moderate - documented in LSA, habitat is known to be present in the LSA and may be impacted by the Project due tosensory disturbance during construction.
Ungulates						
Mountain Goats	*Oreamnos americanus*	n/a	n/a	Regular	Year-round	High – documented in LSA. Habitat is known to be present in the LSA, and may be impacted by the Project.

[a] **COSEWIC** - Committee on the Status of Endangered Wildlife in Canada; **SARA** - *Species at Risk Act* (Environment Canada 2016).

[b] **Regular** - Occurrence of the Element is consistent in the LSA (e.g., it may migrate in and out of the area, but it returns on a regular basis). **Accidental/Nonregular** - The Element does not persist or return regularly in the LSA. **Unknown/Undetermined** - Regularity of the Element in the LSA has not been, or cannot be, determined.

[c] **Year-round** - A significant proportion of individuals of the Element are non-migratory or remain in the LSA throughout the year. **Breeding** - Individuals of the Element occur in the LSA as part-time (seasonal) residents when breeding, and they are not year-round residents in any significant numbers. **Nonbreeding** - Individuals of the Element occur in the LSA as part-time (seasonal) residents when not breeding, and they are not year-round or breeding season residents in any significant numbers. **Transient** - Individuals of the Element are long distant migrants that regularly occur.

Amphibians

Western Toad is federally listed as Special Concern on Schedule 1 of SARA and has potential to occur in the LSA, although use has not been documented. Project construction and operations activities will occur on steep slopes above the treeline for the RACS and in the currently disturbed Shale Pit Staging Area. No amphibian habitat is present in the areas proposed as locations for the Project footprints, and amphibians are unlikely to be affected by Project construction and operation. Therefore, amphibians have not been selected as a VC for the impact analysis.

Migratory Birds

Several species of migratory birds, some of which are of conservation concern (Appendix C, Table C-2), may use the Project footprint for breeding, nesting and foraging and may therefore be directly impacted by small-scale vegetation clearing and ground disturbance associated with Project construction. Migratory birds utilize a range of habitat types for foraging and breeding. Vegetation clearing and ground disturbance due to Project construction activities may result in limited direct habitat loss for some migratory bird species, and has the potential to result in the destruction of nests, eggs, and young birds if construction occurs during the general migratory bird nesting season (i.e., April 14 to August 19 for nesting zone A3 [ECCC 2016a]).

Of the migratory birds that have potential to occur in the LSA, Common Nighthawk and Olive-sided Flycatcher are listed as Threatened on Schedule 1 of SARA. No other migratory birds with potential to occur in the LSA are SARA-listed as Threatened, Endangered or Extirpated. Olive-sided flycatcher is a forest dwelling species and is not likely to be affected by the Project, as construction activities will occur above the tree line and within the already disturbed Shale Pit. Common Nighthawk is a ground nesting bird that could potentially interact with the Project in or around the Shale Pit. Barn Swallow and Black Swift are not listed by SARA, but are listed by COSEWIC as Threatened and Endangered, respectively. Barn Swallow are not likely to interact with the Project, although Black Swift forage and breed at high elevations and do have potential to interact with the Project. Although there are differences in habitat associations and the likelihood of Project interactions, Project impacts to migratory birds in the LSA can be effectively generalized for the purposes of conducting the impact assessment. Therefore, migratory birds as a group have been selected to be carried forward to the effects analysis.

Bats

Little Brown Myotis is federally listed as Endangered on Schedule 1 of SARA and is likely to occur regularly in the LSA. Areas likely to be affected by Project construction and operations activities are on steep slopes above the treeline for the RACS and in the currently disturbed Shale Pit Staging Area. Bat roosting habitat or hibernacula is not likely to be present in areas proposed as locations for the Project footprint, and therefore bats are unlikely to be affected by Project construction and operation. Bats have not been selected as a VC for the impact analysis.

Carnivores/ Furbearers

Grizzly Bears are capable of occupying a diverse array of habitats and exploiting a wide range of food resources (Mace et al. 1999). Avalanche slopes are used by Grizzly Bear as important foraging areas in spring and summer months (Ramcharita 2000). Studies of grizzly bear denning habitat in the Central Rockies Ecosystem around Banff show that grizzly bears prefer to den in Upper Subalpine habitats, where they excavate their dens on steep slopes, most often choosing slopes between 30 and 38° (Vroom et al. 1980). Grizzly Bears have been frequently observed in the LSA (Appendix A, Figure 2). The Project may have some limited potential to reduce Grizzly Bear habitat, as well as result in impacts due to sensory disturbance (i.e., helicopter flights during construction). In addition, human food and garbage present during construction activities have the potential of attracting bears to the area. Bears that become conditioned to human foods or that persist in areas where humans frequent may have to be destroyed. Grizzly Bear has been selected to be carried forward to the effects analysis.

Wolverine can be found within a wide range of habitats within GNP, including in the vicinity of the Project sites. Wolverines typically utilize a wide variety of forested and alpine habitats and exist at low populations densities within large home ranges. Krebs and Lewis (2000) observed that the upper elevation ESSF biogeoclimatic zone is preferred for wolverine denning sites. Avalanche slopes have been documented as important forage habitat for wolverine as food sources because of winter avalanche kill (e.g., large mammals such as mountain goat and moose), as well as summer use by hoary marmots, which are important summer prey (Krebs et al. 2007). Avalanche slopes provide suitable denning habitats for wolverine and depth of spring snow pack is considered a key habitat feature (i.e., deep enough to provide protection and thermodynamic stability for kits) (Magoun and Copeland 1998). The Project may have some limited impacts on Wolverine habitat, and may also result in impacts due to sensory disturbance. Wolverine has been selected to be carried forward to the effects analysis.

Ungulates

In the northern Rocky Mountains, Mountain Goat spend the majority of their time on steep slopes and rocky cliffs in alpine and subalpine habitats from 1,500 to 2,700 m in elevation (Smith 1977; Côté and Festa-Bianchet 2003). Mountain Goats require access to escape terrain, which restricts their movement to relatively small, fixed home ranges (McFetridge 1977; Chadwick 1983). Mountain Goats are considered intermediate browsers, and will consume a variety of forage (Saunders 1955; Laundré 1994). Avalanche slopes provide foraging opportunities for Mountain Goats in the spring, summer and fall (Festa-Bianchet and Côté 2007). In winter, Mountain Goats concentrate their activities in areas such as avalanche chutes, where high winds reduce snow cover and allow easier access to food. Mountain Goats have been observed at a number of locations in the LSA at Mount Bosworth, as well as at mineral licks near km 85.3 and km 85.4 (Appendix A, Figure 2).

The Project may have some limited impacts on Mountain Goat habitat, and may also result in impacts due to sensory disturbance (i.e., helicopter flights during construction). Mountain goats in the Mount Bosworth area currently coexist with the existing helicopter-based avalanche control activities on Mount Bosworth. However, Mountain Goats are adversely affected by disturbance from helicopters (Côté 1996). Helicopter disturbance within 500 m of Mountain Goats has been shown to cause the animals to move >100m in greater than 85% of the individuals studied (Côté 1996). Although noise associated with avalanche control should decline after construction of the Project (i.e., fewer helicopter flights than currently occur during the winter avalanche season), construction may result in a temporary increase in sensory disturbance to mountain goats. Mountain Goats have been selected to be carried forward to the effects analysis.

6.4 Terrain and Soils

Soils and non-soil surficial materials occupying the upper slopes of the Project are generally derived from calcareous sedimentary parent material (Coen and Kuchar 1982). Non-soils consist of surficial materials, bedrock or coarse colluvial materials, with unconsolidated materials less than 10 cm in depth that do not support plant growth. Where soil development has occurred, they are typified by thin (<50 cm), well drained, weakly developed, medium to coarse textured profiles with high percentages of coarse fragments occurring throughout the soil stratum. Soil type is influenced by slope position and percentage, climate, and vegetation type. Within the upper Subalpine and Alpine, soils are generally classified as Regosols (Coen and Kuchar 1982).

The Project is located on avalanche paths that are characterized by steep, rocky, rugged mountain slopes that receive heavy snowfalls. Gravitational erosion and climatic systems, patterns and events such as wind, precipitation and avalanches are primary factors responsible for influencing the slopes on which the Project Sites are located. The Project will require the construction of footings for the RACS, which is anticipated to affect terrain and/or soils. Because Project activities may affect soils and/or terrain characteristics during construction, terrain and soils will be carried forward to the effects analysis.

6.5 Air Quality

Existing anthropogenic impacts to air quality in YNP are mainly a result of vehicle traffic along the TCH, which include heavy-duty and light-duty diesel and gasoline vehicles. Railway emissions also have a limited contribution to decreased air quality within YNP. Overall, the concentrations of emissions are located along the TCH corridor (Province of British Columbia 2015; Air Emissions [1 km Grid]).

The Project is anticipated to have a limited, incremental contribution to air quality during construction. These effects will be primarily associated with machinery, helicopters and dust produced by excavation and blasting. During operation/maintenance phases, although car and truck use is not expected to change relative to existing conditions, helicopter use is likely to decline because helicopters will no longer be used for active avalanche control for these sites. Therefore, air quality has not been selected to be carried forward to the effects analysis.

6.6 Cultural Resources

The LSA is within the Kicking Horse Pass National Historic Site (NHS), which follows the railway corridor from Field, BC to Lake Louise, AB. This NHS '*retains a strong sense of place, inspiring views and intact cultural resources that connect people to the history and cultural landscape of the historic railway corridor*' (PCA 2007). The Project is not anticipated to affect existing viewscapes or otherwise affect the quality of the Kicking Horse Pass National Historic Site.

