33. Federal Summaries

This section summarizes the changes to the environment, as defined in the *Canadian Environmental Assessment Act, 2012* (2012), which are outlined as areas of federal concern under Section 5 of the Act. These include changes to the components of the environment within federal jurisdiction, changes to the environment that would occur on federal or transboundary lands, and changes to the environment that are directly linked or necessary incidental to federal decisions and the effects of those changes in the human environment (Table 33-1).

Table 33-1. Summary of Federal Areas of Interest under the *Canadian Environmental Assessment Act, 2012*

Federal Area of Concern	Changes to the Environment
Changes to Components of the Environment within Federal Jurisdiction (Section 33.1)	
Fish and Fish Habitat	Direct mortality; erosion and sedimentation; water quality; habitat loss
Aquatic Species at Risk	No aquatic species at risk, as defined under the *Species at Risk Act* (2002a) will be affected by the Project
Migratory Birds	Habitat loss and alteration; sensory disturbance; direct mortality; attractants; chemical hazards
Changes to the Environment that would occur on Federal or Transboundary Lands (Section 33.2)	
None	
Changes to the Environment that are Directly Linked or Necessarily Incidental to Federal Decisions (Section 33.3)	
Explosives Act (1985a)	Loss and degradation of ecosystems and soil; fugitive dust effects to Knipple Glacier
Transportation of Dangerous Goods Act (1992)	Loss and degradation of ecosystems and soil; fugitive dust effects to Knipple Glacier
Effects of Changes to the Environment that are Directly Linked or Necessarily Incidental to Federal Decisions (Section 33.4)	
None	

33.1 CHANGES TO COMPONENTS OF THE ENVIRONMENT WITHIN FEDERAL JURISDICTION

Pursuant to Section 5(1)(a) of the *Canadian Environmental Assessment Act, 2012* (2012), the components of the environment under federal jurisdiction are fish and fish habitat, aquatic species at risk, and migratory birds. A summary of changes to these components as a result of the Project are described below.

33.1.1 Fish and Fish Habitat

Fish and fish habitat was included as a receptor Valued Component (VC) in the Project's environmental assessment. Fish and fish habitat receptor VC sub-components included in the assessment process are:

- Fish, which includes:
  - Dolly Varden (*Salvelinus malma*);
  - Bull Trout (*S. confluentus*); and

  - Pacific Salmon, including Coho Salmon (*Oncorhynchus kisutch*), Chinook Salmon (*O. tshawytscha*), and Sockeye Salmon (*O. nerka*).
- Fish habitat.

Potential key effects to fish were identified as: direct mortality, erosion and sedimentation, and water quality. Potential key effects to fish habitat were identified as erosion and sedimentation, and habitat loss.

33.1.1.1 Direct Mortality

Potential Effect

Residual effects on fish receptor VC sub-components (Bull Trout, Dolly Varden, and Pacific Salmon) may potentially occur because of direct mortality in the Local Study Area (LSA) and Regional Study Area (RSA).

Potential causes of direct mortality to fish include construction equipment working in water for access road maintenance, dewatering activities for construction during bridge and culvert maintenance, salvage and relocation of fish downstream during maintenance activities, and fish stranding during maintenance. For the Project, direct mortality could take place during all Project phases because the access road will require periodic maintenance and decommissioning. Fish may be affected by Project components along the access road since they are present in the Bell-Irving River, Bowser Lake, Bowser River, and their tributaries. Fish do not inhabit streams in remaining areas of the Project, and thus will not be affected by direct mortality. There is the potential for direct mortality through increased angler pressure and harvesting of fish species. This would be largely due to the increased road access. Although all of the Project workers will not be anglers, some proportion of the workforce will be, and this influx of anglers has the potential to increase the fishing pressure on sport and traditional fish populations in lakes and rivers within the LSA and RSA.

Lastly, spills of hazardous materials particularly fuels could lead to the direct mortality of fish. The Project requires fuels be brought onto site with fuel trucks. A rare worst-case scenario would see a full fuel truck load released into the aquatic environment.

Mitigation Measures

To mitigate direct mortality effects within fish-bearing streams, access road construction and maintenance activities will be done in accordance with best management practices (BMPs) such as the *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO 1993), *Standards and Best Practices for Instream Works* (BC MWLAP 2004), and DFO's operational statements for bridge and culvert maintenance (DFO 2007). Appropriate fisheries operating windows for fish-bearing streams will be adhered to where possible. Mitigation strategies include isolating Project work sites to prevent fish movement into the work site, salvaging/removing fish from the enclosed work site, and environmental monitoring.

Increased fishing access by the public within the LSA and RSA will be mitigated and controlled on the Brucejack Access Road during the Project's Construction and Operation phases. Limited sport fishing for trout, char (Bull Trout and Dolly Varden), and salmon already occurs within the LSA and RSA in the larger creeks, rivers, and lakes. The potential increase in fishing pressure and associated increase in fish harvesting due to the presence of the mine Construction and Operation workforces will be mitigated by the following features:

- gating of the Brucejack Access Road to prohibit the entry by non-authorized vehicles;

- design of gates and security measures to control access and mobility of snow machines and all-terrain vehicles;
- at Closure, all non-essential roads will be deactivated and bridges will be removed, thereby preventing vehicle access;
- implementing a company policy that prohibits employees and contractors from engaging in fishing while present at the Brucejack Mine Site or while travelling to and from the mine on company business; and
- transporting personnel to and from the Brucejack Mine Site so that employees have limited opportunity to engage in angling during mine Construction and Operation.

As a result of these administrative and mitigation measures, there will be no sanctioned opportunities for employees or contractors to engage in fishing while on site during mine Construction or Operation.

Residual Effect

After the application of mitigation measures, Project-related changes to fish mortality are predicted to occur during the Project Construction, Operation, and Closure phases due to Brucejack Access Road use and maintenance, and decommissioning of the Brucejack Access Road. Fish mortality may arise from impact with construction machinery leading to blunt tissue trauma causing mortality to early life history stages.

The magnitude of all effects associated with direct mortality will be minor because events will be localized and geographically isolated. In addition, direct mortality events will be of short duration and occur sporadically. Since the timing and duration of events causing direct mortality is short, this effect can be reversed relatively quickly at the population level (not individual level; e.g., reversible short term) and fish species will be able to respond and adapt (e.g., resiliency is high). Mortality of fish was determined to be of high ecological context because salmon introduce marine derived nutrients into freshwater ecosystems and support aquatic productivity.

The probability (likelihood) of the residual effect on fish due to direct mortality occurring was rated as low. This low probability that a potential effect could occur is due to the efficiency and size selectivity of sampling gear to remove fish from a work area.

Significance of Residual Effect

The potential residual effects on fish from direct mortality was assessed as not significant with a high confidence in the significance predictions and mitigation measures that have proven effectiveness being followed.

33.1.1.2 Erosion and Sedimentation

Potential Effect

Residual effects on fish (Dolly Varden, Bull Trout, and Pacific Salmon) and fish habitat receptor VCs may occur because of erosion and sedimentation (including dust and runoff) resulting from Project components in the Construction, Operation, and Closure phases.

Fish may be affected by the Brucejack Access Road, Bowser Aerodrome, and Knipple Transfer Area since they are present in streams within or near these Project activities. Fish do not inhabit streams in other Project areas and will thus not be affected by erosion and sedimentation.

Potential Project-specific sources of erosion and sedimentation include Brucejack Access Road, Bowser Aerodrome, and the Knipple Transfer Area. Sedimentation and erosion can take place during the Construction, Operation, and Closure phases due to a number of Project activities. These activities have the potential to cause temporary increases in turbidity. The geographic extent of erosion and sedimentation can range from localized to far-reaching events, depending on the amount and type (e.g., particle size) of sediment that is introduced into the aquatic environment.

Erosion and sedimentation can affect fish habitat in many ways, including physical alterations to habitat in the form of increased turbidity. In turn, sedimentation can affect aquatic organisms by smothering primary and secondary producers at various life stages, reducing visibility, diminishing feeding efficiency, increasing exposure to elevated metal concentrations, and leading to habitat avoidance by aquatic organisms. Erosion and sedimentation can affect fish by blocking oxygen transport to gills (Turnpenny and Williams 1980; Ingendahl 2001), causing death to incubating eggs (Platts and Megahan 1975; Lisle 1989), and causing alterations in fish behavior (Cordone and Kelley 1961).

Recovery from sedimentation will be more rapid in high-velocity streams relative to wetlands or lakes. Many streams and rivers in the RSA have naturally high sediment loads due to glacial origins, and thus will not be affected to the same extent as clear, low-velocity streams.

Sedimentation to fish-bearing waters during transmission line construction and maintenance is not anticipated. The Bowser River transmission line crossing will be the only crossing of fish-bearing waters. At this location, the closest tower locations will be more than 560 metres (m) from the floodplain and the transmission line conductor will be located approximately 120 m above the high-water mark of the river. Thus, no habitat loss will occur as existing tree and shrub riparian habitat will meet clearance standards for overhead transmission lines. Therefore, no trees will be removed within the riparian zone of the Bowser River crossing.

Mitigation Measures

To minimize the effects on fish and their habitats, several mitigation measures relating to erosion and sedimentation will be required. Mitigation strategies will be tailored to address Project-specific issues associated with erosion and sedimentation. Mitigation objectives outlined in accordance with BMPs such as Fisheries and Oceans Canada's (DFO's) *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO 1993), *Standards and Best Practices for Instream Works* (BC MWLAP 2004), *Fish-Stream Crossing Guidebook* (BC MFLNRO and DFO 2012), and Pacific Region Operational Statements (DFO 2007), which all provide guidelines for the mitigation of erosion and sedimentation effects on fish and fish habitat.

