TECHNICAL MEMORANDUM

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DOMINION DIAMOND JAY PROJECT
RISK ASSESSMENT FOR ACCIDENTS AND MALFUNCTIONS OF THE JAY PROJECT

1.0 INTRODUCTION

This technical memorandum presents the methods and results of the risk assessment developed for the evaluation of accidents and malfunctions associated with the Jay Project (Project). This Revision 1 (Rev1) version of the technical memorandum supersedes the Rev 0 version issued on October 15, 2014. The evaluation of accidents and malfunctions during construction, operation, and closure phases has been developed to fulfill the requirements of the Mackenzie Valley Review Board Revised Terms of Reference EA1314-01 (July 17, 2014) for the Developer's Assessment Report (DAR) (Dominion Diamond 2014, Appendix 1A).

The risk assessment was carried out in a workshop on August 27, 2014, that included key personnel from Dominion Diamond Ekati Corporation (Dominion Diamond) and Golder Associates Ltd. (Golder) involved in the design and environmental assessment of the Jay Project and an external reviewer of the Project.

1.1 Purpose and Scope

The risk assessment was developed to address potential impacts to the Key Lines of Inquiry defined for the Project from an accident or malfunction, as though it has happened. Accidents and malfunctions are unplanned events caused by industrial hazards (e.g., equipment failure) or natural hazards (e.g., earthquake) and were identified for the following components of the Project:

1) dike;
2) dewatering system (construction phase) and water management system (operations);
3) power distribution system;
4) haulage and transportation (project roads, ore stockpiles);
5) waste rock storage area (WRSA);
6) Jay Pit, Misery Pit, and Lynx Pit; and,
7) failures of other components (e.g., dust suppression mechanisms in crushers and roads), evaluated where applicable.

The environmental and social Key Lines of Inquiry and Subjects of Note addressed in the risk assessment, as specified in the Mackenzie Valley Review Board Revised Terms of Reference EA1314-01 (Dominion Diamond 2014, Appendix 1A), are as follows:

- Key Lines of Inquiry:
  - impacts to water quality and quantity;
  - impacts to fish and fish habitat;
  - impacts to caribou; and,
  - maximizing benefits and minimizing impacts to communities.
- Subjects of Note:
  - impacts to air quality from Project components;
  - impacts to vegetation from Project components;
  - impacts to wildlife and wildlife habitat from Project components;
  - impacts to terrain from Project components; and,
  - impacts to cultural aspects (including archaeological sites) from Project components.

Impacts to the Key Lines of Inquiry and Subjects of Note were combined into two consequence categories (environment and public health and safety) for the assessment of risks as shown in Table 1. Consequences to workers' health and safety, costs, or schedule were not included as part of the scope of the assessment.

Table 1: Consequence Categories

Consequence Category	Description
Environment	Category to assess potential impacts to land, water resources, air, ecosystems, biodiversity, archaeological aspects and community. Consequences to fish and fish habitat, caribou, water quality and quantity, air quality, vegetation, wildlife, terrain, and cultural aspects are assessed under this category.
Public Health and Safety	Category to assess potential impacts to public such as injury and health issues resulting from accidents and malfunctions of Project components. Potential impacts to workers' or mine personnel health and safety have not been considered when assessing risks for this category.

The qualitative assessment of environmental and public health and safety risks posed by potential accidents and malfunctions of key Jay Project components during construction, operations, closure, and post-closure included the following:

- identification of potential accidents and malfunctions of components of the Jay Project that may impact the environment or public health and safety;
- identification of existing operational management plans or design considerations that will be in place for control of any significant hazards or risks; and
- estimation of residual risks following the implementation of risk mitigation measures.

1.2 Spatial Boundary

The spatial boundary for the risk assessment was defined as the development footprints during construction and operation phases shown in Figures 1 and 2.

1.3 Temporal Boundary

The temporal framework for the risk assessment includes the phases of construction, operations, closure and post-closure. An overview of the mine development sequence is provided in Table 2.

Table 2: Mine Development Sequence

Year	Mine Development and Water Management Activities
2016 (construction)	■ Road construction will commence. ■ Dike construction will commence during summer 2016 from the northern abutment of the dike, and will continue along the entire length of the dike during the 2016/2017 winter (rockfill placement). ■ Curtain grouting will commence. ■ Pipeline installation will commence.
2017 (construction)	■ Dike construction will continue. ■ Fish-out of the isolated portion of Lac du Sauvage may commence. ■ Rockfill placement for the dewatering ramps will commence during winter of 2017/2018. ■ Jet grouting will commence. ■ Pipeline installation may continue.
2018 (construction)	■ Dike construction will continue. ■ Fish-out is completed. ■ Rockfill placement for the dewatering ramps during winter 2018/2019 is completed. ■ Sub-basin B diversion channel will be constructed. ■ Pipeline installation will continue.
2019 (construction/ operations)	■ Dike construction is completed. ■ Pipeline installation is completed. ■ The sub-basin B diversion channel is put into operation. ■ Dewatering of the diked area of Lac du Sauvage will occur. ■ Stripping for pit development will begin following completion of dewatering. Initial ore will be mined.
2020 – 2030 (operations)	■ Mining of the Jay Pit: ▪ Minewater inflows to the Jay Pit and runoff from the WRSA will be collected and pumped to the Misery Pit. ▪ Runoff toward the diked area will be collected and pumped to the Misery Pit. ▪ The sub-basin B diversion channel will divert runoff from the sub-basin B away from the diked area. ▪ After Misery Pit has reached storage capacity, and if water quality is suitable for discharge, water will be pumped from the Misery Pit to Lac du Sauvage.
2030 – 2033 (closure)	■ Mining is completed, closure and reclamation commence. ■ Closure back-flooding: ▪ The top 60 m of Misery Pit water will be pumped to the Jay Pit. ▪ The Misery Pit, the Jay Pit, and the diked area will be back-flooded with water from Lac du Sauvage.

Year	Mine Development and Water Management Activities
2030 – 2033 (closure)	▪ Water quality within back-flooded areas (Misery Pit and diked area) will be monitored. ▪ Decommissioning of infrastructure not required for back-flooding will begin. ■ Decommissioning and dike breaching: ▪ Roads and sub-basin B diversion channel will be decommissioned, and original flow-paths re-established. ▪ The Jay Dike will be breached once water quality within diked area is suitable for mixing with neighbouring waters. ▪ Hydraulic connection between the Misery Pit and Lac de Gras is established, once water quality is suitable.
Post-closure	■ The diked area and Lac du Sauvage are hydraulically connected through the breaches. ■ The Misery Pit is discharging to Lac de Gras. ■ Monitoring and maintenance continue.

1.4 Risk Assessment Terminology

Definitions for the key risk assessment terminology used throughout this document are provided in Table 3.

Table 3: Risk Assessment Terminology

Term	Definition
Failure mode	Description of how a system may fail, including all possible causes ranging from natural hazards, such as earthquakes to equipment failures, operator errors, and management system deficiencies.
Consequence categories	Categories for which the consequence effects of a given failure mode will be assessed (e.g., environment, public health and safety).
Consequence effects	Potential effects resulting from a failure mode (e.g., loss of life, contamination of aquatic habitat).
Hazard scenario	Series of events that lead to a failure mode and its resulting consequence effects (includes the failure mode, its causes and consequences).
Consequence severity	Magnitude or severity of the consequence effects resulting from a hazard scenario. Consequence severities are defined in the risk matrix in Section 2.2.
Likelihood	Chance of the consequence effects occurring considering control measures are in place. Likelihood categories are defined in the risk matrix in Section 2.2.
Risk level	Magnitude of the risk that will define required management actions. The risk level will be defined in a risk matrix as the combination of likelihood and consequence severity.
Risk matrix	Matrix composed of one index representing the measure of likelihood and another index representing the measure of consequence severity.
Risk register	Document where hazard scenarios are registered along with their corresponding likelihood, consequence severity, and risk level.

2.0 ASSESSMENT METHODS

The assessment methods for accidents and malfunctions were based on the Systems Failure Modes and Effects Criticality Analysis approach, which is a standard risk assessment method (Canadian Standards Association 1997; International for Standardization 2009a,b). Failure modes, along with their associated causes and consequences (defined as a hazard scenario), were identified for each major Project component in the workshop with the participation of key personnel from Dominion Diamond, Golder, and an external reviewer to the Project. Planned mitigation measures for each hazard scenario were identified, and residual risks (following implementation of risk mitigation measures) to the environment and public health and safety were determined using a risk matrix based on Dominion Diamond's Risk Management System.

2.1 Identification of Hazard Scenarios

Hazard scenarios and risks associated with potential accidents and malfunctions of the system were identified during the workshop using the following approach:

1) A phase of the Project (construction, operations, closure and post-closure) was selected.
2) Significant failure modes were identified for the Project components listed in Section 1.1 using the knowledge base of the risk assessment team and reference drawings and information.
3) Possible causes for the failure mode ranging from natural events such as earthquakes to equipment failures, operator errors, and management system deficiencies were identified.
4) Potential consequences from the failure mode that could impact the environment or public health and safety were discussed and documented.
5) Steps 1) to 4) defined the hazard scenario to be assessed in terms of risk level.
6) Planned prevention measures that would minimize the probability of the causes associated with the failure mode from occurring or controls to reduce the consequence severity were identified once the entire hazard scenario was identified.
7) Risk level was assigned taking into account the mitigations.

Table 4 through Table 6 provide a summary of the failure modes (accidents and malfunctions) evaluated during the workshop for each phase of the Project and their related activities (outlined in Table 2). The numbering of each failure mode is based on the Project component number (per the list in Section 1.1) and the component element and failure mode numbers shown in the risk registers presented in Attachment 1. The risk registers in Attachment 1 include all failure modes assessed, including some that resulted in no risks to the environment or public health and safety.

Table 4: Potential Accidents and Malfunctions (Failure Modes) – Construction

Project Component	Failure Mode[(a)]	
1) Dike	1.1.1	Slope failure during material placement
	1.1.2	Dike breach during dewatering
	1.1.3	Release of grout
	1.1.4	Collapse of slurry trench
	1.1.5	Failure to meet performance with respect to settlement and deformations
	1.2.1	Failure of turbidity control systems
	1.3.1	Failure to meet performance with respect to seepage quantities and quality
2) Dewatering and Water Management System	2.1.1	Failure of pumps during dewatering
	2.2.1	Pipeline rupture
	2.3.1	Failure to meet assumed discharge volume directly to Lac du Sauvage during dewatering
	2.5.1	Failure of sub-basin B diversion channel
3) Power Distribution System	3.1.1	Leaks or spills from transformers
	3.1.2	Disruption of power supply between Jay Pit and Misery Pit
4) Haulage and Transportation	4.1.1	Erosion of the roads connecting the dike abutments
	4.1.2	Small fuel spills
	4.1.3	Large fuel spills
7) Other Accidents and Malfunctions	7.2.1	Failure of dust suppression mechanisms from crushing operations
	7.2.2	Failure of dust suppression mechanisms from roads

a) Numbering as shown in the risk registers presented in Attachment 1.

Table 5: Potential Accidents and Malfunctions (Failure Modes) – Operations

Project Component	Failure Mode[(a)]	
1) Dike	1.1.1	Dike failure during operations
	1.3.1	Seepage flows exceeding capacity of the pumping system
2) Water Management System	2.1.1	Overflow of sumps
	2.1.2	Overflow of Misery Pit due to failure of pumping system
	2.1.3	Reduced storage capacity in Misery Pit at the beginning of operations due to failure of water management strategy during dewatering
	2.2.1	Pipeline rupture
	2.3.1	Failure of the diffuser in Lac du Sauvage
	2.5.1	Failure of sub-basin B diversion channel
3) Power Distribution System	3.1.1	Leaks or spills from transformers
	3.1.2	Disruption of power supply between Jay Pit and Misery Pit
4) Haulage and Transportation	4.1.1	Erosion of the roads connecting the dike abutments
	4.1.2	Small fuel spills
	4.1.3	Large fuel spills
5) Waste Rock Storage Area	5.1.1	Slope failure

Project Component	Failure Mode(a)	
6) Open Pits	6.1.1	Misery Pit slope failure
	6.1.2	Lynx Pit slope failure
	6.1.3	Jay Pit slope failure
7) Other Accidents and Malfunctions	7.2.1	Failure of dust suppression mechanisms from crushing operations
	7.2.2	Failure of dust suppression mechanisms from roads

a) Numbering as shown in the risk registers presented in Attachment 1.

