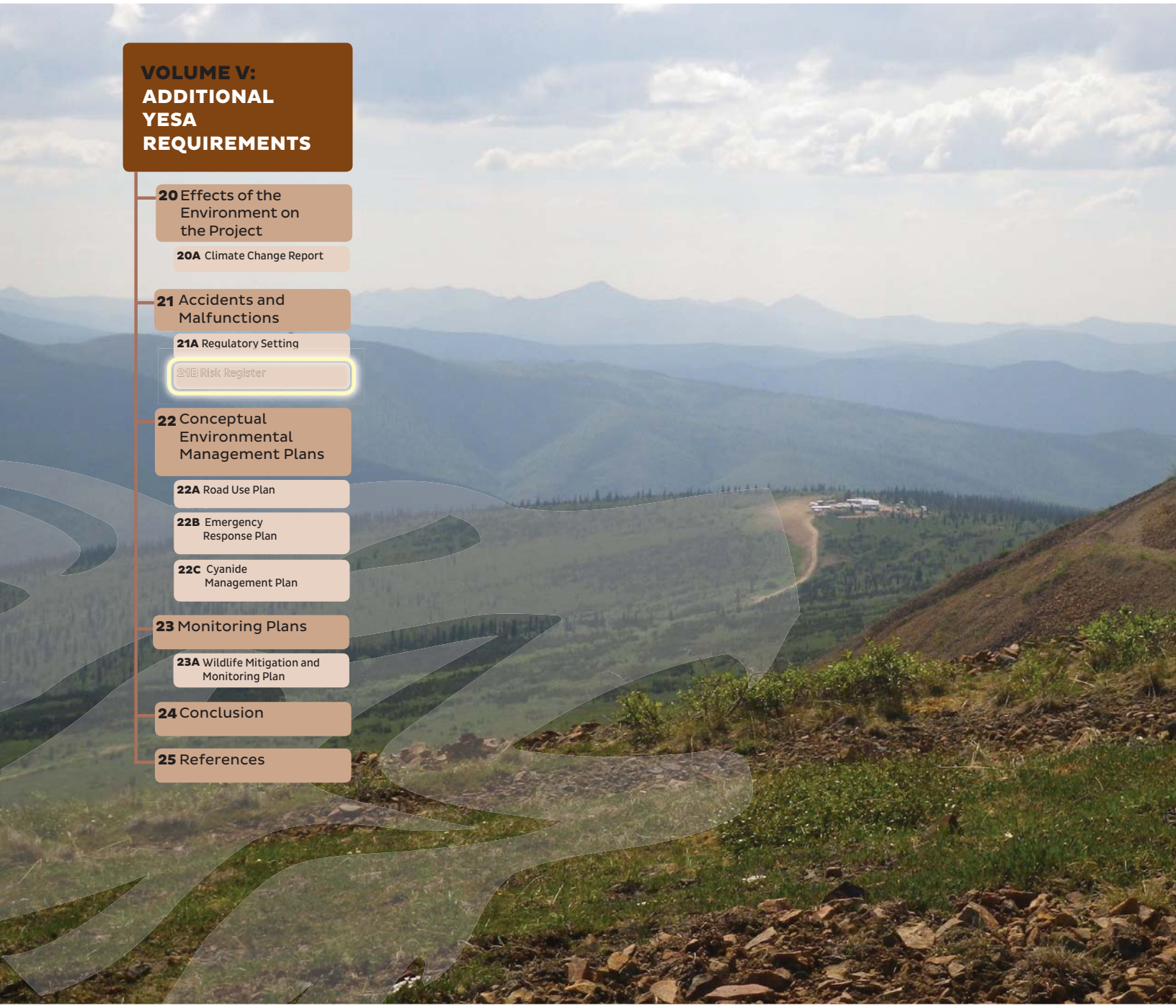
APPENDIX 21B: RISK REGISTER



Appendix 21B
Casino Project
Accidents and Malfunctions
Risk Register

Reference Number	Component/ Activity	Phase	Accident/Malfunction	Hazard scenario	Design Measures	Risk Assessment			Rationale	VC Interaction	Mitigation / Management	Risk Level	Significance
						Likelihood	Consequence	Confidence					
1.a	Mining	O	Hazardous materials spill	Spill of fuel from mobile and stationary storage during refueling and maintenance in pit	Two mobile re-fuelers and two portable fueling stations supply LNG to required locations throughout the Casino mine site	Likely	Very Low	High	Spills will be contained on site and will not enter into the surrounding environment.	No VC effect	Spill Contingency Plan Emergency Response Plan	Low	Not significant
1.b	Mining	O, CD, PC	Pit wall failure	Slope failure or instability in surrounding terrain	• Slope design for Open Pit is based on kinematic and rock mass stability analysis and site-specific geotechnical and hydrogeological information; • Design factors considered in selecting the final open pit wall angle include slope height, rock mass strength, ground water pressure, blasting, and the inter-ramp angles	Possible	Low	Moderate	Slope failure in surrounding terrain would be limited to small slumps Slump in NW edge of pit as pit edge intersects Canadian Creek could introduce sediment into the watercourse - effects would be localized and remediated, with no residual impacts	Surface Water and Sediment Quality	Blasting trials will be implemented when there are observed changes in the characteristics of the rock during excavation. Slope monitoring will be conducted during all stages of open pit development.	Low	Not significant
1.c	Mining	O	Uncontrolled Explosion	Fly rock from blasting causing injury or mortality to wildlife	Blasting carried out by a licensed explosives contractor	Possible	Low	Moderate	Wildlife likely not present within fly rock zone due to avoidance of human presence	Wildlife	Emergency Response Plan	Low	Not significant
1.d	Mining	O	Uncontrolled Explosion	Air overpressure damage to public infrastructure	Blasting carried out by a licensed explosives contractor	Unlikely	Very Low	High	No existing public infrastructure in proximity to pit	No VC effect	Emergency Response Plan	Non-actionable	Not significant
1.e	Mining	O	Pump malfunction or high flow event - pit overflow during operations resulting in release of contact water	Discharge of deleterious substances to environment	A series of pumps and collection systems will transfer water from the pit excavation to a surface sump located near the primary crusher for recycle to the milling process	Rare	Moderate	Moderate	Water potentially discharged to Canadian Creek during high flood events or pump failure	Surface Water and Sediment Quality Fish and Fish Habitat	Backup pumps	Low	Not significant
1.f	Mining	O, CD, PC	Ore stockpiles slope failure	Deposit of material into surrounding terrain, blockage of collection or diversion ditches at toe resulting in discharge of deleterious substances to environment (sediment)	Design measures to minimize the risk of ore stockpile slope failures include: • Geological information and geotechnical site conditions derived from site investigations • Designed to remain stable under static and seismic loading conditions; the minimum acceptable factor of safety for static conditions is 1.3 for short-term operating conditions and 1.5 after closure and reclamation • The design earthquake defined for seismic stability assessment of the stockpile slopes was the 1 in 500 year earthquake and earthquake magnitude of 8.0. • The 1 in 100 year 24-hour storm event was used to size diversion ditches	Rare	Very Low	High	Material from stockpile slumping into surrounding terrain would be limited; contact water overflowing diversion ditches would flow down gradient to the TMF	Surficial Geology, Terrain, and Soils		Non-actionable	Not significant
1.g	Mining	O, CD, PC	Ore stockpiles erosion	Blockage of collection or diversion ditches at toe resulting in discharge of deleterious substances to environment (sediment)	• Sediment control fencing is placed around ore stockpiles to prevent sediment discharge • 20 m benches along the toe of each lift will capture sloughing or ravelling material	Possible	Very Low	High	Contact water overflowing diversion ditches would flow down gradient to the TMF	Surficial Geology, Terrain, and Soils		Low	Not significant