Parks Canada has completed an extensive inventory of cultural resources, including archeological remains within Yoho National Park (PCA 2007). The Project is anticipated to avoid all known historic sites and is not anticipated to have an effect on cultural resources. A formal Archeological Overview Assessment (AOA) was deemed to not be necessary by the Archaeology and History Branch of PCA for this Project (Langemann 2016). The Archaeology and History Branch of PCA communicated that there are no archaeological or historical resources at high elevations recorded from Mount Bosworth. Furthermore, no archaeological resources have been identified from the proposed staging areas, which have been surveyed in the past (Langemann 2016). The Project is not anticipated to materially affect the Kicking Horse Pass NHS or cultural resources; therefore, cultural resources have not been selected to be carried forward to the effects analysis.

6.7 Visitor Experience

High quality visitor experience has been identified as a priority for Yoho National Park (PCA 2008). Visitor experiences vary widely, from those who seek solitude and adventure in back-country experiences, to those who seek good opportunities for driving and sightseeing at popular front-country attractions (PCA 2008). Visitor experience has been considered in relation to the Project for the following indicators: traffic pattern changes, and natural aesthetic. Changes in these two indicators are expected to have an effect on visitor experience. It is a priority of PCA to provide for reliable movement along the TCH in Yoho National Park by maximizing highway safety and minimizing delays that can lengthen travel times (Government of British Columbia 2015). The reliability of transportation along the TCH during winter is affected by avalanche risk at Mount Bosworth and avalanche control activities. Mount Bosworth has historically required avalanche control work by helicopter with associated temporary closures, to maintain an acceptable level of risk for the public use of the TCH (McElhanney 2013). Traffic patterns along the on the TCH across YNP, between Lake Louise, AB and Golden, BC are highly seasonal. July and August are considered peak season, receiving higher volumes of traffic than the rest of the year. The construction phase of the Project will require temporary traffic control for construction operations when lane closures are required, leading to disruptions in traffic flow and increased travel times through the park during the peak season. The operations phase of the Project will improve highway safety and reliability along the TCH and improve visitor access to YNP.

Sight-seeing and appreciation of natural aesthetics is a major attraction to YNP (PCA 2010). The construction phase of the Project will require machinery on Mount Bosworth and at Shale Pit, which may affect the viewscape within YNP. Helicopters will be required during initial Project construction, and will be used for maintenance of the RACS in subsequent years. Helicopter noise may also negatively affect visitor experience.

Because Project construction has the potential to affect traffic flow and natural aesthetic, visitor experience has been selected to carry forward to the effects analysis.

7.0 POTENTIAL EFFECTS

For this BIA, potential effects were analyzed with the information available at the time of writing (i.e., June 28, 2016) and based on professional judgment. Effects were characterized using parameters such as direction (positive, negative or neutral), expected magnitude (e.g., negligible to high), geographic extent (i.e., spatial extent of the effect), duration/ reversibility (i.e., reversible in the short-term to permanent effects), frequency (i.e., number of times the effect happens per unit time) and probability (i.e., likelihood the effect will happen) (Appendix D).

The effects analysis considers the possible interactions between the Project infrastructure components and activities and the VCs within the identified spatial boundaries, prior to the implementation of mitigation measures. Project interactions may be direct (e.g., as a result of small-scale vegetation clearing and ground disturbance for the Project affecting a VC), or indirect (i.e., as a result of a change to one VC affecting another VC). Potential effects of the Project on the VC are determined by comparing the existing conditions to those that are expected to result from the implementation of the Project.

A preliminary identification of potential Project interactions was undertaken to focus the assessment on the issues of key importance (Appendix D). The interactions identified in the matrix were used to focus the description of the effects analysis (Section 7) and mitigations (Section 8). All relevant Project activities were analyzed individually to determine if there was a plausible mechanism for an effect on each VC during normal Project conditions. The analyses were based on professional judgment and experience of the BIA team.

Potential effects of the Project on VCs are described in the paragraphs below and are summarized in Table 6. A determination of the significance of these effects after the implementation of mitigation is provided in Section 10.

Table 6: Potential Project Effects

Valued Components	Measurement Indicator	Project Phase	
		Construction/ Installation	Operation/ Maintenance
Vegetation	Whitebark Pine	Change in Whitebark Pine abundance due to loss of individuals	None
		Change to Whitebark Pine habitat quantity and/ or quality due to ground disturbance	None
		Change in Whitebark Pine abundance due to increased invasive plant species	None
Wildlife	Migratory birds	Change in habitat quantity and / or quality due to small-scale vegetation clearing, ground disturbance and sensory disturbance	Change in habitat quality due to sensory disturbance during maintenance activities
		Reduction in migratory bird abundance due to small-scale vegetation clearing and ground disturbance during the nesting period	None
	Carnivores/ Furbearers - Grizzly Bear	Change in habitat quality due to sensory disturbance	Change in habitat quality due to sensory disturbance during maintenance activities
		Change in bear abundance due to human-bear encounters	None
	Carnivores/ Furbearers - Wolverine	Change in habitat quality due to sensory disturbance	Change in habitat quality due to sensory disturbance during maintenance activities
	Ungulates - Mountain Goats	Change in habitat use as a result of sensory disturbance	Change in habitat quality due to sensory disturbance during maintenance activities
Terrain and Soils	Change in soil quality through compaction and erosion	Change in soil quality through compaction, erosion, and contamination by spills	Change in soil quality though erosion and sedimentation.
Visitor Experience	Loss of natural aesthetic	Temporary loss of natural aesthetic appeal during construction	Improved traffic flow
	Traffic pattern changes	Increased wait times associated with road closures during construction	None

7.1 Vegetation

A qualitative approach was used to assess the potential effects of the Project on Whitebark Pine. Project activities have the potential to affect vegetation during Project construction and operation phases (Table 6).

Site preparation and ground disturbance associated with RACS installation, and on-site staging may contribute to limited losses of Whitebark Pine individuals that may be present within the Project footprint. Generally, Project activities are anticipated to occur in high-elevation, steep rocky areas above the tree line and above the upper limit of Whitebark Pine habitat; however, individual occurrences may exist within these areas. The potential effect on Whitebark Pine individuals is anticipated to be negligible magnitude and local, because occurrences are not anticipated in high elevation areas associated within the small Project footprint and staging will occur in areas that are below the elevation range of the species in areas that are already disturbed; however, any losses are considered permanent and continuous through operations.

Stand replacement by avalanches within the range and elevational limits of Whitebark Pine in Canada may result in open canopy conditions that facilitate Whitebark Pine regeneration (Arno and Hoff 1989). In the absence of avalanche mitigation, avalanche slide paths 3, 4 and 5 on Mt. Bosworth would not be effective regeneration habitat for Whitebark Pine because they would naturally have high intensity, stand-initiating avalanches at a frequency that would be too high to provide sufficient opportunities for Whitebark Pine to develop. Outside of the Project footprint, avalanche mitigation on Mt. Bosworth has likely improved regeneration opportunities for Whitebark Pine by reducing avalanche intensity and allowing seedlings the opportunity to mature. Using RACS will not have an adverse effect on Whitebark Pine or Whitebark Pine habitat relative to existing (i.e., baseline) conditions, in which avalanche mitigation is already occurring using helicopters. Project footprints and staging areas will occur in areas that are low suitability habitat for Whitebark Pine because they are outside the elevational range of the species, and in areas where vegetation is sparse or absent. These potential effects associated with the Project footprint on Whitebark Pine habitat will be negligible in magnitude and local, because the effects would be restricted to the small Project footprint. However, potential effects are considered permanent and would be continuous through operations.

Invasive species brought in during Project activities may have an adverse effect on Whitebark Pine abundance. Project activities including the movement of machinery or equipment from and to the site, ground disturbance and vegetation clearing could introduce invasive plants to the LSA. Although the high-elevation habitat associated with the Project footprint is low-quality habitat for invasive species, fast-growing invasive plants can reduce soil moisture and nutrient availability, and colonize the post-construction landscape to the detriment of slow-growing Whitebark Pine seedlings. Invasive plant species brought in during construction could remain within and adjacent to existing disturbance, and effects on Whitebark Pine abundance would be local. Therefore, during construction and operation of the Project a low magnitude potential effect is predicted, and effects on community composition would be long-term and continuous.

7.2 Wildlife and Wildlife Habitat

Project activities have the potential to affect wildlife during Project construction and operation phases (Table 6).

Migratory Birds

The Project has the potential to have a negative effect on migratory bird habitat quantity and quality and abundance due to ground disturbance and small-scale vegetation clearing associated with the installation of RACS. There is potential for ground disturbance and the small-scale vegetation clearing that may occur to result in the loss of nesting and foraging habitat for several species of migratory birds; ground and shrub nesting birds above treeline are those with the greatest potential to be affected. There is also potential for sensory disturbance, which may lead to displacement from suitable habitat during construction. Given the small size of the proposed footprints, the Project has the potential to have localized effects on the species and individuals with territories near the project footprints. These individuals may move to unaffected adjacent habitats.

Migratory birds are highly mobile and adults can typically avoid interactions with Project activities that could result in direct mortality. However, the Project has the potential to result in the destruction of nests, eggs, and young birds if construction occurs during the general migratory bird nesting season (i.e., April 14 to August 19 for nesting zone A3 [ECCC 2016a]).

Vegetation clearing and ground disturbance associated with the Project is considered to be permanent habitat loss; therefore, effects to migratory bird habitat quantity and quality are expected to be permanent, although the potential effect of increased avian mortality would be short-term. These potential effects would be low magnitude and local in extent because of the relatively small size of the project footprints.

The operations phase of the project is not likely to have an effect on migratory birds.