Table 6: Potential Accidents and Malfunctions (Failure Modes) – Closure and Post-closure

Project Component	Failure Mode(a)	
1) Dike	1.1.1	Blockage of dike breaches
	1.2.1	Failure of turbidity control system
2) Water Management System	2.2.1	Pipeline rupture
4) Haulage and Transportation	4.1.1	Erosion of the roads connecting the dike abutments
	4.1.2	Small fuel spills
	4.1.3	Large fuel spills
5) Waste Rock Storage Area	5.1.1	Slope failure
	5.1.2	Generation of runoff (loss of frozen conditions)
6) Open Pits	6.1.1	Jay Pit slope failure
	6.1.2	Misery Pit slope failure
	6.1.3	Lynx Pit slope failure
7) Other Accidents and Malfunctions	7.3.1	Injury to public entering the area post-closure

a) Numbering as shown in the risk registers presented in Attachment 1.

2.2 Risk Measurement and Required Management Actions

Following the identification of hazard scenarios, the risk associated with each hazard scenario was estimated as the combination of likelihood (frequency) and consequence severity. Risk was estimated using the risk matrix shown in Table 7, which includes the likelihood and consequence severity indices used for the assessment and the risk levels resulting from their combination (represented as colours in the matrix). Risk levels were classified from low (green) to moderate (yellow) to high (orange) to highest (red). Management actions required for each risk level (related to the colours in the matrix) were defined and are also shown in Table 7.

During the workshop, the likelihood and the consequence severity of each hazard scenario were estimated based on industry and operational experience, Project-specific conditions, and the knowledge base of the risk assessment team participating in the workshop. The assessment assumed that all mitigation and planned safeguards identified would be in place. Additional management actions were discussed for hazard scenarios resulting in the high or highest risk levels.

Table 7: Risk Matrix

	CONSEQUENCE CATEGORY	CONSEQUENCE SEVERITY				
		1)	2)	3)	4)	5)
	I) Environment	Minor disturbances and/or low-level impact to land, biodiversity, ecosystem services, water resources or air.	Moderate impact (<1 year) to land, biodiversity, ecosystem services, water resources or air.	Serious impact (1-5 years) to land, biodiversity, ecosystem services, water resources or air.	Major impact (5-20 years) to land, biodiversity, ecosystem services, water resources or air.	Extensive impact (>20 years) to land, biodiversity, ecosystem services, water resources or air.
	II) Public Health and Safety	Medical treatment not required.	Reversible disability or injury requiring medical treatment Reversible health effects requiring medical treatment.	Irreversible moderate (<30%) disability to 1 or more people Severe, reversible health effects of concern.	Single fatality, single irreversible severe (>30%) disability. Irreversible health effects or disabling illness.	Multiple fatalities, multiple irreversible severe health effects, permanent impairment to multiple people.
LIKELIHOOD						
A)	Almost certain to occur (>99% probability)					
B)	Likely to occur at least once (50% to 99% probability) over the life of the Project					
C)	Unlikely to occur (10% to 50% probability) over the life of the Project					
D)	Very unlikely to occur (1% to 10% probability) over the life of the Project					
E)	Extremely unlikely to occur (<1% probability) over the life of the Project					

Risk Level		Management Action
	Highest	Action required. More detailed risk analysis may be required.
	High	Assess risk mitigation options and reduce risk, where practical. Prioritize resources to manage these risks before Moderate or Low ranked risks. More detailed risk analysis may be required.
	Moderate	Assess risk mitigation options and reduce risk, where practical.
	Low	Accept risk (and monitor)

3.0 RISK MITIGATIONS

Risk mitigations considered in the assessment included further site investigation, design controls, monitoring and inspections, quality assurance (QA) and quality control (QC) during construction and maintenance during operations and closure. In addition, mitigation of risks was considered to be further controlled through implementation of the various operational management plans, which include the following:

- Waste Management Plan;
- Incinerator Management Plan;
- Hazardous Waste Management Plan;
- Solid Waste Landfill Management Plan;
- Hydrocarbon Impacted Material Management Plan;
- Waste Rock and Ore Management Plan;
- Wastewater and Processed Kimberlite Management Plan;
- Interim Closure and Reclamation Plan;
- Winter Road Regulations and Rules of the Road;
- Traffic Management Standard;
- Emergency Response and Spill Contingency Plans;
- Water Management Plan;
- Archaeological Management Plan; and,
- Geochemical Characterization and Metal Leaching Management Plan.

4.0 RISK ASSESSMENT

A summary of the risks to the environment and to public health and safety from accidents and malfunctions during all phases of the project is presented in Table 8 and Table 9. The numbers in these tables follow the structure for the failure modes presented in Table 4 through Table 6 for each phase of the Jay Project.

Due to the remoteness of the site and the limited access permitted, no risks to public health and safety were identified from accidents and malfunctions of components within the Project footprint during construction and operations. Injury to the public entering the site after closure (post-closure) resulted in a moderate risk but is considered similar to the risk of injury from the surrounding environment (i.e., no incremental risk compared to natural areas not affected by mining activities).

A discussion of the risks for each Project component is provided in the following sections. The focus of the discussion is around those risks ranked as moderate or higher. Details of the assessment and resulting risk of each failure mode are provided in the risk registers in Attachment 1.

Table 8: Risks to the Environment

		CONSEQUENCE CATEGORY	CONSEQUENCE SEVERITY					
			1)	2)	3)	4)	5)	
		I) Environment	Minor disturbances and/or low-level impact to land, biodiversity, ecosystem services, water resources, or air	Moderate impact (<1 year) to land, biodiversity, ecosystem services, water resources, or air	Serious impact (1 – 5 years) to land, biodiversity, ecosystem services, water resources, or air	Major impact (5 – 20 years) to land, biodiversity, ecosystem services, water resources, or air	Extensive impact (>20 years) to land, biodiversity, ecosystem services, water resources, or air	
LIKELIHOOD								PHASE [a]
A)	Almost certain to occur (>99% probability)		4.1.2					Construction
			4.1.2					Operations
			4.1.2					Closure and post-closure
B)	Likely to occur at least once (50% to 99% probability) over the life of the Project		1.1.3 3.1.1 3.1.2 7.2.1 7.2.2	4.1.3				Construction
			3.1.1 7.2.1 7.2.2	4.1.3				Operations
				4.1.3				Closure and post-closure
C)	Unlikely to occur (10% to 50% probability) over the life of the Project		1.1.4 2.1.1 2.3.1 4.1.1	1.1.1 1.2.1 2.2.1				Construction
			1.3.1 4.1.1	2.2.1 2.3.1				Operations
			1.2.1 4.1.1	2.2.1				Closure and post-closure
D)	Very unlikely to occur (1% to 10% probability) over the life of the Project			2.5.1				Construction
			2.1.2 6.1.3	1.1.1 2.5.1 5.1.1 6.1.1 6.1.2				Operations
			1.1.1	5.1.1 5.1.2 6.1.3	6.1.1 6.1.2			Closure and post-closure
E)	Extremely unlikely to occur (<1% probability) over the life of the Project			1.1.2				Construction
								Operations
								Closure and post-closure

a) Numbering of failure modes during each phase as presented in Table 4 through Table 6.

> = greater than; < = less than.

Table 9: Risks to Public Health and Safety

		CONSEQUENCE SEVERITY					
	CONSEQUENCE CATEGORY	**1)**	**2)**	**3)**	**4)**	**5)**	
	II) Public Health and Safety	Medical treatment not required	Reversible disability or injury requiring medical treatment Reversible health effects requiring medical treatment	Irreversible moderate (<30%) disability to 1 or more people Severe, reversible health effects of concern	Single fatality, single irreversible severe (>30%) disability Irreversible health effects or disabling illness	Multiple fatalities, multiple irreversible severe health effects, permanent impairment to multiple people	
LIKELIHOOD							**PHASE [(a)]**
A)	Almost certain to occur (>99% probability)						Construction Operations Closure and post-closure
B)	Likely to occur at least once (50% to 99% probability) over the life of the Project						Construction Operations Closure and post-closure
C)	Unlikely to occur (10% to 50% probability) over the life of the Project						Construction Operations Closure and post-closure
D)	Very unlikely to occur (1% to 10% probability) over the life of the Project			**7.3.1**			Construction Operations Closure and post-closure
E)	Extremely unlikely to occur (1<% probability) over the life of the Project						Construction Operations Closure and post-closure

a) Numbering of failure modes during each phase as presented in Table 4 through Table 6.

> = greater than; < = less than.

4.1 Construction

4.1.1 Dike

Moderate or higher risks to the environment due to failures of the dike are related to small-scale slope failures of fill materials (surface sloughing) during placement, release of grout during grouting operations, and failure of the turbidity control system. Consequences of such accidents and malfunctions during construction of the dike are the release of sediments or other substances (grout, fuel, oil) into Lac du Sauvage.

Small-scale slope failures of fill materials could occur due to improper placement during construction or surface sloughing due to saturation of fills, weaker than anticipated foundation soils, or over-steepened slopes during excavation. Such failure could result in equipment falling into Lac du Sauvage, potential spills, and generation of turbidity. Rates of fill placement will be controlled and QA/QC will be conducted during placement of fills to reduce the likelihood for slope instability during construction, and investigation of the foundation soils prior to construction will be carried out. If failure occurs, the design has considered the implementation of primary and secondary turbidity curtains, which are intended to limit migration of sediments into a larger portion of the environment. Small-scale slope instabilities may impact the primary turbidity curtains but are less likely to affect the secondary curtains. In addition, any spills in the water will be managed following the procedures outlined in the Emergency Response and Spill Contingency Plans. Therefore, such a failure mode would result in moderate impacts to the environment (consequence severity 2) at the most; and the likelihood of this hazard scenario was estimated at less than 50% probability or unlikely to occur over the life of the Project (likelihood C).

Release of grout could occur due to operational errors in batching plants or during grouting operations, or migration of grout through existing geological features. Grouting operations will be controlled and monitored, and early identification of grout losses may be possible through measurements of grout volumes and injection pressures. Visual inspection during summer construction may also allow the identification of grout being released into Lac du Sauvage. As such, any losses of grout through geological features or due to operational errors are expected to be of short duration and relatively low. The failure mode would result in low impacts to the environment (consequence severity 1) and the likelihood of this hazard scenario was estimated as likely to occur over the life of the Project (likelihood B).

Failure of turbidity curtains due to wind, currents, and wave actions could occur due to high wind, wave action, or slow rates of rockfill placement during winter. As such, redundancies have been included in the design by considering placement of primary and secondary curtains during construction. During the summer of 2017 and 2018, the upstream rockfill platform will provide some protection from wind and currents and provide an anchoring point for the primary curtain. The primary turbidity curtains have been designed as small cells to limit the potential for a large release of sediments in case of rupture of any given primary curtain. Any sediment released from rupture of the primary curtains will be contained by the secondary curtains, providing these are still intact, thereby reducing the area impacted by the release of sediments from the dike area, resulting in low to moderate consequences to the environment (consequence severity 2 was considered in the risk assessment as a conservative estimate). The likelihood of this hazard scenario was estimated at less than 50% probability or unlikely to occur over the life of the Project (likelihood C).

Other failure modes assessed for the dike resulted in low risks due to either a lower likelihood or consequence severity. Key considerations when addressing the risks associated with other failure modes for the dike are as follows:

- A dike breach during Jay Dike dewatering activities is considered very to extremely unlikely over the life of the Project (likelihood D to E). Piping or internal erosion during dewatering is possible but not expected to result in a complete dike breach (likelihood E). Design controls and construction QA/QC programs will help to reduce the potential for this to occur. Monitoring of pore water pressures will take place as dewatering progresses to ensure that critical gradients within the foundation and filter materials are not exceeded. Dewatering rates can be adjusted based on ongoing monitoring. In the event of a breach during dewatering, the consequences to the environment should be primarily contained within the diked area and are considered to be moderate (consequence severity 2) at the most.
- Seismicity in the area is such that motions due to earthquakes (peak ground accelerations) are low even for low frequency events. The design has considered an earthquake with frequency of 1 in 2,500 years, resulting in an earthquake design ground motion of 0.036 g. As such, earthquake-induced failures are considered very to extremely unlikely over the life of the Project (likelihood D to E).
- Release of slurry bentonite to the receiving environment as a result of failure of the trench or pipeline during construction of the cut-off wall is unlikely over the life of the Project (likelihood C) due to the location and amount of filter material upstream and downstream of the trench. In addition, any slurry bentonite spills reaching Lac du Sauvage can be partially controlled by the turbidity curtains.

4.1.2 Dewatering and Water Management Systems

Moderate or higher risks to the environment due to failures of the dewatering and water management systems are related to pipeline ruptures. Consequences of such failures would be related to erosion of land and discharge of sediments to waterbodies and erosion of sensitive areas such as the esker.