1.h	Mining	O	Motor vehicle collision resulting in spill	Hazardous materials spill	All movement of vehicles within the Open Pit is monitored by a central dispatching system to ensure worker health and safety and efficiency in operation	Rare	Very Low	High	Spills will be contained on site and will not enter into the surrounding environment	No VC effect	Spill Contingency Plan Emergency Response Plan	Non-actionable	Not significant

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2.a	HLF	C, O, CD, PC	Heap leach pad embankment failure	Discharge of deleterious substances to environment (sediment, barren solution, pregnant solution)	• Heap leach pad foundation excavated to a stable bedrock foundation - removing frozen overburden mitigates the risk of potential settlement events and instability resulting from melting of frozen overburden • Closure design will consider the consequence of failure, including the probable maximum site seismic event	Unlikely	Very Low	Moderate	Events pond immediately downstream designed for sufficient storage capacity to contain the excess HLF leachate and surface runoff from the 1 in 100 year 24-hour storm event without discharge to the environment.	No VC effects	Spill Contingency Plan Emergency Response Plan	Non-actionable	Not significant
2.b	HLF	C, O, CD, PC	Heap leach pad slope failure resulting in ore deposited in surrounding terrain	Blockage of collection or diversion ditches at toe resulting in discharge of deleterious substances to environment (sediment)	• Bench lift heights of 8 m with repose bench face angles of 1.4H:1V. • 9 m wide benches will be left at the toe of each lift	Unlikely	Moderate	Moderate	Solids (ore and liner material) contained on benches or at base	Surficial Geology, Terrain, and Soils	Best Management Practices Erosion and Sediment Control Plan Emergency Response Plan	Low	Not significant
2.c	HLF	C, O, CD	Events pond overflow	Discharge of deleterious substances to environment (sediment, barren solution, pregnant solution)	• Events pond designed for sufficient storage capacity to contain the excess HLF leachate and surface runoff from the 1 in 100 year 24-hour storm event • Storage requirements are based on modelled surface runoff results using the Hydrologic Modeling System	Unlikely	Very Low	High	Overflow could enter Casino Creek prior to completion of Main Embankment prior to operation. Overflow will flow to the TMF and be contained on site during operation.	Water and Sediment Quality Fish and Fish Habitat	Emergency Response Plan	Non-actionable	Not significant
2.d	HLF	C, O, CD	Events pond embankment failure	Discharge of deleterious substances to environment (sediment, barren solution, pregnant solution)	• The embankment designed with a 2H:1V downstream slope and a 3H:1V upstream slope • The embankment will be underlain with a 1 m thick drainage blanket layer to promote and facilitate drainage of any 'leakage' out of the embankment and to discharge into the TMF	Unlikely	Very Low	High	Barren and pregnant solution would be contained within the TMF	No VC effects	Emergency Response Plan	Non-actionable	Not significant
2.e	HLF	C, O, CD	Failure of the slopes, HLF liner, tanks, pipes, or pumps	Discharge of deleterious substances to environment (sediment, barren solution, pregnant solution)	• Leachate and solution lines are winterized (e.g., heat tracing, insulation) • Leachate collection will be conducted within the heap leach pad within the ore voids rather than in the external free-surface pond	Unlikely	High	High	Discharge will primarily flow to the TMF and be contained on site	Water and Sediment Quality Fish and Fish Habitat Wildlife	Emergency Response Plan	Low	Not significant
2.f	HLF	C, O	Fire involving processing reagents	Fire emitting toxic fumes	• Reagents used in oxide ore processing are stored, prepared, and distributed in the oxide ore processing facility • Fire protection system comprised of a primary fire pump (and backups) and sprinkler systems will be installed in the accommodation, administration, laboratory and warehouse facilities • A dry sprinkler system will be used for the maintenance facility	Rare	High	Moderate	Some reagents combustible at high temperatures or react with other chemicals e.g., Sodium Cyanide may be combustible at high temperature - it will produce toxic and flammable vapors of CN-H and sodium oxide; contact with acids and acid salts causes immediate formation of toxic and flammable hydrogen cyanide gas	Air Quality Noise Rare Plants and Vegetation Health Wildlife Sustainable Livelihood Land Use and Tenure	Emergency Response Plan	Moderate	Not significant