Erosion and sedimentation will be mitigated in the LSA and RSA through the implementation of BMPs, particularly during construction and maintenance. Specific BMPs relating to the mitigation and/or minimizing of effects caused by erosion and sedimentation to the aquatic environment include:

- using water diversion structures to direct dirty water from the work zone to a sediment control area;
- installing silt fencing, geotextile cloth, straw bales, berms, or other sediment control structures;
- conducting instream work from the point farthest away from the construction access point and working backward;
- allowing constructed ponds to settle before connecting to the stream;

- storing soil, substrate, removed vegetation, and building materials in stable areas away from the channel;
- ensuring that all rock materials used in the stream are inert (non-acid generating);
- ensuring constructed banks are graded at a stable slope;
- stabilizing excavated materials and areas denuded of vegetation using temporary erosion control blankets, biodegradable mats, planted vegetation, or other erosion control techniques;
- environmental monitoring;
- repairing areas that are potential sediment sources;
- using dust suppression on roads; and
- adhering to appropriate construction operating windows for instream work.

When in-water work occurs, an environmental monitor will be on site monitoring water quality. Construction and maintenance activities near areas of fish-bearing waters will occur during appropriate fisheries operating windows for fish-bearing streams. In-water works outside of fisheries operating windows will only be conducted under a permit. To minimize the effects of erosion and sedimentation (including dust) during access road maintenance, an access road maintenance plan will be developed and adhered to during the Project Construction, Operation, and Closure phases, which will be a component of the Transportation and Access Management Plan (Section 29.16) prepared for this Application for an Environmental Assessment Certificate/Environmental Impact Statement (Application/EIS).

Residual Effect

After the application of mitigation measures, Project-related changes to fish from erosion and sedimentation are predicted to occur during the Project Construction, Operation, and Closure phases due to Brucejack Access Road use and maintenance, and decommissioning of the Brucejack Access Road. These Project activities may cause entry of sediment to waterbodies during instream construction and bridge/culvert removal, and entry of sediment to waterbodies from road runoff and dust during operation and maintenance. The predicted residual changes to fish remaining after mitigation measures have been applied are decreased feeding efficiency and habitat avoidance.

The magnitude of all residual changes to fish and fish habitat that are associated with erosion and sedimentation will be minor. The extent of the residual sediment effect will be at the landscape level as the sediments are flushed downstream. Erosion events, should they occur, will be of medium-term duration (effect lasts from one to five years) and would occur sporadically during all Project phases. The effects of erosion and sedimentation cannot be easily reversed, thus reversal will occur over many years (reversible medium-term). Furthermore, fish may not be able to fully respond or adapt to the effects of erosion and sedimentation, thus resiliency was assessed as neutral. Sedimentation on fish was determined to be of neutral ecological context because fish in the receiving aquatic environment have attributes (e.g., move to other habitats) to deal with increased sediment loads.

The probability (likelihood) of the residual effect occurring was rated as medium.

Significance of Residual Effect

Potential residual effects on fish and fish habitat from erosion and sedimentation were assessed as not significant, with a high confidence in the significance predictions with the implementation of mitigation measures that are known to be highly effective.

33.1.1.3 Water Quality

Potential Effect

The health of fish, other aquatic life, and sediment quality are all intimately linked to the quality of the water in the aquatic environment. Chemical contaminants may enter the aquatic environment from a number of sources as a result of Project activities in all phases and may pose a risk to fish.

A number of different chemical classes may be used or be naturally present within the LSA and RSA. Examples of types of chemicals that could be introduced into the aquatic environment as a result of Project activities include metals, process chemicals (e.g., chemicals used in water treatment or ore processing), petroleum products, and nitrogen and phosphorus associated with sewage disposal.

Metals

Metals occur naturally in the water and sediments of the LSA and RSA due to the presence of mineral-rich deposits, sometimes at concentrations above federal and/or provincial guideline limits.

The potential for fish or fish habitat exposure to acidic water or metals could occur during all phases of the Project (Construction, Operation, Closure, and Post-closure). Sources of metals due to Project activities may include point sources (e.g., discharges from Brucejack Lake). Potential sources of metal leaching/acid rock drainage (ML/ARD) include any locations where potentially acid generating (PAG) rock may be exposed. Exposure of fish in the aquatic environment to increases in pH or metals can lead to both lethal and sub-lethal effects. At high enough concentrations, metals can cause mortality in exposed organisms. At lower concentrations, sub-lethal effects may occur; although these effects do not cause immediate mortality, they can affect population dynamics or stability in the long term. The interaction of acidic water with metals can change metal speciation and increase the mobility and bioavailability of metals in the aquatic environment, thereby altering the toxicological implications of exposure. Low pH, such as what naturally occurs in the fish and fish habitat study area can mobilize surface-bound metals, leading to increased potential for toxic effects on fish. The toxicology of mixtures of metals and other chemicals in the aquatic environment is poorly understood, although it is known that antagonistic, additive, synergistic, or potentiating effects are possible outcomes.

Exposure of fish to metals in their aquatic habitat can lead to accumulation of those contaminants in fish tissue. As part of baseline studies, whole body tissue metal analysis was conducted for Dolly Varden collected at two sites downstream of the Project discharge location: one in lower Sulphurets Creek and the other in the Unuk River. The results indicate that fish downstream of the Brucejack Mine Site had naturally high tissue metal residues for certain metals. Concentrations of selenium in Dolly Varden tissue from lower Sulphurets Creek were above the BC MOE tissue residue guideline of 1 µg/g ww (equivalent to approximately 4 µg/g dw using a 75% moisture content conversion; Nagpal 2001; BC MOE 2006). Selenium has been associated with reproductive and developmental toxicity, particularly in egg-laying vertebrates (Chapman et al. 2009).

Concentrations of mercury in some of the analyzed fish from the Unuk River were greater than tissue residue guidelines, which are intended to be protective of consumers of fish such as wildlife and humans. The Canadian Council of Ministers of the Environment and BC tissue residue guideline is 0.033 µg/g ww, which is approximately 0.132 µg/g dw, assuming 75% tissue moisture content. Most or all of the mercury present in fish tissue is likely in the form of methylmercury (CCME 2000); for the purposes of comparison to guidelines, it has been assumed to be 100% methylmercury. Mercury can also bioaccumulate through the food chain and pose a greater risk to higher trophic level organisms. Elevated tissue mercury concentrations in fish have been associated with sublethal effects such as decreased growth, developmental and reproduction abnormalities, and neurological and behavioural

effects (Kidd and Batchelar 2012). However, it is unlikely that the current mercury residues in the fish are directly toxic to the fish. Beckvar, Dillon, and Read (2005) estimate that a mercury tissue residue threshold for fish of 0.2 µg/g ww (approximately 0.8 µg/g dw, assuming 75% tissue moisture) is protective against adverse sub-lethal effects in both juvenile and adult fish. This tissue residue threshold was not exceeded.

Process Chemicals

Chemicals used in ore processing or for environmental protection (e.g., water treatment process chemicals) may be present in the Brucejack Mine Site during all Project phases and may pose a risk of toxicity to downstream fish and fish habitat in the LSA and RSA. Metal concentrates produced at the mill building will be present in the Brucejack Mine Site during the Operation phase. Process chemicals are introduced after the water treatment process, in the mill building, and may be released in discharge effluent during the normal course of Project activities.

Important or heavily used chemicals that will be used during Project activities include potassium amyl xanthate (PAX; ore processing), lime and/or NaOH (water treatment), hydrochloric acid (water treatment), and flocculants (water treatment). Sodium cyanide will not be used as a process chemical in the mill building, and thus will not be present in the discharge from Brucejack Lake.

PAX is used as a collector in the flotation step of ore processing. There is limited information available on the persistence or toxicity of this chemical in the environment. However, Vigneault, Desforges, and McGeer (2009) report that at concentrations of 0.5 mg/L, PAX can impair algal growth, although an aquatic invertebrate and a macrophyte were shown to be less sensitive. Lime, at high concentrations, can be hazardous to fish and fish habitat. In general, a pH of 9 or more will cause mortality in most fish species (Ye and Randall 1991). When exposed to lower levels of alkalinity, fish experience impaired ammonia excretion and sodium influx that may result in changes to blood ammonia levels (Ye and Randall 1991).

For aquatic invertebrates, flocculants can also interact with sensory surfaces such as antennae, leading to immobilization and death. Therefore, direct effects on aquatic resources can have an indirect effect on fish growth and fecundity. Some flocculants have been shown to cause acute lethality to fish, and toxicity is dependent on the charge associated with the compound (anionic, cationic, non-ionic). Anionic or non-ionic flocculants have a much lower toxicity, with LC50 values typically greater than 100 mg/L, although some (e.g., MagnaFloc 10) are reported to impair Rainbow Trout survival at 18 µg/L (Vigneault, Desforges, and McGeer 2009).

Petroleum Products

Potential Project-specific activities where petroleum products may be present include all Project access roads, the Brucejack Transmission Line, Bowser Aerodrome, and the Knipple Transfer Area. Fish and fish habitat are present within or near the above listed Project infrastructure. Release of petroleum products could occur during the Project's Construction, Operation, and Closure phases due to a number of Project activities. Routine Project-related traffic creates a risk of diesel fuel or lubricants entering fish habitat, either directly or due to runoff associated with precipitation. Vehicles on access roads will range from ATVs to large fuel supply trucks (gasoline or diesel) with up to 20,000-L capacity. A worst-case scenario would be an accident and spill from a 20,000 L fuel truck. Fuel trucks will make 20 to 25 trips a month during Operations. Activities involving mechanized equipment in or near waterways, such as road, bridge, dam, or other infrastructure construction and activities during Closure and Post-closure reclamation can lead to introduction of small amounts of fuel, oil, or petroleum-based lubricants into the aquatic environment.

Most petroleum products that may enter waterways during normal Project activities (e.g., gasoline, diesel, fuel oil, and lubricants) are toxic to fish and can cause mortality at high enough levels (Tagatz 1961; Hedtke and Puglisi 1982; Lockhart et al. 1996). Acute and chronic stress responses, as indicated by alteration in blood chemistry and cortisol production, can lead to behavioural changes such as decreased feeding activity, growth, and changes in swimming behaviour (Struhsaker 1977; Little and DeLonay 1996).