Pipeline ruptures along the entire length of all pipelines (total of approximately 20 km during final dewatering stages) could occur during dewatering. The main causes for rupture were considered to be inadequate welding or construction and freezing of water within the pipe during winter. Design safeguards to control the likelihood of rupture due to freezing include insulation, maintenance of high flow velocities within the pipe, and a drainage system to remove the water within the pipe during stand-by or repairs (contingency only). In addition, most of the dewatering is scheduled to occur during spring and summer months reducing the likelihood of failure due to freezing. Quality assurance (QA) and QC during construction and commissioning activities, including pressure testing, will also reduce the likelihood of improper welding or other construction issues that could lead to rupture. Ongoing visual inspections and maintenance and calibration of instruments during dewatering should allow early identification of flaws or wear of the pipes. If failure occurs, monitoring of flows and pressures within the pipe should allow for early identification of ruptures and implementation of emergency response procedures (rapid system shutdown to allow for repairs and reduction of environmental impacts). Monitoring procedures will be in place for early identification of ruptures so that the volume of water released is minimized and corrective actions (following Spill Contingency Plans) can be taken to avoid migration of water with high sediments to nearby waterbodies. As such, pipe ruptures resulting in discharge to waterbodies were estimated as unlikely to occur over the life of the Project (likelihood C); if they occur the consequences are expected to involve short term release of small volume of water potentially with high sediments (consequence severity 1). Ruptures resulting in erosion and release of sediments were estimated to have greater likelihood (likelihood B) and will be of short duration and contained within a limited area not reaching waterbodies (consequence severity 1). Due to the relevance of the esker, pipe ruptures in this area were considered to have a moderate impact (consequence severity 2) to the environment but with lower likelihood (likelihood C) due to the reduced length of pipe crossing the esker area.

Other failure modes assessed for the dewatering and water management system resulted in low risks due to either a lower likelihood or consequence severity. Key considerations when addressing the risks associated with other failure modes for the system are as follows:

- Failure of pumps during dewatering due to power shutdowns and equipment failure are not expected to have immediate impacts to the environment. The only possible consequence on the environment is that larger discharge flows to Lac du Sauvage may be required during initial dewatering to compensate for delays in the dewatering schedule, which should have a low consequence to the environment (consequence severity 1). Considering that initial dewatering will only last three months and considering the redundancies of the pumping systems (one pump operating and another one in standby), this scenario is unlikely to occur over the life of the Project (likelihood C).
- Initial dewatering considers that 50% of the water volume within the diked area will be suitable for direct discharge into Lac du Sauvage. Failure to meet this discharge volume could occur if turbidity or total suspended solids concentration of the discharge water exceeds discharge criteria before 50% of the volume is removed. Suitability of the water for direct discharge will be monitored. If results indicate water does not meet discharge criteria, water will be pumped to the Misery Pit, which has enough capacity to contain 100% of the water within the diked area. As such, no to low environmental impacts (consequence severity 1) are expected from this scenario.

4.1.3 Power Distribution System

Moderate or higher risks to the environment due to failures of the power distribution system are related to leaks or spills from transformers or disruptions of power supply affecting dewatering operations.

Leaks and oil spills from transformers due to equipment failure or poor maintenance could occur and will be controlled through regular maintenance and inspections. Consequences of leaks or spills will be controlled by design safeguards (spilling basins or containment areas) and managed following the procedures outlined in the Emergency Response and Spill Contingency Plans. As such, consequences to the environment are expected to be low (consequence severity 1); and the likelihood of this hazard scenario was conservatively estimated as likely to occur during the life of the Project (likelihood B).

Disruption of power supply between the Jay and Misery pits could occur due to traffic accidents (which are controlled through the existing Traffic Management Standard) or adverse climatic conditions. Disruption of power supply is not expected to result in direct impacts to the environment but could require increasing discharge flows during dewatering to compensate for delays in construction schedule. Monitoring of water discharged to Lac du Sauvage will take place during dewatering and if discharge criteria are not met, water will be pumped to the Misery Pit as a contingency. An increase in discharge flows to Lac du Sauvage is expected to have no to low consequences to the environment as water will meet discharge criteria (consequence severity 1); and the likelihood of this hazard scenario was conservatively estimated as likely to occur during the life of the Project (likelihood B).

4.1.4 Haulage and Transportation

Moderate or higher risks to the environment due to accidents associated with haulage and transportation activities are related to small and large fuel spills.

Small leaks of fuel or other petroleum based fluids are almost certain to occur (likelihood A) on site roads or anywhere construction equipment frequently transits. The likelihood of accidents causing such spills should be effectively reduced through proper equipment maintenance and inspections and through enforcement of the existing Traffic Management Standard. Small leaks or spills can be rapidly controlled and managed following the procedures outlined in the Emergency Response and Spill Contingency Plans so that resulting consequences to the environment are low (consequence severity 1).

Large spills could occur due to fuel line ruptures, equipment damage, operator error, or other accident involving fuel trucks or mobile equipment. The likelihood is less than small leaks, and was conservatively estimated as likelihood B. The consequences of a larger fuel spill to the environment have been considered to be moderate (consequence severity 2) provided that they will be managed following the procedures outlined in the Emergency Response and Spill Contingency Plans and proper equipment maintenance and inspections are conducted.

4.1.5 Other Risks Associated with Accidents and Malfunctions

Crushing activities will take place for construction of the dike and roads. Failure of dust suppression mechanisms for the crusher could result in short-term impacts to air quality. Crushed rockfill is used as surfacing on the roads, and inadequate dust control measures could result in short-term impacts to air quality, soils, waterbodies, vegetation and wildlife habitat. Although crusher dust suppression systems will be inspected regularly, failures of the systems are considered possible. Monitoring will be carried to measure dust emissions and should allow for corrective measures to be taken to limit the extent of time and areal extent impacted by any failures in the dust suppression controls. Temporary shutdown of crushing activities may be applied as a contingency measure if dust suppression systems fail.

Failure of the dust suppression mechanisms for roads may be quickly controlled by the application of additional water on roadways or additional application of chemical suppressants, such as DL10, if required.

Only short-term impacts to the environment are expected provided that contingency measures are applied, and consequence to the environment should be low for both failure modes.

Both dust suppression failure scenarios were estimated to be likely to occur over the life of the Project (likelihood B) with low environmental consequences (consequence severity 1).

4.2 Operations

4.2.1 Dike

No moderate or higher risks to the environment were identified for failures of the dike during operations. Considerations for the assessment are as follows.

A dike failure resulting in complete loss of containment was estimated at less than 10% probability or very unlikely to occur over the life of the Project (likelihood D). The most likely causes for such failure are internal erosion or piping of foundation and filter materials, inadequate construction/operation of seepage control systems, and slope failures within the open pit that impact the stability of the dike (all very unlikely to occur over the life of the Project).

The potential for internal erosion or piping will be controlled through investigation of dike foundation conditions, design considerations (dike geometry, specifications for compaction of filters, cement quantities required for cut-off wall to reduce the erosion potential, definition of critical seepage gradients, grouting of contact and shallow bedrock, broad rockfill shell upstream and downstream of the cut-off wall), QA and QC during all phases of the construction, and implementation of an operation maintenance and surveillance program, including regular inspections. In addition, monitoring of pore water pressures, thermal data, and quantity/quality of seepage may provide early warnings of the occurrence of internal erosion or higher than expected gradients and may allow for corrective actions before this can result in complete breach of the dike.

The potential for slope failures within the Jay Pit that could destabilize the Jay Dike will be controlled through investigation to characterize rock quality and structurally controlled features, with incorporation of findings from this investigation into the pit wall design and dike alignment selection. The setback distance between the dike and open pit will be revised once additional site investigation is conducted to confirm that failure surfaces impacting the dike's performance would have a minimum factor of safety of 1.5. In addition, further site investigation and ongoing geological mapping during operations will be carried out to confirm design assumptions and demonstrate a good understanding of geological conditions, identifying areas that may require additional design or monitoring considerations. Monitoring during operations will include geological structural mapping, visual inspections for evidences of slope instability, slope displacement monitoring using prisms, seepage monitoring, and pore pressure measurements in the pit walls using piezometers. Results of the monitoring program during operations should provide early warnings of potential pit wall instabilities. Guidelines for blasting vibrations from open pit operations have been developed to avoid impacts to fish in nearby waterbodies and are more stringent than those required to ensure integrity of the cut-off wall. As such, failure of the dike due to blast induced vibration is considered extremely unlikely to occur over the life of the Project (likelihood E).

Other causes for dike breach including slope instability and overtopping were considered to have lower likelihood for the following reasons:

- Slope failures resulting in loss of the seepage control element (dike breach) could occur due to the high shear strength of the rockfill and wide crest of the dike. The larger failure surface required to compromise filters and low permeability element significantly reduces the likelihood of this failure mechanism, which requires a minimum factor of safety of 1.5 to be met during operations. In addition, the dike has been designed to sustain an earthquake with frequency of 1 in 2,500 years. Thus, the likelihood of this hazard scenario was estimated at less than 1% probability or extremely unlikely to occur (likelihood E).
- A dike breach due to overtopping could occur due to higher water levels in Lac du Sauvage due to increased inflows or blockage of outlets, wave runup, or large settlements of the dike (larger than 2.5 m) that could compromise freeboard. Freeboard of the dike has been designed to account for inflows and water levels associated to the 1 in 1,000 year flood and also include wave runup in the calculations. In addition, if higher than expected waves are generated due to wind, the broad upstream rockfill platform between the low permeability element and Lac du Sauvage in combination with the rockfill berm should serve as spilling basin, and presence of rockfill and filter material adjacent to the cut-off wall reduce the chances for erosion of the low permeability element that could compromise retention of water and/or lead to a dike breach. Static settlement of the rockfill and filters can be compensated by placement of additional material to maintain the specified freeboard requirements during operations. Seismic induced settlements are not expected to result in complete loss of freeboard (estimated to be less than 2.5 m) and can also be compensated for by placement of additional rockfill after the earthquake. The likelihood of this hazard scenario was thus estimated at less than 1% probability or extremely unlikely to occur (likelihood E).

The consequence to the environment as a result of a dike breach would be inundation of the Jay Pit and diked area with resulting generation of sediments due to wash-out of materials and spills due to equipment and infrastructure within the open pit at the time of flooding. It is almost certain to occur (likelihood A) that most of the sediments and spills generated as a result of a dike breach may be contained within the disturbed footprint of the Jay Project (diked area), with only a limited amount potentially migrating away from the area. In addition, early warning of dike instability should be possible from monitoring of instruments within the dike and foundation soils so removal of equipment within the diked area may be possible before inundation occurs. As such, if a dike breach occurs, consequences to the environment should be moderate (consequence severity 2).

Temporary or gradual increases in seepage through the dike would be effectively managed by the dike seepage management system and should not result in direct consequences to the environment. In addition, sumps within the diked area would be designed to provide additional storage capacity for any excess dike seepage water, additional in-pit sumps will also be constructed and provide some storage capacity, and the pit itself could act as a temporary containment area for additional water seeping through the dike. Additional pumping and pipeline capacity could be added for management of dike seepage water, if necessary. An indirect consequence of higher seepage flows through the dike could be the early discharge of water from the Misery Pit to Lac du Sauvage (earlier than five years into operations), which has minimal impacts to the environment (provided that water meets discharge criteria) but would not be consistent with current commitments for the Project. As such, water management contingencies have been considered in the design to accommodate additional runoff or seepage through the dike and avoid early discharge.

These water management contingencies include the following (Golder 2014a):

- maintaining a storage contingency allowance in the existing King Pond Settling Facility throughout the construction and operations stage, for use as additional total suspended solids management facility during construction and operations phase, or for short-term emergency minewater storage;
- maintaining the contingency storage in the Misery Pit (approximately 3 million m^3) throughout the operations stage, for use as emergency minewater storage;
- maintaining pumping system and a pipeline between the Misery Pit and the Lynx Pit throughout the operations stage to allow for lowering of the Lynx Pit water level to generate additional contingency minewater storage if required; and
- increasing storage capacity in the Jay runoff sump and mine inflows sump (e.g., construct contain berms around the sumps) to increase temporary minewater storage capacity within the diked area.

Seepage flows through the dike exceeding the capacity of the pumping systems are considered unlikely to occur over the life of the Project (likelihood C) but could be caused by the presence of higher permeability materials in the dike foundation, construction defects in the low permeability element of the dike (controlled through design and construction QA/QC), or loss of permafrost in the dike abutments (not likely to occur as a result of climate changes during the 10-year operation, and permafrost exists in the abutments where the head of water acting on the dike is low). This would result in short-term flooding (until seepage is controlled) within the diked area (already disturbed by the Project development), which is considered to have a consequence to the environment of low (consequence severity 1).

4.2.2 Water Management System

Moderate or higher risks to the environment due to failures of the water management system are related to pipeline ruptures and failure of the diffuser in Lac du Sauvage. Consequences of pipeline rupture would be erosion of land and potential discharge of sediments to waterbodies, erosion of sensitive areas such as the esker, and release of high salinity water (mine inflows) to waterbodies. Consequence of failure of the diffuser would be inadequate mixing of water at the discharge.

