13 ACCIDENTS AND MALFUNCTIONS

13.1 SCOPE OF ASSESSMENT

13.1.1 Terms of Reference

This is the accidents and malfunctions component

This section consists of the accidents and malfunctions component of the environmental assessment (EA) of the De Beers Canada Mining Inc. (De Beers) Snap Lake Diamond Project.

Accidents and malfunctions are included in the Terms of Reference

The accidents and malfunctions component provides the information required by the Snap Lake Diamond Project EA Terms of Reference issued by the Mackenzie Valley Environmental Impact Review Board (MVEIRB). Section 2.4.2 of the Terms of Reference requires that De Beers "Clearly explain the probability and potential magnitude of an accident and/or malfunction occurring, and the resulting impacts on the proposed development, including the underground workings. Link the outcome of the accident and malfunction probability analysis to consequential impacts to the environment."

To meet the Terms of Reference, this component has to be different

In order to fulfill the Terms of Reference by determining probability and potential magnitude, this component of the EA follows a risk assessment approach, which is slightly different than other components. In addition, terms used in this component may have different definitions than used elsewhere.

The objective is to assess the high severity risks from accidents and malfunctions

The objective of this section is to assess the risks from accidents and malfunctions for both the proposed development (including underground mine workings) and the environment. Risks were estimated according to their associated frequencies and environmental consequences. Only risks that have the potential to result in impacts of high severity are evaluated in this section.

13.1.2 Component Description and Organization

The assessment scope included all mining activities and transportation

The assessment of accident and malfunction risks includes the construction and operation of all mining facilities on the Snap Lake site, including the airstrip and access roads, and transportation to the site via both aircraft and the winter access roads (the Tibbitt-Contwoyto winter road and the winter access road to the site).

Policies, procedures, and management systems are integral to managing risk

Standard policies, procedures, practices, and operating systems are integral to managing risks associated with potential accidents and malfunctions. Accidents and malfunctions are unlikely to adversely impact the development or the environment due to management systems or mitigation that:

- prevent accidents and malfunctions though proper training, awareness, education, and equipment maintenance;
- assess accidents and malfunction risks during the design of the proposed project;
- continue to assess these risks through all project life cycles including detailed engineering design, construction, operation, and closure;
- incorporate inherently safe designs and effective contingency plans; and,
- implement a site environmental management plan including effective and efficient emergency response plans.

Risks will be reduced through implementation of the loss control policy, the environmental policy, an environmental management plan, and an emergency response plan

As described in the Project Description (Section 3.9.2), De Beers has a loss control policy and an environmental policy that are specific to the Snap Lake Diamond Project. In the loss control policy, De Beers commits to a program of risk reduction that will provide protection from accidental losses for all personnel and physical assets under its control. Accidental losses will be controlled through best management practices and systems, combined with the active participation of the workforce. In the environmental policy, De Beers will assess, plan, construct, and operate its facilities in a manner that complies with or exceeds all applicable legislation providing for the protection of the environment, employees, and the public. A site environmental management plan will comply with International Organization for Standardization (ISO) 14001 requirements including the emergency response plan to mitigate potential environmental impact. These management systems will mitigate most environmental risks and limit the consequences.

Risks were screened according to frequency and environmental consequences

Therefore, the focus of this assessment is only on those risks with the potential to impact the off-site environment or the long-term viability of the Snap Lake Diamond Project. Risks were estimated according to their associated frequencies and environmental consequences. Frequency is an expression of the estimated number of accident or malfunction occurrences per unit time.

Section 13 includes the approach and methods, the risk assessment, and conclusions

Section 13.1 describes the Terms of Reference, the component description and organization, the assessment approach, the study area, and the assessment methods. Section 13.2 defines the baseline for accidents and malfunctions, and Section 13.3 presents the risk assessment. Conclusions are provided in Section 13.4. References, units, acronyms, and the glossary are summarized for easy reference in Sections 13.5 and 13.6.

13.1.3 Assessment Approach

13.1.3.1 Key Issues and Key Questions

The key issues are related to the effects of accidents and malfunctions on both the proposed development and the environment

The key issues related to accidents and malfunctions are the effects on the proposed development, and the effects on the environment around the mine site and the winter roads to the mine site. Concerns regarding spills and accidents at the mine site and on the winter roads were expressed during traditional knowledge consultation and community consultation. People are worried about the effects of spills on water quality and wildlife, and are concerned for human life.

> *I worked on the winter roads before. I am concerned about oil spills, especially when trucks are parking for the night….. (Madeline Drybones 11 07 01)* (Lutsel K'e Dene First Nation 2001).

> *It is important that fuel from the tank farm does not leak into the ground* (Lutsel K'e site visit, May 9, 2000).

> *Does the company have an emergency response team for spills and environmental stuff?* (Dogrib Treaty 11 community members site visit, May 11, 2000).

> *They have spills every year. Sometimes a tanker tips over ….. The summer would be the worse case scenario because spills go directly into the earth. Whereas in winter it's frozen and you can remove it, it will still be there in puddles …. Deal with it right away. Quick response. And I think everything will go fine* (D'Arcy Mercredi, NSMA, no date).

> *…Fish … could potentially (be damaged) from any spills resulting from trucks going through the winter road* (Weledeh Yellowknives Dene 1997).

> *Mining companies must take responsibility to secure their fuel storage from spills, explosions and other disasters. Fuel storage must be far from shorelines and creeks to reduce seepage. Fuel tanks should be placed in retainers with cement bottoms and walls so that, if tanks leak, any leaks can be contained. Fuel storage should be located a safe distance from camp facilities to reduce impacts (and lives) from potential fires resulting from lightning strikes* (Weledeh Yellowknives Dene 1997).

There are two key questions

The accident and malfunction issues have been consolidated in the following two key questions:

Key Question AM-1: What impacts will potential accidents and malfunctions at the Snap Lake Diamond Project site have on the development and the environment?

Key Question AM-2: What impacts will potential accidents and malfunctions on the winter road have on the environment?

13.1.3.2 Assessment Cases

The risk assessment was completed for two cases: the mine site and the winter road

In order to achieve the assessment objectives, a high level systems risk assessment was done. The risk assessment was carried out for the following two cases corresponding to each of the two key questions:

- the mine site case representing potential impacts from constructing, operating, and closing all mining facilities on site; and,
- the winter road case representing potential impacts from transporting hazardous materials to the mine site on both the Tibbitt-Contwoyto winter road and the winter access road.