Contamination of aquatic resources leading to decreased productive capacity could potentially occur if petroleum products are released to the aquatic environment. Localized contamination of sediments may occur, since most petroleum products have constituents that are hydrophobic and will move from the water to the sediment. Accidental release of petroleum products (e.g., diesel fuel) have been shown to reduce primary and secondary producer densities and alter community structure (Lytle and Peckarsky 2001).

Nitrogen and Phosphorus

Introduction of nitrogenous compounds and phosphorus into the aquatic environment may occur as a result of Project activities involving nitrogen-based explosives and disposal of effluent from the Brucejack Mine Site sewage treatment plant. The primary nitrogenous compounds that may be a concern include ammonia, nitrate, and nitrite.

Blasting residues, composed of nitrogen species, will be generated during the Construction and Operation phases for the Project, but only within the Brucejack Mine Site. Fish are not located within the Brucejack Mine Site and are approximately 21 kilometres (km) downstream from Brucejack Lake; therefore, blast residues were not considered further in this effects assessment because potential effects would be negligible at that distance.

Potential sources of effluent containing both nitrogenous compounds and phosphorus include the Brucejack Mine Site sewage treatment plant during the Construction, Operation, and Closure phases. All other camps associated with the Project will include a septic field; therefore, there will be no discharge to surface waters and introduction of nitrogenous compounds and phosphorus into the aquatic environment will not occur. Effluent from the Brucejack Mine Site sewage treatment plant (discharge into Brucejack Lake) may have nitrogen (including both ammonia and nitrate) and phosphorus which, if not treated properly, can contribute to alterations in productive capacity and eutrophication, as well as the potential for toxicity to fish (CCME 2004) in downstream environments (lower Sulphurets Creek).

Nitrogen loading can increase the potential for eutrophication in aquatic systems if there are sufficient macronutrients (e.g., phosphorus), micronutrients (e.g., iron), light for primary production, and nitrogen is in limited supply. This could degrade water quality and alter primary producer growth and community composition away from baseline conditions if the system is nitrogen limited. Community shifts such as these may have a cascading effect, leading to changes in the structure of several successive trophic levels, including fish. On a population scale, continued exposure to elevated levels of nutrients could lead to changes in species diversity and abundance relative to control areas (Grigg 1994).

Nitrogenous compounds in high enough concentrations can be toxic (lethal) to all life history stages of fish due to gill and other tissue damage (Lewis and Morris 1986; Servizi and Gordon 1990; Camargo, Alonso, and Salamanca 2005), and at lower concentrations can cause sub-lethal effects such as a general stress response (Wendelaar Bonga 1997), decreased growth (Smith and Suthers 1999; Saborido-Rey et al. 2007), and decreased swimming performance (Smith and Suthers 1999; Saborido-Rey et al. 2007).

Based on the most likely Project-related pathways that would cause an effect on fish and fish habitat, the following direct potential effects and pathways were assessed:

- toxicity of fish due to metal or process chemical exposure associated with the Brucejack Lake discharge;
- toxicity of fish due to introduction of petroleum products into aquatic environments during normal Project activities; and
- toxicity of fish due to introduction of nitrogenous compounds associated with blasting residues or sewage.

The following indirect potential effects and pathways were assessed:

- change in fish growth, fecundity, and bioenergetics from alterations in primary and secondary productivity due to metal or process chemical exposure associated with the Brucejack Lake discharge;
- change in fish growth, fecundity, and bioenergetics from alterations in primary and secondary productivity due to introduction of petroleum products into aquatic environments during normal Project activities; and
- change in fish growth, fecundity, and bioenergetics from alterations in primary and secondary productivity due to introduction of nitrogenous compounds associated with blasting residues or sewage.

Mitigation Measures

In addition to the specific mitigation measures outlined for each class of chemical in the following sections, a comprehensive Aquatic Effects Monitoring Plan (Section 29.3) will be implemented. This monitoring plan will detect alterations to the receiving environment, including changes to fish health. Additional monitoring to fish health will be triggered if alterations in water quality and aquatic resources are detected. This plan will include provisions for identification of causes of alteration and implementation of additional mitigation measures or adaptive management strategies, if effects are identified.

Mitigation for Metals

The ML/ARD Management Plan (Section 29.10) outlines measures that will be implemented to decrease the potential for impacts due to acid generation and subsequent mobilization of metals associated with PAG rock. Under this plan, more than half of the waste rock will be re-deposited in the underground mine, and an estimated two million tonnes will be subaqueously stored in the southwest corner of Brucejack Lake. Freshwater diversion channels will be constructed to divert non-contact water away from Project infrastructure. Water that has been in contact with PAG material or mine infrastructure will be directed to the contact water pond and then to water treatment. This water may be expected to be acidic and contain higher concentrations of metals. In the mill building, a water treatment process will be applied to treat groundwater from the underground workings, runoff from the plant site excavation, and from the temporary waste rock stockpile. This process will decrease the concentrations of some metals and ions and adjust the pH from acidic to a more neutral pH. Discharges from the water treatment plant will occur during the Operation phase of the Project year-round and will be closely managed to minimize potential for effects in the receiving environment (i.e., Brucejack Creek). The potential for water quality effects in Brucejack Creek (the receiving environment) will be monitored regularly through the implementation of an Aquatic Effects Monitoring Plan (Section 29.3).

Mitigation for Process Chemicals

The handling and storage of all process chemicals will follow BMPs, and general transportation, storage, and handling requirements that are outlined in a Hazardous Materials Management Plan (Section 29.7). These measures include:

- MSDSs will accompany all goods and materials, including process chemicals;
- non-compatible materials will be transported in separate shipments;
- fire extinguishers and fire prevention materials will be adequate and appropriate for the material being transported;
- containers will be appropriate for the material being shipped;
- containers will be properly secured;
- containers and trucks will be properly marked, labelled, and placarded;
- manifests will be maintained in accordance with federal and provincial regulations;
- spill response materials will be adequate and appropriate for the materials being transported;
- drivers will be adequately trained and equipped for spill first response, containment, and communication;
- knowing which hazardous materials are on site through the maintenance of an inventory system;
- allocating clear responsibility for managing hazardous materials, including process chemicals;
- understanding the actual or potential hazards and environmental impacts associated with the storage and handling of these materials;
- minimizing the use and/or generation of hazardous materials, including process chemicals;
- constructing storage facilities that safely contain the materials in all foreseeable circumstances;
- implementation of physical controls and procedures to ensure that no materials escape during routine operation as well as in upset conditions. An example would be the containment of the fuel storage area with an impervious membrane under gravel to collect any spillage;
- having an emergency response plan in place to ensure immediate action to minimize the environmental effects should accidental or unplanned releases occur;
- monitoring all discharges and reporting unplanned discharges should they occur; and
- accurate record keeping and appropriate reporting of events and accidents.

The Spill Prevention and Response Plan provides additional information on response plans in the event of any spills of hazardous materials, including process chemicals. A Project-wide communication system will ensure rapid notification of any observed spills. In addition to all staff having basic spill response training appropriate to their positions, the site will have a trained emergency response team with resources to contain and recover spills so as to reduce their size and thus reduce any related potential adverse environmental impact. Storage areas and transfer stations will have spill kits appropriate for the products being handled. On-site equipment will include a comprehensive spill recovery kit (containing items such as absorbent pads and booms, skimmers, and dike materials) that will be ready to be loaded on a truck for rapid deployment to any spill scene. This kit will be easily transferable to enable delivery by helicopter if required.

The concentration of the flocculant is expected to be below levels that would cause adverse effects to aquatic life. Tailings will be flocculated in the tailings thickener; this water would then be discharged with the tailings to Brucejack Lake. Flocculant compounds with lower toxicity (non-ionic or anionic flocculants) will preferentially be used.

Mitigation for Petroleum Products

Petroleum products will be in use during the Construction, Operation, and Closure phases. To minimize the effects on fish and fish habitat, several mitigation measures relating to petroleum products will be required. Mitigation strategies will be tailored to address Project-specific issues associated with petroleum product introduction into aquatic environments. Mitigation objectives outlined in accordance with DFO's *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO 1993), *Standards and Best Practices for Instream Works* (BC MWLAP 2004), and Pacific Region Operational Statements (DFO 2007) which all provide guidelines for the mitigation of petroleum product effects and spills on the aquatic environment.

Petroleum product introduction into the aquatic environment will be mitigated through the implementation of BMPs, particularly in the Construction and Operation phases. BMPs relating to petroleum spills are managed within the framework of a Spill Prevention and Response Plan (Section 29.14). This plan provides performance-based environmental specifications for preventing and controlling the release of spills during the Construction, Operation, and Closure phases to minimize adverse effects to downstream water quality. Specific BMPs relating to the mitigation and/or minimizing of effects caused by petroleum product introduction into the aquatic environment outlined in this plan include:

- environmental monitoring;
- adhering to appropriate construction operating windows for instream work;
- fuel stored in bermed and lined containment facilities to prevent seepage into the soil;
- inspection of all equipment and machinery prior to and during instream/riparian work to ensure that it is clean and free of leaks;
- use of biodegradable fluids (fuels and oils) for machinery working within 30 m of any stream;
- placement of drip pans and spill pads underneath pumps or other stationary machinery within riparian areas;
- provision of readily accessible spill kits in all areas where machinery or fuel tanks will be used, stored, or refuelled, and training of personnel in their use prior to beginning construction;
- spill control measures; and
- an emergency response plan.

These measures will be monitored and modified, as necessary, to ensure compliance with regulatory requirements and BMPs. When instream work occurs, an Environmental Monitor will be on site monitoring water quality, and for activities near areas of fish-bearing waters, appropriate fisheries operating window requirements for fish-bearing streams will be adhered to. In certain circumstances, instream work may need to occur outside of the least risk windows. Therefore, necessary permits will be obtained from appropriate agencies and work will comply with necessary conditions.