Carnivores/ Furbearers

The potential effects of the construction phase of the Project on Grizzly Bear habitat due to the small-scale vegetation clearing that may occur are minimal, although sensory disturbance (e.g., helicopter traffic) may deter Grizzly Bears during construction and maintenance activities. The presence of food and garbage also have the potential of attracting bears to the Project area because of the species' opportunistic nature. This may increase the potential for vehicle-bear collisions related to traffic on the TCH. Bears that become conditioned to human foods or that persist in areas where humans frequent may have to be destroyed. Once construction is complete, the Project will no longer have an effect on bears within the LSA. Potential effects on bears are expected to be local, short term and moderate in magnitude prior to the application of mitigation.

The project will not substantively change the frequency of avalanches in the LSA; therefore, the vegetation composition of the avalanche slopes are not expected to materially change from existing conditions. Grizzly bears are likely to continue to use the avalanche slopes as preferred foraging habitat in the summer months. The operation phase of the Project is not anticipated to have an effect on Grizzly Bears.

If present when construction activities are occurring, Wolverine use of alpine habitat in the vicinity of the project footprints will be reduced as a result of sensory disturbance due to localized construction activity and associated helicopter traffic. During operations, sensory disturbance due to maintenance activities are likely to intermittently reduce habitat quality for Wolverine in the LSA. Potential effects on wolverines are expected to be local, short-term and moderate in magnitude prior to the application of mitigation.

Ungulates

The Project has the potential to have a negative effect on Mountain Goats in the Mount Bosworth area during construction. Small-scale vegetation clearing may occur, which may result in the direct loss of foraging habitat on the project footprints for Mountain Goats. Mountain goat habitat use in the vicinity of the project footprints will be reduced because of localized construction disturbance and associated helicopter traffic. During the operation phase of the Project, Mountain Goats will be affected by sensory disturbance associated with the periodic helicopter flights to service the RACS. Potential effects on Mountain Goats are expected to be local, short term and moderate in magnitude without mitigation. Planned mitigations will reduce the likelihood and severity of adverse effects.

7.3 Terrain and Soils

The Project has the potential to have a negative effect on soils and terrain, through an increase in erosion, and sedimentation prior to the implementation of mitigation measures. Erosion risk in the Project area may increase through ground disturbance associated with site preparation ahead of and during construction. Minimal vegetation clearing is anticipated because vegetation cover in the Project area where RACS installation will occur is naturally low and sporadic in occurrence. However, disturbance of the non-soil surficial materials and low growing forb and graminoid species on the thin soils that are present has the potential to increase erosion and sedimentation downslope. A reduction in soil quality also may be associated with compaction and spills during the construction phase of the Project. The long and sometimes steep slopes within the LSA will increase erosion potential within construction areas where exposed soil and construction materials are present. Erosion potential is determined by:

- rainfall and runoff;
- soil erodibility (i.e., texture, structure, permeability);
- slope length and gradient;
- vegetation cover; and
- erosion control mitigations.

Therefore, the Project has the potential to have a low magnitude, local and long-term effect on soil quality primarily associated with erosion and sedimentation without mitigation. Potential changes to soil quality would be continuous though construction and persist through operations until any cleared areas, if required, in the construction areas are revegetated and stabilized.

7.4 Visitor Experience

During construction, there will be temporary effects on visitor experience through a temporary loss of natural aesthetic within the LSA and temporary traffic delays. Visibility of construction equipment and materials at the Shale Pit and on Mount Bosworth are expected to be limited because all construction sites have limited visibility from the TCH and heavily used visitor areas. The effect has the potential to be low in magnitude, local, short term, and likely to occur. During operations, the natural viewscape will not be impacted because the RACS are relatively small compared to their surrounding landscape, and will be inconspicuous along the skyline. Anticipated effects to natural aesthetic are predicted to be small and will primarily be associated with noise disturbance during construction (i.e., equipment and helicopters).

Temporary traffic delays to accommodate equipment mobilization, construction or demobilization may affect visitor experience. The predicted effect of this Project in conjunction with other planned construction projects along on the TCH may result in a cumulative impact to visitor experience because of multiple highway delays within the Parks road system. Although the construction period will occur during peak visitor season, few road closures will be required. Operations of the Project will likely have a positive impact on visitor experience and public safety by reducing TCH closures in the long term as a result of improved avalanche mitigations.

7.5 SARA-listed Species Summary

Two SARA listed species and/or associated habitat could be associated with the Project: Whitebark Pine and Common Nighthawk. Adverse residual effects are not anticipated for either Whitebark Pine or Common Nighthawk, provided mitigation measures identified in Section 8 are followed.

Paragraph 83(1)(a) and subsection 83(2) of the SARA provide that under specific circumstances, the protection of human beings can take precedence over the protection of listed species to the extent that the decision-maker determines and is able to demonstrate that:

- the proposed activities contravene SARA prohibitions;
- the activities are necessary for the protection of public safety;
- they are or could be authorized by or under another Act of parliament; and
- in making the decision, the decision maker respects the purposes of SARA to the greatest extent possible.

As currently proposed, an exemption under Subsection 83(1) and 83(2) will not be required for the Project. However, an exemption may be appropriate if Project plans are altered, or depending on the definition of Whitebark Pine CH once the recovery strategy for that species is finalized.

All negative impacts as a result of the Project are considered to be minor and primarily associated with construction and therefore, short-term. Where Project effects cannot be avoided, mitigations will be applied and are discussed in Section 8.

8.0 MITIGATION MEASURES

In general, the Parks Canada Best Management Practices for Ordinance Detonation in Mount Revelstoke and Glacier National Parks (PCA 2015c) and Sections 1, 2, 4, 7 and 9 of the Parks Canada National Best Management Practices: Roadway, Highway, Parkway and Related Infrastructure BMP (PCA 2015d) will be applied. Mitigations to reduce Project effects have been compiled considering the BMPs (PCA 2015d) and Project effects and Project requirements. Mitigation measures are either general in that they apply to more than one VC, or specific to an individual VC.

8.1 General Mitigations

The Contractor is required to prepare an Environmental Protection Plan (EPP) in accordance with Parks Canada Environmental Procedures and submit it two weeks prior to the initiation of construction for review and approval from the Environmental Assessment (EA) department. The EPP will outline:

1) Details on how the work limits will be marked and procedures to limit operations small, defined boundaries to minimize damage to vegetation and soil.

2) A Vegetation Management Plan will be prepared and implemented to minimize the potential for Whitebark Pine to be damaged or removed due to the Project (Section 8.2). Pre-construction field surveys will identify and flag any Whitebark Pine individuals in the work area for avoidance during construction. Removal or damage to Whitebark Pine is prohibited at all sites.

3) A Spill Response Plan will be prepared and will detail the containment and storage, security, handling, use and disposal of empty containers, surplus fuels or other hydrocarbon products to the satisfaction of the Departmental Representative and LLYK ESO and in accordance with all applicable federal and provincial legislation. The Spill Response Plan will include a list of products and materials to be used or brought to the work site that are considered or defined as hazardous or toxic to the environment. Such products may include, but are not limited to fuels and lubricants. The Material Safety Data Sheets (MSDS) for all chemicals used will be made available on- site. Appropriately sized and stocked spill kits will be on site capable of dealing with 110% of the largest potential spill. All Contractor's staff must be aware of their location(s) on site and must be trained on spill response procedures. Pumps, tanks and generators must have secondary containment capable of holding 110% of the stored volume.

4) An Emergency Response Plan that outlines procedures to follow in the case of an emergency (e.g., wildlife encounter, equipment malfunction/failure, fire).

5) A Fire Prevention Plan which describes the fire prevention equipment (e.g., fire extinguishers) and procedures on-site in the event of a fire. Should a fire occur, Banff Dispatch and the Fire Duty Officer must be notified immediately.

6) The Contractor will ensure that works are completely contained such that deleterious substances (e.g., sediment, spills or leaks) will not be released into the environment, through the following procedures:

   a) To prevent spills, helicopter fueling will not occur at the Project Sites; instead it will take place either at an impermeable roadside staging area or at the helicopter base.

   b) Prior to use on the Project sites and during daily use, equipment and fuel lines will be inspected for leaks and structural integrity, and inspections will be recorded. Any detected leaks will be addressed immediately, and spills over 5 L or any spill quantity in water are to be reported to Banff Dispatch and the LLYK Environmental Surveillance Officer (ESO) immediately.

   c) Hazardous or toxic products (e.g., fuels, lubricants) will be stored no closer than 100 m from any watercourse.

   d) Any absorbent materials used in spill clean-up or soils contaminated by a spill will be disposed of in the appropriate facilities and transported in accordance with the Transportation of Dangerous Goods Regulations.

7) All equipment will be stored either on the road or on previously hardened surfaces in order to avoid trampling roadside vegetation and compaction of soils.

8.2 Vegetation

8) The Contractor will control/restrict the spread of invasive plant species within the construction and staging areas through the following procedures:

   a) A cleaning station will be set at the primary staging area to remove soil and plant material from vehicles and equipment before being moved. The cleaning station will be inspected, photographed, documented, and approved by the Field Unit, where possible and appropriate, during setup and prior to entry/exit. Materials removed from the vehicles and equipment, and the water used for cleaning will be collected and disposed in a manner dictated by the LLYK field unit.

   b) Construction staff and others entering the Project site will be required to scrape mud off their boots and brush seeds and dirt from their clothing before entering the Project site.

   c) Discussion about sites of concern where special attention must be paid to invasive species control will take place between the contractor and the Field Unit before work commences.

9) Once siting is finalized and prior to construction, Qualified Environmental Professionals will conduct a site survey to confirm Whitebark Pine individuals will not be affected by proposed Project footprint. During this field survey Whitebark Pine individuals in the work area will be identified and flagged for avoidance during construction. The proposed RACS have small footprints and there is flexibility for placement of these structures; therefore, it is expected that impacts to Whitebark Pine can be avoided through adjusted placement of the structures. Removal or damage to Whitebark Pine is prohibited at all sites. Any damage or mortality that occurs during operations/maintenance must be documented and reported to the LLYK Field Unit to develop a mitigation plan.