13.1.3.3 Temporal Considerations

Construction will last three years beginning in 2003 and the project will continue until closure in 2028

The accidents and malfunctions section assesses the impacts for the construction, operation, closure, and post-closure phases of the project. Assuming that permits for construction and operation have been received during the first quarter of 2003, a limited pre-construction work program will begin in 2003. Full construction will begin in early 2004 and be completed by the end of 2005. The production phase will be approximately 22 years from 2005 to 2026, although pre-production mining from underground development will occur from 2003 to 2005. The site closure activities will be carried out primarily in 2027, with limited final clean-up and the continuation of effectiveness monitoring in 2028. The total elapsed duration of the project is 26 years. The proposed schedule for the Snap Lake Diamond Project is provided in more detail in Section 3.2.

13.1.4 Study Areas

Two study areas were selected

The study areas for the De Beers Snap Lake Diamond Project were selected by evaluating the regions around the mine site and winter road that are expected to be affected by potential accidents and malfunctions.

The local study area includes the mine site and a buffer

There are two study areas for accidents and malfunctions. The local study area (LSA) includes the mine site and the area immediately surrounding the mine site facilities. This LSA is principally on the northwest peninsula of Snap Lake but also includes the two vent raises on the north shore. The LSA for accidents and malfunctions is the same as the LSA for other components (*e.g.*, terrestrial resources). It consists of the project footprint plus a 500 metre (m) buffer as shown in Figure 13.1-1.

The regional study area includes the winter roads and a buffer

The regional study area (RSA) includes the area adjacent to the Tibbitt-Contwoyto winter road from Tibbitt Lake to MacKay Lake and the winter access road to the mine site. A 5 kilometre (km) buffer on either side of the road is included to encompass the lakes traversed by the winter roads. Spill consequences from truck transportation along this road were assessed to estimate risks to aquatic life in the RSA. The RSA is shown in Figure 13.1-2.

13.1.5 Assessment Methods

The residual impacts are assessed by using frequency and environmental consequence

The Terms of Reference identified in Section 13.1.1 require that probability and potential magnitude of accidents and malfunctions be assessed. Therefore, risk criteria were used to evaluate residual impacts based on the frequency with which the impact could occur and the environmental consequence. This method is different from that presented in other sections of the EA but is consistent with the Terms of Reference (MVEIRB 2001). In other sections of the EA, impact criteria were not defined as risks but were ranked according to a list of criteria.

Frequency terms are defined as negligible, low, moderate, and high

The frequency of accidents and malfunctions was defined according to four levels as follows:

negligible: extremely unlikely to occur during the life of the mine (1/10,000 events per year);

low: unlikely to occur during the life of the mine (1/1,000 events per year);

moderate: may occur during the life of the mine (1/100 events per year); and,

high: likely to occur repeatedly during the life of the mine (1/10 events/year).

Figure 13.1-1 Local Study Area for Accidents and Malfunctions

Figure 13.1-2 Regional Study Area for Accidents and Malfunctions

Environmental consequence terms are defined as negligible, low, moderate, and high in Table 13.1-1

Environmental consequence used in this section is ranked according to four levels (Table 13.1-1). These levels are defined according to a combination of magnitude of the toxic effect, spatial extent, duration, and reversibility. One level, (*e.g.*, moderate) may be defined by more than one combination (*e.g.*, moderate can be defined by four different combinations). The particular combinations of toxicity, spatial extent, duration, and reversibility corresponding to each level of environmental consequence are presented in Table 13.1-1. Although this risk assessment uses the same term (*i.e.*, environmental consequence) as earlier sections of the EA, the environmental consequence is determined differently, as shown in Table 13.1-1.

Table 13.1-1 Definition of Levels of Environmental Consequence

Environmental Consequence Rating (Level)	Magnitude (Based on Toxicity to Aquatic Life)	Spatial Extent	Duration (Duration of Toxic Effects)	Reversibility
A: Negligible	no toxicity	not relevant	not relevant	reversible
	sub-lethal	< 5% of total lake volume	<24 hours	reversible
B: Low	acutely lethal	< 1% of total lake volume	<24 hours	reversible
	sub-lethal	<20% of total lake volume	<24 hours	reversible
	sub-lethal	< 10% of total lake volume	1 year	reversible
C: Moderate	acutely lethal	<10% of total lake volume	<24 hours	reversible
	acutely lethal	<10% of total lake volume	> 24 hours; < 1 year	reversible
	sub-lethal	<20% of total lake volume	1 year	reversible
	sub-lethal	<20% of total lake volume	multi-year	reversible
D: High	acutely lethal	>10% of total lake volume	<24 hours	reversible
	sub-lethal	>20% of total lake volume	multi-year	reversible
	acutely lethal or sub-lethal	not relevant: any irreversible impact rated high regardless of spatial extent	any duration	irreversible

A project risk matrix was developed to estimate environmental risks

The risk is estimated using the project risk matrix presented in Table 13.1-2. A risk matrix is comprised of one index representing the measure of frequency (also called likelihood) and another index representing the measure of environmental consequence. When an accident or malfunction scenario is identified, the associated risk is estimated by locating it within the risk matrix. Indices for this risk matrix were defined previously in Section 13.1.5 and Table 13.1-1.

Risk increases from the bottom left corner of the matrix

The measure of risk increases from the bottom left corner of the risk matrix to the top right as shown by the arrow in Table 13.1-2. If either the frequency or environmental consequence of the risk is less than the range shown in Table 13.1-2, the risk is not determined.

Table 13.1-2 Generic Project Risk Matrix

FREQUENCY INDEX		ENVIRONMENTAL CONSEQUENCE INDEX			
(Events/Year)	(Description)	A Negligible	B Low	C Moderate	D High
1/10	Likely to occur repeatedly*				
1/100	May occur once*				
1/1,000	Unlikely to occur *				
1/10,000	Extremely unlikely to occur*				

Increasing Risk

*During the life of the mine.

13.2 BASELINE

Baseline is the pre-accident condition, not the pre-project condition

The term baseline is defined differently in this section (Section 13) than in the rest of the EA. For the purposes of the accident and malfunction assessment, the baseline was considered to be the pre-accident condition. This could occur during the construction, operation, or closure phases. The baseline before the Snap Lake Diamond Project is developed is addressed in the other components of the EA.

13.3 IMPACT ASSESSMENT

13.3.1 Introduction

Key questions pertain to accidents and malfunctions at the site and on the winter road

The key questions concerning accidents and malfunctions from the Snap Lake Diamond Project are as follows:

Key Question AM-1: What impacts will potential accidents and malfunctions at the Snap Lake Diamond Project site have on the development and the environment?

Key Question AM-2: What impacts will potential accidents and malfunctions on the winter road have on the environment?

The risk assessment used a systems failure modes and effects analysis method

Accidents and malfunctions were considered system failures and associated risks for the mine site were assessed using a standard risk assessment methodology called a systems failure modes and effects analysis. Risks were then estimated for the criteria defined in Table 13.1-1, Section 13.1.5 using a project risk matrix as illustrated in Table 13.1-2. Accident and malfunction risks for the winter access road were assessed using the Tibbitt-Contwoyto winter road accident statistics and project specific hazardous material data. Each of the key questions is addressed separately in the following two subsections.