Mitigation for Nitrogen and Phosphorus

Secondary-treated effluent from the Brucejack Mine Site sewage treatment plant will be discharged to Brucejack Lake. This is not expected to have an effect outside of the initial dilution zone due to high dilution ratios, existing poor sediment and water quality in these areas, limited aquatic life (periphyton and benthic invertebrates), and the absence of fish in these areas. Fish exposure to sewage effluent spills or leaks to streams is not expected to occur with proper design and engineering of the sewage disposal systems.

Potential for Residual Effect

Water quality modelling was conducted to predict the total concentrations of the various metals, including process chemicals, nitrogen and phosphorus, due to all mine effluent discharges to Brucejack Creek. These predictions are based on mean and maximum water chemistry and hydrology and represent the water quality that is most likely to occur during the Operation, Closure, and Post-closure phases of the Project. Water quality was modelled at Site BJ 200 m downstream of Brucejack Lake. At this site, a total of four contaminants of potential concern (COPC; arsenic, zinc, chromium, and total aluminum) had hazard quotients (HQs) greater than 1.0. These fours COPCs (or any other Project related metal, process chemical, nitrogen or phosphorus) due to the Project are not expected to result in the potential for residual effects in the fish-bearing reach of Sulphurets Creek or the Unuk River. This is because Brucejack Creek discharges to the upper reach of Sulphurets Creek (glacial reach upstream of Sulphurets Lake) in which metal contents are orders of magnitude larger than in Brucejack Creek, as a result the COPC concentrations would be greatly reduced to HQs less than 1.0. By the time a COPC reaches fish-bearing waters, 21 km downstream of Site BJ 200 m, the COPC concentration would be greatly reduced to HQs less than 1.0. Therefore, potential effects associated with metals, process chemicals, nitrogen, and phosphorus are not expected to have a residual effect on fish and fish habitat.

No significant effects to fish populations are predicted to occur from the result of accidents and malfunctions. This is largely due to the low probability of an accident creating a large scale fuel spill after preventative measures were in place. Furthermore, the immediate detectability of a spill and availability of standardized of mitigation measures greatly diminishes the residual effects after a spill.

Significance of Residual Effect

N/A

33.1.1.4 Habitat Loss

Potential Effect

There is no fish or fish habitat within the Brucejack Mine Site. Potential Project-specific fish habitat loss includes access roads, the Brucejack Transmission Line, Bowser Aerodrome, and the Knipple Transfer Area. Habitat loss can take place during the Construction, Operation, and Closure phases of a number of Project activities. Fish habitat loss refers to removing or physically altering aspects of the environment that are directly or indirectly used by fish. More specifically, fish habitat loss can refer to the removal of riparian and instream habitat, and the restricting of fish passage. Habitat loss or alteration due to water quantity changes was not considered a potential effect for the Project because there will be no interaction between water quantity changes and fish. Fish are not present within Brucejack Lake and Creek (21 km downstream in Lower Sulphurets Creek) and water quantity changes in Sulphurets Creek are not predicted.

Mitigation Measures

To mitigate fish habitat and passage effects related to the Brucejack Access Road maintenance of fish-bearing stream crossings, any work performed will follow DFO's (2007) operational statements for bridges and culverts and *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO 1993). Efforts will be undertaken to minimize potential effects from the Project on fish habitat and passage, and to avoid fish habitat loss. If any instream work within fish-bearing streams should occur, an environmental monitor will be on site monitoring water quality. Appropriate fisheries operating windows for fish-bearing streams will be adhered to whenever feasible. Alternatively, appropriate permits will be acquired for out-of-window activities. Instream fish habitat loss related to the maintenance and use of the Brucejack Access Road is not anticipated through the Construction, Operation, Closure, and Post-closure phases of the Project.

Only one fish-bearing stream crossing is required along the proposed transmission line, which is the Bowser River. The placement of a transmission line over the Bowser River is not considered to result in habitat loss because existing tree and shrub riparian habitat already meet clearance standards for overhead transmission lines. Therefore, no additional trees will be removed within the riparian zone of the Bowser River crossing.

To protect fish habitat near project infrastructure, such as the Bowser Aerodrome and Knipple Transfer Area, appropriate riparian zones will be applied as per the BC *Forest and Range Practices Act* (2002b).

Potential for Residual Effect

Project-specific instream and riparian habitat loss in areas of fish habitat are not anticipated through the Construction, Operation, Closure, and Post-closure phases of the project.

Significance of Residual Effect

N/A

33.1.1.5 Summary of Effects to Fish and Fish Habitat

A summary of the changes to fish and fish habitat from the Project is presented in Table 33.1-1. No significant effects are predicted for fish or fish habitat. The residual effects identified in Table 33.1-1 were carried through to a cumulative effects analysis. This analysis found that there were no significant residual cumulative environmental effects for fish and fish habitat (Table 33.1-1).

33.1.2 Aquatic Species at Risk

No aquatic species at risk listed under the *Species at Risk Act* (2002c) occur in the Project area or have the potential to be affected by the Project.

33.1.3 Migratory Birds

Migratory waterbirds and migratory landbirds birds were included as a receptor VC in the Project's environmental assessment. The effects assessment for migratory birds was split into two categories—migratory waterbirds and migratory landbirds—as each of these cohorts have unique habitat requirements and may be affected by the Project in different ways. The key effects to both migratory waterbirds and migratory landbirds were identified as: habitat loss and alteration, sensory disturbance, direct mortality, and attractants.

Table 33.1-1. Summary of Residual Effects, Mitigation, and Significance on Fish and Fish Habitat

Residual Effects	Project Phase(s)	Mitigation Measures	Significance of Residual Effects	
			Project	Cumulative
Fish				
Blunt tissue trauma causing mortality to all fish life stages	Construction Operation Closure	Use of best management practices to minimize fish mortality with construction machinery; Adhere to DFO's operational statements; Adhere to appropriate construction operating window for instream work; Site isolation; Controlled access; Implement no fishing policy for employees	Not significant	Not significant
Erosion and sedimentation causing smothering of eggs, decreased feeding efficiency, habitat avoidance	Construction Operation Closure	Use of best management practices to minimize sediment entry to waterbodies; Adhere to DFO's operational statements; Adhere to appropriate construction operating window for instream work and the Soils Management Plan (Section 29.13); Riparian re-vegetation; Dust suppression on roads; Site isolation; Water quality maintenance	Not significant	Not significant
Fish Habitat				
Erosion and sedimentation causing habitat loss	Construction Operation Closure	Use of best management practices to minimize sediment entry to waterbodies; Adhere to DFO's operational statements; Adhere to appropriate construction operating window for instream work and the Soils Management Plan (Section 29.13); Riparian re-vegetation; Dust suppression on roads; Site isolation; Water quality maintenance	Not significant	Not significant

33.1.3.1 Habitat Loss and Alteration

Potential Effect

Migratory bird habitat will be lost or altered through the Project's Construction and Operation phases at the Brucejack Mine Site assessment footprint (i.e., Project footprint and buffers). Because cohorts of migratory birds (i.e., wetland, cavity-nesting, riverine, and landbird) have unique habitat requirements, the assessment of habitat loss and alteration was considered by cohort.

Wetland Migratory Bird Habitat Loss and Alteration: A total of 4.4 hectares (ha) of wetland migratory bird habitat will be lost or altered due to the Project during the Operation phase. This loss represents 0.05% of the suitable wetland habitat available in the RSA and 0.53% in the LSA. The majority of wetland habitat loss will occur within the Brucejack Mine Site assessment footprint (4.1 ha; 92.7%); the remaining wetland loss will be along the Brucejack Transmission Line (0.3 ha; 7.3%; Figure 18.6-18b).

Cavity-nesting Migratory Waterfowl Habitat Loss and Alteration: For cavity-nesting waterfowl, the loss or alteration of mature forest within 1 km of wetlands was calculated. A total of 41.7 ha of suitable cavity-nesting habitat will be lost due to the Project during the Operation phase. This represents approximately 0.07% of available habitat within the RSA and 0.68% in the LSA. The majority (96%;

40.1 ha) of cavity-nesting habitat will be lost due to the Brucejack Transmission Line. This habitat type will not be lost or altered within the Brucejack Mine Site assessment footprint.

Migratory Riverine Bird Habitat Loss and Alteration: A total of 0.8 km of suitable riverine habitat will be lost or altered due to Project development during the Operation phase. The total lost or altered habitat represents 0.16% of available riverine habitat in the RSA and 1.37% in the LSA. The majority of this habitat is within the Brucejack Mine Site assessment footprint (61%); the remaining habitat is along the Brucejack Transmission Line (34%) and at the Tide Staging Area (5%).

Migratory Landbird Habitat Loss and Alteration: Direct habitat loss and alteration (i.e., Project assessment footprint) would occur wherever forest stands are cleared. Most songbirds are sensitive to habitat features such as vegetation composition and vertical stratification, snags, and the age of trees within a stand (Harrison, Schmiegelow, and Naidoo 2005). In addition to direct removal of forest stands, removal of snags and other debris from otherwise open areas can constitute habitat loss for species that rely on these features. As landbirds are ubiquitous throughout the study areas, habitat loss and alteration was calculated for all the Biogeoclimatic (BEC) subzones within the LSA (excluding 341 ha of previously disturbed habitat along the access road within the LSA) and RSA that overlapped with the individual Project components. Overall, at the end of the Operation phase, 388 ha (0.16% of the RSA, 2.5% of the LSA) of migratory landbird habitat will be removed or altered (Table 18.6-16). The majority of this loss and alteration will occur in the Coastal mountain heather-alpine undifferentiated Biogeoclimatic subzone (234 ha) at high elevation near the Brucejack Mine Site, and the Englemann Spruce Subalpine-fir very wet cold Biogeoclimatic subzone (138 ha) along the Brucejack Transmission Line and Bowser Aerodrome.