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3.a	Processing	C, O	Failure of tanks, pipes, pumps between HLF and gold recovery building, resulting in release of pregnant solution	Hazardous materials spill	Location of Gold Recovery Building/SART plant within TMF catchment	Rare	Low	Moderate	Discharge will flow to the TMF and be contained on site	Surficial Geology, Terrain, and Soils	Spill Contingency Plan Emergency Response Plan	Low	Not significant
3.b	Processing	C, O	Failure of control system or operator error during handling or mixing resulting in on-site reagent spill	Hazardous materials spill	Reagent storage and mixing facilities for the flotation circuits will be located within a structurally independent building adjacent to the flotation building	Possible	Very Low	High	Discharge will flow to the TMF and be contained on site	Surficial Geology, Terrain, and Soils	Spill Contingency Plan Emergency Response Plan	Low	Not significant
3.c	Processing	O	Failure of mechanical equipment or control system resulting in on-site concentrate spill	Hazardous materials spill	Copper concentrate is dewatered and transported as a filtered cake; molybdenum concentrate produced from sulphide ore is dewatered and packaged in super sacks	Possible	Very Low	Moderate	Concentrate will be a slurry or semi-solid and will be contained on site	Surficial Geology, Terrain, and Soils	Spill Contingency Plan Emergency Response Plan	Low	Not significant
3.d	Processing	O	Failure of the thickeners, pipes, and pumps from sulphide ore processing facility to the TMF and release of PAG tailings	Discharge of deleterious substances to environment	PAG tailings (or wastes) dewatered and concentrated in a pyrite flotation circuit into thickened tailings prior to flowing by gravity via the PAG tailings distribution pipeline to the TMF for subaqueous disposal	Rare	Moderate	Moderate	Material released from tailings pipeline rupture or from the plant site would flow down gradient and report to the TMF	Surficial Geology, Terrain, and Soils	Spill Contingency Plan Emergency Response Plan	Low	Not significant
3.e	Processing	O	Fire involving reagents	Fire emitting toxic fumes	• Reagent storage and mixing facilities for the flotation circuits are located within a structurally independent building adjacent to the flotation building • Support buildings will include a fire protection system comprised of a primary fire pump (and backups) and sprinkler systems for the accommodation, administration, laboratory and warehouse facilities; dry sprinkler system will be used for the maintenance facility	Rare	Moderate	Moderate	Some reagents combustible at high temperatures or react with other chemicals e.g., Sodium Cyanide may be combustible at high temperature - it will produce toxic and flammable vapors of CN-H and sodium oxide; contact with acids and acid salts causes immediate formation of toxic and flammable hydrogen cyanide gas	Air Quality Noise Rare Plants and Vegetation Health Wildlife Sustainable Livelihood Land Use and Tenure	Emergency Response Plan	Low	Not significant