13.3.2 What Impacts will Potential Accidents and Malfunctions at the Snap Lake Diamond Project Site Have On the Development and the Environment?

The steps of the environmental assessment method have been combined in the risk assessment method

The risk assessment process is designed to identify accidents and malfunctions from all mining facilities and operations. Associated potential consequences for the proposed development or the environment are also determined. The identification of potential systems failures and their associated consequences in this risk assessment achieves the same objective as the linkage and impact analyses carried out for other EA components. Selected safeguards (or mitigation measures) are identified and the residual risk is estimated using a project risk matrix. These steps are combined in the systems failure modes and effects analysis and, therefore, are not presented under separate headings as was done for other EA components.

Since on-site risks will be reduced through implementation of site management systems, this assessment focusses on severe risks

As described in Section 13.1.2, mine site management systems will mitigate most environmental risks. The focus of this assessment is only on those risks with the potential to impact the long-term development viability or the off-site environment. Risks were estimated according to their associated frequencies and environmental consequences. The lowest frequency used to assess risks was one event in 10,000 years which may be considered a boundary for well engineered systems. More rare accidents, such as a meteor strike, may occur but were not included in order to focus on credible scenarios. The environmental consequences were described in terms of magnitude of toxic effect, spatial extent, duration, and reversibility of impacts to off-site aquatic life.

Impacts to terrestrial organisms are likely to be less severe than impacts to aquatic organisms

Terrestrial were not considered the primary receptors because spills in the terrestrial environmental during the winter will be more easily cleaned up. Because mitigation measures are more effective on land than under ice, it is highly unlikely that accidents or malfunctions will cause death or injury to more than a very few terrestrial animals or plants. Onsite environmental impacts will be mitigated through the management systems previously described.

A project team assessed the potential systems failures

Potential systems failure modes were determined to assess the risks from accidents and malfunctions. This approach was based on a team of project personnel lead by a risk facilitator assessing risks for each operating system on the mine site. Potential failure modes were identified along with associated consequences based on the team knowledge and experience. This step also describes how a system may fail and includes all possible causes ranging from natural causes to structural failures, inadequate construction, and improper procedures. The potential failure modes were screened to focus on accident scenarios with off-site consequences.

The risk assessment included all systems and operations on the site

The project team systematically evaluated all operations as shown on the overall site plan and the facilities site plan (Figures 3.1-3 and 3.1-4 in the Project Description). Potential risks were assessed for the following systems or operations on the Snap Lake Diamond Project site:

- airstrip;
- airstrip access road;
- bulk emulsion plant;
- Dams 1 and 2;
- north pile;
- fuel storage and distribution system;

- crushed ore reclaim;
- kimberlite processing and paste backfill plant;
- water treatment system;
- sewage treatment system;
- power and utilities;
- underground mine workings;
- kimberlite ore storage;
- cement storage; and,
- hazardous waste storage.

Scenarios were recorded

The principal accident or malfunction scenarios were recorded in a worksheet presented in Table 13.3-1.

The worksheet includes the principal scenarios, mitigation, consequences, and residual risks

Once the principal failure modes were identified as scenarios, the worksheet was used to determine the next steps in the risk assessment. The following information was recorded in the worksheet (Table 13.3-1):

- accident or malfunction scenarios (numbered one, two, *etc*.);
- selected safeguards (including prevention measures and consequence mitigation measures);
- consequence to the environment and the project after safeguards have been applied (*i.e.* the residual consequence);
- residual risk (with safeguards in place); and,
- notes.

The results of the worksheet are entered on the project risk matrix

Consequences were quantified in terms of residual impacts to the long-term development viability and releases to the off-site environment. Once the frequency and environmental consequence of the residual (*i.e.*, after safeguards were applied) risk was determined in the worksheet, the risk was estimated using the project risk matrix presented in Table 13.1-2. Indices for this risk matrix were defined previously in Section 13.1.5 and Table 13.1-1.

Table 13.3-1 Accident Assessment Worksheet

	Accidents and Malfunctions	Selected Safeguards	Consequences (After Safeguards Applied)	Residual Risk *		Notes
				Freq.	Consq.	
1.	crash of aircraft transporting workers or fuel to site	1. emergency response procedures and preparedness training 2. operational policies and practices 3. use of reputable carrier 4. reclamation contingency - present landfill on-site can be enlarged to store any contaminated soil from fuel spill 5. flight paths do not cross mine site	1. *Environment* offsite and onsite impacts potentially similar, localized fire (loss of vegetation), soil and water contamination depending on location	1/100	A	1. access for onsite incident but potentially limited for offsite incident; no severe secondary environmental consequences from impacts to the proposed development 2. approximately 400 flights/year expected; site landing strip is 2 km from mining facilities
			2. *Proposed Development* emergency response implemented	-	-	
2.	**Loss of Processed Kimberlite**					
2a.	small volume release from breech of Dam 1 (*e.g.*, overtopping during spring freshet, crest settles)	1. robust engineering design of rock filled structure, low crest height and conservative freeboard 2. construction quality assurance 3. operational policies and practices 4. small catchment area (reduces quantity of surface runoff) 5. credible potential only during May (extreme freshet) 6. annual formal inspections, regular monitoring of instrumentation and visual checks 7. pathway to Snap Lake allows time for emergency response to limit amount reaching the lake	1. *Environment* assume 200 cubic metres (m^3) pond water (containing processed kimberlite and chlorides) released in Snap Lake	1/100	A	1. environmental issue would involve total suspended solids (TSS); TSS issue with this volume of release would be short-term; there would be no recovery of processed kimberlite once it was in the lake 2. consequences are less severe than those described in category A; other smaller release scenarios such as from liner failure are associated with less risk 3. traffic accident along airfield access road run-in along crest of Dam 1 may cause liner failure but this would be repaired before causing adverse environmental impacts
			2. *Proposed Development* emergency response implemented; short term impacts on production, water surge capacity unavailable, access road unavailable; repair and rebuild as required	-	-	

Table 13.3-1 Accident Assessment Worksheet (continued)