Pipeline ruptures could occur along the entire length of all pipelines (total of approximately 24 km during operations). Main causes for rupture were considered to be inadequate welding or construction and freezing of water within the pipe during winter. Design safeguards to control the likelihood of rupture due to freezing include insulation, maintenance of high flow velocities within the pipe, a drainage system to remove the water within the pipe during stand-by or repairs (contingency only), and heat tracing of pipes that are required to be operated during winter months (for control of mine inflows and return water to Lac du Sauvage). The QA/QC during construction and commissioning activities, including pressure testing, will also reduce the likelihood of improper welding or other constructive issues that could lead to rupture. Ongoing visual inspections and maintenance and calibration of instruments during operations should allow early identification of flaws or wear of the pipes. If failure occurs, monitoring of flows and pressures within the pipe should allow for early identification of ruptures and implementation of emergency response procedures (rapid system shutdown to allow for repairs). Monitoring procedures will be in place for early identification of ruptures so that the volume of water released is minimized and corrective actions (following Spill Contingency Plans) can be taken to avoid migration of water with high sediments or high TDS to nearby waterbodies. As such, ruptures resulting in discharge to Lac du Sauvage or other waterbodies (consequence severity 2) were estimated at less than 50% probability or unlikely to occur over the life of the Project (likelihood C). Ruptures resulting in significant erosion and release of sediments will be of short duration and contained within a limited area.

Consequences to the environment from ruptures of the pipelines carrying water with low salinity are expected to be low (consequence severity 1) assuming the most likely consequence will be erosion of land or runoff to nearby waterbodies.

Consequences to the environment as a result of ruptures of the mine inflows pipeline (~7 km) were considered moderate (consequence severity 2) due to the higher salinity of the water being transported by this pipeline and assuming impacts would be to receiving waterbodies.

Due to the relevance of the esker, pipe ruptures in this area were considered to have a moderate (consequence severity 2) impact to the environment (erosion of the esker) but were estimated at lower likelihood (likelihood C) due to the reduced length of pipe crossing the esker area.

Failure of the diffuser at the discharge into Lac du Sauvage results in moderate risk to the environment. Although water to be discharged to Lac du Sauvage is not expected to be acutely toxic to fish (Golder 2014b), consequences to the environment of improper mixing of discharge water due to diffuser failure are considered to be moderate (consequence severity 2) due to the extended time potentially required for replacement of the diffuser. Monitoring programs in the receiving environment during operations will provide any warnings of potential diffuser malfunction and discharge will cease if water does not meet end-of-pipe discharge criteria.

Other failure modes assessed for the water management system resulted in low risks due to either a lower likelihood or consequence severity. Key considerations when addressing the risks associated with other failure modes for the water management system are as follows:

- Overflow of sumps would only result in flooding within the area disturbed by the Project, and no impacts to the environment or public safety are expected. Sumps have additional storage capacity to accommodate inflows in the event pumps fail and repairs are required. As such, this event is considered to unlikely occur over the life of the Project (likelihood C).
- Overflow of the Misery Pit and release of water not meeting discharge criteria to Lac de Gras is considered very unlikely to occur over the life of the Project (likelihood D). Possible causes are failure of the return water pumping system along with high natural inflows. Safety freeboard of 10 m in the Misery Pit should provide enough capacity to control any natural inflows occurring if repairs to the return water pumping system are required. Downtimes are expected to be short enough to allow for corrective actions to take place before overflow occurs.
- Failure of the sub-basin B diversion channel resulting in erosion and sediment transport to Lac du Sauvage or blockage of fish migration is very unlikely to occur over the life of the Project (likelihood D). Design has been developed to carry storm flows with frequency of 1 in 100 years, and the diversion channel will be lined with riprap (reducing likelihood for sediment generation). Slope instability or differential settlements due to thawing that could result in blockage or grade changes in the channel will be addressed through site investigation to define presence of ice rich soils along the alignment of the diversion channel, and adaptations of the design will be carried if needed. Periodic visual inspections and regular removal of sediments and snow should allow for repairs and restoration of the channel to take place in the short term if blockage occurs. Consequence to the environment is considered to be low to moderate (consequence severity 2 has been considered as a conservative estimate).

4.2.3 Power Distribution System

Risks are assumed to be the same as construction phase. Refer to the discussion of risks provided in Section 4.1.3.

4.2.4 Haulage and Transportation

Risks are assumed to be the same as construction phase. Refer to the discussion of risks provided in Section 4.1.4.

4.2.5 Waste Rock Storage Area

No moderate or higher risks to the environment were identified for failures of the waste rock storage area.

Slope failure of the waste rock storage area resulting in runout that could reach Lac du Sauvage or the esker area is considered very unlikely to occur over the life of the Project (likelihood D). The most likely cause for slope failure during operations is fast dumping rates on thawing foundations. Ice-rich soils are expected to be limited within the footprint of the waste rock storage area as there is a limited amount of fine grained soils (silts and clays) in this area. In addition, thawing of ice rich soils is expected to be slow enough to allow for consolidation and strength gains to avoid failures resulting in significant runout. The results of stability analyses have been developed assuming thawed foundation conditions and indicate that the minimum design factors of safety are satisfied for both static and pseudo-static loading conditions. Minimum factors of safety of 2.0 and 2.3 were obtained for a toe failure and a crest failure, respectively, under static conditions. For pseudo-static conditions, minimum factors of safety of 1.6 and 1.9 were obtained for a toe failure and a crest failure, respectively (Golder 2014c). Although a foundation site investigation program has not been completed, a reasonable amount of information is available about the foundation conditions based regional geology mapping to support the validity of the predicted factors of safety. Additional foundation investigations are expected to be conducted to confirm the foundation conditions, particularly the presence or absence of ice-rich soils. If a large runout occurs, consequences to the environment are considered to be moderate, primarily due to the potential for generation of sediments in Lac du Sauvage, impacts to the esker, or blockage of surrounding watercourses and local terrestrial habitat.

4.2.6 Open Pits

No moderate or higher risks to the environment were identified for failures of the open pits during operations.

Slope failures in the Jay Pit are not expected to result in direct impacts to the environment or public safety as any debris and damaged equipment would remain within the pit. A consequence to the environment of low (consequence severity 1) was considered as a conservative estimate. Failures may result in disruption of operations or early closure of the pit (if failure is large enough, which is considered very unlikely to occur - likelihood D). The potential for slope failures within the Jay Pit will be controlled through investigation to characterize rock quality and structurally controlled features, with incorporation of this into the pit wall design. In addition, further site investigation and ongoing geological mapping during operations will be carried out to confirm design assumptions and demonstrate a good understanding of geological conditions, and to identify any areas that may require additional design or monitoring considerations. Monitoring during operations will include geological structural mapping, visual inspections for evidence of slope instability, slope displacement monitoring using prisms, seepage monitoring, and pore pressure measurements in the pit walls using piezometers. Results of the monitoring program during operations should provide early warnings of potential pit wall instabilities.

Slope failures in the Misery Pit and the Lynx Pit resulting in overtopping of in-pit water and discharge into Lac de Gras resulted in low risk.

It was considered that the 10 m freeboard to be kept in the Misery Pit during operations would significantly reduce the likelihood and volume of water that could migrate outside of the open pit in case of failure, making this scenario very unlikely to occur (likelihood D). Consequences to the environment are expected to be moderate (consequence severity 2) at the most considering only water at the surface of the pit (low in salinity) would be released. Mixing of the water within the open pit and rupture of pipelines as a result of pit slope failure would result in potential disruption of operations but would not result in any impacts to the environment as discharge to Lac du Sauvage would only be resumed once water within the Misery Pit met discharge criteria.

The Lynx Pit will only receive water from the dewatering phase, and the remaining storage volume in the pit will be filled by surface runoff. The Lynx Pit will overflow to Lac de Gras during operations and as such, no significant freeboard is expected to be present to control any releases resulting from slope failure of the pit. Failure of the Lynx Pit slopes that could result in additional release of water in the form of a wave is considered very unlikely to occur (likelihood D). Water quality in the Lynx Pit is expected to meet discharge criteria and, therefore, any release resulting from failures of the pit is considered to have a moderate consequence to the environment (consequence severity 2).

4.3 Closure and Post-closure

4.3.1 Dike

No moderate or higher risks to the environment were identified for failures of the dike during closure and post-closure. Failures due to piping or internal erosion relevant to the operational phase will be precluded once back-flooding of the pit is completed.

Release of sediment associated with potential construction of the localized breaches through the dike, or instability of the excavated breaches, is considered very unlikely to occur over the life of the Project (likelihood D) and would only result in low (consequence severity 1) consequences to the environment. Turbidity control measures would be implemented during construction of the breaches to reduce the likelihood and extent of area impacted by elevated levels of turbidity.

4.3.2 Water Management System

Moderate or higher risks to the environment due to failures of the water management system during closure are related to pipeline ruptures (during back-flooding operations).

Risks levels for pipeline ruptures are assumed to be the same as those during operations. Refer to the discussion of risks provided in Section 4.2.2.

4.3.3 Power Distribution System

Risks assumed to be the same as construction and operation phase. Refer to the discussion of risks provided in Section 4.1.3.

4.3.4 Haulage and Transportation

Risks assumed to be the same as construction and operation phase. Refer to the discussion of risks provided in Section 4.1.4.

4.3.5 Waste Rock Storage Area

No moderate or higher risks to the environment were identified for failures of the waste rock storage area during closure and post-closure.

The Jay WRSA foundation is generally flat, and areas of higher relief within the Jay WRSA footprint are typically bedrock outcrops. Therefore, the slope of the foundation is generally not a significant factor for long-term stability. The critical stability of the Jay WRSA is predominantly controlled by the strengths of the foundation soils, where soil is encountered within the footprint. Frozen soils and bedrock have high strengths, and where the pile is founded on these materials it is expected to have a very high degree of stability. Finer grained foundation soils in a thawed condition will present the weakest foundation conditions. Although there is a higher likelihood for thawing of foundation soils in the long term due to changes in climate (compared to operations), the expectation is that the rate would be slow enough that consolidation of thawing foundations will take place without significant increases in pore water pressures that could result in failures of the slopes with significant runout distances (likelihood D).

Minimizing oxidation of waste rock through geochemical management and scheduling the timing of waste rock placement in key areas are anticipated to result in freezing conditions within the pile. Installation of thermistors within the pile will allow for monitoring of the thermal performance of the pile during operations and allow for implementation of mitigation measures, if required. Although the loss of permafrost in the long term may result in generation of runoff, the results of geochemical calculations indicate that mixing of non-acid generating granite (75%) and potentially acid generating metasediment waste rock (25%) during construction of the WRSA should be suitable for achieving an overall non-acid generating mixture of rock and as such significant impacts to the environment should be rare even if loss of permafrost occurs. The evaluation of the acid generation potential of waste rock materials from the Jay Pit has been carried out using site-specific samples and regional geochemical characterization data (Dominion Diamond 2014, Annex VIII).

Ongoing monitoring of runoff from the WRSA during operations will help refine the estimates for long-term water quality, and management of the facility after closure may be adapted if needed.

4.3.6 Open Pits

No moderate or higher risks to the environment were identified for failures of the open pits during closure. Loss of meromictic conditions as a result of large scale slope failures in Jay Pit and Misery Pit resulted in a moderate risk for the post-closure phase.

Failures of the Jay Pit during back-flooding could result in some mixing of water within the diked area, potentially delaying the closure process and requiring more time to bring the area to conditions similar to those in the surrounding areas not affected by mine operations. This hazard scenario was estimated to be very unlikely to occur over the life of the Project (likelihood D) with a moderate consequence to the environment (consequence severity 2).

Failure of the Misery Pit and the Lynx Pit could result in immediate release of water not meeting discharge criteria into Lac de Gras. Although the Misery Pit and the Lynx Pit will be hydraulically connected (overflow) to Lac de Gras after closure, failures within the open pits will likely release water coming from the surface of the open pits, which is expected to meet discharge criteria. As such, the release of water not meeting discharge criteria is considered very unlikely to occur over the life of the Project (likelihood D) with moderate consequences to the environment (consequence severity 2).

Mixing of high TDS water and loss of meromictic conditions following a large scale slope failure in the Misery Pit and the Jay Pit post-closure could result in longer term release of water not meeting discharge criteria. Impacts of this scenario will be further addressed through geochemical modelling in the next stages of design and have currently been considered to be of potentially serious consequence (consequence severity 3). Likelihood for a large scale pit slope failure with the capacity to fully mix the water in the pits is considered very unlikely to occur over the life of the Project (likelihood D) and this would be supported by geological mapping carried in the Misery Pit and the Jay Pit prior to closure. Mapping will be carried to identify if areas of potential long-term and large enough instabilities are present and if further controls are required to improve stability prior to closure.