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4.a	TMF	O, CD, PC	Failure of tailings embankment and release of tailings	Discharge of deleterious substances to environment	The embankment has been designed in consideration of seismic loading for the 1 in 10,000 year earthquake, which is more robust than the recommended CDA Guidelines for a "High" classification of a 1 in 2,500 year earthquake	Unlikely	High	High	Embankment raises constructed by a centerline raise construction method result in an inherently stable structure that does not rely on the strength of the deposited tailings solids; selected because of its superior seismic and static stability as compared to upstream construction methods	Fish and Fish Habitat Surficial Geology, Terrain, and Soils Water and Sediment Quality Wildlife	Emergency Response Plan Scheduled Dam Safety Reviews in accordance with CDA Guidelines	Low	Not significant
4.b	TMF	O	Tailings distribution pipelines failure (bulk non-PAG tailings, PAG tailings, cyclone sand, cyclone overflow)	Discharge of deleterious substances to environment	• Bulk Non-PAG tailings will be disposed of in the waste storage area near the southwest end of the TMF • Discharge will be from valved off-takes located along the Main Embankment and from the West Saddle Embankment • Slurry pipelines will be drained for shutdowns longer than 2 hours to prevent freezing	Rare	Very Low	High	PAG tailings will flow by graivity into the TMF; NAG tailings used in embankment construction or discharged to TMF could result in high TSS concentrations and sedimentation in Casino Creek downstream	Fish and Fish Habitat Water and Sediment Quality	Emergency Response Plan Spill Contingency Plan	Non-actionable	Not significant
4.c	TMF	O, CD, PC	TMF supernatant pond overflow	Discharge of deleterious substances to environment	• TMF is designed with considerations for flood events, seismic events, and meets regulations and requirements according to the CDA for a "High" consequence dam failure • The Inflow Design Flood (IDF) for a "High" consequence dam as defined by the CDA is 1/3 between 1/1,000 and Probable Maximum Flood	Unlikely	Moderate	High	• TMF is in headwaters of Casino Creek, which minimizes the upstream catchment area and reduces peak flow rate and volume of storm water runoff from the IDF • The operation and construction schedule will take into account seasonal fluctuation in pond volume (Halle and Brouwer 2012)	Fish and Fish Habitat Water and Sediment Quality	Emergency Response Plan Spill Contingency Plan	Low	Not significant
4.d	TMF	O, CD, PC	TMF seepage collection failure	Discharge of deleterious substances to environment	• Seepage water losses from the TMF are collected in seepage collection systems constructed downstream of the embankments. The seepage is collected and pumped back into the TMF • 20m wide low permeability core located in the Main Embankment is surrounded by filter and transition zones constructed from crushed and screened rock; the filter zones function in the prevention of piping and porewater pressure increases, while the transition zone prevents migration of fines	Possible	Low	High	Non-PAG tailings beach provides a low permeability transition zone between the coarse and permeable waste rock in the waste storage area and the TMF embankments will function as a seepage limitation and control measure between the two areas	Fish and Fish Habitat Water and Sediment Quality	Emergency Response Plan Spill Contingency Plan	Low	Not significant
4.e	TMF	O	Rupture of reclaim water line	Discharge of deleterious substances to environment (erosion causing sedimentation)	Contained within the TMF pond	Possible	Very Low	High	Water discharged from a ruptured pipeline would report to the TMF	Fish and Fish Habitat Water and Sediment Quality	Sediment and Erosion Control Plan Emergency Response Plan Spill Contingency Plan	Low	Not significant

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5.a	Topsoil/Overburden & Waste Rock Disposal	C, O, CD, PC	Stockpiles erosion and sedimentation	Discharge of deleterious substances to environment	• Soil salvaging and stockpiling operations will require a variety of management practices to ensure that soils are handled and stored properly during all phases of the mine development • Erosion control measures will be implemented	Possible	Very Low	High	Best practices followed	Surficial Geology, Terrain, and Soils	Best Management Practices Erosion and Sediment Control Plan Emergency Response Plan	Low	Not significant
5.b	Waste Rock Disposal	C, O, CD, PC	Stockpiles and dump slope failure	Discharge of deleterious substances to environment	Design measures to minimize the risk of WSA slope failures include: • An overall slope of 1.5H:1V • TMF will be operated to maintain a minimum distance of 1 km between the WSA and TMF embankments to allow development of a NAG tailings beach and provide a low permeability transition zone • Trial sections may be constructed in the field during the initial stages of development to monitor waste pile stability and foundation performance • Waste rock shall be end dumped over the crest to allow for maximum segregation of the coarser material at the base of each bench	Possible	Very Low	High	Best practices followed	Surficial Geology, Terrain, and Soils	Best Management Practices Erosion and Sediment Control Plan Emergency Response Plan	Low	Not significant
5.c	Topsoil/Overburden	C, O, CD, PC	Stockpiles and dump slope failure	Discharge of deleterious substances to environment	Design measures to minimize the risk of Topsoil/Overburden Stockpile slope failures include: • Wet conditions will be avoided when possible during soil salvage operations • Topsoil/Overburden Stockpiles will be limited to a maximum height of about 20 m, with consideration of site-specific ground conditions, and constructed as wrap around dumps in an ascending sequence to improve overall stability • Overall slope angle will average 14 degrees (4H:1V) to minimize the risk of slope instability, reduce erosion potential and improve the amenability for vegetation growth	Possible	Moderate	High	Best practices followed	Fish and Fish Habitat Surficial Geology, Terrain, and Soils Water and Sediment Quality	Best Management Practices Erosion and Sediment Control Plan Emergency Response Plan	Moderate	Not significant