Mitigation Measures

To mitigate potential Project-related changes to migratory bird habitat a Wildlife Management and Monitoring Plan (Section 29.21) will be implemented. Mitigation activities described in that plan include:

- Active bird nests will not be disturbed or destroyed during site clearing for infrastructure.
- Vegetation clearing activities will be scheduled outside of the general breeding period for waterbirds and landbirds (April 1 to July 31) to avoid contravention of Section 34 of the BC *Wildlife Act* (1996), where practical.
- If clearing must be completed during the breeding period, pre-clearing surveys will be conducted to identify locations of active nests and disturbance-free buffers applied until the nest is inactive.
- Harlequin duck pair surveys will be conducted prior to any work on crossings of streams with wet widths greater than 10 m. If any nests are identified, buffer zones of 50-m radius will be maintained throughout the breeding season, where possible, or the appropriate regulators will be consulted to develop appropriate strategies.

Residual Effect

After the implementation of mitigation measures, the effect of habitat loss and alteration is not predicted to result in a residual effect for either migratory waterbirds or landbirds.

Significance of Residual Effect

N/A

33.1.3.2 Sensory Disturbance

A potential source of migratory bird sensory disturbance associated with the Project includes elevated noise levels due to Project Construction and Operation. The potential consequences of disturbance include functional loss of habitat due to avoidance, increased energetic costs due to decreased foraging time and increased flying time, nest abandonment and increased predation rates, and reduced reproductive success (Hockin et al. 1992).

A GIS analysis was conducted to determine the amount of migratory waterbird and landbird habitat that could be functionally lost or disturbed due to Project and traffic noise averaged throughout the day. When analyzing increased noise levels due to the Project, a 45 dBA Ln noise contour was used. The area of migratory waterbird and landbird habitat that falls within the 45 dBA noise modelling contours was calculated. Again, because cohorts of migratory birds (i.e., wetland, cavity-nesting, riverine, and landbird) have unique habitat requirements, the assessment of functional habitat lost due to sensory disturbance was considered by cohort.

Potential Effect

Migratory Wetland Birds: The total wetland area that will be functionally lost or disturbed as wetland bird habitat within the 45 dBA and greater sound contour is 41 ha (0.5% of the RSA, 5% of the LSA) during Construction and 51 ha (0.6% of the RSA and 6% of the LSA) during Operation (Table 33.1-2). The majority of the area affected during Construction is the Knipple Transfer Area, Bowser Aerodrome, and Brucejack Mine Site, while the majority of disturbance during Operation will be associated with the Bowser Aerodrome and Knipple Transfer Area.

Table 33.1-2. Functional Loss of Suitable Wetland Bird, Cavity-nesting Waterfowl, and Riverine Bird Habitat due to Sensory Disturbance during Construction and Operation

		Project Noise (45 dBA)		
		Functional Habitat Lost (ha)	Suitable Habitat[1] Lost (%)	
Waterbird Group	Project Phase		Regional Study Area	Local Study Area
Wetland bird	Construction	41	0.5	4.9
	Operation	51	0.6	6.2
Cavity-nesting waterfowl	Construction	121	0.2	2.0
	Operation	90	0.2	1.5
Riverine bird[2]	Construction	2 km	0.4	3.3
	Operation	3 km	0.6	5.1

[1] Suitable habitat refers to high-quality habitat in the RSA and LSA; see text for definition of high-quality habitat.
[2] Area of functional habitat lost is given in length of stream (km) rather than area.

Migratory Cavity-nesting Waterfowl: The total area of cavity-nesting habitat that will be functionally lost or disturbed within the 45 dBA and greater sound contour is 121 ha (0.2% of the RSA, 2% of the LSA) during Construction and 90 ha (0.2% of the RSA and 1.5% of the LSA) during Operation (Table 33.1-2). The majority of the disturbed habitat during Construction and Operation is associated with the access road between Highway 37 and the Bowser Aerodrome.

Migratory Riverine Birds: The total length of riverine habitat that will be functionally lost or disturbed within the 45 dBA and greater sound contour is 2 km (0.4% of the RSA, 3.3% of the LSA) during Construction and 3 km (0.6% of the RSA, 5.1% of the LSA) during Operation (Table 33.1-2). The majority of the disturbance will occur near the Bowser Aerodrome and Knipple Transfer Area during both Construction and Operation.

Migratory Landbirds: The total area of suitable migratory landbird habitat within the RSA that may be disturbed due to continuous Project noise is 881 ha (0.36% of the RSA, 4.9% of the LSA) during Construction and 523 ha (0.21% of the RSA, 3.3% of the LSA) during Operation. The majority of Construction disturbance will be associated with the Brucejack Mine Site (495 ha) and along the access road from the highway to the Bowser Aerodrome (153 ha). The majority of Operation disturbance will be associated with the Knipple Transfer Area, Browser Aerodrome (245 ha), and the Brucejack Mine Site (188 ha).

Mitigation Measures

To reduce the potential Project-related effects to migratory birds as a result of sensory disturbance, a noise management plan will be developed with the objective to ensure that noise levels during all phases of the Project are acceptably low for migratory bird receptors. The following noise mitigation measures will be implemented:

- noise specifications will be considered when selecting equipment to purchase;
- vehicles will be maintained regularly;
- speed limits will be imposed;
- mufflers will be installed on vehicles and maintained;
- noise dampening measures will be applied where possible;
- pre-determined flight paths will be used by helicopters and fixed wing aircraft, that will have a vertical buffer distances of at least 300 m, where possible, from sensitive habitats and known areas of wildlife use;
- pilot education regarding the negative effects of over-flights on wildlife species and the importance of maintaining a minimum prescribed altitude when possible above wildlife species and identified sensitive habitat areas; and
- noise will be monitored periodically at various human and wildlife receptor locations, as part of the Noise Management Plan (Section 29.11) and mitigation strategies will be adjusted accordingly, if required. Noise monitoring locations will be at locations to enable confirmation of noise modelling and effects assessment.

General mitigation measures will be implemented as part of the Wildlife Management and Monitoring Plan that will also reduce the effect of sensory disturbance to migratory birds. These measures are listed below.

- Active bird nests will not be disturbed or destroyed during site clearing for infrastructure.
- Vegetation clearing activities will be scheduled outside of the general breeding period for waterbirds and landbirds (April 1 to July 31) to avoid contravention of Section 34 of the BC *Wildlife Act* (1996), where practical.
- If clearing must be completed during the breeding period, pre-clearing surveys will be conducted to identify locations of active nests and disturbance-free buffers applied until the nest is inactive.
- Harlequin duck pair surveys will be conducted prior to any work on crossings of streams with wet widths greater than 10 m. If any nests are identified, buffer zones of 50-m radius will be maintained throughout the breeding season, where possible, or the appropriate regulators will be consulted to develop appropriate strategies.

Residual Effect

The effect of sensory disturbance is not anticipated to result in a residual effect on migratory birds. The extent of the wetlands, cavity-nesting habitat, and riverine, and landbird habitat that are considered functionally lost or disturbed due to noise is less than 1% of the available habitat in the RSA for any group regardless of the Project phase (Table 33.1-2). Due to the small area of disturbed habitat, no residual effect of sensory disturbance on migratory waterbirds or landbirds is anticipated.

Significance of Residual Effect

N/A

33.1.3.3 Direct Mortality

The potential sources of migratory bird mortality in association with the Project are nest destruction during clearing operations, and collisions with the Brucejack Transmission Line.

Potential Effect

Vegetation Clearing

Construction activities could result in direct mortality of migratory birds through clearing of vegetation that is actively used for nesting.

Transmission Line

Direct mortality of migratory birds from collisions with or electrocutions by transmissions lines can occur, but is a relatively rare occurrence. The risk of mortality when migratory birds collide with transmission lines is primarily based on the type of line and the configuration of electrical hardware and support structures (Lehman, Kennedy, and Savidge 2007). The majority of collisions with transmission lines occur in specific habitats such as next to wetlands (Bevanger 1998), between nesting and foraging areas (Savereno et al. 1996), near and parallel to shores (Cooper and Day 1998), in valleys and river valleys (Bevanger 1998; Moritzi et al. 2001), and along ridge lines where soaring birds congregate on thermal updrafts (Barrios and Rodriguez 2004). Poor weather and visibility may increase the frequency of collisions, particularly in regularly used areas (e.g., migration corridors, approach flyways to nests; Bevanger 1998). Migratory waterfowl, in particular, are sensitive to collisions with transmission lines because of their poor manoeuvrability (Bevanger 1998; Cooper and Day 1998; Moritzi et al. 2001; Erickson, Johnson, and Young Jr 2005; Barrett and Weseloh 2008). Juvenile species that have not yet mastered the flight capabilities of adults are also at a greater risk of transmission line collisions (Bevanger 1998).

Migratory birds may use transmission line infrastructure for nest building, or for perching on insulators, energized equipment (transformers), and/or between conductors. This attraction may increase the possibility of electrocution. Frequent perching on insulators can lead to the accumulation of bird guano, known as streaming. Streaming inhibits the insulation qualities, causing an electrical fault; although mortality due to this is rare (Vosloo 2009).

Vehicle Collisions

Direct mortality of birds, particularly flocking species, may occur because of traffic along the access road. Most road mortalities to these species occur during winter or early spring (Campbell et al. 1997). Carduelinae finches are particularly vulnerable to vehicle collisions on highways, as they are attracted to road salts, gravel, and sand (Mineau and Brownlee 2005).

Mitigation Measures

Vegetation Clearing

General mitigation measures will be implemented as part of the Wildlife Management and Monitoring Plan that will also reduce the effect of direct mortality due to vegetation clearing to migratory birds.

- Active bird nests will not be disturbed or destroyed during site clearing for infrastructure
- Vegetation clearing activities will be scheduled outside of the general breeding period for waterbirds and landbirds (April 1 to July 31) to avoid contravention of Section 34 of the BC *Wildlife Act* (1996), where practical.
- If clearing must be completed during the breeding period, pre-clearing surveys will be conducted to identify locations of active nests and disturbance-free buffers applied until the nest is inactive.
- Harlequin duck pair surveys will be conducted prior to any work on crossings of streams with wet widths greater than 10 m. If any nests are identified, buffer zones of 50-m radius will be maintained throughout the breeding season, where possible, or the appropriate regulators will be consulted to develop appropriate strategies.