	Accidents and Malfunctions	Selected Safeguards	Consequences (After Safeguards Applied)	Residual Risk *		Notes
				Freq.	Consq.	
2b.	large volume release from breech of Dam 1(*e.g.*, major failure from substandard construction, improper liner installation, fill failure, foundation failure, overtopping for extended period, improper procedures)	1. robust engineering design of rock filled structure, low crest height and conservative freeboard; designed for rock foundation 2. construction quality assurance 3. operational policies and practices (water management pond will not be kept full since it provides surge capacity) 4. annual formal inspections, regular monitoring of instrumentation and visual checks	1. *Environment* assume 250,000 m^3 pond water (containing processed kimberlite, ammonia, TSS, and chlorides) released in Snap Lake; potential for 1 km dilution zone with acute environmental effects over several days or weeks	1/10,000	C	1. probability estimate for engineered system (including impacts from construction conditions in northern climates)
			2. *Proposed Development* emergency response implemented; impacts production, water surge capacity unavailable, access road unavailable; repair and rebuild as required	-	-	
2c.	any release from breach of Dam 2 (*e.g.*, see failure modes associates with Dam 1)	1. robust engineering design 2. construction quality assurance 3. operational policies and practises 4. annual formal inspections, regular monitoring of instrumentation and visual checks 5. low discharge volume potential	1. *Environment* released pond water contained on-site and remediated through the spill contingency plan	-	-	1. smaller structure compared to Dam 1, holding back less pond volume; consequences from a failure are less than those for Dam 1
			2. *Proposed Development* emergency response implemented; short term impacts on production, water surge capacity unavailable, may impact processed kimberlite pipeline (traverses north of Dam 2); repair and rebuild as required	-	-	

Table 13.3-1 Accident Assessment Worksheet (continued)

	Accidents and Malfunctions	Selected Safeguards	Consequences (After Safeguards Applied)	Residual Risk * Freq.	Residual Risk * Consq.	Notes
3.	**Failure of North Pile**					
3a.	small release from shallow slump and erosion	1. pile designed with high density paste and small pond back from face that will mitigate potential failure modes associated with other approaches 2. design allows for flexibility in operation and therefore minimizes potential for creating stability problems 3. designed to expect small slumps on a continuous basis that are contained through a ditch and toe to the north of the face 4. low pile height design (25 m) and resulting 10 degree slope minimizes potential for run-out 5. operational policies and practices 6. annual formal inspections, regular monitoring of instrumentation and visual checks	1. *Environment* greater than design slump flows over toe and runs on surface, erosion and precipitation releases 200 m^3 of processed kimberlite into Snap Lake	1/1000	A	
			2. *Proposed Development* emergency response implemented; revise procedures and/or relocate if appropriate	-	-	
3b.	large release from major slump flowing to Snap Lake (*e.g.*, inadequate compaction, incorrect operating procedures)	1. pile designed with high density paste and small pond back from face that will mitigate potential failure modes associated with other approaches 2. design allows for flexibility in operation and therefore minimizes potential for creating stability problems; construction quality assurance 3. designed to expect small slumps on a continuous basis that are contained through a ditch and toe to the north of the face 4. low pile height design (25 m) and resulting 10 degree slope minimizes potential for run-out 5. operational policies and practices 6. annual formal inspections, regular monitoring of instrumentation and visual checks	1. *Environment* greater than design slump flows over toe and 10,000 m^3 of processed kimberlite runs 50 m into Snap Lake	1/10,000	B	1. potential for deep seated failures is extremely remote given the design foundation conditions 2. only some fines with higher moisture content have the potential to run-out to Snap Lake
			2. *Proposed Development* emergency response implemented; revise procedures and/or relocate if appropriate	-	-	

Table 13.3-1 Accident Assessment Worksheet (continued)

	Accidents and Malfunctions	Selected Safeguards	Consequences (After Safeguards Applied)	Residual Risk * Freq.	Residual Risk * Consq.	Notes
4.	catastrophic failure of fuel storage system (*e.g.*, brittle fracture)	1. engineered system with secondary containment for spillage, capacity equal to 110% of largest fuel tank 2. construction quality assurance 3. operational policies and practices	1. *Environment* instantaneous failure mode results in fuel wave over containment wall with 1,000 m^3 reaching Snap Lake	1/10,000	B	
			2. *Proposed Development* emergency response implemented; contaminate potable water intake, shut down until remedied; repair as appropriate	-	-	
5.	failure of fuel distribution system	1. engineered system with secondary containment for spillage, double walled pipe 2. observation wells provide detection capability for leaks 3. operational policies and practices 4. spill contingency plan	1. *Environment* most failure modes result in fuel captured by double walled pipe and leak detected through observation wells; leakage at extremities of system (intake fan) may release 10 m^3 of fuel to Snap Lake	1/1000	A	
			2. *Proposed Development* emergency response implemented with environmental management system; repair as appropriate	-	-	
6.	failure of water treatment system	1. engineered system with excess storage capacity in water management pond for extended downtime periods 2. regular monitoring of discharge water quality 3. treatment incorporates flocculation (a process whereby small particles adhere together with the aid of chemical additions) and filtration, filtration alone may provide required quality, therefore some inherent redundancy 4. operational policies and practises	1. *Environment* blockage failure modes result in diverting mine water to the pond (limited environmental effect); inadequate water quality failure modes result in 1 hour release to Snap Lake (before detection and diversion)	1/100	B	
			2. *Proposed Development* impacts production, underground water must continue being pumped to surface; emergency response implemented; repair as appropriate	-	-	

Table 13.3-1 Accident Assessment Worksheet (continued)

	Accidents and Malfunctions	Selected Safeguards	Consequences (After Safeguards Applied)	Residual Risk *		Notes
				Freq.	Consq.	
7.	power system failure	1. redundant back-up power supply for all essential services including mine water pumping (potential environmental impact); physical separation to minimize common fault failures and fire risk; power plant management system that will automatically shut off low priority loads if only partial power system failure 2. planned outages designed for all critical distribution circuits	1. *Environment* emergency operational mode but no severe environmental impact	-	-	
			2. *Proposed Development* impacts production, underground water must continue being pumped to surface; emergency response implemented; repair as appropriate	-	-	
8.	catastrophic geotechnical failure under Snap Lake impacting underground mine shaft	1. water infiltration handled under standard operating conditions 2. many detailed geotechnical engineering studies carried out 3. operating plan includes drilling test holes ahead of development and grouting where appropriate	1. *Environment* no severe environmental impacts	-	-	1. severe consequences are associated with safety and economic impacts to the proposed development
			2. *Proposed Development* massive water influx impacts safety; potential to shut down production, perhaps permanently	-	-	
9.	failure of kimberlite ore stockpile collection system	1. leaks from this system will flow to the water management pond (remain on-site) 2. operational policies and practices	1. *Environment* no severe environmental impacts	-	-	1. severe consequences are associated with safety and economic impacts to the proposed development
			2. *Proposed Development* emergency response implemented with environmental management system; repair as appropriate	-	-	

* Risk is shown as "-" if either the frequency or consequence of the risk is less than the range shown on the project risk matrix (Table 13.3-2).
Residual risk refers to risk remaining after safeguards have been applied.