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6.a	Transport of Equipment, Materials, Personnel to/from Site	C, O, CD	Collision of mine related-vehicles	Blocked access along road	Access and transportation management will include materials management procedures, regular maintenance and inspections for safe operation, snow clearing, and the application of dust suppressants The Road Use Plan will specifies rules for the Freegold Road Extension including potential use of the access road by the public including hunters; speed limits and enforcement; travelling in convoys for safety; truck traffic communications; community notification and update process for the village of Carmacks	Possible	Low	Moderate	Freegold Road Extension may be a restricted use road to minimize the risk of accidents with other road users	Sustainable Livelihood Land Use and Tenure	Road Use Plan Emergency Response Plan	Low	Not significant
6.b	Transport of Equipment, Materials, Personnel to/from Site	C, O, CD	Reagent spill resulting from motor vehicle accident	Hazardous materials spill - reagents	• Regular road maintenance, including snow clearing in the winter will be carried out to ensure user safety, preserve the condition of the access road, and ensure access to the Casino mine site management of fuel, hazardous materials and explosives will be in accordance with applicable regulations and legislative bodies • LNG will be transported to the Casino mine site from Fort Nelson, British Columbia via double wall vacuum tanker trucks	Possible	Moderate	High	• Consequences of an off-site spill will vary, depending on the location of the spill, and volume and characteristics of material • Spills at or near watercourse crossings could result in widespread effects if the substance enters the watercourse	Surficial Geology, Terrain, and Soils Water and Sediment Quality Fish and Fish Habitat Sustainable Livelihood	Spill Contingency Plan Emergency Response Plan	Moderate	Not significant
6.c	Transport of Equipment, Materials, Personnel to/from Site	C, O, CD	Wildlife collision	Injury, mortality to wildlife	The Road Use Plan will specifies rules for the Freegold Road Extension including potential use of the access road by the public including hunters; speed limits and enforcement; travelling in convoys for safety; truck traffic communications	Likely	Low	Moderate	Road Use Plan will be strictly enforced	Wildlife	Road Use Plan Wildlife Protection Plan	Moderate	Not significant
6.d	Transport of Equipment, Materials, Personnel to/from Site	C, O, CD	Fire/explosion resulting from motor vehicle collision	Fire/explosion causing injury, mortality, use of essential services RCMP, fire department, ambulance service	Access and transportation management will include materials management procedures, regular maintenance and inspections for safe operation, snow clearing, and the application of dust suppressants The Road Use Plan will specifies rules for the Freegold Road Extension including potential use of the access road by the public including hunters; speed limits and enforcement; travelling in convoys for safety; truck traffic communications; community notification and update process for the village of Carmacks	Unlikely	High	Moderate	Some reagents combustible at high temperatures or react with other chemicals e.g., Sodium Cyanide may be combustible at high temperature - it will produce toxic and flammable vapors of CN-H and sodium oxide; contact with acids and acid salts causes immediate formation of toxic and flammable hydrogen cyanide gas	Air Quality Noise Rare Plants and Vegetation Health Wildlife Sustainable Livelihood Land Use and Tenure	Emergency Response Plan	Low	Not significant
6.e	Transport of Personnel to/from Site	C, O	Aviation accident during takeoff or landing	Injury, mortality to wildlife	• Airstrip engineering design will conform to the most current version of the Transport Canada Aerodrome Standards and Recommended Practices (TP 312) • Airstrip is located in an area considered to pose few aeronautical challenges and provide safe aircraft operations during all visible weather conditions	Rare	Low	Moderate	• Airstrip design considers factors such as elevation, temperature, and weight in determining the amount of runway required for takeoff • Site not accessible to public	Wildlife	Emergency Response Plan Wildlife Protection Plan	Low	Not significant
6.f	Transport of Personnel to/from Site	C, O	Hazardous materials spill resulting from aviation accident during takeoff or landing	Hazardous materials spill	• Airstrip engineering design will conform to the most current version of the Transport Canada Aerodrome Standards and Recommended Practices (TP 312) • Airstrip is located in an area considered to pose few aeronautical challenges and provide safe aircraft operations during all visible weather conditions	Rare	Moderate	Moderate	• Aircraft used primarily for transport of personnel; any spills would be materials and amounts required for the aircraft itself • Materials entering Dip Creek could result in effects beyond the event site that would not be readily remediated	Surficial Geology, Terrain, and Soils Water and Sediment Quality Fish and Fish Habitat	Spill Contingency Plan Emergency Response Plan	Low	Not significant
6.g	Transport of Personnel to/from Site	C, O	Fire/explosion resulting from aviation accident during takeoff or landing	Fire/explosion	• Airstrip engineering design will conform to the most current version of the Transport Canada Aerodrome Standards and Recommended Practices (TP 312) • Airstrip is located in an area considered to pose few aeronautical challenges and provide safe aircraft operations during all visible weather conditions	Rare	High	Moderate	Airstrip design considers factors such as elevation, temperature, and weight in determining the amount of runway required for takeoff	Air Quality Noise Rare Plants and Vegetation Health Wildlife Sustainable Livelihood Land Use and Tenure	Emergency Response Plan	Moderate	Not significant

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7.a	Hazardous Materials Storage	C, O	Hazardous materials spill	Release of ANFO during off loading	Separate structures are constructed for storage of fuel, hazardous materials and explosives in accordance with applicable regulations and specific permitting requirements	Possible	Very Low	High	Storage and handlilng will be in accordance with Explosives Act magazine license requirements with respect to storage and handling of explosives and factory license requirements with respect to the manufacturing of explosives	Fish and Fish Habitat Surficial Geology, Terrain, and Soils Water and Sediment Quality	Spill Contingency Plan Emergency Response Plan	Low	Not significant
7.b	Hazardous Materials Storage	C, O	Hazardous materials spill	Spill of reagents: • Spill of liquid chemicals during offloading of trucks • Release of solid chemicals during on-site transfer and handing • Overflow of storage tanks and chemical release • Failure of pumps, pipes, valves and release of chemicals	• Separate structures for storage of fuel, hazardous materials and explosives in accordance to applicable regulations and specific permitting requirements • Reagent storage and mixing facilities for flotation circuits located within a structurally independent building adjacent to flotation building	Possible	Very Low	High	Reagent storage and mixing facilities for flotation circuits located within a structurally independent building to ensure that any material released is fully captured on site	Fish and Fish Habitat Surficial Geology, Terrain, and Soils Water and Sediment Quality	Spill Contingency Plan Emergency Response Plan	Low	Not significant
7.c	Hazardous Materials Storage	C, O	Fire/Explosion	Fire/Explosion from improper storage of fuels, explosives, etc.	• All storage tanks will be constructed and managed in accordance with the National Fire Code and the Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products • Explosives will be prepared and stored in accordance with the explosives license issued by Natural Resources Canada to a licensed explosives contractor • Explosives and blast caps will be stored in separate facilities, away from operational areas	Unlikely	Moderate	High	Industry standards and best practices will ensure that any material released is fully captured on site	Air Quality Noise Rare Plants and Vegetation Health Wildlife Sustainable Livelihood Land Use and Tenure	Spill Contingency Plan Emergency Response Plan	Low	Not significant
7.d	Hazardous Materials Storage	C, O	Fire/Explosion	Fire involving processing reagents in the storage area	• Reagent storage and mixing facilities for the flotation circuits are located within a structurally independent building adjacent to the flotation building • Support buildings will include a fire protection system comprised of a primary fire pump (and backups) and sprinkler systems for the accommodation, administration, laboratory and warehouse facilities; dry sprinkler system will be used for the maintenance facility	Unlikely	Moderate	High	Some reagents combustible at high temperatures or react with other chemicals e.g., Sodium Cyanide may be combustible at high temperature - it will produce toxic and flammable vapors of CN-H and sodium oxide; contact with acids and acid salts causes immediate formation of toxic and flammable hydrogen cyanide gas	Air Quality Noise Rare Plants and Vegetation Health Wildlife Sustainable Livelihood Land Use and Tenure	Spill Contingency Plan Emergency Response Plan	Low	Not significant