Transmission Line

The Transmission Line will be monitored by technicians to ensure design features implemented to minimize interactions with birds are in good condition, and will be repaired and/or replaced if necessary. If carcasses are found, these will be recorded and reported.

Vehicle Collisions

Speed restrictions can be imposed to reduce incidences of vehicle-wildlife collisions. Direct mortality rates of wildlife species have been shown to drop dramatically below 70 km/hour (Seiler 2005; Ng, Nielson, and St Clair 2008). The maximum speed limit on access road will be 40 km/hour, which will result in substantially reduced mortality to migratory birds, compared to what would be expected along typical highways. During the winter months, mortality of Carduelinae finches is a concern. Mitigation on the access road may include the monitoring of winter flocking bird (e.g., finch) mortality and timing of de-icing sand (no salt added) to reduce excessive use (Jacobson 2005).

Residual Effects

After mitigation measures are applied, there are no anticipated residual effects to migratory birds resulting from direct mortality.

Significance of Residual Change

N/A

33.1.3.4 Attractants

Potential Effect

Features or materials associated with the Project that interest or provide resources to migratory birds are considered to be attractants. The Project contains both features and materials that have the potential to attract migratory birds. Project infrastructure and activities with the potential to attract migratory birds include:

- refuge, shelter, nesting, perching, or roosting habitat provided by Project structure; and
- ponds or ditches created by development that provide water and aquatic habitat.

Structures (e.g., buildings, adits, towers) can act as attractants and can affect migratory birds. Migratory birds that use Project infrastructure may be at risk of mortality since their presence can interfere with mechanical functions of equipment. A small portion of the upland migratory bird community may be attracted to the areas close to the Project footprints or to Project infrastructure for establishment of breeding territories. It is possible that birds may use Project infrastructure as habitat (e.g., elevated sites for perching, singing, and nesting). Barn swallow displayed nesting behaviour at Pretium Resources Inc. (Pretivm) exploration camps and a nest was recorded at the site of the proposed Brucejack Transmission Line (Rescan 2013).

Brucejack Lake was not identified as being suitable habitat for waterbirds.

Mitigation Measures

Mitigation of attractants typically takes a two-tiered approach. First, positive behavioural stimuli are removed, such as limiting high-quality forage on road verges. Second, if wildlife are still attracted to the feature, then negative reinforcement is used to dissuade them from returning.

Mitigation strategies that are designed to reduce the effect of attractants on migratory birds VCs will include, but are not limited to:

- avoiding use of salt included in traction grit being used for winter road management;
- limiting access to infrastructure by birds and removing nesting material prior to egg-laying; and
- monitoring and adaptive management of the use of physical structures by wildlife for security habitat (refuge, shelter), daily activities (roosting, perching), or nesting purposes.

Monitoring of migratory waterbird use of Brucejack Lake will be conducted; if species are attracted to the area and it is considered a potential hazard, measures will be taken to prevent migratory waterbirds from using these areas.

Residual Effect

After mitigation, no residual effects on migratory birds are anticipated due to attractants.

Significance of Residual Effect

N/A

33.1.3.5 Summary

After all mitigation measures are applied, no residual effects on migratory birds are predicted to result from the Project. As no residual effects were predicted for migratory birds, no cumulative effects are predicted and no cumulative effects analysis was performed.

33.2 CHANGES TO THE ENVIRONMENT THAT WOULD OCCUR ON FEDERAL OR TRANSBOUNDARY LANDS

Pursuant to Section 5(1)(b) of the *Canadian Environmental Assessment Act, 2012* (2012), a federal EA must consider changes to the environment that would occur on federal lands, in a province other than the one in which the Project is being conducted, or outside Canada.

The Project occurs entirely on provincial Crown Land. The nearest federal lands to the Project are the port at Prince Rupert (240 km), Gwai Haanass Nation Park Reserve and Haida Heritage Site (416 km), the Kuldoe Indian Reserve (156 km), and the Andimaul Indian Reserve (206 km). No federal lands are anticipated to be affected by the Project.

The Project is located 45 km from the Canadian border with Alaska, as measured along the Unuk River. Potential transboundary changes may result if the Project will result in any changes to water quality or quantity of the Unuk River at the international border. As well, air emissions from the Project activities may also affect air quality in Alaska. The Project will not cause changes to any other Canadian or International jurisdictions.

As the Project is located close to the Canadian border with Alaska, transboundary effects may occur through degradation of air quality, although modeling results predict that these effects will not occur at the border. The RSA for this study is defined as the model domain where dispersion modelling will be conducted. The RSA is a 30 km by 30 km square centred at the Brucejack Mine Site. This area is expected to be sufficiently large to include all isopleths that represent 10% of the ambient air quality objective. The Canadian/US boundary is approximately 10 km outside of the RSA (nearest distance); no transboundary changes to air quality are expected.

The Project will discharge tailings and waste rock into Brucejack Lake during Operations. Brucejack Lake drains to Sulphurets Creek and ultimately to the Unuk River. These activities, combined with sediment and water quality control and mitigation measures have the potential to alter flows and water quality in the Unuk River at the international boundary.

33.2.1 Flow Change

33.2.1.1 Potential Changes

Three potential changes of the Project on surface water hydrology were identified. These changes are:

- streamflow changes – Project components and activities could potentially alter streamflow indicators including annual runoff, monthly distribution of runoff, peak flows, and low flows;
- channel morphology alteration – drainage morphology and stability may be affected due to Project activities; and
- effects on glaciers – Project activities may have effects on glacier ablation.

Assessment of these three changes provides a comprehensive understanding of the potential impacts on surface water hydrology. Changes of different components and physical activities of the Project on surface water hydrology during the Construction, Operation, Closure, and Post-closure phases are identified. Project components and physical activities are categorized into four major groups. These are:

- Brucejack Access Road;
- Brucejack Mine Site Water Management Components and Activities;
- Bowser Aerodrome and Knipple Transfer Area; and
- Brucejack Transmission Line.

The Brucejack Access Road, Bowser Aerodrome, Knipple Transfer Area, and Brucejack Transmission Line have the potential to change channel morphology and glaciers along the access road and

transmission corridor which are outside the Unuk River watershed. No transboundary changes are expected.

Brucejack Mine Site Water Management Components and Activities could potentially affect Unuk River streamflows. The remainder of this discussion will focus on changes of the Project on streamflows in the Unuk River at the US/Canada boundary.

33.2.1.2 Mitigation Measures

A variety of diversion, collection, and treatment structures will be developed to manage water for the Project. The primary goals of water management activities are to divert non-contact water and collect contact water for treatment. By minimizing the amount of contact water that is produced on the Project site, surface water diversion reduces the volume of water that must be treated. Additionally, surface water diversion decreases the potential for erosion and sediment production by limiting the volume of water that enters a work area.

A Water Management Plan (Section 29.19) will be implemented to reduce or eliminate the potential effects of the Project on surface water hydrology.

33.2.1.3 Residual Change

Predictive water quantity models and analyses, inclusive of mitigation measures, were developed to estimate streamflows in Brucejack Creek and the downstream receiving environment, Sulphurets Creek and Unuk River. Streamflows were estimated for the Construction, Operation, Closure, and Post-closure Phases. Predicted effects of the Project on streamflows (i.e., mean annual flows, monthly distribution of runoff, and peak and low flows) in the Unuk River at the Canada/US boundary are summarized here:

- *mean annual flows*: during Construction and Operation, annual flows are expected to increase by less than 0.1%. The flows are expected to decrease by less than 0.1% during Closure. At Post-closure, annual flows will be similar to baseline flows.
- *monthly distribution of runoff*: changes from baseline conditions are expected to be negligible.
- *peak flows*: changes from baseline conditions are expected to be negligible.
- *low flows*: during Construction and Operation, low flows are expected to increase by 0.5 %. Low flows are expected to decrease by 0.2% during Closure. At Post-closure, low flows will be similar to baseline flows.

33.2.1.4 Significance of Residual Change

The results of the water quantity predictive study conclude that changes of the Project on streamflows in the Unuk River at the Canada/US boundary are negligible (i.e., within the reasonable data and modelling uncertainty range). As negligible changes are predicted for streamflows at the international border, no cumulative changes are predicted and no cumulative effects analysis was performed.

33.2.2 Water Quality Change in the Unuk River

33.2.2.1 Potential Changes

Changes in surface water quality have the potential to occur through various pathways during the life of the Project, many of which overlap in terms of definition and scope. For the purposes of the surface water quality effect assessment for the Project, six potential effects were identified:

- discharges, including:
  - effluent release (water treatment plant, sewage treatment plant) into Brucejack Creek during the Construction phase;
  - discharge from Brucejack Lake (site of permanent tailings and waste rock disposal);
- ML/ARD;
- erosion and sedimentation;
- leaching of nitrogen residues generated from blasting;
- groundwater and surface water interactions and seepage; and
- atmospheric deposition.

Extensive mitigation and management plans for Project effects on surface water quality were included in the design for the proposed Project. Proposed mitigation strategies include measures to avoid, reduce, and monitor adverse effects to surface water quality.

Predictive water quality models, inclusive of mitigation measures and water treatment, were developed for the Construction, Operation, Closure, and Post-closure Phases for Brucejack Lake and the downstream receiving environment, Brucejack Creek (assessment/objective point: BJ 200m D/S, approximately 800 m downstream from the outlet of Brucejack Lake). The receiving environment (Brucejack Creek) is in the headwaters of Sulphurets Creek, which is a tributary of the Unuk River. The primary objective of water quality modeling for the Project was to predict the concentrations of total and dissolved metals, nutrients, and anions within the Project footprint and in the surrounding surface waters that will receive direct effluent discharge, waste rock and tailings deposition, and/or seepage from Project components. Water quality was semi-quantitatively assessed for the receiving environment outside of the predictive model domains.