10) Workers will be educated on the importance of protecting Whitebark Pine and associated mitigation measures.

8.3 Wildlife and Wildlife Habitat

11) Where practicable, the small-scale vegetation removal that may be required should occur outside of the general migratory bird nesting period, which is April 14 to August 19 in the LSA (Zone A3; ECCC 2016a). Where removal of vegetation cannot occur outside of this restricted activity period, and if directed by an Environmental Surveillance Officer (ESO), pre-clearance nest surveys should be conducted by Qualified Environmental Professionals with an appropriate level of experience identifying migratory birds and migratory bird nesting behaviour. Should active nests be detected during surveys, consultation will occur with LLYK Field Unit staff to determine the appropriate course of action, which may include species-specific setback distances until nestlings have fledged. Most migratory birds, their nests and eggs are protected under the Migratory Birds Convention Act, 1994 (MBCA) (Government of Canada 1994). As vegetation and ground disturbance will occur above the treeline or in the already disturbed Shale Pit, habitat is relatively simple and pre-clearance nest surveys are expected to be highly effective at locating any nests that may be present.

12) Any active nests, roosts, or dens of species protected by the SARA or the Migratory Birds Convention Act (MBCA) and detected on the Project Sites will not be disturbed, and consultation with the LLYK Field Unit will occur to determine appropriate mitigation, if any are observed.

13) Crews will avoid the use of dynamite when possible and use pry bars or S-mite as an alternative.

14) Prior to any blasting that cannot be avoided, the Contractor will "sweep" the work area and maintain a continuous watch for wildlife that might be present. If wildlife is observed, work will be stopped until the wildlife has passed through the area. If wildlife persist at the work area, a Human-Wildlife Conflict/Wildlife Specialist will develop mitigation plan to move the wildlife.

15) If sensitive wildlife are observed during flights between the Shale Pit and work sites, the pilot should immediately retreat to an altitude of 1,000 feet, divert to a lateral distance of 1,500 feet or alter flight paths to the fullest extent possible to reduce stress on wildlife. Sensitive wildlife includes Grizzly Bear, Mountain Goat, Black Bear, Wolf, and Cougar.

16) Limit human presence to areas essential for construction to limit the potential for disturbance of and interactions with wolverine and grizzly bears, which have a strong association to avalanche chutes for foraging.

17) Helicopter use for construction activities will begin after July 15th and extend through September when the impact on goats and kidding periods is less harmful, as it is anticipated that goats with kids will be on these slopes. If flights are required outside these time windows, a plan with rationale will reviewed by Parks Canada wildlife specialists and a separate permit will be required.

18) In general, helicopter will stay 1.5 horizontal km or further from cliffs that are below 9000 feet. Helicopters will follow approach routes that avoid goat cliffs.

19) Helicopters will be shut down when stopping at a site for a prolonged period of time (i.e., >10 minutes) to limit sensory disturbance.

20) Boxes for controls associated with RACS will be properly secured to prevent nesting of animals, and wires will be properly enclosed to prevent chewing by rodents.

21) Inspections of the RACS will be conducted during maintenance activities to ensure that wildlife are not using the equipment for nesting or shelter. If wildlife is found, they will not be disturbed. LLYK wildlife conflict specialists will be contacted in order to identify the appropriate course of action.

22) Overflight and ground surveillance using spotting scopes should be conducted within 1.5 km of the target area prior to the detonation of any unexploded ordinance as a part of summer and fall maintenance programs. If wildlife are present near the blasting area, potential adverse effects of unexploded ordinance detonation on mountain goats and other wildlife will be minimized through the following procedures:

    a) Follow guidelines outlined in the Best Management Practice 04.00 for Ordinance Detonation (Parks Canada 2015c).

    b) If mountain goats are observed within the surveillance area, crews will first allow animals to leave the area prior to conducting any hazing activity.

        i) If animals do not leave area when left undisturbed, a Human-Wildlife Conflict/Wildlife Specialist will develop mitigation plan to move the wildlife.

c) Once mountain goats have left the planned detonation site, the animals should be monitored to ensure that they do not re-enter the area.

23) Wildlife will be prevented from obtaining food, garbage or other domestic wastes by the Contractor and contract staff. Wildlife attractants will be stored away from animal access and will not be stored at the work site overnight. Existing Parks Canada waste receptacles will not be used for disposal of such wastes without prior arrangement with PCA. Incidents involving wildlife accessing garbage or attractants will be reported immediately to the ESO or Resource Conservation staff.

24) Wildlife encountered at or near Project locations will be allowed to passively disperse without undue harassment. If wildlife persist at the work area, a Human-Wildlife Conflict/Wildlife Specialist will develop mitigation plan to move the wildlife.

25) Wildlife observations, in particular observations of Mountain Goats, Black Bears, Grizzly Bears and Wolverine, will be reported to the ESO.

26) Parks Canada will be notified in the event of human-wildlife interactions, or activity or encounters with bears, Canada Lynx, Wolves, Cougars (*Puma concolor*), Wolverines, and any species at risk, dens and/or nests. Work will be stopped and the following will be reported immediately to Banff dispatch and the ESO:

a) aggressive encounters involving any species,

b) sightings of large carnivores,

c) toad migration,

d) snake hibernaculum,

e) bat roost,

f) bird nest, or

g) observations of carcasses.

8.4 Terrain and Soils

27) Erosion and sediment control measures will be implemented by the contractor prior to and during work to prevent downslope and potential downstream sedimentation. Specific details of erosion and sediment control measures will be provided in the EPP.

28) Work will be scheduled to avoid ground disturbance during high precipitation or runoff events. Contingency plans for isolating worksites during high precipitation and runoff events will be identified in the EPP.

29) Soil stripping will be minimized. If present, top soil will be retained to facilitate recovery.

30) To minimize compaction, use only the pre-determined designated staging areas near the Project Sites for helicopters and equipment, preferably surfaces that are already cleared vegetation.

8.5 Cultural Resources

31) If significant features (i.e., structural remains and/or high artifact concentrations) are encountered, work will stop in the immediate area, photographs and a GIS reading should be taken, and the LLYK Field Unit informed. The LLYK Field Unit will then contact Parks Canada's Terrestrial Archaeology section for advice and assessment of significance that will in turn determine what will be required to mitigate the chance find.

8.6 Visitor Experience

32) The Contractor will keep the LLYK Field Unit apprised of timelines, work periods and construction activities so that their staff (e.g., visitor centre and media) can provide information to the public to prevent additional safety risks for recreational users in the vicinity of the Project Sites during construction.

33) Construction equipment will be turned off when not in use, equipment and vehicles will be operated at optimal efficiency and performance, and carpooling of personnel to staging areas and Project sites will be encouraged.

9.0 PUBLIC/ STAKEHOLDER ENGAGEMENT AND ABORIGINAL CONSULTATION

- Indicate whether public/stakeholder engagement was undertaken in relation to potential adverse effects of the proposed project:

☒ No

☐ Yes (describe the process to involve relevant parties and indicate how comments were taken into consideration).

- Indicate whether Aboriginal consultation was undertaken in relation to potential adverse effects of the proposed project:

☒ No

☐ Yes (describe the process to involve relevant parties and how the results were taken into consideration).

10.0 SIGNIFICANCE OF RESIDUAL ADVERSE EFFECTS

For each VC, a determination of significance was made based on the residual effects characterization (Table 7). Residual adverse effects are defined as effects remaining after the mitigation measures are applied (Section 8). Residual effects were characterized using direction (positive, negative or neutral), expected magnitude (i.e., negligible to high), geographic extent (i.e., spatial extent of the effect), duration/reversibility (i.e., reversible in the short-term to permanent effects), frequency (i.e., number of times the effect happens per unit time), and probability (i.e., likelihood the effect will happen). These criteria were considered together, along with context identified within Section 6, to estimate the overall effects from the Project on each VC. Definitions and ranking of the above listed criteria are provided in Appendix D.

Significance was predicted to be either significant or not-significant. For natural resource-valued components (e.g., aquatic resources, vegetation), the residual effect was determined to be significant if the VC was expected to be altered to the point that it was no longer self-sustaining. The residual effect was also determined to be significant if the VC was no longer self-sustaining under existing conditions, and residual effects contributed to the factors limiting the VC. For visitor experience, the residual effect was determined to be significant if the VC was expected to be altered to a point where it became highly modified.

Project impacts that can be avoided or completely mitigated were not considered to have a residual impact, and therefore, were not been rated or incorporated into the Significance of Residual Adverse Effects Table (Table 7), below.

Overall, it is anticipated that there will be no significant adverse residual effects because of the Project, provided mitigation measures described in Section 8 are effectively implemented (Table 7).