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8.a	Freegold Road	C, O, CD	Blocked drainage ditch or culvert	Discharge of deleterious substances to environment (sediment)	• Road drainage systems to control runoff and to provide a barrier and storage for snow and falling rocks have been considered in the road design • Cross culverts will be placed at an average frequency of 5/km; in steeper terrain the culvert placement frequency will be increased to reduce ditch erosion • Surface and subsurface drainage for roads located in wet valley bottoms can be partially facilitated through the angular rock that makes up the road prism	Possible	Low	High	Effects to land localized and contained	Surficial Geology, Terrain, and Soils	Best Management Practices Road Use Plan Erosion and Sediment Control Plan Emergency Response Plan	Low	Not significant
8.b	Freegold Road	C, O, CD	Road foundation failure	Discharge of deleterious substances to environment (sediment)	• Locating the road in valley bottoms reduces the risk of the road passing through unstable terrain, thus minimizing construction costs and long term road maintenance • Adequate road drainage systems to control runoff and to provide a barrier and storage for snow and falling rocks have been considered in the road design • In regions where the road climbs out of the valley bottoms, the road construction method includes both cut and fill	Rare	Low	High	Effects to land localized and contained	Surficial Geology, Terrain, and Soils	Best Management Practices Road Use Plan Erosion and Sediment Control Plan Emergency Response Plan	Low	Not significant
8.c	Freegold Road	C, O, CD	Erosion	Terrain instability	Areas with potential terrain stability issues will be monitored during construction; detailed design of the embankment slopes and retaining walls will consider the stability of the slope	Possible	Moderate	High	Effects could extend beyond immediate site; depending on size of site conditions such as weather, river and flow, remediation could be delayed resulting in medium term impact	Surficial Geology, Terrain, and Soils	Best Management Practices Emergency Response Plan	Moderate	Not significant
8.d	Freegold Road	C, O, CD	Improper snow management creating wildlife barrier	Wildlife mortality	Rules for the Freegold Road use will include: • Yielding the right-of-way to wildlife and reporting wildlife observations; • Truck traffic communications	Possible	Low	High	Effects could extend beyond immediate site; depending on size of site conditions such as weather, river and flow, remediation could be delayed resulting in medium term impact	Wildlife	Best Management Practices Wildlife Protection Plan Road Use Plan	Low	Not significant

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9.a	Water Supply and Management	C	Temporary Freshwater Supply Pond cofferdam failure or overflow	Discharge of deleterious substances to environment (high suspended solids in water, sediment)	• Cofferdam constructed in Year -4 in Casino Creek upstream of the TMF Stage IA Starter Embankment • During construction of the cofferdam, all contact runoff water is collected in temporary ponds and stored to prevent sediment laden water from entering the downstream watercourse	Rare	Very Low	High	Any water or sediment released would be captured by the starter embankment downstream	Water and Sediment Quality	Best Management Practices Erosion and Sediment Control Plan Emergency Response Plan	Non-actionable	Not significant
9.b	Water Supply and Management	O	Freshwater Pond embankment failure or overtopping	Discharge of deleterious substances to environment - erosion from released water	22,000 m^3 freshwater pond located northeast of the Open Pit and adjacent to the Yukon River Access Road	Rare	Moderate	Moderate	• Sediment and high TSS water could discharge into Britannia Creek and possibly the Yukon River; • Depending on flow, release could result in impacts outside of the event site	Water and Sediment Quality Fish and Fish Habitat	Best Management Practices Erosion and Sediment Control Plan Emergency Response Plan	Low	Not significant
9.c	Water Supply and Management	O	Process Water Pond/ /seepage collection ponds embankment failure or overflow	Discharge of deleterious substances to environment (contact water, high suspended solids in water)	• Process Water Pond - stores water reclaimed from the TMF and processing plant • Seepage collection ponds will be constructed downstream of TMF embankments	Rare	Very Low	High	Any material released would be captured within the TMF	Surficial Geology, Terrain, and Soils	Best Management Practices Erosion and Sediment Control Plan Emergency Response Plan	Non-actionable	Not significant
9.d	Water Supply and Management	O	Water Management Pond embankment failure	Discharge of deleterious substances to environment (contact water, high suspended solids in water)	Downstream of Main Embankment	Rare	Moderate	High	Depending on flow, release could result in impacts outside of the event site	Water and Sediment Quality Fish and Fish Habitat	Best Management Practices Erosion and Sediment Control Plan Emergency Response Plan	Low	Not significant
9.e	Water Supply and Management	C, O	Yukon River Water Supply caisson, radial wells, pipeline rupture	Discharge of deleterious substances to environment (erosion and sedimentation)	Fresh water pipeline roughly follows an existing road that leads northward from the Casino mine site to the Yukon River along Britannia Creek; the existing road acts as a service road to facilitate construction, access, inspection, and maintenance of the fresh water pipeline	Rare	Moderate	High	• Pipeline rupture could cause erosion and sedimentation into Britannia Creek or the Yukon River • Depending on flow released and location of rupture could result in impacts outside of the event site	Water and Sediment Quality Fish and Fish Habitat	Best Management Practices Erosion and Sediment Control Plan Emergency Response Plan	Low	Not significant
9.f	Water Supply and Management	C, O, CD, PC	Blocking/ overtopping of surface runoff diversion or collection ditches	Discharge of deleterious substances to environment (high suspended solids in water, sediment)	Diversion ditching system meets the following design criteria: • Design storm conveyance: 1 in 100 year 24-hour duration storm event • Minimum freeboard = 0.3 m • Maximum design storm flow depth = 0.5 m • Minimum ditch grade = 0.01 m/m • Minimum channel side slope = 2H:1V	Possible	Low	High	Majority of project components are located upstream of the TMF - contact water would report to TMF by gravity	Water and Sediment Quality Fish and Fish Habitat	Best Management Practices Erosion and Sediment Control Plan Emergency Response Plan	Low	Not significant