The results of the water quality model conclude that water quality at the Brucejack Lake outlet will be in compliance with federal and provincial regulations and suitable for year-round release; it is not anticipated that ongoing water treatment will be required beyond Closure.

The results of the water quality model conclude that there will be no significant residual change for water quality of the receiving environment (Brucejack Creek) as a result of Project activities. Further, incremental increases of water quality parameters due to chemical loading upstream at Brucejack Creek are expected to be negligible/ indistinguishable from background in Sulphurets Creek (mid-field receiving environment). Thus, the potential for any transboundary changes to occur (i.e., change in water quality 45 km downstream of the outflow of Brucejack Lake and Brucejack Creek) is considered extremely unlikely and no Project changes to surface water quality are expected in the Unuk River.

Monitoring of downstream watercourses will be designed and executed to detect any potential changes in water quality as part of the Aquatics Effects Monitoring Plan (Section 29.3) for the Project; adaptive management and mitigation measures will be implemented to manage any potential effects on surface water quality, as required.

As no Project changes are predicted for water quality at the international border, no cumulative changes are predicted and no cumulative effects analysis was performed.

33.2.3 Summary of Transboundary Changes

No effects to federal lands or other Canadian provincial lands are predicted for the Project.

No transboundary changes to air quality, surface water hydrology, and surface water quality are predicted for the Project.

33.3 CHANGES TO THE ENVIRONMENT THAT ARE DIRECTLY LINKED OR NECESSARILY INCIDENTAL TO FEDERAL DECISIONS

Pursuant to Section 5(2) of the *Canadian Environmental Assessment Act, 2012* (2012), a federal EA must evaluate changes to the environment that are directly linked or necessarily incidental to federal decisions as a result of the Project. Table 33.3-1 describes the federal decisions as well as the relevant Project components and activities required for the Project.

Federal decisions may be anticipated under the following enabling legislation for the Project:

- *Explosives Act* (1985a);
- *Navigation Protection Act* (1985d);
- *Radiocommunications Act* (1985e); and
- *Nuclear Safety and Control Act* (1997).

Project activities related to permits required under the *Explosives Act* (1985a), *Radiocommunications Ac*t (1985e), and the *Nuclear Control and Safety Act* (1997) will not result in any effects to the environment (i.e., no or negligible land disturbance will occur) and will not be discussed further.

The proponent is unclear at this time if a permit under the *Transportation of Dangerous Goods Act* (1992) is required for the Project. On May 27, 2014, Pretivm received guidance from the CEA Agency that "the proponent will be responsible for a portion of the transportation of dangerous goods to the mine site, in an area to which public access is controlled. If an ERAP is not required, there is not likely to be a requirement for consideration of effects under Section 5(2). An assessment of Section 5(2) environmental effects between the transfer station and mine site may be required in the EIS." Pretivm has chosen to adopt a precautionary approach and has assessed the environmental effects of the transportation of dangerous goods from the Knipple Transfer Area to the Brucejack Mine Site.

33.3.1 *Navigation Protection Act*

The NPA provides conditions for the approval or permitting by Transport Canada for "works" on the List of Scheduled Waters, as well as for navigable waters for which opt-in requests by work owners under s.(4) of the NPA are accepted. There are no waters affected by the Project on the List of Scheduled waters, and Pretivm has decided to not opt-in to the NPA regime for any waters affected by the Project to date. Some Project works were previously approved and permitted under the *Navigable Waters Protection Act* (1985b); these works are automatically opted into the NPA regime, and any terms or conditions imposed on them remain in effect (Transport Canada 2014). Pretivm has five years to determine if it will choose to opt-out of the NPA regime for these works.

For this Application/EIS, a total of 58 of works interacting with 55 waters were assessed for the Project, including 49 transmission line crossings, seven bridge crossings, and subaqueous tailings and waste rock disposal were assessed to determine if they would have an effect on the ability to safely navigate or access navigable waters within the Project region. Of these, six works have already been permitted by Transport Canada under the *Navigable Waters Protection Act* (1985b) for the Brucejack Access Road.

Table 33.3-1. Federal Decisions and Relevant Project Components and Activities Required for the Brucejack Gold Mine Project

Government Agency	Federal Legislation	Details and Considerations	Relevant Project Component or Activity
Natural Resources Canada	*Explosives Act* (1985a)	Section 7(1)(a) of the *Explosives Act* states that the Minister of Natural Resources Canada may issue a licence for the manufacture (factory) and/or storage (magazine) of explosives. NRCan confirmed via email (March 3, 2013) that an *Explosives Act* licence would not be required for the storage of explosives on the Brucejack Mine Site.	Pre-manufactured emulsion explosives will be stored in surface and underground magazines; detonators stored separately from explosives. The storage of bulk emulsion may require the proponent to acquire a license as an Explosives Manufacturer.
Environment Canada	*International Rivers Improvement Act* (IRIA; 1985c)	Section 2 of the IRIA defines "international river improvement" as a dam, obstruction, canal, reservoir or other work the purpose or effect of which is: • to increase, decrease or alter the natural flow of an international river, and • to interfere with, alter or affect the actual or potential use of the international river outside Canada. Section 3(1)(a) and 3(1)(b) of the IRIA's International Rivers Improvement Regulation allow for the two following exemptions from the IRIA: if the improvement has an effect of less than 3 cm or 0.3 m^3/s on the flow of water at the Canadian boundary; or if the improvement is temporary in nature, to be operated for a period not exceeding two years.	No changes to flow are predicted for the Unuk River at the Canada/US international boundary (see Section 33.2.1). Therefore, no permit under the IRIA is expected to be required.
Transport Canada	*Navigation Protection Act* (1985d)	On April 1, 2014, amendments to the *Navigable Waters Protection Act* (1985b), came into effect. The amendments include changing the name of the *Navigable Waters Protection Act* to the *Navigation Protection Act* (NPA; 1985d), and changing permitting requirements for approvals on works affecting waters that are not listed under a list of scheduled waters to the NPA. None of the waters potentially affected by Project stream crossings are on the list of scheduled waters. A project proponent can elect to "opt in" for a given waterway to be treated as though it was on the list of scheduled waters. Pretivm does not intend to opt-in in relation to any proposed work, **therefore no approvals for Project works under sections 6 and 9 of the NPA are anticipated (i.e., no federal decision is required).**	An aerial cableway (power transmission line) will cross the Bowser River as well as several low order tributaries of the Bowser River. There will be one bridge crossing of Brucejack Creek downstream of Brucejack Lake. Waste rock and tailings will be deposited in Brucejack Lake. Waste rock will be placed in the lake as a submerged pile by advancing a platform or rock out into the lake from the south western shore. Tailings deposition will occur at depth within the lake via submerged pipeline.

(continued)

Table 33.3-1. Federal Decisions and Relevant Project Components and Activities Required for the Brucejack Gold Mine Project (continued)

Government Agency	Federal Legislation	Details and Considerations	Relevant Project Component or Activity
Transport Canada (*cont'd*)	*Navigation Protection Act* (1985d)	Section 22 of the NPA contains a general prohibition—that applies regardless of whether a water is on the list of scheduled waters or not—against depositing materials that are liable to "sink to the bottom in any water, any part of which is navigable or that flows into any navigable water, where there is not a minimum depth of 36 metres of water at all times." Tailings will be deposited at depth in Brucejack Lake. It is currently anticipated that at its ultimate extent, the surface of the tailings deposit within Brucejack Lake will reach a depth of about 44 metres from the lake surface. However, based on consultation with local Aboriginal groups and land users, there is no known or intended use of Brucejack Lake for public navigation. Thus, the proponent has concluded that the lake is considered not navigable for the purposes of the NPA. TC will make the final decision on navigability based on information provided by Pretivm.	
Transport Canada	*Transportation of Dangerous Goods Act* (1992)	Section 2.1 of the Transportation of Dangerous Goods Regulation (SOR/2001-286) states that "A substance is dangerous goods when: • it is listed by name in Schedule 1 and is in any form, state or concentration that meets the criteria in this Part for inclusion in at least one of the 9 classes of dangerous goods; or • it is not listed by name in Schedule 1 but meets the criteria in this Part for inclusion in at least one of the 9 classes of dangerous goods." Substances that may be considered dangerous goods for the Project include fuel, some types of explosives and ammonium nitrate. Schedule 1 of the Transportation of Dangerous Goods Regulations list dangerous goods for which an Emergency Response Assistance Plan (ERAP) is required quantity limit above which there must be an ERAP for the dangerous goods in accordance with section 7.1 of Part 7, Emergency Response Assistance Plan. Section 1.25 Transportation within a Facility says that the Regulations do not apply to dangerous goods that are transported solely within a manufacturing or processing facility to which public access is controlled.	At a minimum, transport of diesel fuel in volumes great than 60 L will require an ERAP, other substances that may trigger the need for an ERAP include, explosives, batteries, and spoiled process reagents. The Project will employ third-party suppliers to transport dangerous goods to and from the Project's transfer station near the base of the Knipple Glacier, located 55 km along a controlled access road (Brucejack Access Road). After that, transportation of dangerous goods to the Brucejack Mine Site will be the responsibility of Pretivm using specialized vehicles over a distance of 16 km, which will include 12 km over the Knipple Glacier. Public access to the Project areas will be controlled at the entrance to Brucejack Access Road by a manned security gate at the turn-off point from Highway 37. Thus, ERAPs are most likely not required for the Project and no permits under the *Transportation of Dangerous Goods Act* (1992) would be required .