Table 7: Significance of Residual Adverse Effects

Valued Component		Residual Effects [a]	Residual Impact Criteria Rating						Significance
			Direction	Magnitude	Geographic Extent	Duration/ Reversibility	Frequency	Probability	
Vegetation	Whitebark Pine	Change in Whitebark Pine abundance due to loss of individuals	Neutral	n/a	n/a	n/a	n/a	n/a	n/a
		Change to Whitebark Pine habitat quantity and/ or quality due to ground disturbance	Neutral	n/a	n/a	n/a	n/a	n/a	n/a
		Change in Whitebark Pine abundance due to increased invasive plant species	Neutral	n/a	n/a	n/a	n/a	n/a	n/a
		Net Residual Effects	Neutral	n/a	n/a	n/a	n/a	n/a	n/a
Wildlife	Migratory Birds	Change in habitat quantity and / or quality due to small-scale vegetation clearing, ground disturbance and sensory disturbance	Negative	Low	Local	Permanent	Continuous	Certain	Not Significant
		Reduction in migratory bird abundance due to small-scale vegetation clearing and ground disturbance during the nesting period	Neutral	n/a	n/a	n/a	n/a	n/a	n/a
		Net Residual Effects	Negative	Low	Local	Permanent	Continuous	Certain	Not Significant
	Carnivores/ Furbearers - Grizzly Bear	Change in habitat quality due to sensory disturbance	Negative	Low	Local	Short-term	Infrequent	Certain	Not Significant
		Change in bear abundance due to human-bear encounters	Neutral	n/a	n/a	n/a	n/a	n/a	n/a
		Net Residual Effects	Negative	Low	Local	Short-term	Infrequent	Certain	Not Significant
	Carnivores/ Furbearers - Wolverine	Change in habitat quality due to sensory disturbance / Net Residual Effects	Negative	Low	Local	Short-term	Infrequent	Probable	Not Significant
	Ungulates - Mountain Goats	Change in habitat use as a result of sensory disturbance / Net Residual Effects	Negative	Low	Local	Short-term	Infrequent	Certain	Not Significant
Terrain and Soils	General	Change in soil quality through compaction and erosion / Net Residual Effects	Negative	Negligible	Local	Medium-term	Continuous	Certain	Not Significant
Visitor Experience	General	Loss of natural aesthetic	Negative	Low	Local	Short-term	Continuous	Likely	Not Significant
		Traffic pattern changes	Positive	n/a	n/a	n/a	n/a	n/a	n/a
		Net Residual Effects	Positive	n/a	n/a	n/a	n/a	n/a	n/a

[a] Residual effects are those that remain after mitigations have been applied to avoid or reduce potential effects. Net residual effects are assessed for VCs impacted by more than one residual effect.

Note: If a residual effect was identified as positive or neutral, no additional assessment criteria other than likelihood were summarized for that VC. See Appendix D for Residual Effects Definitions.

11.0 SURVEILLANCE

☐ Surveillance is not required

☒ Surveillance is required (provide details such as the proposed schedule and the focus of inspections)

An ESO, other qualified PCA staff, or designated Qualified Environmental Practitioners will be required to conduct pre-construction surveys for Whitebark Pine and migratory bird nests. The ESO will conduct an environmental briefing with construction crews prior to the start of construction activities to alert crews of the potential for encountering sensitive species or environmental features, and associated communication and response protocols. Periodic inspections by the ESO will be coordinated with the Contractor and will occur throughout the project as helicopter availability permits.

12.0 FOLLOW-UP MONITORING

Follow-up monitoring is:

☒ not required

☐ required by legislation or policy (indicate basis of requirement – e.g. required by the *Species at Risk Act*; *Fisheries Act*, or the *Parks Canada Cultural Resource Management Policy*)

☐ required to evaluate effectiveness of mitigation measures and/or assess restoration success

13.0 SARA NOTIFICATION

Notification is:

☒ not required

☐ required under the Species at Risk Act (outline the nature of and response to any notification)

14.0 EXPERTS CONSULTED

Include Parks Canada experts. Add as many entries as necessary for the Project.

Department/Agency/Institution: Parks Canada Agency, Highway Services Engineering (HSE)	Date of Request: 2016-05
Expert's Name & Contact Information: Trevor Kinley P.O. Box. 220, Radium Hot Springs, BC V0A 1M0 Telephone: 250-347-6634 Email: trevor.kinley@pc.gc.ca	Title: Environmental Assessment Scientist
Expertise Requested: Clarification on BIA requirements for the Project.	
Response: Provided reports, data and clarification on BIA requirements for Project.	
Department/Agency/Institution: Dynamic Avalanche Consulting Ltd.	Date of Request: 2016-06-23
Expert's Name & Contact Information: Chris Argue Dipl. T.	Title: Avalanche Technician
Expertise Requested: Clarification on project design and requirements.	

Response: Provided clarification on Project design and requirements.	
Department/Agency/Institution: McElhanney Consulting Services Ltd.	Date of Request: 2016-06 and ongoing
Expert's Name & Contact Information: Jaime Sanderson, E.I.T. 502 Bow Valley Trail #203 Canmore, Alberta T1W 1N9 Mobile: 403-493-9309 Office: 403-621-4093 Email: JSanderson@mcelhanney.com	Title: Project Engineer
Expertise Requested: Clarification on project design and requirements.	
Response: Provided clarification on Project design and requirements.	
Department/Agency/Institution: Parks Canada Agency	Date of Request: 2016-06-23
Expert's Name & Contact Information: Brian Webster Bag 900, Banff AB T1L 1K2 Office: 403-762-1401 brian.webster@pc.gc.ca	Title: Visitor Safety Specialist
Expertise Requested: Clarification on project design and requirements.	
Response: Provided clarification on Project design and requirements.	

15.0 DECISION

Taking into account implementation of mitigation measures outlined in the analysis, the Project is:

☑ not likely to cause significant adverse environmental effects.

☐ likely to cause significant adverse environmental effects.

NOTE: If the project is identified as likely to cause significant adverse effects, CEAA 2012 prohibits approval of the project unless the Governor in Council (Cabinet) determines that the effects are justified in the circumstances. A finding of significant effects therefore means the project CANNOT go ahead as proposed.

FOR SARA REQUIREMENTS:

☑ There are no residual adverse effects to species at risk and therefore the SARA-Compliant Authorization Decision Tool was not required

OR, the SARA-Compliant Authorization Decision Tool (Appendix F) was used and determined:

☐ There is no contravention of SARA prohibitions

☐ Project activities contravene a SARA prohibition and CAN be authorized under SARA

☐ Project activities contravene a SARA prohibition and CANNOT be authorized

16.0 RECOMMENDATION AND APPROVAL

Prepared by:	
Marcie Plishka, M.Sc., P.Biol. Terrestrial Ecologist	2016-08-09
Signature:	
Valerie Coenen, B.Sc. Senior Terrestrial Ecologist	2016-08-09
Signature:	
Brock Simons, MSc, RPBio, PBiol Associate, Senior Wildlife Biologist	2016-08-09
Signature:	
Reviewed by:	
Martin Jalkotzy, M.E.Des., P.Biol. Principal, Senior Wildlife Ecologist	2016-08-09
Signature:	
Approved by:	
Dan Teleki, A/ILUPP MANAGER	2016-08-10
Signature:	

17.0 ATTACHMENTS

- Appendix A – Figures
  - Figure 1 – Vegetation Elements Occurring in the Local Study Area
  - Figure 2 – Historical Wildlife Observations and Cultural Resources in and around the Local Study Area
- Appendix B - Environmental Impact Analysis Tools: Effects Identification Matrix
  - Table B-1: Direct Effects That May Result from the Project
  - Table B-2: Indirect Effects That May Result from the Project
- Appendix C – Vegetation and Wildlife Elements of Management Concern with Potential to Occur in the Local Study Area
  - Table C-1 – Vegetation Elements of Management Concern with Potential to Occur in the Local Study Area

- Table C-2 – Wildlife Species of Management Concern with Potential to Occur in the Local Study Area

- Appendix D – Definition of Criteria Used to Describe Predicted Residual Effects for Valued Components
  - Table D-1: Definition of Criteria Used to Describe Predicted Residual Effects for Valued Components
  - Table D-2: Definitions of the Significance Determination of Predicted Residual Effects on Valued Components

18.0 NATIONAL IMPACT ASSESSMENT TRACKING SYSTEM

☐ Project registered in http://collaboration/sites/ea/SitePages/Impact%20Assessment%20Tracking%20System.asp

☑ Not yet registered *(CEAA 2012 requires PCA submit a report to Parliament annually. EIAs must be entered in the tracking system* ***by the end of April*** *to enable reporting.*

19.0 REFERENCES

Arno, S.F. and R.J. Hoff. 1989. Silvics of Whitebark Pine (*Pinus albicaulis*). General Technical Report INT-253. Ogden, Utah: US Department of Agriculture, Forest Service, Intermountain Research Station. 11pp.

BC Conservation Data Centre (BC CDC). 2014. Occurrence Report Summary, Shape ID: 68416, whitebark pine. B.C. Ministry of Environment. Available: http://delivery.maps.gov.bc.ca/ess/sv/cdc. Accessed Jun 24, 2016.

BC CDC. 2015. BC Species and Ecosystems Explorer. BC Ministry of Environment, Victoria BC. Available: http://a100.gov.bc.ca/pub/eswp/search.do?method=reset. Accessed June 27, 2016.

BC MOE (British Columbia Ministry of the Environment). 2009. Kootenay Region (Region 4) Periods of Least Risk for Instream Works by Fish Species. Available at: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/work_window_kootenays.pdf. Accessed June, 2016.

BC MOE. 2012. Habitat Wizard. Available at: http://maps.gov.bc.ca/ess/sv/habwiz/. Accessed December 23, 2015.

BC MOFR (British Columbia Ministry of Forests and Range). 2006. The Ecology of Alpine Zones. Pp.7. Available at: https://www.for.gov.bc.ca/hfd/pubs/Docs/Bro/Bro83.pdf

BC MOFR. 2011. Biogeoclimatic Ecosystem Classification Program. Available at: http://www.for.gov.bc.ca/hre/becweb/. Accessed February 6, 2015.

BC MoTI (British Columbia Ministry of Transportation and Infrastructure). 2014. Annual day of week summary for 2014. Site name: Kicking Horse - P-37-5EW, T Location: Route 1, 15.0 km east of Route 95 (at the east end of Park Bridge), Golden–Report generated online from: http://www.th.gov.bc.ca/trafficData/index.html. Accessed June 2016.