Frequency and environmental consequence indices were developed in Section 13.1

The frequency index in the project risk matrix ranges from a low value of 1/10,000 to a high value of 1/10 events per year. The environmental consequence index ranges from a category A (negligible) to a category D (high). These categories were previously described in Section 13.1.5. The measure of risk increases from the bottom left corner of the risk matrix to the top right as shown by the arrow in Table 13.3-2. If either the frequency or environmental consequences of the risk is less than the range shown in Table 13.3-2, the risk is not determined.

Table 13.3-2 Eight Identified Mine Site Risks Located on the Project Risk Matrix

FREQUENCY INDEX		ENVIRONMENTAL CONSEQUENCE INDEX			
(Events/Year)	(Description)	A Negligible	B Low	C Moderate	D High
1/10	Likely to occur repeatedly*				
1/100	May occur once*	**1, 2a**	**6**		
1/1,000	Unlikely to occur *	**3a, 5**			
1/10,000	Extremely unlikely to occur*		**3b, 4b**	**2b**	

Increasing Risk

*During the life of the mine.

Risk results are shown in the project risk matrix

Results from the risk assessment documented in the Table 13.3-1 worksheet are shown in the project risk matrix presented in Table 13.3-2. The eight risks identified by accident number in the worksheet are located in the lower risk area of the project risk matrix, reflecting their low frequency and/or their negligible or low environmental consequence.

Probability of occurrence is shown as frequency

The probability of occurrence is shown as frequency in Table 13.3-1. The level of confidence is moderate, since the assessment uses a standard method and known project components.

13.3.3 What Impacts Will Potential Accidents and Malfunctions On the Winter Road Have On the Environment?

Winter road transportation requirements were collated

A description of the winter road characteristics and transportation requirements for the Snap Lake Diamond Project is presented in Section 6.6. The winter road location is shown in Figure 13.1-2. Environmental risks from accidents and malfunctions along the Tibbitt-Contwoyto winter road have been successfully managed with negligible environmental impacts for twenty years through construction procedures, traffic management practices, and spill contingency plans. Upgrades to the winter road practices are planned or in progress (see Section 6.6). The 35-km long winter access road connecting the mine to the Tibbitt-Contwoyto winter road will be operated according to the same management standards.

A risk assessment approach involved historical data

Risks associated with the winter road were assessed based on the substantial historical experience from transporting mining commodities. The greatest environmental risk from truck traffic on the winter road is due to potential spills especially those associated with a truck breaking through ice. All truck spills along the Tibbitt-Contwoyto winter road have been documented since 1983 by the Department of Resources, Wildlife and Economic Development (RWED) Environmental Protection Service. Using this record, the probability of spills occurring on the winter road due to transportation activities was assessed.

Historical and estimated future truck traffic data were collated

Truck traffic volumes on the winter road were collated from historical usage since 1995 and predicted usage to the year 2020 as presented in Section 6.6 (Figure 6.6-2). The proportion of the total traffic prediction estimated for the Snap Lake Diamond Project is also shown in Figure 6.6-2.

Distribution of materials is summarized

The estimated average distribution of materials that will be transported in the high volume year 2008 for total truck loads and those associated with the Snap Lake Diamond Project are summarized in Table 13.3-3.

Diesel fuel and cement are the largest volumes transported

Fuel represents a large portion of the total truck transportation volumes as shown in Table 13.3-3. Hazardous material volumes included in the consumables data for the Snap Lake Diamond Project in 2008 are listed according to specified materials in Table 13.3-4. The largest consumable volumes are cement (1,086 loaded trucks/year), lubricants and oils (29 loaded trucks/year), ammonium nitrate (29 loaded trucks/year), and food (29 loaded trucks/year).

Table 13.3-3 Estimated Distribution of Truck Transportation on the Tibbitt-Contwoyto Winter Road, 2008

Material	Total Truck Loads	(%)	Snap Lake Truck Loads	(%)
Fuel	5,276	53%	1,300	46%
Consumables	4,269	42%	1,300	46%
Construction materials	500	5%	200	7%
Total	**10,045**	**100%**	**2,800**	**100%**

Table 13.3-4 Transportation of Hazardous Material Consumables to Snap Lake Diamond Project, 2008

Potentially Hazardous Material	Approx. Annual Quantity	Units	Material Container	Trucks/Year (Years 2005-2009)
Diesel fuel	45,000,000	litres (L)	tanker truck	1,125
Cement	38,000	tonnes (t)	2 t sealed bags	1,086
Ammonium nitrate	1,000	t	1 t sealed bags	29
Sodium nitrate	182	t	25 kg sealed bags	6
Ferrosilicon	350	t	1 or 2 t sealed bags	10
Flocculent	40	t	1 or 2 t sealed bags	2
Lime	450	t	1 or 2 t sealed bags	13
Ferric sulphate	350	t	sealed drums	10
Glycol	10,000	L	205 litre drums	1
Gasoline	9,000	L	205 litre drums	1
Lubes and oils	1,000	t	various drums, pails, cans and tubes	29
Hydrofluoric acid	1,250	L	double-walled drum	1
Nitric acid	1,250	L	double-walled drum	1
Jet B fuel	100,000	L	tanker truck	3
Food	1,000	t	various bags, cans, boxes, crates, *etc*.	29
Miscellaneous[a]			various	454
Total				**2,800**

[a] Miscellaneous includes emulsifiers (N7, N25, and N16), glass beads, dynamite/packaged emulsion, perimeter explosives, and boosters for bulk emulsion.

Historical spill rates were used to estimate future spill probabilities

Historical spill accidents on the winter road since 1983 were assessed in terms of spill rates, causal factors, and amount spilled. This spill rate record was also analyzed to evaluate potential risk mitigation effects due to increased operational experience and increased usage of the winter road. The historical spill rate can be applied to the planned increased traffic associated with the Snap Lake Diamond Project to estimate future spill incidents if the winter road conditions are not adversely impacted by the increased traffic.

Historical spill incidents were assessed

The RWED Environmental Protection Service maintains a database of truck spill accidents that is summarized in Table 13.3-5. A requirement to report all spills has been strictly enforced by the winter road operator; therefore, the database is comprehensive. Table 13.3-5 shows all recorded spills from 1983 to 2001 according to the spill date, commodity, amount spilled, accident cause, and the identification number. Of all the hazardous materials transported over the winter road, only the following commodities have been spilled:

- diesel;
- gasoline, oil, antifreeze, hydraulic fluid;
- cement;
- kimberlite; and,
- ammonium-nitrate.