NOTES
Phase C = Construction O = Operation Closure and Decommissioning = CD Post-Closure = PC

Appendix 21B
Casino Project
Accidents and Malfunctions
Risk Register

Reference Number	Component/ Activity	Phase	Accident/Malfunction	Hazard scenario	Design	Risk Assessment			Rationale	VC Interaction	Mitigation / Management	Risk Level	Significance
						Likelihood	Consequence	Confidence					
10.a	Power Supply and Distribution	O, CD	Hazardous materials spill	LNG storage tank rupture	• LNG is stored at the Casino mine site in a 10,000 m3 storage tank(s) and re-gasified to natural gas as required; equivalent to 10 days of consumption • Fuels will be transferred from tanker trucks to storage tanks by enclosed lines, hoses, and pumps equipped with pressure transducers and volume counters to ensure tanks cannot be overfilled • All storage tanks will be constructed and managed in accordance with the National Fire Code and in conformity with the Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products • Stationary equipment will be located away from watercourses in a bermed and lined area with an impermeable barrier, with a holding capacity equal to 110% of the largest tank within the berm	Rare	Very Low	Moderate	Released LNG would be captured by LNG spill containment pond; secondary containment ensures that fuel is not released to the environment	Water and Sediment Quality	Emergency Response Plan Spill Contingency Plan	Non-actionable	Not significant
10.b	Power Supply and Distribution	O, CD	Fire/Explosion	Accumulation of gas in confined space in LNG facility	Vaporization facility converts the LNG into natural gas	Rare	High	Moderate	Confinement can allow flammable vapour to accumulate and increases the possibility of ignition flame speeds decelerate rapidly beyond the confined area and limit the extent of potential damage and injuries	Air Quality Noise Rare Plants and Vegetation Health Wildlife Sustainable Livelihood Land Use and Tenure	Emergency Response Plan Spill Contingency Plan	Moderate	Not significant
10.c	Power Supply and Distribution	O, CD	Fire/Explosion	Transportation accident resulting in fire/explosion	LNG is transported from Fort Nelson to the Casino Project via by 95,000L double wall vacuum tanker trucks	Unlikely	High	High	LNG in liquid form will not burn or explode; if unconfined, released vapor poses little risk of fire or explosion due to its narrow flammability range	Air Quality Noise Rare Plants and Vegetation Health Wildlife Sustainable Livelihood Land Use and Tenure	Emergency Response Plan Spill Contingency Plan	Low	Not significant
10.d	Power Supply and Distribution	O, CD	Hazardous materials spill	LNG spill during transport	LNG is transported from Fort Nelson to the Casino Project via by 95,000L double wall vacuum tanker trucks	Unlikely	Low	High	• Release of cryogenic LNG due to spills, leaks could result in oxygen deficiency in confined areas or freezing injury on contact • LNG is less dense than water and when spilled on water will form a floating pool that will spread and evaporate	Fish and Fish Habitat Wildlife Surficial Geology, Terrain, and Soils Land Use and Tenure	Emergency Response Plan Spill Contingency Plan	Non-actionable	Not significant
10.e	Power Supply and Distribution	C, O, CD	Hazardous materials spill	Spill during refueling	Two mobile re-fuelers and two portable fueling stations supply LNG to required locations throughout the Casino mine site	Likely	Low	High	Contained on site	Fish and Fish Habitat Water and Sediment Quality Surficial Geology, Terrain, and Soils	Emergency Response Plan Spill Contingency Plan	Moderate	Not significant