Bebi, P., D. Kulakowski and C. Rixen. 2009. *Snow avalanche disturbances in forest ecosystems—State of research and implications for management*. Forest Ecology and Management 257:1883-1892.

Chadwick, D.H. 1983. A Beast the Color of Winter. Sierra Club Books. San Francisco. 208 pp

Coen, G., M., and P. Kuchar. 1982. Biophysical (ecological) inventory of Yoho National Park, British Columbia, Canada. Research Branch – Agricultural Canada, 92 pp.

COSEWIC. 2010. COSEWIC Assessment and Status Report on the Whitebark Pine *Pinus albicaulis* in Canada.

COSEWIC. 2014. COSEWIC assessment and status report on Limber Pine Pinus flexilis in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Ix+49 pp. + 93 pp

Côté, S. 1996. Mountain Goat Responses to Helicopter Disturbance. Wildl. Soc. Bull. 24(4): 681-685.

Côté, S. D. and M. Festa-Bianchet. 2003. Mountain goat, *Oreamos americanus*. P. 1061-1075 In: Wild mammals of North America (2nd edition). GA Feldhamer and B. Thompson, eds. The John Hopkins University Press, Baltimore, Maryland.

Dukes, J.S. and H.A. Mooney. 2004. *Disruption of ecosystem processes in western North America by invasive species*. Revista Chilena de Historia Natural 77:411-437

Environment Canada. 2016. Species at Risk Public Registry. Available at: http://sararegistry.gc.ca/search/SpeciesSearch_e.cfm [updated January 19, 2016]. Accessed January 28, 2016.

ECCC (Environment and Climate Change Canada). 2016a. General nesting period of migratory birds in Canada. Available at: http://www.ec.gc.ca/paom-itmb/default.asp?lang=En&n=4F39A78F-1. Accessed June 2016.

ECCC. 2016b. Species at Risk Public Registry. http://sararegistry.gc.ca/search/SpeciesSearch_e.cfm_[updated January 19, 2016]. Accessed June 2016.

Festa-Bianchet, M. and S.D. Côté. 2007. Mountain Goats: Ecology, Behavior, and Conservation of an Alpine Ungulate. Island Press.

GoC (Government of Canada). 1985. *Fisheries Act* [R.S.C., 1985]. Current to February 3 2016. Last amended on February 26, 2015. Available at: http://laws-lois.justice.gc.ca/PDF/F-14.pdf. Accessed February 11, 2016.

GoC. 1994. *Migratory Birds Convention Act.* SC 1994, c. 22. Available at: http://laws.justice.gc.ca/eng/acts/M-7.01/index.html

Government of British Columbia. 2015. B.C. on the Move: A 10-Year Transportation Plan. Available at gov.bc.ca/transportationplan. Accessed June 2016.

Krebs, J.A. and Lewis. 2000. Wolverine ecology and habitat use in the North Columbia Mountains: progress report. *In* Proc. Conf. on the biology and management of species and habitat at risk. L.M. Darling (editor). Kamloops, B.C., Feb. 15-19, 1999. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., pp. 695-703.

Krebs, J.A, E.C. Lofroth and I. Parfitt. 2007. Multiscale habitat use by Wolverine in British Columbia, Canada. The Journal of Wildlife Management (71)7:2180-2192.

Langemann, E. Gwyn. 2016. Personal communication (email) between E. Gyyn Langemann (Archaeologist, Archaeology and History Branch, Parks Canada Agency) and Trevor Kinley (Environmental Assessment Scientist, Highway Engineering Services, Parks Canada Agency) regarding AOA for Mt. Bosworth avalanche control, June 14.

Laundré, J.W. 1994. Resource overlap between mountain goats and bighorn sheep. Great Basin Naturalist. 54:114-121.

Mace, R. D., J. S. Waller, T. L. Manley, K. Ake and W.T. Wittinger. 1999. *Landscape evaluation of grizzly bear habitat in western Montana*. Conservation Biology 13:367-377.

Magoun, A.J., and J.P. Copeland. 1998. Characteristics of wolverine reproductive den sites. Journal of Wildlife Management 62:1313-1320.

McElhanney (McElhanney Consulting Services Ltd.). 2013. TCH Avalanche Risk Management – Mount Bosworth Remote Avalanche Control System Study. pp. 25.

McFetridge, R.J. 1977. Strategy of resource use by mountain goat nursery groups. Pages 1169-173 in W. Samuel and W. G. Macgregor, eds. Proceedings of the first international mountain goat symposium. Kalispell, mt.

Meidinger, D. and J. Pojar. 1991. *Ecosystems of British Columbia*. British Columbia Ministry of Forests, Victoria, B.C., Special Rep. No. 6. ISSN 0843-6452. 330 pp.

PCA (Parks Canada Agency). 2007. Mountain Parks: National Historic Sites of Canada Management Plans. Available at: http://www.pc.gc.ca/pn-np/inc/PM-MP/plan/pd-mp_e.pdf

PCA. 2008. Yoho National Park, State of the Park Report. 56 pp. Available at: http://www.pc.gc.ca/eng/pn-np/bc/yoho/plan/gestion-management/plandirecteur-mgmtplan.aspx

PCA. 2010. Yoho National Park of Canada Management Plan. Available at: http://www.pc.gc.ca/docs/v-g/yoho/plan1/index.aspx

PCA. 2013. PCA Biotics Web Explorer. Available at: http://www.pc.gc.ca/apps/bos/bosfieldselection_e.asp?oqqc=aqs. Accessed June, 2016.

PCA. 2015a. BIA. Trans-Canada Highway Rock Slope Reprofiling 2015 Works. *Trans-Canada Highway: Sherbrooke Creek, Lower Sherbrooke Creek, Little Topple and Phyllite Rock Slopes - Yoho National Park*. May 2015. 59 pp.

PCA. 2015b. BIA. Vegetation Removal for 2015 TCH Rock Reprofiling- Yoho National Park. April 16, 2015. pp 27.

PCA. 2015c. Best Management Practice 04.00: Ordinance Detonation, Mount Revelstoke and Glacier National Parks. February 2015.

PCA. 2015d. Parks Canada National Best Management Practices: Roadway, Highway, Parkway and Related Infrastructure BMP.

Quinn, M.S. and J. Phillips. 2000. *Avalanche Paths in TFL14: Inventory, Description, Classification and Management*. Final report to Crestbrook Forest Industries Inc. University of Calgary, AB, April 2000.

Province of British Columbia. 2015. iMapBC. DataBC. Available at: http://maps.gov.bc.ca/ess/sv/imapbc/. Accessed February 2016.

Rancharita, R. K. 2000. Grizzly Bear Use of Avalanche Chutes in the Columbia Mountains, British Columbia. M.Sc. Thesis. University of British Columbia. 50 pp.

Saunders. J.K. Jr. 1955. Food habits and range use of the Rocky Mountain goat in the Crazy Mountains, Montana. Journal of Wildlife Management. 19: 429-437.

Smith, B. L. 1977. Influence of snow conditions on winter distribution, habitat use, and group size of mountain goats. Pages 174–89 in W. Samuel and W. G. Macgregor, eds. Proceedings of the first international mountain goat symposium. Kalispell, MT.

Steen, O.A., and R.A. Coupé. 1997. *A field guide to forest site identification and interpretation for the Cariboo Forest Region*. B.C. Ministry of Forest, Research Branch, Victoria, B.C., Land Management. Handbook. No. 39. Available at: https://www.for.gov.bc.ca/hfd/pubs/docs/lmh/lmh39.htm. Accessed 20 February, 2016.

Vroom, G. W., S. Herrero, and R. T. Ogilvie. 1980. The ecology of winter den sites of grizzly bears in Banff National Park, Alberta. Int. Conf. Bear Res. and Manage. 4:321-330.

APPENDIX A

Figure 1: Vegetation Elements Occurring in the Local Study Area
Figure 2: Historical Wildlife Observations and Cultural Resources in and Around the Local Study Area

LEGEND

- WHITEBARK PINE LOCATION
- TRANS-CANADA HIGHWAY KILOMETRE POST WITHIN YOHO NATIONAL PARK
- RAILROAD
- TRANS-CANADA HIGHWAY (TCH)
- WATERCOURSE
- BIOGEOCLIMATIC ZONE
- LOCAL STUDY AREA
- SLIDE PATH
- WATERBODY

INVASIVE SPECIES

- COMMON TANSY
- HOUND'S TONGUE
- POTENTIAL WHITEBARK PINE HABITAT

NOTE(S)

POTENTIAL WHITEBARK PINE HABITAT REPRESENTS AREAS WHERE ECOLOGICAL LAND CLASSIFICATION (ELC) DATA IDENTIFY WHITEBARK PINE AS A FOREST STAND COMPONENT

0 400 800

1:12,000 METRES

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6. ECOLOGICAL LAND CLASSIFICATION DATA OBTAINED FROM GOVERNMENT OF CANADA, PARKS CANADA AGENCY
DATUM: NAD 83 P PROJECTION: UTM ZONE 11

CLIENT

PARKS CANADA

PROJECT

TRANS-CANADA HIGHWAY AVALANCHE MITIGATION – YOHO NATIONAL PARK

CONSULTANT

Golder Associates

DATE	2016-08-03
DESIGNED	AA
PREPARED	SG
REVIEWED	MS
APPROVED	BS

TITLE

VEGETATION ELEMENTS OCCURRING IN THE LOCAL STUDY AREA

PROJECT NO	CONTROL	REV	FIGURE
1659658	2000	0	1

LEGEND

- MOUNTAIN GOAT OBSERVATION
- GRIZZLY BEAR OBSERVATION
- MOUNTAIN GOAT LICK
- TRANS-CANADA HIGHWAY KILOMETRE POST WITHIN YOHO NATIONAL PARK
- RAILROAD
- TRAIL
- TRANS-CANADA HIGHWAY (TCH)
- WATERCOURSE
- LOCAL STUDY AREA
- SLIDE PATH
- WATERBODY

0 400 800

1:12,000 METRES

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DATUM: NAD 83 PROJECTION: UTM ZONE 11

PARKS CANADA

TRANS-CANADA HIGHWAY AVALANCHE MITIGATION – YOHO NATIONAL PARK

Golder Associates

DATE	2016-09-30
DESIGNED	AA
PREPARED	SG
REVIEWED	BS
APPROVED	MS

HISTORICAL WILDLIFE OBSERVATIONS AND CULTURAL RESOURCES IN AND AROUND THE LOCAL STUDY AREA

PROJECT NO.	CONTROL	REV.	FIGURE
1659658	2000	0	2

APPENDIX B

Effects Identification Matrix

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Table B-1 focuses on direct effects of the project and Section B on indirect effects that are caused by changes to the environment.