4.3.7 Other Risks Associated to Accidents and Malfunctions During Closure and Post-closure

Accidents resulting in injury to the public entering the mine area after closure have a moderate risk level; similar to the risk of injury to public from the surrounding environment (i.e., no incremental risk compared to natural areas not affected by mining activities). Due to the remoteness and difficulty of access to the site, public access to the closed mine area is not expected to be frequent. In addition, removal of infrastructure and buildings, back-flooding of open pits, and re-grading activities (e.g., for roads, benches) are expected to bring the site to conditions close to those of natural surroundings. As such, even if public access the closed mine, accidents resulting in serious injury (consequence severity 3) should be very unlikely to occur over the life of the Project (likelihood D).

5.0 CONCLUSIONS

Hazard scenarios were identified for accidents and malfunctions that result in risks to the environment and public health and safety. None of the risks identified were classified as highest (red) using the Project risk matrix. A total of three scenarios were classified as high risks for the environment (orange). The remaining 38 scenarios were classified as posing either moderate or low risks to the environment. One moderate risk to public health and safety was identified for the post-closure phase but was not considered to be an incremental risk associated to the Jay Project development.

Accidents and malfunctions that may pose high risks to the environment are large fuel spills that could escape containment area and reach Lac du Sauvage (for construction, operations, and closure phase). Controls for these scenarios include enforcing the application of standards intended to manage and control spills, including the following:

- Hydrocarbon Impacted Material Management Plan;
- Traffic Management Standard; and,
- Emergency Response and Spill Contingency Plans.

6.0 CLOSURE

We trust the above meets your present requirements. If you have any questions or requirements, please contact the undersigned.

The reader is referred to the Study Limitations which follow the text and form and integral part of this technical memorandum.

GOLDER ASSOCIATES LTD.

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ES/JCC/ER/DT/caf/jc/rs/it

Attachments: Study Limitations
Figures 1 and 2
Attachment 1: Risk Registers for Accidents and Malfunctions of the Jay Project

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PROFESSIONAL ENGINEERS,
GEOLOGISTS and GEOPHYSICISTS
OF THE NORTHWEST TERRITORIES
PERMIT NUMBER
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16 January 2015

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STUDY LIMITATIONS

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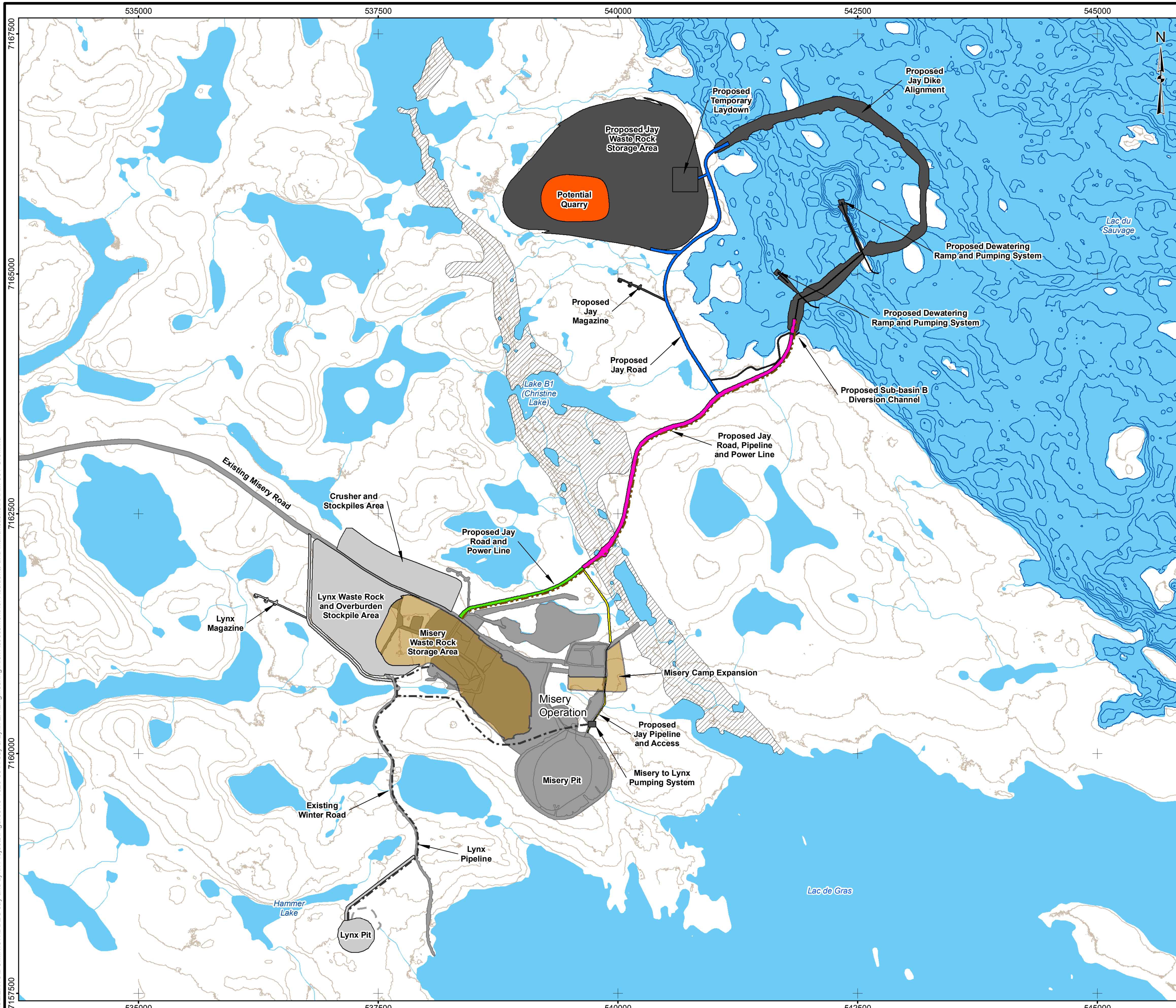

LEGEND

- EKATI MINE FOOTPRINT (MISERY OPERATION)
- BATHYMETRY CONTOUR (5 m INTERVAL)
- ELEVATION CONTOUR (10 m INTERVAL)
- WATERCOURSE
- WATERBODY
- ESKER

JAY PROJECT FOOTPRINT

- POWER LINE
- PROPOSED JAY PROJECT INFRASTRUCTURE
- PROPOSED JAY ROAD NORTH (HAUL ROAD)
- PROPOSED JAY ROAD (HAUL ROAD AND POWER LINE)
- PROPOSED JAY ROAD (HAUL ROAD, PIPELINE AND POWER LINE)
- PROPOSED JAY PIPELINE ROAD (ACCESS ROAD AND PIPELINE)
- POTENTIAL QUARRY

LYNX PROJECT FOOTPRINT

- EXISTING SHORELINE OF DEWATERED LYNX LAKE
- LYNX PIPELINE
- LYNX PROJECT INFRASTRUCTURE

MISERY PROJECT FOOTPRINT EXPANSION

- MISERY PROJECT INFRASTRUCTURE

NOTES

ROAD, PIPELINES, AND POWER LINE ARRANGEMENT TO BE DETAILED AS PART OF PRE-FEASIBILITY DESIGN. APPROXIMATE CORRIDOR WIDTHS ARE SHOWN.
POTENTIAL QUARRY MAY BE REQUIRED WITHIN THE FOOTPRINT OF THE PROPOSED JAY WASTE ROCK STORAGE AREA

REFERENCE

JAY PROJECT CONCEPTUAL ENGINEERING REPORT, EKATI MINE, DOC#: 1313280041-E14037-R-REV0-4060, DATED: MAY 13, 2014
JAY PROJECT DESIGN BASIS MEMORANDUM FOR PRE-FEASIBILITY DESIGN OF PROJECT ROADS AND PIPELINE BENCHES, DOC#: 1313280041-E14031-TM-REVD-2020, DATED: AUGUST 1, 2014
LIDAR AND BATHYMETRIC DATA OBTAINED FROM AURORA, 2013
WATER OBTAINED FROM CANVEC © NATURAL RESOURCES CANADA, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

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SCALE 1:40,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

DEVELOPMENT FOOTPRINT CONSTRUCTION AND DEWATERING

Golder Associates

PROJECT		13-1328-0041	FILE No. RAAM-001-GIS
DESIGN	ESD	15/10/14	SCALE AS SHOWN REV 0
GIS	ANK	15/10/14	
CHECK	ESD	15/10/14	FIGURE 1
REVIEW	JCC	15/10/14	

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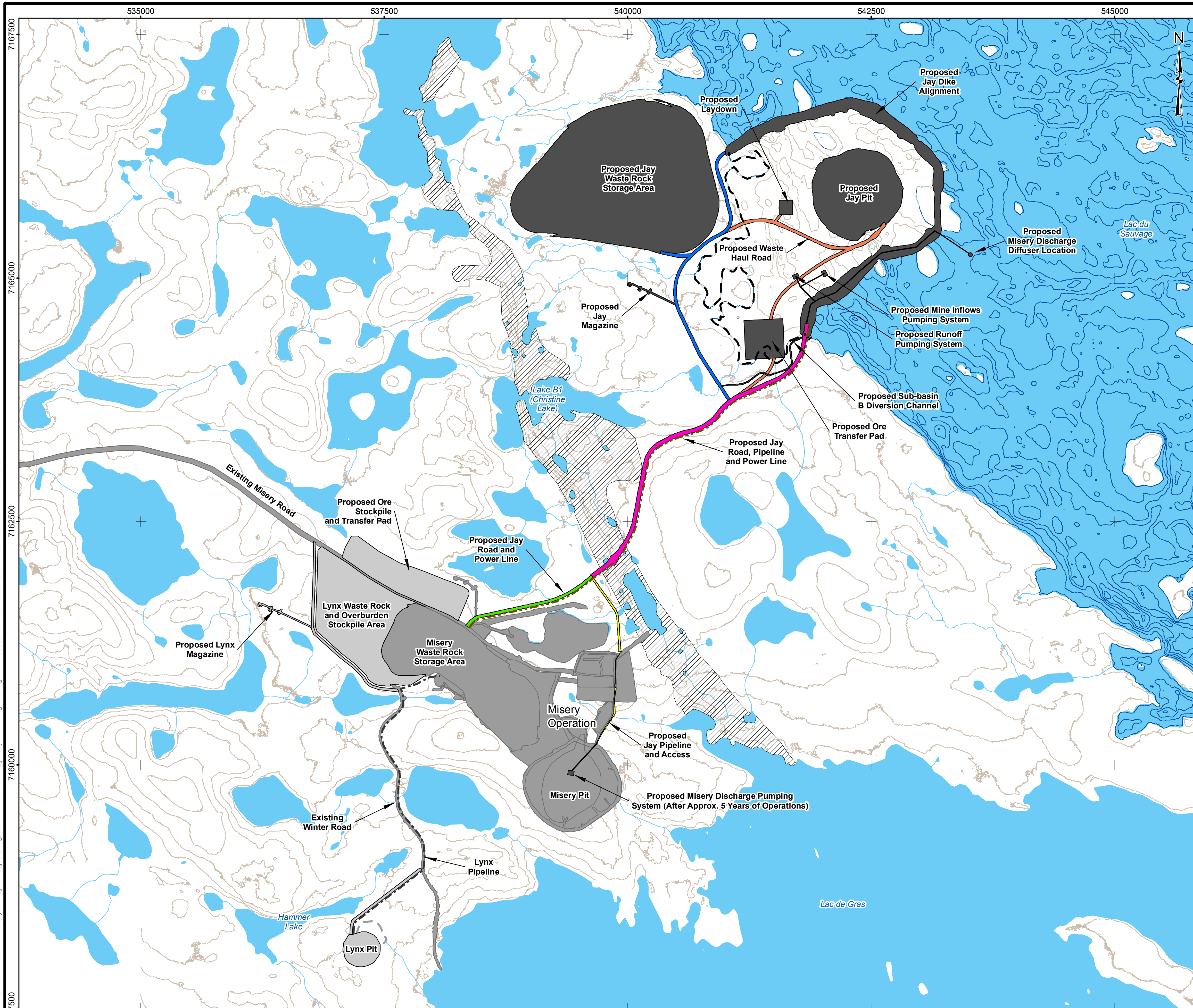

LEGEND

- EKATI MINE FOOTPRINT (MISERY OPERATION)
- BATHYMETRY CONTOUR (5 m INTERVAL)
- ELEVATION CONTOUR (10 m INTERVAL)
- WATERCOURSE
- WATERBODY
- ESKER

JAY PROJECT FOOTPRINT

- EXISTING SHORELINE OF DEWATERED AREA
- POWER LINE
- PROPOSED JAY PROJECT INFRASTRUCTURE
- PROPOSED JAY ROAD NORTH (HAUL ROAD)
- PROPOSED JAY ROAD (HAUL ROAD AND POWER LINE)
- PROPOSED JAY ROAD (HAUL ROAD, PIPELINE AND POWER LINE)
- PROPOSED JAY PIPELINE ROAD (ACCESS ROAD AND PIPELINE)
- PROPOSED OPERATION ROADS

LYNX PROJECT FOOTPRINT

- EXISTING SHORELINE OF DEWATERED LYNX LAKE
- LYNX PIPELINE
- LYNX PROJECT INFRASTRUCTURE

NOTES

ROAD, PIPELINES, AND POWER LINE ARRANGEMENT TO BE DETAILED AS PART OF FURTHER PRE-FEASIBILITY DESIGN. APPROXIMATE CORRIDOR WIDTHS ARE SHOWN.