(continued)

Table 33.3-1. Federal Decisions and Relevant Project Components and Activities Required for the Brucejack Gold Mine Project (completed)

Government Agency	Federal Legislation	Details and Considerations	Relevant Project Component or Activity
Industry Canada	*Radio Communications Act* (1985e)	Wireless communications and broadcast operators in Canada are licensed by the Department of Industry (Industry Canada) in accordance with the exclusively federal jurisdiction vested in the *Radiocommunications Act* Section 5(1) (a) (i.1).	The Project will use radio for communications at the Project site and along the access road. Current radio communications for the Project are controlled by a third-party operator, who holds the appropriate license(s); Pretivm is undecided at this point whether the company (Pretivm) will assume control of these communications once Project construction starts, or if this responsibility will remain with a third-party. However, as no land disturbance will occur with respect to this permit, no effects to the environment are expected.
Canada Nuclear Safety Commission	*Nuclear Control and Safety Act* (1997)	The Canadian Nuclear Safety Commission administers the *Nuclear Safety and Control Act* (1997). Under Section 24(1) of the *Nuclear Safety and Control Act*, the "The Commission may establish classes of licences authorizing the licensee to carry on any activity described in any of paragraphs 26(a) to (f) that is specified in the licence for the period that is specified in the licence". Activities described under paragraphs 26(a) through (f) include possession or use of a nuclear substance, and transportation of a nuclear substance.	A nuclear density gauge will be part of monitoring equipment of the comminution circuit within the mill building. No land disturbance will occur with respect to this permit, and no effects to the environment are expected.

Regarding navigability of the remaining affected waters, an assessment was conducted based on physical and public utility criteria. Five assessed waters (Bell-Irving River, Bowser River, Knipple Creek, Scott Creek, and Wildfire Creek) were found to meet the criteria for being navigable, and all others were assessed non-navigable. If this assessment of non-navigability is upheld by Transport Canada, then there would be no effects to navigation on these waters. However, in case Transport Canada differs on their determination of navigability of the affected remaining waters, potential navigational safety effects to them has been assessed by taking a precautionary approach.

Temporary effects by road crossings were predicted to safety and access of local site roads during Construction, to safety in Operation by the Brucejack Access Road and haul roads, and in Closure to safety and access from the decommissioning of the Brucejack Access Road and local site roads (occurring on the Bell-Irving River, Bowser River, Knipple Creek, Scott Creek, and Wildfire Creek). Temporary effects by transmission line crossings to safety and access were predicted during Construction and Closure on the Bowser River crossing (crossing site 800). Effects by discharge from Brucejack Lake to safety and access were predicted for Closure. Finally, potential effects to safety from subaqueous tailing and waste rock disposal in Brucejack Lake have been predicted during Operation through Post-closure.

Mitigation measures to address safety effects to navigation include appropriate signage, installing bridges and aerial cables at sufficient heights to not interfere with navigation (i.e., clear span where possible). Mitigation measures to address temporary access effects will include appropriate signage during construction, the avoidance of permanent structures within the high water mark, and sufficient cable height to not interfere with navigation. Any additional appropriate mitigation measures identified by Transport Canada will be included.

After the implementation of mitigation measures, no residual effects are expected to be not significant (Table 33.3-2). Cumulative effects to navigation are not expected and were not assessed.

Table 33.3-2. Summary of Potential Effects, Mitigation, and Significance on Navigation

Effects Considered	Project Phase(s)	Mitigation Measures	Significance
Ability to safely navigate Navigational access	All phases	• Appropriate signage while works are being constructed or removed from waterways, if necessary • Aerial cables and bridge decks will be installed at heights that do not interfere with navigation, where possible • Clear-span bridge designs • Any Project personnel operating boats on Brucejack Lake will be made aware of any hazards, if any exist, and appropriate signage will be displayed	Not significant

33.3.2 *Transportation of Dangerous Goods Act*

Transportation of dangerous goods to the Project will occur along the Brucejack Access Road. The Project will employ third-party suppliers to transport dangerous goods to and from the Project's Knipple Transfer Area near the base of the Knipple Glacier, located 55 km along a controlled access road (Brucejack Access Road). After that, transportation of dangerous goods to the Brucejack Mine Site will be the responsibility of the Proponent. Pretivm will use specialized vehicles over the 16-km road, including the 12 km over the Knipple Glacier. Public access to the Project areas will be controlled at the entrance to Brucejack Access Road by a manned security gate at the turn-off point from Highway 37. It is assumed that third-party operators will hold the appropriate licenses; the effects of transportation of explosives by these parties are not considered in this assessment.

Use of the Knipple Glacier for transportation was not identified as a potential source of sedimentation for surface water quality, aquatic resources, and fish and fish habitat. Maximum 30-day dust deposition rates during Operation in off-site areas along the access road range from 0.8 to 3.7 mg/dm^2/day. These dustfall rates from atmospheric deposition are negligible as compared to baseline TSS loads of potential receiving waters (mean: 7.5 mg/L, maximum 21.6 mg/L.). Maximum 30-day dust deposition rates during Operation in the Brucejack watershed range from 0.8 to 3.0mg/dm^2/day. These dustfall rates from Project-related atmospheric deposition are negligible as compared to baseline TSS loads of potential receiving waters (mean: 1.5 to 150 mg/L; maximum: 1.5 to 624 mg/L). Thus, the effects of transportation of explosives and fugitive dust to surface water quality, aquatic resources, and fish and fish habitat are not considered further in this assessment.

For the Project, major sources of fugitive dust include unpaved road dust (on gravel road). It was assumed that the segments of the access road built on the glacier do not generate dust as the road would be covered with snow or ice. As only 4 km of the Brucejack Access Road from the Knipple Transfer Area to the Brucejack Mine Site will traverse the terrestrial environment (i.e., not on the glacier), and much of the transportation will occur in winter when frozen soils limit fugitive dust emissions (because of the alpine location of this portion of the road) the effects of this fugitive dust from transportation of dangerous goods on ecosystems are expected to be negligible and will not be considered further in this assessment.

33.3.2.1 Fugitive Dust on Knipple Glacier

Potential Change

For the Project, major sources of fugitive dust include unpaved road dust (on gravel road). It was assumed that the segments of the access road built on the glacier do not generate dust as the road would be covered with snow or ice.

To assess the amount of dust that might settle on the Knipple Glacier as a result of the transportation along the Brucejack Access Road, an air quality dispersion model was developed. For this modelling exercise, the Knipple Glacier segment of the Brucejack Access Road was conservatively assumed to be shorter than the planned length of this segment (i.e., the dust generating segment of the Road was increased). The air quality dispersion model predicted increased dustfall levels due to access road dust covering approximately 3 km of the southeast end of Knipple Glacier during the Construction and Operation phases of the Project. The dustfall level on this portion of Knipple Glacier is predicted to be up to 0.95 mg/dm^2/day based on the highest 30-day average. Compared to the baseline level of 0.71 gm/dm^2/day, this is approximately an increase of 34%, but it is still lower than the provincial objectives of 1.7 to 2.9 mg/dm^2/day (BC MOE 1979). Effects of the dustfall on albedo, and therefore on glacier ablation, has been identified in the literature (Oerlemans et al. 2009; Adhikary et al. 2000).

It is important to note that the inherent limitations described in Section 7.5.2, Air Emissions Dispersion Modelling, such as the uncertain emission factors and the fact that background dustfall monitoring was conducted during the summer when dustfall deposition is typically higher than that during the winter, mean that the results should be regarded as conservative. They can nevertheless provide an indication as to where dustfall monitoring may be required once the Project moves into the Construction and Operation phases.

On the northwest end of the Brucejack Access Road, the air quality dispersion model predicted increased dustfall levels due to ore processing for an area approximately 200 m along the Knipple Glacier. That is, 2.0% of the Knipple Glacier (10.1 km long) is expected to be affected. The dustfall level on this portion of Knipple Glacier is predicted to be up to 0.95 mg/dm^2/day based on the highest 30-day

average. The baseline dustfall monitoring results from July to September 2012 varied from 0.14 to 2.67 mg/dm^2/day, indicating natural variation of dustfall levels based on seasons or activities in the area.

Mitigation Measures

While the area affected for the storage of explosives is minimal, additional mitigation measures related to the loss and degradation of soil and vegetation transportation of dangerous goods are as follows:

- all vehicles and machinery will travel only on designated road surfaces;
- dust suppression on roads (e.g., watering) will be carried out to prevent fugitive dust from impacting the glacier;
- reclamation of roads will occur once no longer in use; quantified effects of increased dustfall on glacier ablation are case specific, and the increased dust may be washed by the melt during the ablation season. Thus, the glacier monitoring program implemented in 2013 will continue, and additional road dust suppression measures will be taken if necessary.

The Hazardous Materials Management Plan (Section 29.7) and the Air Quality Management Plan (Section 29.2) will be implemented to further reduce the chance of effects related to the transportation of dangerous goods.

Residual Change

Based on a first approximation analysis of the glaciohydrology, the change in Knipple Glacier summer ablation due to the access road is expected to be less than 1% of the baseline summer ablation values.

After mitigation measures, no residual changes to glacier ablation rates as a result of fugitive dust are predicted. No cumulative effects are expected or were assessed as no residual effects are predicted for glacier ablation due to transportation.

Significance of Residual Change

N/A

33.4 EFFECTS OF CHANGES TO THE ENVIRONMENT

Pursuant to Section 5(2)(b) of the *Canadian Environmental Assessment Act, 2012* (2012), a federal EA must evaluate changes to the environment that are directly linked or necessarily incidental to federal decisions as a result of the Project that result in an effect to health or socio-economic conditions, physical and cultural heritage, or any site or thing that is of historical, archaeological, paleontological or architectural significance.

33.4.1 Effects of Changes to the Environment that are Directly Linked or Necessarily Incidental to Federal Decisions

This section of the Application/EIS describes the effects of changes to the environment that are directly linked or necessarily incidental to federal decisions, as summarized in Section 33.3, if they result in a change, other than as they pertain to Aboriginal peoples, to:

- health and socio-economic conditions;
- physical and cultural heritage; and

- any structure, site, or thing that is of historical, archaeological, paleontological or architectural significance.

As no changes to the environment that are directly linked or necessarily incidental to a federal decision are predicted for the Project, no effects of any changes are predicted.

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1985c. *International Rivers Improvements Act*, RSC. C. I-20.

1985d. *Navigation Protection Act*, RSC. C. N-22.

1985e. *Radiocommunication Act*, RSC. C. R-2.

1992. *Transportation of Dangerous Goods Act*, SC. C. 34.

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