Diesel spill volumes impacting exposed aquatic life have been small

Diesel spills account for about 70% of the total; however, diesel also represents the greatest transportation volumes of any commodity. Two types of spill scenarios or failure modes were observed with diesel spills. The first spill scenario includes the more recent larger diesel spills over 1000 litres caused by rollovers occurring on land. These spills were cleaned up and the material properly disposed of with minimal environmental impact, since the trucks did not break through ice and spill diesel into water bodies. The second scenario involves spills less than 200 litres caused by a truck breaking through the winter road when it traverses a lake. These spills result in a direct environmental effect for aquatic life in the lake. Historically, these have occurred with a frequency of one order of magnitude less than the average spill rate described later. The spill volumes have involved less than 200 litres because of check valves that prevent excess flow through pipes damaged from the truck breaking through the ice.

Other materials were recovered

Cement, kimberlite, and ammonium nitrate have also been spilled and these have been recovered with minimal environmental impact.

The average spill rate has not increased since 1994, although traffic volumes have increased some 400% over the past three years

Although the number of spills has increased over the past three years, the truck transportation volume has also increased some 400% as shown in Section 6.6. The spill rate of 10^{-6} per loaded truck km of travel from the last three years is similar to that for the past nine years. Therefore, the spill risk management program has been successful in dealing with major increases in traffic.

Table 13.3-5 Historical Truck Spill Record on the Tibbitt-Contwoyto Winter Road

Year	Day	Commodity	Amount Spilled (litre)	Cause	Spill ID #
1983	5-Mar	Diesel P-40	13,000	vehicle overturned	83016
	13-Mar	Diesel	2,273	vehicle overturned	83019
	20-Mar	Diesel	>5	vehicle overturned	83021
1984	15-Feb	Diesel P-50	16,164	vehicle overturned	84019
	21-Dec	Diesel	>5	other transportation	84126
1985	NONE				
1986	4-Feb	Diesel P-40	180	vehicle overturned	86004
	10-Mar	Diesel P-40	1,800	vehicle overturned	86022
	21-Mar	Diesel	>5	vehicle overturned	86024
1987	17-Jan	Gasoline	>5	collision	87009
1988	21-Mar	Diesel P-40	3,637	other transportation	88027
1989	15-Jan	Diesel	454	pipe leak	89003
	27-Feb	Diesel P-40	682	vehicle overturned	89020
	24-Mar	Diesel	90	other transportation	89031
	31-Mar	Diesel	227	vehicle overturned	89034
1990	25-Jan	Diesel	270	vehicle overturned	90009
1991	05-Feb	Diesel	45	other transportation	91013
1992	22-Feb	Diesel P-50	50	leak	92023
1993	21-Feb	Diesel P-50	454	vehicle overturned	93017
	18-Mar	Diesel P-50	>5	other transportation	93027
	24-Mar	Cement	800	vehicle overturned	93033
1994	5-Feb	Diesel/Cement		other transportation	94025
1995	19-Jan	Diesel	90	tank leak	95005
1996	27-Feb	Cement	80,000	vehicle overturned	96030
	06-Mar	Kimberlite	91	other transportation	96036
	11-Mar	Portland cement	50 kg	other transportation	96037
	10-Mar	Cement	10 kg	vehicle overturned	96040
1997	NONE				
1998	10-Feb	Diesel	5,000	vehicle overturned	98015
	23-Feb	Oil / antifreeze	125 / 23	other transportation	98025
	16-Mar	Diesel	4,000	vehicle overturned	98036
1999	NONE				
2000	17-Feb	Ammonium-nitrate	12,000	leaking container	00033
	03-Mar	Diesel	15,000	vehicle overturned	00048
	30-Mar	Hydraulic fluid	45	blown line	00107
2001	25-Feb	Diesel	300	collision	01051
	28-Feb	Diesel	<300	leaking tank	01059
	28-Feb	Ammonium-nitrate	750 kg	1t bag fell from trailer	01058
	01-Mar	Ammonium-nitrate	100 kg	1t bag fell from trailer	01061
	24-Mar	Diesel	<200	trailer valve leak	01087
	05-Apr	Diesel	50	truck-leaking tank	01103

Planned improvements will manage future increased traffic volumes

A detailed study was undertaken by others on all aspects of the winter road engineering and operation (EBA 2000). Specific improvements were identified in this study to ensure that historical spill rates (and environmental impacts) would not increase due to the predicted increased traffic. Various improvements from this study are summarized in Section 6.6. For the purposes of the present study, the historical experience from operating the winter road was used to assess future risks associated with the Snap Lake Diamond Project.

Spill rates from three to six per year are expected depending on traffic

Results from the risk assessment of transportation activities along the winter road included an estimate of expected spills and residual hazardous material that may impact aquatic life. Spill incident estimates were based on the historical spill rate of 10^{-6} per loaded truck km of travel and the projected traffic volumes presented in Section 6.6. Spills are expected to increase from the recent three per year to six per year over the largest volume years from 2010 to 2015, then return to less than three per year following the predicted decrease in traffic after 2015. The Snap Lake Diamond Project is expected to contribute about 28% of the total based on its proportion of traffic.

Diesel spill volumes were assessed from historical incidents

Diesel is expected to account for 42% of the spills based on predicted traffic for the Snap Lake Diamond Project. Since spills associated with spill scenario #2 (*i.e.*, break through ice) were no greater than 200 litres, the impacts to aquatic life resulting from this scenario were evaluated.

Spills of other hazardous materials were evaluated

Spill frequencies of most other hazardous materials are expected to be less than 1 in 100 years given the comparatively small traffic volumes associated with these materials. Residual spill volumes may remain following the implementation of emergency response measures and these were determined from historical incidents and the trucking containers described in Table 13.3-4. Residual hazardous material spills for 200 litres of liquids and 1 t of solids were assessed to determine potential impacts on aquatic life.

The effect of spills on aquatic life will be addressed

Spills associated with the terrestrial environment under winter conditions are quickly remediated. Because mitigation can usually be more effective in the terrestrial environment, a spill is unlikely to affect habitat suitability and organisms to the same degree as a spill in the aquatic environment. Therefore, this assessment focusses on the effects of spills on aquatic life. Risk of a spill on the winter road affecting aquatic life is defined by the potential for an accident and spill; the type and amount of hazardous material spilled; the effectiveness of spill cleanup; and the environmental effect of the residual material remaining.

Aquatic life toxicity was assessed for hazardous materials

A review of toxicity information was undertaken to define aquatic life toxicity thresholds (lowest level of concentration of a contaminant that shows evidence of a toxic effect) for hazardous materials identified in Table 13.3-4. The resulting toxicity thresholds are provided in Table 13.3-6. Minimum values from the range of toxicity were used as thresholds for this assessment.