REFERENCE

JAY PROJECT CONCEPTUAL ENGINEERING REPORT, EKATI MINE, DOC#: 1313280041-E14037-R-REV0-4060, DATED: MAY 13, 2014
JAY PROJECT DESIGN BASIS MEMORANDUM FOR PRE-FEASIBILITY DESIGN OF PROJECT ROADS AND PIPELINE BENCHES, DOC#: 1313280041-E14031-TM-REVD-2020, DATED: AUGUST 1, 2014
LIDAR AND BATHYMETRIC DATA OBTAINED FROM AURORA, 2013
WATER OBTAINED FROM CANVEC © NATURAL RESOURCES CANADA, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

1 0 1

SCALE 1:40,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

DEVELOPMENT FOOTPRINT OPERATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. RAAM-002-GIS
DESIGN	ESD	15/10/14	SCALE AS SHOWN REV 0
GIS	ANK	15/10/14	
CHECK	ESD	15/10/14	FIGURE 2
REVIEW	JCC	15/10/14	

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Engineering\Risk Assessment for Accidents and Malfunctions\RAAM-002-GIS.mxd

ATTACHMENT 1

Risk Registers for Accidents and Malfunctions of the Jay Project

RISK REGISTER - CONSTRUCTION PHASE

13-1328-0041 4060 - Dominion Diamonds - Engineering EA Support - Accidents and Malfunctions

Dike - composed of broad rockfill shell, central zone of crushed granular fine and coarse filters and a composite low permeability element (seepage control system) including a cut-off wall, jet grouted columns and a grout curtain (dependent on depth to bedrock). **Dewatering system** - composed of three pumping stations (PS1, PS2, PS3), each with two vertical turbine pumps. Three pipelines going from Jay Pit to Lac du Sauvage during initial dewatering (approximately 350 m each) and from Jay Pit to Misery and Lynx Pit during final dewatering (6 to 10 km long). Pumping stations will be used for initial and final dewatering of the diked area. Water discharged to Lac du Sauvage during initial dewatering and to Misery Pit and Lynx Pit during final dewatering. **Power Distribution System** composed of powerlines and substations. **Haulage and transportation** - composed of Jay Road, Jay North Road, Jay Pipeline Road.

RISK COMPONENT / ELEMENT	FAILURE MODE	CAUSES	CONSEQUENCE EFFECTS	PLANNED SAFEGUARDS AND RISK MITIGATION MEASURES	LIKELIHOOD*	CONSEQUENCE SEVERITY*		NOTES Estimate Confidence	RISK CLASSIFICATION*	
						Environment	Public H&S		Environment	Public H&S
1) Dike										
1.1 Isolation Dike										
1	Slope failures of fill materials during placement	Surface sloughing. Improper material placement during construction.	Equipment falling into Lac du Sauvage. Spills (fuel, oil, etc) from falling equipment into Lac du Sauvage. Generation of higher turbidity and sediments than expected in Lac du Sauvage.	Placement of turbidity curtains. Control rate of fill placement. QA/QC during fill placement. Emergency response, management plans, monitoring and contingency plans in place.	c	2				
2	Dike breach during dewatering	Internal erosion or piping during dewatering phase. Overtopping due to higher water levels in Lac du Sauvage than predicted or due to larger settlements. Overall slope instability due to unknown geological conditions at the foundation. Inadequate construction.	Inundation of diked area. Generation of sediments within the disturbed footprint of the Jay Project (diked area). Potential for short term migration of sediments away from the disturbed area. Minor impacts to water levels and immediate aquatic environment.	Monitoring plan during dewatering. Dewatering rates controlled. Monitor pressure response in the dike.	e	2		Consequences rating assuming failure occurs at the end of dewatering phase. Failure occurring early in the dewatering phase can be managed and would not have significant consequences to the environment.		
3	Release of grout	Operational errors in batching plants or during grouting operations. Migration of grout through existing geological features.	Grout migrating from the dike area to Lac du Sauvage	Grouting operation controls in place. Monitoring of pressures and volumes of grout to identify loss of grout materials and visual inspection when no ice is present. Control of grout takes. QA/QC during grouting operations.	b	1				
4	Collapse of slurry trench during construction of cutoff wall	Improper compaction of filters, pressure from bentonite slurry not enough to hold the trench (due to inability to maintain slurry level high enough with respect to water level)	Involuntary bentonite slurry release into the water	Proper design and compaction of filter materials. QA/QC during construction.	c	1		Slurry trench located close to the center of the dike. Bentonite slurry is not likely to reach the water in case of failure of the trench.		
5	Failure to meet performance with respect to settlement and deformations	Unexpected geological conditions. Compressible sediments remaining in dike foundation.	Delays on construction schedule, impacts to fill quantities required for construction.	Settlements to be compensated during construction to achieve desired elevations for the dike. Surveying. QA/QC of fill materials.	b			Project risk, will not affect the environment or public safety.		
1.2 Turbidity Control System										
1	Failure of turbidity control systems	high wind, wave action. Slow rates of rockfill placement during winter not sufficient to avoid generation of sediments.	Short term release of sediments into Lac du Sauvage	Redundancy of controls (primary and secondary turbidity curtains in place). Rockfill platform upstream constructed first to provide shelter from winds and wave actions. Further control of placement rates depending on results of monitoring.	c	2		Low to Moderate environmental consequence, conservatively estimated as Moderate (2).		
1.3 Seepage Control System										
1	Failure to meet performance with respect to seepage quantities and quality	Unexpected geological conditions at foundation. Inadequate construction of seepage control system. Cracking of cutoff wall due to earthquake or deformations larger than expected.	Increased volume of seepage water from the dike into Jay Pit area. Inability to discharge into Lac du Sauvage.	More water sent to Misery Pit. Design and construction of cutoff wall to accommodate deformations and earthquake. Contingency measures provided in Water Management Plan.	c			Water management issue. Increase in volume should be relatively small that it would not require early discharge of water to Lac du Sauvage during operations.		

* From the Risk Matrix

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2) Dewatering System

2.1 Pumping System

RISK COMPONENT / ELEMENT	FAILURE MODE	CAUSES	CONSEQUENCE EFFECTS	PLANNED SAFEGUARDS AND RISK MITIGATION MEASURES	LIKELIHOOD*	CONSEQUENCE SEVERITY* Environment	CONSEQUENCE SEVERITY* Public H&S	NOTES Estimate Confidence	RISK CLASSIFICATION* Environment	RISK CLASSIFICATION* Public H&S
1	Failure of pumps during dewatering	Power shutdowns, equipment failure, excess of turbidity in water.	Overflow of sumps. Delay of dewatering. Potential for higher discharge flows to Lac du Sauvage required to compensate delays in dewatering schedule	Redundancy in design (1 pump operating and another one in standby) reduce likelihood due to equipment failure. Monitoring of discharge points in Lac du Sauvage to ensure discharge criteria is met.	c	1				

2.2 Pipelines

RISK COMPONENT / ELEMENT	FAILURE MODE	CAUSES	CONSEQUENCE EFFECTS	PLANNED SAFEGUARDS AND RISK MITIGATION MEASURES	LIKELIHOOD*	CONSEQUENCE SEVERITY* Environment	CONSEQUENCE SEVERITY* Public H&S	NOTES Estimate Confidence	RISK CLASSIFICATION* Environment	RISK CLASSIFICATION* Public H&S
1	Pipeline rupture	Traffic hitting pipe, inadequate construction, power shutdowns and freezing.	Generation of ice surfaces or erosion that could affect migration of terrestrial species (caribou in particular).	Monitoring of flows and pressures for early identification of pipeline ruptures. Rapid pumping system shutdown to allow for repairs. Emergency response, management plans, monitoring and contingency plans in place. Insulation, heat tracing, high flow velocities and pipeline drainage system in place to avoid freezing of water in the pipes (reduced probability of failure).	c	1		Dewatering occurring mostly during spring-summer. Not a likely scenario during this phase.		
			Generation of ice surfaces that could affect traffic of construction equipment.		c			Project risk, will not affect the environment or public safety.		
			Erosion of land and release of sediments		b	1		Most likely consequence is erosion of soils and generation of sediments. Sediments reaching water bodies is considered less likely due to rapid shutdown of the system.		
			Erosion of the dike crest and slopes and release of sediments to Lac du Sauvage		c	1		Shorter pipeline length over dike makes it less likely than a failure on-land. Dike will be constructed with rockfill reducing potential for sediment release.		
			Erosion of the esker. Potential impacts to wildlife migration		c	2				

2.3 Discharge Points/Areas

RISK COMPONENT / ELEMENT	FAILURE MODE	CAUSES	CONSEQUENCE EFFECTS	PLANNED SAFEGUARDS AND RISK MITIGATION MEASURES	LIKELIHOOD*	CONSEQUENCE SEVERITY* Environment	CONSEQUENCE SEVERITY* Public H&S	NOTES Estimate Confidence	RISK CLASSIFICATION* Environment	RISK CLASSIFICATION* Public H&S
1	Failure to meet assumed discharge volume directly to Lac du Sauvage during dewatering	Sediments and other effluents generated during construction activities.	Minor disruption of aquatic habitat within the diked area. Inability to discharge water into Lac du Sauvage during initial dewatering (more water into Misery Pit during dewatering) May require early discharge to Lac du Sauvage (during operations).	Misery or Lynx Pit can accommodate additional water during dewatering. Flocculants may be used as an additional contingency to reduce the amount of water going into Misery and Lynx Pits (if required).	c	1		Impacts only within the diked area. Fish out will take place during construction reducing consequences.		

2.4 Ramps and Pipe Benches

NO RELEVANT RISKS TO THE ENVIRONMENT OR PUBLIC H&S DUE TO ACCIDENTS AND MALFUNCTION WERE IDENTIFIED

2.5 Diversions

RISK COMPONENT / ELEMENT	FAILURE MODE	CAUSES	CONSEQUENCE EFFECTS	PLANNED SAFEGUARDS AND RISK MITIGATION MEASURES	LIKELIHOOD*	CONSEQUENCE SEVERITY* Environment	CONSEQUENCE SEVERITY* Public H&S	NOTES Estimate Confidence	RISK CLASSIFICATION* Environment	RISK CLASSIFICATION* Public H&S
1	Failure of Sub-basin B diversion channel	Higher flow than design, permafrost thawing. Blockage with ice.	Migration of fish not possible until fixed (short term). Erosion and sediment transport to Lac du Sauvage	Design flow is for 1 in 100 year return period. Rip-rap lining reduces erosion potential. Maintenance will be carried. Investigation to define ice rich areas and design to control failure due to thawing.	d	2				