Table B-1: Direct Effects

Project Components	Project Phases	Project Activities	Valued Components Potentially Directly Affected by the Proposed Project				
			Natural Resources			Cultural Resources	Visitor Experience
			Vegetation (Whitebark Pine and Whitebark Pine Critical Habitat)	Wildlife (Migratory Birds, Grizzly Bear, Wolverine, and Mountain Goats)	Soils and Terrain	General	General
	Site Preparation / Construction	Preparation of Environmental Protection Plan (EPP)	☐	☐	☐	☐	☐
		Mobilization of equipment	☐	☐	☐	☐	☒
		Supply and storage of materials	☐	☐	☐	☐	☒
		Temporary facility	☐	☐	☐	☐	☐
		Clearing	☒	☒	☒	☐	☒
		Disposal of waste	☒	☒	☐	☐	☒
		Blasting/Drilling	☒	☒	☒	☐	☒
		Excavation	☒	☒	☒	☐	☒
		Use of machinery	☐	☒	☐	☐	☒
		Backfilling	☐	☐	☒	☐	☐
		Transport of materials/equipment	☐	☒	☐	☐	☐
	Operation/ Implementation/ Decommissioning	Disposal of waste	☐	☐	☐	☐	☒
		Maintenance	☐	☒	☐	☐	☒
		Use	☐	☒	☒	☐	☒
		Use/Removal of temporary facilities	☐	☐	☐	☐	☐

Section B of the matrix should be used to identify potential indirect effects that may result from impacts of the project to components of the environment you have identified on the preceding pages (see Section A - direct effects to natural resources). Consideration of indirect effects is required under CEAA 2012 Sections 5(1)(c) and 5(2)(b), and by the PCA mandate. For example:

- if the proposed project could lead to adverse effects to water quality and quantity, could this then effect the quantity and quality of water resources (e.g. potable water) used by an Aboriginal community?
- could there also be adverse socio-economic effects to a community that relies on recreational fishing tourism?
- could changes to the environment (e.g. digging, clearing) affect visitor access, opportunities, or safety?

Table B-2: Indirect Effects (all phases)

Project Components	Project Phase	Natural Resource Components Affected by the Project	Impacts as a Result of Changes to the Environment					
			With respect to non-Aboriginal peoples	With respect to Aboriginal peoples		With respect to visitor experience		
			Health and socio-economic conditions	Health & socio-economic conditions	Current use of lands and resources for traditional purposes	Access & services	Recreation & accommodation opportunities	Safety
	Preparation /construction operation /implementation /decommissioning	None Identified	☐	☐	☐	☐	☐	☐
		-	☐	☐	☐	☐	☐	☐
		-	☐	☐	☐	☐	☐	☐
		-	☐	☐	☐	☐	☐	☐
		-	☐	☐	☐	☐	☐	☐
		-	☐	☐	☐	☐	☐	☐

APPENDIX C

Vegetation Elements and Wildlife Species of Management Concern with Potential to Occur in the Local Study Area

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Report No. 1659658_RP0001_Rev 1

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APPENDIX C
Vegetation Elements and Wildlife Species of Management Concern with Potential to Occur in the Local Study Area

Table C-1: Vegetation Elements of Management Concern with Potential to Occur in the Local Study Area

Scientific Name	Common Name	Status					Habitat
		Provincial	BC List	COSEWIC	SARA	Global	
Androsace chamaejasme ssp. lehmanniana	Sweet-flowered fairy-candelabra	S3	Blue	n/a	n/a	G5T5 (1991)	Rock and sparsely vegetated rock in rocky alpine and arctic tundra zones.
Arenaria longipedunculata	low sandwort	S3	Blue	n/a	n/a	G3G4 (2012)	Rock and sparsely vegetated rock, moist sand, gravel, frost boils, rock crevices and moist habitat in the alpine and tundra.
Arnica longifolia	Seep-spring arnica	S2	Red	n/a	n/a	G5 (1988)	Moist to wet meadows and seepage slopes in subalpine and alpine zones.
Arnica louiseana	Lake Louise arnica	S2S3	Blue	n/a	n/a	G3 (2015)	Rock, sparsely vegetated rock, and meadows in grassland, shrub, alpine, and tundra zones.
Botrychium lineare	Linear-leaf moonwort	S3	Blue	n/a	n/a	G2G3 (2013)	Mostly at higher elevations (about 1500-3000 m) in mountains, but specific habitats have ranged from a meadow dominated by knee-high grass, shaded woods and woodlands, grassy horizontal ledges on a north-facing limestone cliff, and a flat upland section of a river valley.
Botrychium spathulatum	spoon-shaped moonwort	S3	Blue	n/a	n/a	G3 (2008)	Mostly in open to partially open habitats in montane areas. Often associated with moderate disturbance, sparse vegetation or grassy areas in grassland, shrub, subalpine meadow, alpine and tundra zones.
Carex incurviformis var. incurviformis	Curved-spiked sedge	S3	Blue	n/a	n/a	G4G5T4T5Q (2000)	Rock, sparsely vegetated rock, cliffs, talus, and meadows in grassland, shrub, alpine, and tundra zones.
Carex krausei	Krause's sedge	S2S3	Blue	n/a	n/a	G4 (1994)	Moist gravel bars, exposed banks and dry grassy slopes in the subalpine zone.
Carex petricosa	Rock-dwelling sedge	S2?	Red	n/a	n/a	G4 (1988)	Rock, sparsely vegetated rock, talus, and meadows in grassland, shrub, alpine, and tundra zones.
Castilleja gracillima	Slender paintbrush	S2S3	Blue	n/a	n/a	G3G4Q (1999)	Rock, sparsely vegetated rock, and meadows in grassland and shrub zones.
Cryptogramma cascadensis	Cascade parsley fern	S3	Blue	n/a	n/a	G5 (2011)	Rock, sparsely vegetated rock, cliffs, talus in subalpine and alpine zones.
Delphinium bicolor ssp. bicolor	Montana larkspur	S3	Blue	n/a	n/a	G4G5T4T5 (2002)	Dry grasslands, shrublands, rocky slopes and forests from the steppe to subalpine zones.
Delphinium sutherlandii	Sutherland's larkspur	S3	Blue	n/a	n/a	GNR	Mesic to dry shrublands and open forests in the montane zone.
Draba lactea	Milky draba	S3	Blue	n/a	n/a	G5 (2012)	Rock, sparsely vegetated rock, cliffs, talus, and meadows in grassland, shrub, subalpine, alpine, and tundra zones.
Draba porsildii	Porsild's draba	S2S3	Blue	n/a	n/a	G3G4 (2006)	Moist to dry sites on ridges, slopes, cliffs, ledges and summits in alpine and tundra zones. Often found on talus, gravel, moist bank, course-textured open soil and grassy meadows.
Dryopteris cristata	Crested wood fern	S3	Blue	n/a	n/a	G5 (2015)	Wet swamps and meadows in the steppe and montane zones.
Eleocharis elliptica	Elliptic spike-rush	S2S3	Blue	n/a	n/a	G5 (1984)	Lakeshores, streamsides and wet meadows in the steppe and montane zones.
Hypericum scouleri ssp. nortoniae	Western St. John's-wort	S3?	Blue	n/a	n/a	G5T3T5 (2002)	Rock and sparsely vegetated rock and meadows in grassland, shrub, alpine and tundra zones.
Juncus albescens	Whitish rush	S3	Blue	n/a	n/a	G5 (1989)	Wet calcareous fens in the montane to alpine zones.
Pellaea gastonyi	Gastony's cliff-brake	S3	Blue	n/a	n/a	G2G3 (2011)	Dry calcareous cliffs and crevices in the montane and subalpine zones; rare in SE BC, E to SK and disjunct in WY, SD, and MO.
Pellaea glabella ssp. occidentalis	Western dwarf cliffbrake	S2	Red	n/a	n/a	G5T4 (2011)	Rock and sparsely vegetated rock, cliffs, dry to mesic crevices of rocks in the steppe, montane, and subalpine zones.
Phacelia lyallii	Lyall's phacelia	S2S3	Blue	n/a	n/a	G3 (2002)	Rock and sparsely vegetated rock in alpine, and tundra zones.
Physaria didymocarpa ssp. didymocarpa	Common twinpod	S2S3	Blue	n/a	n/a	G5T4 (1994)	Rock and sparsely vegetated rock, grassland and talus in grassland, shrub, alpine, and tundra zones.
Pinus albicaulis	Whitebark pine	S2S3	Blue	Endangered	Schedule 1	G3G4 (2011)	From high-elevation krummholz forests to lower elevations as part of mixed and/or closed subalpine forests. Elevations ranging from approximately 1,950 to 2,250 masl, and occasionally at lower elevations.
Pinus flexilis	Limber pine	S2	Red	Endangered	n/a	G4 (2011)	Warm, dry sites on the lower portions of the mountains and foothills at elevations approximately 850 to 1900 masl. They generally exist on southerly or westerly aspects and gentle to steep slopes.
Poa laxa ssp. banffiana	Banff bluegrass	SH	Red	n/a	n/a	G5?T1 (1994)	Rock, sparsely vegetated rock, and meadows in grassland, shrub, alpine, and tundra zones.
Ranunculus pedatifidus ssp. affinis	Birdfoot buttercup	S3	Blue	n/a	n/a	G5T5 (1991)	Moist meadows in the montane to alpine zones; rare throughout BC in and east of the Coast-Cascade; circumpolar, N to AK, YT and NT, E to NF and S to NJ, WY, CO, NM and AZ; Eurasia.
Stellaria obtusa	Blunt-sepaled starwort	S3?	Blue	n/a	n/a	G5 (1990)	Wet to moist meadows and streambanks in the montane zone; rare E of the Coast-Cascade Mountains in S BC, N to S AK, E to AB and S to CO and CA.