Table 13.3-6 Aquatic Life Toxicity Thresholds for Hazardous Materials

Potentially Hazardous Material	Threshold Value (mg/L)	Type of Effect[1]	Source
Diesel	74 - 10299	96 hour (hr) LC_{50} [2]	WHO (1996)
Gasoline	5.4 - 182	48 to 168 hr LC_{50}	CONCAWE (1992)
Lube oils, hydraulic fluids and oils, waste oils, transmission oils, drive oils	1000	LC_{50}	CONCAWE (1997)
Ethylene glycol	100 - 1000	96 hr LC_{50}	Environment Canada (1985)
Ammonium nitrate	9.8	chronic toxicity	Based on chronic toxicity of ammonia (2.2 mg/L) to trout CCME (1999)
Hydrofluoric acid	1.5	affects hatching of fish eggs	Reviewed in Environment Canada (1984a)
Slaked lime	10 - 1000	96 hr LC_{50}	Environment Canada (1984b)
Sodium nitrate [3]	NA [2]	NA	CCME (1999)
Emulsifiers	no information		
Nitric acid	NA [5]	lowering of pH	

1 mg/L = milligram per litre.
2 LC_{50} is the concentration which is lethal to 50% of the test organisms over the duration of the test (*e.g.*, 96 hr).
3 Sodium and nitrate do not have aquatic life thresholds.
4 N/A = not available.
5 Nitric acid could affect aquatic life by lowering the pH of the water.

Magnitudes of effect for spills were described

The environmental consequence of a spill on aquatic life depends on the residual volume of the spill, its toxicity, and the volume of the lake affected by the spill. For the purposes of the risk assessment, the environmental consequence was evaluated for fish-bearing lakes (lakes equal to or greater than 1 hectare (ha) in area). The winter road crosses 20 fish-bearing lakes, ranging in size from 121 to 107,800 ha (Table 13.3-7 and Figure 13.3-1). There is an undetermined number of very small, non fish-bearing water bodies along the winter road route. The environmental consequence rating was determined using the same four levels defined previously in Table 13.1-1 for the mine site risk assessment. These levels are defined according to a combination of magnitude of toxic effect, spatial extent, duration, and reversibility.

Figure 13.3-1 Fish Bearing Lakes Along the Winter Road

Table 13.3-7 Fish-Bearing Lake Sizes Along the Winter Road

Lake Size Affected	Number of Lakes
< 1 ha (=0.01 square kilometres) will not support fish population	undetermined
121-7065 ha	17
7065-18,800 ha	2
18,800-107,800 ha	1

Gasoline, hydrofluoric acid, ammonium nitrate, and lime may affect small non fish-bearing lakes

Materials with the potential to exceed toxicity thresholds if spilled into small, non fish-bearing lakes include gasoline, hydrofluoric acid, ammonium nitrate, and lime. Spills into larger, fish-bearing lakes would be much less likely to cause exceedances of toxicity thresholds, except over very small areas over short periods of time.

A project risk matrix was developed to estimate environmental risks

The risk of an accidental truck spill was estimated using the project risk matrix as was done for the mine site risk assessment. The risk associated with each of the material spill scenarios identified in Table 13.3-8 is estimated by locating it within the risk matrix. Indices for this risk matrix were defined previously in Section 13.1.5 and Table 13.1-1.

Table 13.3-8 Material Spill Scenarios

Material Spill Scenario	Aquatic Life Toxicity Threshold (mg/L)	Spill Volume (m^3)	Maximum Concentration in a Small Lake[a] (mg/L)
1) Diesel	74 (acute)	200	6
2) Gasoline	5.4 (acute)	200	6
3) Lube oils, hydraulic fluids and oils, waste oils, transmission oils, drive oils	1000 (acute)	200	6
4) Ethylene glycol	100 (acute)	200	7
5) Ammonium nitrate	9.8 (chronic, sub-lethal)	1000	58
6) Hydrofluoric acid	1.5 (chronic, sub-lethal)	200	8
7) Slaked lime	10 (acute)	1000	75

[a] Small lake is 1 ha in area and 3 m deep, which is the smallest volume known to support fish.

Risk indices were developed from the residual impact criteria

The frequency index in the project risk matrix ranges from a low value of 1/10,000 to a high value of 1/10 events per year. The environmental consequence index ranges from category A (negligible) to category D (high). These categories were previously described in Section 13.1.5. The measure of risk increases from the bottom left corner of the risk matrix to the top right as shown by the arrow in Table 13.3-9. If either the frequency or environmental consequence of the risk is less than the range shown in Table 13.3-9, the risk is not determined.

Environmental consequences are negligible or low for fish-bearing lakes

Risks to non fish-bearing water bodies fall into the higher-risk categories because of exceedances of toxicity thresholds lake-wide (Table 13.3-9). Risks to the 20 fish-bearing lakes are located in the lower risk area of the matrix because of the combination of low frequency and negligible or low environmental consequences. The environmental consequences are rated negligible or low because concentrations of contaminants are expected to be well below toxicity thresholds for all but a tiny fraction of the lake volume and/or the duration of exposure would be < 24 hours.

Table 13.3-9 Seven Identified Winter Road Risks Located on the Project Risk Matrix

FREQUENCY INDEX		ENVIRONMENTAL CONSEQUENCE INDEX			
(Events/Year)	(Description)	A Negligible	B Low	C Moderate	D High
1/10	Likely to occur repeatedly*				
1/100	May occur once*	1			
1/1,000	Unlikely to occur *	3	5		
1/10,000	Extremely unlikely to occur*	4	2, 6, 7		

Increasing Risk

*During the life of the mine.

Confidence in the assessment is high and the probability of occurrence is 10^{-1} events/year

The level of certainty that effects would not be greater than predicted would be high due to the following assumptions:

- the lowest known toxicity thresholds were used;
- conservative residual spill volumes were used; and,
- conservative fate of materials in lakes was assumed with localized elevations in concentrations persisting for at least 24 hours without rapid mixing and dilution, and with no breakdown or neutralization.

The probability of occurrence is shown as frequency in Table 13.3-9.

13.4 CONCLUSIONS

Each risk scenario was documented on a worksheet

Results from the mine site risk assessment are documented in a worksheet according to the following steps:

- accident or malfunction;
- selected safeguards;
- consequence; and,
- residual risk (with safeguards in place).

Eight risk scenarios were identified

Twelve risk scenarios were assessed and environmental risks were estimated for eight of these scenarios, using a project risk matrix.

All risks were associated with minor environmental consequence except Dam 1 failure which is extremely unlikely

All risks from accidents and malfunctions were associated with the more minor environmental consequence levels A (negligible) and B (low) with the exception of scenario 2b (major failure of Dam 1) which would result in moderate environmental consequences. However, scenario 2b is extremely unlikely, with a frequency of 1/10,000 years.