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						Environment	Public H&S		Environment	Public H&S
3) Power Distribution System										
3.1 Power Lines and Supply										
	1 Leaks or spills from transformers	Equipment failure, poor maintenance.	Oil spills to immediate environment	Design safeguards, containment features. Spills will be cleaned following Ekati's Spill Contingency Plans	b	1				
	2 Disruption of Power lines between Jay Pit and Misery	Traffic accidents, adverse climatic conditions.	Power shutdowns affecting initial dewatering operations and requiring higher discharge flows to Lac du Sauvage to compensate for delays in construction schedule.	Backup generators. Additional water pumped to Misery or Lynx Pit to reduce discharge flows at Lac du Sauvage (if required)	b	1				
4) Haulage and Transportation										
4.1 Roads (Jay Road, Misery Road)										
	1 Erosion of the roads connecting to dike abutments	Surface runoff	Release of sediments into Lac du Sauvage	Use of rockfill and aggregate for road construction to reduce erosion potential. Extension of turbidity barriers if sediment release to Lac du Sauvage is observed. Water diversions in place for sub-basin B.	c	1				
	2 Small fuel spill	Equipment damage, operator error or other accidents involving mobile equipment	Small fuel spill, rapidly controlled and contained.	Operational, maintenance and emergency response procedures. Control spill following procedures in Ekati's Spill Contingency Plans.	a	1				
	3 Large fuel spill	Fuel line rupture, equipment damage, operator error or other accidents involving fuel trucks or mobile equipment	Large fuel spill, may escape containment; limited volume may reach Lac du Sauvage (e.g., for fuel spill on the dike) or other lakes.	Maintenance and emergency response procedures. Control spill following procedures in Ekati's Spill Contingency Plans.	b	2				
5) Waste Rock Storage Area										
5.1 Waste Rock Facility										
	NO RELEVANT RISKS TO THE ENVIRONMENT OR PUBLIC H&S DUE TO ACCIDENTS AND MALFUNCTION WERE IDENTIFIED									
6) Open Pits										
6.1 Jay and Misery Pit										
	NO RELEVANT RISKS TO THE ENVIRONMENT OR PUBLIC H&S DUE TO ACCIDENTS AND MALFUNCTION WERE IDENTIFIED									
7) Risks from Other Project Components										
7.1 Permitting										
	1 Permits not received on schedule		Project delays.		b			Project risk, will not affect the environment or public safety.		
7.2 Dust Supression Mechanisms										
	1 Failure of dust suppression mechanism from crushing	Equipment malfunction, inadequate implementation of mitigation measures	Dust generation from crusher higher than permitted. Short term impacts to air quality	Monitoring. Maintenance of dust suppression system. Temporary shutdown of crushing operations if permitted levels are not met.	b	1				
	2 Failure of dust suppression mechanism from roads	Inadequate implementation of mitigation measures	Dust generation from roads higher than permitted. Short term impacts to air quality	Monitoring. Additional water or additives to road surface.	b	1				

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						Environment	Public H&S		Environment	Public H&S
1) Dike										
1.1 Isolation Dike										
	1 Dike failure during operations	Slope failure through weak foundation materials. Earthquake induced slope failure.	Inundation of Jay Pit. Generation of sediments within the disturbed footprint of the Jay Project (diked area). Short term migration of fines away from the disturbed area. Minor impacts to lake water level and immediate aquatic environment.	Design, construction and operational controls. Ongoing monitoring. Large crest width reduces likelihood of total loss of freeboard or low permeability element. Dike designed to sustain earthquake with frequency of 1 in 2,500 years.	e	2		This cause was considered to have a lower likelihood than internal erosion, construction errors or failure due to instability of Jay Pit.		
		Internal erosion or piping of foundation or filter materials. Inadequate construction of seepage control system. Cracking of cutoff wall due to earthquake or deformations larger than expected.	This scenario may also result in complete loss of operation and potential for loss of workers life, but has no likely consequences on public safety.	Design, construction and operational controls. Ongoing monitoring of porewater pressures and seepage. Cement quantities in cutoff controlled to reduce potential for erosion.	d	2		Considered as a rare consequence for the failure mode. Controls may be implemented in time to avoid this consequence effects. Temporary increase in seepage is addressed in failure mode 1.3.1.		
		Overtopping of the dike due to higher than expected water levels in Lac du Sauvage, higher than expected settlements during earthquake or higher than expected wave run-up due to wind. Disruption of the seepage control system due to erosion from water.		Design and operational controls. Inflow Design Flood with a frequency of 1 in 1,000 years selected for freeboard calculations. Wide crest serves as spilling basin. Rockfill used for construction of the dike shell is not likely to erode.	e	2		This cause was considered to have a lower likelihood than internal erosion, construction errors or failure due to instability of Jay Pit.		
		Blasting induced vibrations		Blast vibration monitoring. Vibration threshold required to avoid impacts to fish habitat are more stringent than those required to ensure integrity of cutoff walls and foundation soils.	e	2		This cause was considered to have a lower likelihood than internal erosion, construction errors or failure due to instability of Jay Pit. Strain softening of foundation materials is very unlikely		
		Failure in open pit (static or earthquake induced) affecting the dike		Design of open pit to ensure a high factor of safety for failure surfaces affecting the dike. Monitoring of deformation of open pit walls. Dike located at distance far enough from the pit so that instabilities are unlikely to affect the dike.	d	2				
1.2 Turbidity Control System										
	TURBIDITY SYSTEM NOT IN PLACE DURING OPERATIONS									

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						Environment	Public H&S		Environment	Public H&S
1.3 Seepage Control System										
	1 Seepage flows exceeding capacity of the pumping system	Unknown geological conditions of dike foundation. Higher hydraulic conductivity of seepage control system.	Increase in seepage resulting in short term flooding within the diked area. Increased seepage flows may require early discharge from Misery Pit to Lac du Sauvage (before year 5 of operations).	Contingencies in water management plan. Increase flow of water pumped to Misery pit (during operations the system is operating at a lower capacity than design). Sumps provide additional storage for excess seepage water. Flocculants could be used as contingency in Misery Pit if discharge criteria is not being met at the time of discharge.	c	1		Dike seepage water is expected to be high in turbidity but low in salinity and TDS. Consequence to the environment should be low even if higher seepage occurs.		
		Loss of permafrost at abutments		Ongoing monitoring of seepage and temperatures. Short term operation, significant climate change is unlikely	c	1		Low heads at abutments should result in minimal increase in seepage.		

2) Water Management System

2.1 Pumping System										
	1 Overflow of sumps	Flows higher than design capacity of the pumps. Failure of the pumps	Flooding within the disturbed footprint (diked area)	Sumps capacity designed to accommodate additional seepage volumes.	c			Flooding not expected to impact areas outside the disturbed footprint. Consequences are to operations only.		
	2 Overflow of Misery Pit due to failure of pumping system	Power shutdowns, failure of return water pumping system and high natural inflows.	Overflow of Misery Pit resulting in involuntary release of water to Lac de Gras. Non compliance with water license.	Redundancy of pumping system (1 pump operating and 1 standby). Contingencies in water management plan. Safety freeboard in Misery Pit. Manageable situation through shutdown of pumping system to reduce inflows into Misery.	d	1		Scenario is very unlikely over the life of the Project as contingencies are likely to be applied prior to overflow of the Pit. Catchment into Misery is small and inflows other than water pumped from Jay Pit area can be effectively managed. Downtime should be short enough to allow for corrective actions to take place before overflow occurs.		
	3 Reduced storage capacity in Misery Pit at the beginning of operations due to failure of water management strategy during dewatering	More water pumped to Misery Pit during dewatering phases	Early discharge to Lac du Sauvage may be required (before 5 years into operations)	Contingencies in water management plan. Use of flocculants at Misery Pit if criteria is not met at the time of discharge.	c			Early discharge to Lac du Sauvage would not be in compliance with the license. It is assumed that early discharge would only take place if water in Misery Pit meets discharge criteria. Impacts to the environment or public are not expected. Contingency measures will be applied to avoid this scenario.		

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						Environment	Public H&S		Environment	Public H&S
2.2 Pipelines										
	1 Pipeline rupture	Traffic hitting pipe, inadequate construction, freezing.	Release of high salinity water. Erosion of land and discharge of sediments and high salinity water to water bodies	Monitoring of flows and pressures for early identification of pipeline ruptures. Rapid pumping system shutdown to allow for repairs. Emergency response, management plans, monitoring and contingency plans in place. Insulation, heat tracing, high flow velocities and pipeline drainage system in place to avoid freezing of water in the pipes (reduced probability of failure).	c	2		Only one pipeline carrying saline water. Approximately 1% chance of rupture per km per year (full rupture of pipe assumed to be 10 times less likely than industry standard for leaks). With the mitigation measures, ruptures are not expected to significantly affect water bodies.		
			Release of high salinity water. Erosion of the dike crest and slopes and release of sediments and high salinity water to Lac du Sauvage		c	2		Shorter pipeline length over dike makes pipe rupture less likely than on the roads. Nevertheless proximity to Lac du Sauvage makes it more likely for saline water to reach the lake if rupture occurs. Overall likelihood is considered unlikely over the life of the Project.		
			Release of non-saline water. Erosion of land and discharge of sediments to water bodies		b	1		Most likely consequence is erosion of soils and generation of sediments. Sediments reaching water bodies is considered less likely due to rapid shutdown of the system.		
			Release of non-saline water. Erosion of the dike and release of sediments to Lac du Sauvage		c	1		Shorter pipeline length over dike make it less likely than failure on the roads. Dike will be constructed with rockfill reducing sediment release potential.		
			Erosion of the esker. Impacts to migration routes for wildlife		c	2		Shorter pipeline length on esker area makes it less likely than failure over the entire length of the pipeline.		
2.3 Discharge Points/Areas										
	1 Failure of the diffuser at the discharge in Lac du Sauvage	inadequate construction, boat traffic, damage due to ice cover.	Inadequate mixing and possible non compliance with the water license	Contingencies in water management plan. Temporary shutdown of return pumping system during repair. Water quality monitoring.	c	2		Discharge not expected to be toxic to fish but repairs could take a prolonged time. Mixing of water not possible during repairs.		
2.4 Ramps and Pipe Benches										
	NO RELEVANT RISKS TO THE ENVIRONMENT OR PUBLIC H&S DUE TO ACCIDENTS AND MALFUNCTION WERE IDENTIFIED									

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						Environment	Public H&S		Environment	Public H&S
2.5 Diversions										
	1 Failure of Sub-basin B diversion channel	higher flow than design, permafrost thawing. Blockage with ice.	Migration of fish not possible until fixed (short term). Erosion and sediment transport to Lac du Sauvage	Design flow is for 1 in 100 year return period. Rip-rap lining reduces erosion potential. Maintenance will be carried. Investigation to define ice rich areas and design to control failure due to thawing.	d	2				
3) Power Distribution System										
3.1 Power Lines and Supply										
	1 Leaks or spills from transformers	Equipment failure, poor maintenance, leaks.	Oil spills to immediate environment	design safeguards, containment features. Spills will be cleaned following Ekati's Spill Contingency Plans	b	1				
	2 Disruption of Power lines between Jay Pit and Misery	Traffic accidents, adverse climatic conditions.	Inability to operate water management system	Backup generators.	b			Operational risk, will not affect the environment or public safety.		
4) Haulage and Transportation										
4.1 Roads (Jay Road, Misery Road, Waste Haul Road, Ore Haul Road)										
	1 Erosion of the roads connecting to dike abutments	Surface runoff	Release of sediments into Lac du Sauvage	Use of rockfill and aggregate for road construction to reduce erosion potential. Extension of turbidity barriers if sediment release to Lac du Sauvage is observed. Water diversions in place for sub-basin B.	c	1				
	2 Small fuel spill	Equipment damage, operator error or other accidents involving mobile equipment	Small fuel spill, rapidly controlled and contained.	Operational, maintenance and emergency response procedures. Control spill following procedures in Ekati's Spill Contingency Plans.	a	1				
	3 Large fuel spill	Fuel line rupture, equipment damage, operator error or other accidents involving fuel trucks or mobile equipment	Large fuel spill, may escape containment; limited volume may reach Lac du Sauvage (e.g., for fuel spill on the dike) or other lakes.	Maintenance and emergency response procedures. Control spill following procedures in Ekati's Spill Contingency Plans.	b	2				
4.2 Ore Stockpiles										
	NO RELEVANT RISKS TO THE ENVIRONMENT OR PUBLIC H&S DUE TO ACCIDENTS AND MALFUNCTION WERE IDENTIFIED									
5) Waste Rock Storage Area										
5.1 Waste Rock Facility										
	1 Slope failure	Fast dumping rates on thawing foundation.	Runout and sediments reaching Lac du Sauvage or affecting esker area	Design controls, investigation of foundation conditions, monitoring and inspections	d	2				

* From the Risk Matrix

RISK REGISTER - OPERATIONS

13-1328-0041 4060 - Dominion Diamonds - Engineering EA Support - Accidents and Malfunctions

Dike - composed of broad rockfill shell, central zone of crushed granular fine and coarse filters and a composite low permeability element (seepage control system) including a cut-off wall, jet grouted columns and a grout curtain (dependent on depth to bedrock). **Water Management system** - composed of three pumping stations (PS1, PS2, PS3), each with two vertical turbine pumps. Pipelines going from Jay Pit to Misery (approximately 6 to 8 km long) and from Misery Pit to Lac du Sauvage (approximately 8 km long). Water collected in sumps within the Jay Pit area and pumped to Misery Pit. Water meeting discharge criteria within Misery Pit pumped back to Lac du Sauvage (after year 5 of operations). **Power Distribution System** composed of powerlines and substations. **Haulage and transportation** - composed of Jay Road, Jay North Road, Jay Pipeline Road, Waste Haul Road and Ore Haul Road.