Notes:
n/a: not listed by COSEWIC or SARA.
Data was compiled based on queries of the Parks Canada Biotics Web Explorer for regularly occurring species in YNP (PCA 2013), the BC Species and Ecosystems Explorer (BC CDC 2015).

Table C-2: Wildlife Species of Management Concern with the Potential to Occur in the Local Study Area

Common Name	Scientific Name	Status					Regularity within YNP [b]	Population [c]
		Provincial	BC List	COSEWIC Status [a]	SARA Schedule [a]	SARA Legal Status [a]		
Amphibians								
Western Toad	*Anaxyrus boreas*	S3S4	Blue	Special Concern	Schedule 1	Special Concern	Regular	Year-round
Birds								
Barn Swallow	*Hirundo rustica*	S3S4B	Blue	Threatened	No Schedule	No Status	Regular	Breeding
Black Swift	*Cypseloides niger*	S2S3B	Blue	Endangered	No Schedule	No Status	Unknown	Unknown
Common Nighthawk	*Chordeiles minor*	S4B	Yellow	Threatened	Schedule 1	Threatened	Unknown	Breeding
Eared Grebe	*Podiceps nigricollis*	S3B	Blue	Not Ranked	No Schedule	No Status	Regular	Breeding, Non-breeding, Transient
Olive-sided Flycatcher	*Contopus cooperi*	S3S4B	Blue	Threatened	Schedule 1	Threatened	Regular	Breeding
Peregrine Falcon	*Falco peregrinus anatum / tundrius*	S2?B / SUM	Red / Unknown	Special Concern	Schedule 1	Special Concern	Accidental / Nonregular	Unknown
Rusty Blackbird	*Euphagus carolinus*	S3S4B	Blue	Special Concern	Schedule 1	Special Concern	Accidental / Nonregular	Unknown
Bats								
Little Brown Myotis	*Myotis lucifugus*	S4	Yellow	Endangered	Schedule 1	Endangered	Regular	Year-round
Ungulates								
Bighorn Sheep	*Ovis canadensis*	S3?	Blue	Not Ranked	No Schedule	No Status	Regular	Non-breeding, Year-round
Mountain Goat	*Oreamnos americanus*	S3	Blue	Not Ranked	No Schedule	No Status	Regular	Year-round
Carnivores/Fur Bearers								
Grizzly Bear	*Ursus arctos*	S3?	Blue	Special Concern	No Schedule	No Status	Regular	Year-round
Wolverine, luscus subspecies	*Gulo gulo luscus*	S3	Blue	Special Concern	No Schedule	No Status	Regular	Year-round

Notes:

[a] **COSEWIC** - Committee on the Status of Endangered Wildlife in Canada; SARA - Species at Risk Act (Environment Canada 2016a).
[b] **Regularly occurring** - Occurrence of the Element is consistent in the Managed Area (e.g., it may migrate in and out of the area, but it returns on a regular basis).
Accidental/Nonregular - The Element does not persist or return regularly in the Managed Area.
Unknown/Undetermined - Regularity of the Element in the Managed Area has not been, or cannot be, determined.
[c] **Year-round** - A significant proportion of individuals of the Element are non-migratory or remain in the Managed Area throughout the year.
Breeding - Individuals of the Element occur in this Managed Area as part-time (seasonal) residents when breeding, and they are not year-round residents in any significant numbers.
Nonbreeding - Individuals of the Element occur in this Managed Area as part-time (seasonal) residents when not breeding, and they are not year-round or breeding season residents in any significant numbers.
Transient - Individuals of the Element are long distant migrants that regularly occur in the Managed Area as a transient during migration.
Unknown - The residency status of the individuals of the Element in the Managed Area has not been, or cannot be, determined.

APPENDIX D

Definition of Criteria Used to Describe Predicted Residual Effects for Valued Components

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Golder Associates

APPENDIX D

Definition of Criteria Used to Describe Predicted Residual Effects for Valued Components

Table D-1: Definition of Criteria Used to Describe Predicted Residual Effects for Valued Components

Criteria	Definition	Natural Resources Description	Cultural Resources Description
Direction	Direction relates to the value of the effect in relation to the environment.	■ Positive – net gain or benefit; effect is desirable	■ Positive – an improvement over existing values or conditions
		■ Neutral – no change compared with existing conditions and trends	■ Neutral – no change compared with existing conditions and trends
		■ Negative – net loss or adverse effect; effect is undesirable	■ Negative – a less favourable change relative to existing values or conditions
Magnitude	Magnitude is the intensity of the effect, or a measure of the degree of change from existing (baseline) conditions.	■ Negligible – no detectable change is expected from existing values	■ Negligible – no detectable change is expected from existing values
		■ Low – effect occurs that might be detectable, but is expected to be within the range of existing or guideline values, or within the range of natural variability	■ Low – the change has no effect on the cultural resources setting beyond that of a nuisance (annoyance) value
		■ Moderate – effect is expected to be at or to slightly exceed the limits of existing or guideline values – clearly an effect, but unlikely to be a management concern[a]	■ Moderate – the change modifies the cultural resources setting, but there is no change in the system
		■ High – effect is expected to exceed the limits of existing or guideline values – the effect can pose a serious risk and represents a management concern[a]	■ High – the change is large enough to result in a change of cultural resources
Geographic Extent	Geographic extent refers to the spatial extent over which an environmental or socio-economic effect will occur.	■ Local – the effect is confined to the Local Study Area	■ Local – the effect is confined to the LSA
		■ Regional – the effect extends beyond the LSA but is confined within the region (i.e., Yoho National Park)	■ Regional – the effect extends to users throughout Yoho National Park
		■ Beyond regional – the effect extends beyond Yoho National Park	■ Beyond regional – the effect extends beyond Yoho National Park
Duration/reversibility	Duration is the period of time over which the natural or cultural resource effect will be present. The amount of time between the start and end of a Project activity or stressor, plus the time required for the effect to be reversed. Duration and reversibility are functions of the length of time the valued component (VC) are exposed to Project activities.	■ Short-term – the effect occurs during construction or during operation as a result of maintenance activities, and is reversible before or during operation	■ Short-term – the effect occurs during construction or during operation as a result of maintenance activities, and is reversible before or during operation
	Reversibility is an indication of the potential for recovery of the VC from the Project effect. Reversible implies that the effect will not result in a permanent change of state of the VC compared to similar environments not influenced by the Project (similar being an environment of the same type, region and time period). For effects that are permanent, the effect is determined to be irreversible.	■ Medium-term – the effect occurs during construction or operation and is reversible on completion	■ Medium-term – the effect occurs during construction or operation and is reversible on completion
		■ Long-term – the effect occurs during construction or operation and persists beyond completion, but is reversible	■ Long-term – the effect occurs beyond the operational life of the Project, but is reversible
		■ Permanent – the effect occurs during construction or operation and is irreversible	■ Permanent – the effect occurs during construction or operation and is irreversible
Frequency	Frequency refers to the number of times the effect happens per unit time.	■ Infrequent – the effect is expected to occur rarely	■ Infrequent – the effect is expected to occur rarely
	Discussions on seasonal considerations are made when they are important in the evaluation of the effect.	■ Frequent – the effect is expected to occur intermittently	■ Frequent – the effect is expected to occur intermittently
	-	■ Continuous – the effect is expected to occur continually	■ Continuous – the effect is expected to occur continually
Probability	Probability of occurrence is a measure of the likelihood that a Project activity will result in an effect.	■ Unlikely – the effect is not likely to occur	■ Unlikely – the effect is not likely to occur
		■ Possible – the effect may occur, but is not likely	■ Possible – the effect may occur, but is not likely
		■ Probable – the effect is likely to occur	■ Probable – the effect is likely to occur
		■ Certain – the effect will occur	■ Certain – the effect will to occur

Notes:

[a] Effects that pose a management concern can require actions such as research, monitoring or recovery initiatives.

If a residual effect was identified as positive or neutral, no additional assessment criteria other than likelihood were summarized for that VC.

Table D-2: Definitions of the Significance Determination of Predicted Residual effects on Valued Components

Significance	Definition
Natural Resources Valued Components	
Not significant	The effect might be detectable, but is not predicted to result in a change that will alter the sustainability of the valued component (VC) beyond an acceptable level.
Significant	The effect is measurable, and is predicted to result in a change to the VC that will alter its sustainability beyond an acceptable level.
Cultural Resources Valued Components	
Not significant	The degree of change is considered to be either no change or negligible to minor changes (very minor changes, or slight changes to the resource).
Significant	The degree of change is considered to be moderate change (resource is clearly modified) or major change (resource is totally altered and removed/destroyed).

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