The probability of spills occurring and their environmental effects were assessed

The risk assessment of accidents on the winter road was based on the spill probability and the potential effects of spills on aquatic life. Risk of a spill on the winter road affecting water bodies was defined by the potential for an accident and spill; the type and amount of hazardous material spilled; the effectiveness of spill cleanup; and the environmental effect of the residual material remaining.

The historical spill rate and historical causes were used to estimate future spills

Historical truck spill accidents on the winter road since 1983 were assessed in terms of spill rates, causal factors, and spill amounts. This spill rate record was also analyzed to evaluate potential risk mitigation effects due to increased operational experience and increased usage of the winter road. Based on this analysis, the historical spill rate was used to estimate future spill incidents.

The magnitude of the spill impact was based on the size of the lake that would be affected

Effects of a spill on aquatic life depend on the residual volume of the spill, its toxicity, and the volume of the lake affected by the spill. For the purposes of the risk assessment, environmental consequences were determined for fish-bearing water bodies (water bodies with an area of 1 ha or greater). A review of toxicity information was undertaken to define aquatic life toxicity thresholds for hazardous materials to be transported to the mine site. Environmental consequences were rated using the same criteria as for mine site accidents and malfunctions.

The environmental consequence of spills from the winter road is predicted to be negligible to low

Risks of spills to aquatic life fell in the low-risk area of the risk matrix because of a combination of low frequency and negligible to low environmental consequences.

13.5 References

CCME (Canadian Council of Ministers of the Environment). 1999 (with 2000 updates). Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment. Winnipeg, MN.

CONCAWE (The Oil Companies' European Organization for Environmental Health Protection). 1992. Gasolines. Project Dossier no 92/103. Brussels: CONCAWE.

CONCAWE. 1997. Lubricating Oil Basestocks. Product Dossier no. 97/108. Brussels: CONCAWE.

Dogrib Treaty 11 community member. Site visit, May 11, 2000.

EBA Engineering Consultants Ltd. 2000. Tibbitt to Contwoyto Winter Road, Project Description Report. Submitted Indian and Northern Affairs Canada, Yellowknife, YT, on behalf of: Tibbitt to Contwoyto Joint Venture, September 2001.

Environment Canada. 1984a. Environmental Technical Information for Problem Spills: Hydrofluoric Acid. Ottawa: Beauregard Press Limited.

Environment Canada. 1984b. Environmental Technical Information for Problem Spills: Calcium Oxide and Calcium Hydroxide. Ottawa: Beauregard Press Limited.

Environment Canada. 1985. Environmental Technical Information for Problem Spills: Ethylene Glycol. Ottawa: Beauregard Press Limited.

Lutsel K'e Dene First Nation. 2001. Traditional Knowledge in the Na Yaghe Kue region: An Assessment of the Snap Lake Diamond Project. Final Assessment Report submitted to De Beers Canada Mining Inc. Yellowknife.

Lutsel K'e. Site visit, May 9, 2000.

MVEIRB (Mackenzie Valley Environmental Impact Review Board). 2001. Terms of Reference and Work Plan for the Environmental Assessment of the De Beers Canada Mining Inc. Snap Lake Diamond Project.

NSMA (North Slave Métis Alliance). N.D. Can't Live Without Work – A Companion to the Comprehensive Review Study on the Diavik Diamonds Project. On-line document. www.ssimicro.com/~nsma

Weledeh Yellowknives Dene. 1997. Weledeh Yellowknives Dene: a traditional knowledge study of Ek'ati. Yellowknives Dene First Nation Council. 1997.

WHO (World Health Organization). 1996. International Programme on Chemical Safety. Environmental Health Criteria 171. Diesel Fuel and Exhaust Emissions. Geneva: WHO.

13.6 UNITS, ACRONYMS, AND GLOSSARY

UNITS

ha	hectare
km	kilometre
m	metre
m^3	cubic metres
mg/L	milligram per litre
t	tonne

ACRONYMS

CONCAWE	The Oil Companies' European Organization for Environmental and Health Protection (established 1963)
CCME	Canadian Council of Ministers of the Environment
De Beers	De Beers Canada Mining Inc.
EA	environmental assessment
hr	hour
ISO	International Organization for Standardization
LSA	local study area
MVEIRB	Mackenzie Valley Environmental Impact Review Board
LC_{50}	the concentration of a substance which results in a 50% mortality of a test organism over a specified time period
NA	not available
NSMA	North Slave Métis Alliance
RSA	regional study area
RWED	Resources, Wildlife and Economic Development
TSS	total suspended solids
WHO	World Health Organization

GLOSSARY

baseline	describes the environmental setting against which changes in the environment from the accident or malfunction could be assessed; in this section only, baseline is the condition immediately prior to the accident; baseline could occur in any phase of the project
environmental consequence	the overall effect on the environment when the magnitude, spatial extent, duration of toxic effects, and reversibility of the project's impact are considered together; environmental consequence is derived differently in this section (see Table 13.1-1) than in other sections
frequency	an expression of the estimated number of accident or malfunction occurrences per unit time

freshet	a rise or overflowing of a stream caused by heavy rains or melted snow
flocculation	process whereby small particles adhere together with the aid of chemical addition
spatial extent	in this section only, spatial extent is defined as the percentage of the total lake volume that is impacted
level of confidence	the degree of certainly in the impact prediction
magnitude	a measure of the intensity or severity of an impact; it is based on the toxicity (*e.g.*, sub-lethal, acutely lethal) to aquatic life in this section only
paste	tailings material that has been thickened through the removal of entrained water
probability of occurrence	the likelihood that the environmental consequence indicated in the impact prediction will occur if the project goes ahead; it is expressed as the frequency in this section only
residual risk	risk remaining after safeguards are applied
reversibility	refers to changes that occur after the impact ceases allowing the environment to return to a capability or condition equivalent to the baseline
risk	the likelihood or probability that the toxic effects associated with a chemical or physical agent will be produced in populations of individuals under their actual conditions of exposure; risk is usually expressed as the probability of occurrence of an adverse effect
risk assessment	process that evaluates the probability of adverse effects that may occur, or are occurring on target organism(s) as a result of exposure to one or more stressors
risk matrix	a two dimensional table comprised of one index representing the measure of frequency (or likelihood) and another index representing the measure of environmental consequence (or adverse effect)
run-out	the area where tailings may flow if there is a failure in containment
toxicity	the inherent potential or capacity of a material to cause adverse effects in a living organism
toxicity threshold	almost all compounds (except genotoxic carcinogens) become toxic at some level with no evident harm or adverse effect below that level; scientists refer to the level or concentration where they can first see evidence for an adverse effect on an organism as the toxic threshold; genotoxic carcinogens exhibit some toxic potential at any level