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Accidents and Malfunctions
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						Likelihood	Consequence	Confidence					
11.a	Solid and Hazardous Waste Disposal	C, O, CD	Fire/Explosion (waste oil burners, woody debris slash piles)	Discharge of deleterious substances to environment	• Water requirement for firefighting met by keeping a reserve capacity of 682 m3 in the lower portion of the freshwater pond • Support buildings will include a fire protection system comprised of a primary fire pump (and backups) and sprinkler systems for the accommodation, administration, laboratory and warehouse facilities; a dry sprinkler system will be used for the maintenance facility	Possible	Moderate	High	Effects may extend beyond immediate site if fire is not immediately contained - depending on weather and site conditions, and location of fire in relation to firefighting equipment	Air Quality Noise Rare Plants and Vegetation Health Wildlife Sustainable Livelihood Land Use and Tenure	Emergency Response Plan Spill Contingency Plan	Moderate	Not significant
11.b	Solid and Hazardous Waste Disposal	C, O, CD	Hazardous materials spill	Leaks from storage or disposal containers	A permanent waste management facility established during the construction phase will consist of a heated all season building and adjacent laydown areas and will serve as a central depot where wastes generated across the Casino mine site are managed, processed, packaged, labelled, inventoried, secured (e.g., on pallets) and stored for transport, disposed of on site or reused on site	Possible	Very Low	High	Effects can be contained to the immediate area and readily remediated	Water and Sediment Quality	Emergency Response Plan Spill Contingency Plan	Low	Not significant
11.c	Solid and Hazardous Waste Disposal	C, O, CD, PC	Leaching from landfill	Discharge of deleterious substances to environment	• Landfill sites within the Casino mine site are used to dispose of inert solid waste and ashes from the incinerator • Regular cover will be applied over the landfill sites and a cap of native overburden will be placed on top of the landfill before decommissioning, so that the content of the landfill remains permanently frozen and isolated • Open air controlled burning of inert combustible materials will be conducted on an as needed basis to eliminate large quantities of construction related wood waste and cardboard that would otherwise use up landfill capacity • Landfill will be operated by trained personnel who will carry out regular inspection and monitoring of the facility	Rare	Very Low	High	Inert and solid wastes only stored in landfill	Water and Sediment Quality	Emergency Response Plan Spill Contingency Plan	Non-actionable	Not significant

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Accidents and Malfunctions
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						Likelihood	Consequence	Confidence					
12.a	Borrow Sites & Ground Preparation Activities	C	Borrow site slope/wall failure	Slope failure or instability in surrounding terrain	Terrain stability assessment	Possible	Very Low	High	Terrain hazard assessment and geotechnical testing; effects restricted to immediate area	Surficial Geology, Terrain, and Soils	Best Management Practices Emergency Response Plan	Low	Not significant
12.b	Borrow Sites & Ground Preparation Activities	C	Excess erosion and sedimentation during clearing and grubbing	Discharge of deleterious substances to environment (sediment)	Site preparation plan implemented in conjunction with the Construction Environmental Management Plan	Possible	Low	High	Industry standards	Water and Sediment Quality	Best Management Practices Erosion and Sediment Control Plan	Low	Not significant
12.c	Borrow Sites & Ground Preparation Activities	C	Discharge of deleterious substances to environment	Release of uncured concrete to environment from Concrete Batch Plant	Low-volume batch or portable concrete mixer	Unlikely	Low	Moderate	Localized effects	Water and Sediment Quality Fish and Fish Habitat	Emergency Response Plan Spill Contingency Plan	Non-actionable	Not significant
12.d	Borrow Sites & Ground Preparation Activities	C	Discharge of deleterious substances to environment	Vehicle collisions (trucks, track and wheel dozers, graders, water trucks, etc.) resulting in spills or leaks of deleterious substances	Traffic management plan	Possible	Low	High	Industry standards	Surficial Geology, Terrain, and Soils Water and Sediment Quality Fish and Fish Habitat	Emergency Response Plan Spill Contingency Plan	Low	Not significant

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Accidents and Malfunctions
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						Likelihood	Consequence	Confidence					
13.a	Reclamation	CD, PC	Metals uptake in vegetation on reclaimed areas greater than predicted resulting in bioaccumulation in wildlife	Bioaccumulation of metals in wildlife	Progressive reclamation and monitoring	Possible	Low	Moderate	Select plant species less likely to accumulate metals if monitoring of progressive reclamation sites indicates increasing metals levels	Wildlife	Disturbed areas will be monitored for physical and geochemical stability, cover infiltration/erosion, and re-vegetation success	Low	Not significant
13.b	Reclamation	CD, PC	Failure of vegetation to become self-sustainable	Erosion and sedimentation	Placement of soil cover material containing adequate growth media (fines) to sustain re-vegetation; Prescribing a vegetative cover that is capable of self-regeneration without continued dependence on fertilizer or re-seeding	Rare	Moderate	High	Measures will be prescribed to limit the incidence of soil erosion and slumping that would impede re-vegetation, pose a threat to public safety, or lead to wildlife mortality; and prevent excessive sediment loads from entering nearby water bodies	Water and Sediment Quality	Disturbed areas will be monitored for physical and geochemical stability, cover infiltration/erosion, and re-vegetation success	Moderate	Not significant
13.c	Reclamation	CD, PC	Failure of constructed wetland passive treatment	Discharge of deleterious substances to environment (effluent release)	CMC proposes to construct and commission the wetland in advance of the decommissioning of the CDP, in order to demonstrate the effectiveness of the wetland.	Rare	Very Low	Moderate	A contingency option includes adapting the operational seepage collection system for supplemental treatment using sulphate reducing bacteria; effluent will be contained within the TMF	Water and Sediment Quality	Disturbed areas will be monitored for physical and geochemical stability, cover infiltration/erosion, and re-vegetation success	Non-actionable	Not significant

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APPENDIX 22A: ROAD USE PLAN