RISK COMPONENT / ELEMENT	FAILURE MODE	CAUSES	CONSEQUENCE EFFECTS	PLANNED SAFEGUARDS AND RISK MITIGATION MEASURES	LIKELIHOOD*	CONSEQUENCE SEVERITY*		NOTES Estimate Confidence	RISK CLASSIFICATION*	
						Environment	Public H&S		Environment	Public H&S
6) Open Pits										
6.1 Jay and Misery Pit										
1	Misery Pit slope failure	Earthquake. Instability due to geological conditions in pit wall	Overtopping of Misery Pit and release of water not meeting discharge criteria to Lac de Gras.	Geological mapping and surveying of Misery Pit. 10 m freeboard in Misery Pit should reduce likelihood of overtopping. Use of flocculants to restore water quality at the surface prior to resuming operations (if required).	d	2				
			Water in pit fully mixed. Rupture of pipes in Misery Pit. Inability to pump water from Jay Pit. Inability to pump water out of Misery Pit.		d			Operational risk, will not affect the environment or public safety. Would require replacement of pipes in Misery Pit to resume operations.		
2	Lynx Pit slope failure	Earthquake. Instability due to geological conditions in pit wall	Overtopping of Lynx Pit and release of water not meeting discharge criteria to Lac de Gras.	Water at the surface of Lynx Pit should meet discharge criteria.	d	2		Release of water not meeting discharge criteria that could have moderate impacts to the environment is considered rare.		
3	Jay Pit slope failure	Earthquake, instability due to geological conditions in pit wall	Disruption of operations. Early closure of the mine.	Design considerations and field investigation. Monitoring of slope movements and porewater pressures during operations. Geological mapping.	d	1		Considered to be an operational risks with low to no consequences to the environment or public health and safety. Material released during slope failure would be contained within the pit. A consequence of low to environment was considered as a conservative estimate.		
7) Risks from Other Project Components										
7.2 Dust Supression Mechanisms										
1	Failure of dust suppression mechanism from crushing	Equipment malfunction, inadequate implementation of mitigation measures	Dust generation from crusher higher than permitted. Short term impacts to air quality	Monitoring. Maintenance of dust suppression system. Temporary shutdown of crushing operations if permitted levels are not met.	b	1				
2	Failure of dust suppression mechanism from roads	Inadequate implementation of mitigation measures	Dust generation from roads higher than permitted. Short term impacts to air quality	Monitoring. Additional water or additives to road surface.	b	1				

* From the Risk Matrix

RISK REGISTER - CLOSURE AND POST CLOSURE

13-1328-0041 4060 - Dominion Diamonds - Engineering EA Support - Accidents and Malfunctions

During closure water in Misery Pit will be lowered to 60 m below the final overflow elevation. Water from Misery Pit will be pumped to lower portion of Jay Pit. Water removed from the upper portion of Misery will be replaced with water from precipitation, runoff and Lac du Sauvage. Back flooding of the upper portion of Jay Pit will be with water from precipitation, runoff and Lac du Sauvage. Dike will be locally breached once water within the dike meets discharge criteria. Ramps within the diked area will be re-graded. Pipelines, pumps, overhead power lines, substations and other infrastructure will be removed. Water diversions and roads will be re-graded to promote natural drainage patterns to Lac du Sauvage.

RISK COMPONENT / ELEMENT	FAILURE MODE	CAUSES	CONSEQUENCE EFFECTS	PLANNED SAFEGUARDS AND RISK MITIGATION MEASURES	LIKELIHOOD*	CONSEQUENCE SEVERITY* Environment	CONSEQUENCE SEVERITY* Public H&S	NOTES Estimate Confidence	RISK CLASSIFICATION* Environment	RISK CLASSIFICATION* Public H&S
1) Dike										
1.1 Isolation Dike										
	1 Blockage of the breach	Slope instability of the cuts on the dike	Temporary turbidity release, fish movement limited.	Design considerations	d	1				
1.2 Turbidity Control System										
	1 Failure of turbidity control systems	Slope instability of the cut constructed at closure (water passages)	Release of higher turbidity during excavation of water passages	Monitoring	c	1				
1.3 Seepage Control System										
	NO RELEVANT RISKS TO THE ENVIRONMENT OR PUBLIC H&S DUE TO ACCIDENTS AND MALFUNCTION WERE IDENTIFIED									
2) Water Management System										
2.1 Pumping System										
	NO RELEVANT RISKS TO THE ENVIRONMENT OR PUBLIC H&S DUE TO ACCIDENTS AND MALFUNCTION WERE IDENTIFIED									
2.2 Pipelines										
	1 Pipeline rupture	Traffic hitting pipe, inadequate construction, freezing.	Release of high salinity water. Erosion of land and discharge of sediments and high salinity water to water bodies	Monitoring of flows and pressures for early identification of pipeline ruptures. Pumping system shutdown within hours. Emergency response, management plans, monitoring and contingency plans in place. Insulation, heat tracing, high flow velocities and pipeline drainage system in place to avoid freezing of water in the pipes (reduced probability of failure).	c	2		Only one pipeline carrying saline water. Approximately 1% chance of rupture per km per year (full rupture of pipe assumed to be 10 times less likely than industry standard for leaks). With the mitigation measures, ruptures are not likely to significantly affect water bodies.		
			Release of high salinity water. Erosion of the dike crest and slopes and release of sediments and high salinity water to Lac du Sauvage		c	2		Shorter pipeline length over dike makes pipe rupture less likely than on the roads. Nevertheless proximity to Lac du Sauvage makes it more likely for saline water to reach the lake if rupture occurs. Overall likelihood is still considered not likely.		
			Release of non-saline water. Erosion of land and discharge of sediments to water bodies		b	1		Most likely consequence is erosion of soils and generation of sediments. Sediments reaching water bodies is considered less likely due to rapid shutdown of the system.		
			Release of non-saline water. Erosion of the dike and release of sediments to Lac du Sauvage		c	1		Shorter pipeline length over dike make it less likely than failure on the roads. Dike will be constructed with rockfill reducing sediment release potential.		
			Erosion of the esker. Impacts to migration routes for wildlife		c	2		Shorter pipeline length on esker area makes it less likely than failure over the entire length of the pipeline.		
2.3 Discharge Points/Areas										
	NO RELEVANT RISKS TO THE ENVIRONMENT OR PUBLIC H&S DUE TO ACCIDENTS AND MALFUNCTION WERE IDENTIFIED									
2.4 Ramps and Pipe Benches										
	NO RELEVANT RISKS TO THE ENVIRONMENT OR PUBLIC H&S DUE TO ACCIDENTS AND MALFUNCTION WERE IDENTIFIED									
2.5 Diversion										
	NO RELEVANT RISKS TO THE ENVIRONMENT OR PUBLIC H&S DUE TO ACCIDENTS AND MALFUNCTION WERE IDENTIFIED									

* From the Risk Matrix

RISK REGISTER - CLOSURE AND POST CLOSURE

13-1328-0041 4060 - Dominion Diamonds - Engineering EA Support - Accidents and Malfunctions

During closure water in Misery Pit will be lowered to 60 m below the final overflow elevation. Water from Misery Pit will be pumped to lower portion of Jay Pit. Water removed from the upper portion of Misery will be replaced with water from precipitation, runoff and Lac du Sauvage. Back flooding of the upper portion of Jay Pit will be with water from precipitation, runoff and Lac du Sauvage. Dike will be locally breached once water within the dike meets discharge criteria. Ramps within the diked area will be re-graded. Pipelines, pumps, overhead power lines, substations and other infrastructure will be removed. Water diversions and roads will be re-graded to promote natural drainage patterns to Lac du Sauvage.

RISK COMPONENT / ELEMENT	FAILURE MODE	CAUSES	CONSEQUENCE EFFECTS	PLANNED SAFEGUARDS AND RISK MITIGATION MEASURES	LIKELIHOOD*	CONSEQUENCE SEVERITY*		NOTES Estimate Confidence	RISK CLASSIFICATION*	
						Environment	Public H&S		Environment	Public H&S
3) Power Distribution System										
3.1 Power Lines and Supply										
	NO RELEVANT RISKS TO THE ENVIRONMENT OR PUBLIC H&S DUE TO ACCIDENTS AND MALFUNCTION WERE IDENTIFIED									
4) Haulage and Transportation										
4.1 Roads (Jay Road, Misery Road, Ore Stockpile, Waste Haul Road, Ore Haul Road)										
	1 Erosion of the roads connecting to dike abutments	Surface runoff	Release of sediments into Lac du Sauvage	Use of rockfill and aggregate for road construction to reduce erosion potential. Extension of turbidity barriers if sediment release to Lac du Sauvage is observed. Water diversions in place for sub-basin B.	c	1				
	2 Small fuel spill	Equipment damage, operator error or other accidents involving mobile equipment	Small fuel spill, rapidly controlled and contained.	Operational, maintenance and emergency response procedures. Control spill following procedures in Ekati's Spill Contingency Plans.	a	1				
	3 Large fuel spill	Fuel line rupture, equipment damage, operator error or other accidents involving fuel trucks or mobile equipment	Large fuel spill, may escape containment; limited volume may reach Lac du Sauvage (e.g., for fuel spill on the dike) or other lakes.	Maintenance and emergency response procedures. Control spill following procedures in Ekati's Spill Contingency Plans.	b	2				

* From the Risk Matrix

RISK REGISTER - CLOSURE AND POST CLOSURE

13-1328-0041 4060 - Dominion Diamonds - Engineering EA Support - Accidents and Malfunctions

During closure water in Misery Pit will be lowered to 60 m below the final overflow elevation. Water from Misery Pit will be pumped to lower portion of Jay Pit. Water removed from the upper portion of Misery will be replaced with water from precipitation, runoff and Lac du Sauvage. Back flooding of the upper portion of Jay Pit will be with water from precipitation, runoff and Lac du Sauvage. Dike will be locally breached once water within the dike meets discharge criteria. Ramps within the diked area will be re-graded. Pipelines, pumps, overhead power lines, substations and other infrastructure will be removed. Water diversions and roads will be re-graded to promote natural drainage patterns to Lac du Sauvage.

RISK COMPONENT / ELEMENT	FAILURE MODE	CAUSES	CONSEQUENCE EFFECTS	PLANNED SAFEGUARDS AND RISK MITIGATION MEASURES	LIKELIHOOD*	CONSEQUENCE SEVERITY*		NOTES Estimate Confidence	RISK CLASSIFICATION*	
						Environment	Public H&S		Environment	Public H&S
5) Waste Rock Storage Area										
5.1 Waste Rock Facility										
	1 Slope failure	Rapid thawing of permafrost and generation of high porewater pressures in foundation.	Runout and sediments reaching Lac du Sauvage or affecting esker area	Design controls, investigation of foundation conditions, monitoring and inspections. Set back from Lac du Sauvage and esker.	d	2		rate of thaw of ice rich soils expected to be slow enough that soils will consolidate and gain strength. Set back distance reduces likelihood of impacting Lac du Sauvage.		
	2 Loss of frozen conditions	Climate change	Runoff not meeting discharge criteria to receiving environment	Mixing of non-acid generating and acid generating rock should result in non-acid generating configuration	d	2		Moderate impacts to the environment associated to seepage not meeting discharge criteria should be rare even if permafrost is lost		
6) Open Pits										
6.1 Jay and Misery Pit										
	1 Jay Pit slope failure	Earthquake, instability due to geological conditions in pit wall	Mixing of water within diked area during closure. Longer time required to bring the lake back to its pre-development condition (delay of breaching).	Breaching will only take place once water within the dike meets discharge criteria.	d	2				
			Water in pit fully mixed post-closure. Loss of meromictic conditions.		d	3				
	2 Misery Pit slope failure	Earthquake, instability due to geological conditions in pit wall	Overtopping of Misery Pit and release of water not meeting discharge criteria to Lac de Gras.	Geological mapping at Misery Pit to address long term stability.	d	2				
			Water in pit fully mixed post-closure. Loss of meromictic conditions.		d	3				
	3 Lynx Pit slope failure	Earthquake. Instability due to geological conditions in pit wall	Overtopping of Lynx Pit and release of water not meeting discharge criteria to Lac de Gras.	Water at the surface of Lynx Pit should meet discharge criteria.	d	2		Release of water not meeting discharge criteria that could have moderate impacts to the environment is considered very unlikely over the life of the Project.		
7) Risks from Other Project Components										
7.3 Access after Mine Closure										
	1 Injury to public entering area post-closure	Access to closed mine site. Exposure to closed mine facilities.	Injury due to exposure to closed mine facilities or health and safety impacts due to water quality or reclamation features	Water quality in Misery pit lake, Lac du Sauvage, and other water bodies will be managed to meet water quality standards during closure. Reclamation features will be similar to surrounding environment.	d		3	Likelihood of serious injury considered to be the same as that of natural surroundings. No incremental risks to public health and safety are expected due to access to site after closure.		

* From the Risk Matrix